A Scenario of Economic Well-Being, Ecological Integrity and Social Equity for the 21st Century

by

Richard Amander Hayes

A.B. (University of California, Berkeley) 1971
M.A. (University of California, Berkeley) 1995

A dissertation submitted in partial satisfaction of the requirements for the degree of

Doctor of Philosophy

in

Energy and Resources

in the

GRADUATE DIVISION

of the

UNIVERSITY OF CALIFORNIA, BERKELEY

Committee in charge:

Professor Richard B. Norgaard, Chair
Professor Ignacio Chapela
Professor Gene I. Rochlin

Spring 2004

A Scenario of Economic Well-Being, Ecological Integrity and Social Equity for the 21st Century

ABSTRACT

A Scenario of Economic Well-Being, Ecological Integrity and Social Equity for the 21st Century

by

Richard Amander Hayes

Doctor of Philosophy in Energy and Resources

University of California, Berkeley

Prof. Richard B. Norgaard, Chair

This dissertation develops and advocates a scenario of global development for the next 150 years that incorporates progressive and humanitarian values concerning economic well-being, ecological integrity and social equity. Under this scenario we achieve by 2150 a world characterized by high levels of per capita GDP ($82,000 1990 US $); equality of per capita GDP among countries; the absence of poverty; moderate and non-increasing economic inequality among individuals (6.5:1 ratio between top and bottom income quintiles); very slow economic growth (0.5%/year); moderately high and non-increasing levels of energy consumption (60 terawatts); stable world population (9 billion); high technological density; a globally integrated, social democratic/ internationalist governance regime; strong social controls over potentially destabilizing technologies; and a deeply embedded global ethos that supports these conditions. An unresolved tension concerns the years beyond 2150. Although high, stable levels of resource throughput can be maintained indefinitely after that time, even slow output growth would eventually require massive technological transformation of the natural world. The scenario of world development that this dissertation constructs and advocates gets us to a point in 2150 that is both desirable in itself and that will make it easier for us to negotiate the subsequent transitions, whatever they might be.

A Scenario of Economic Well-Being, Ecological Integrity and Social Equity for the 21st Century

Summary Table of Contents

A Scenario of Economic Well-Being, Ecological Integrity and Social Equity For the 21st Century

TABLE OF CONTENTS

LIST OF BOXES

Figures, tables, charts, diagrams and similar material are all contained in boxes, which are numbered in a single sequence.

The first column below shows the number of each box and the second column shows its title.

PART I – SCENARIOS OF GLOBAL DEVELOPMENT

Section IA – Quantitative Scenarios

Section IB – Narrative Scenarios

PART II – EVALUATION OF KEY CONCERNS

Section IIA – Limits to Growth

Section IIB – Economic Inequality

APPENDIX BOXES

INTRODUCTION

In this dissertation I develop and advocate a scenario of global development for the coming 150 years that incorporates progressive and humanitarian values concerning economic well-being, ecological integrity, and social equity. The dissertation is intended to help inform, encourage and empower people working to advance these values.

The first part of this dissertation presents a simple model for developing quantitative scenarios of long-range global development, reviews political-economic and other narrative scenarios of global development, and suggests a framework for integrating quantitative and narrative scenarios. The second part analyzes in detail problematic aspects of various scenarios. The third part pulls together the findings of the previous parts, presents a scenario of global development intended to fulfill the stated objective of the dissertation, identifies unresolved tensions, and concludes.

Motivation

I worked for most of the 1970's as an activist within the broad movement for social and economic justice, and for most of the 1980's and 1990's within those sectors of the environmental movement that promoted ecological awareness as a critical component of a larger vision of social change. Participants in these efforts were motivated by encompassing visions of a just, sustainable world. The accomplishments of these movements have been many, but their larger social, political and economic hopes and dreams have not come to pass.

Today's prevailing political economic ideology is a neoliberal democratic capitalism heavily dependent upon technological innovation and global integration. It holds out a vision of the future in which continuing technological innovation allows economic output to grow indefinitely without endangering environmental values, continuing growth diminishes the

importance of distributional inequities, and a libertarian-democratic ethos empowers the individualist initiatives upon which technology and growth depend.

Even its defenders recognize that this ideology is not without contradictions. In the absence of a global social contract significant portions of the world's population could be left far behind while a majority prospers. Those sectors doing well could still experience growing inequalities of wealth and power. Many persons sense that as traditional vehicles of cultural meaning and cohesion become increasingly eroded or commodified, thresholds might be crossed that generate unforeseen, undesirable societal consequences. The prospect of a future in which continued economic growth requires continually more intensive technological manipulation of the natural world leaves many people uneasy. Even as neoliberalism encourages the spread of formal democracy, global economic integration renders the prospects of substantive democracy more problematic. Finally, many people are dismayed by the thesis implicit within neoliberal capitalism that the highest aspirations of humankind can largely be achieved through the individual acquisition of increasingly greater quantities of commercial goods and services.

But what is the alternative? Persons concerned about growing inequality, the impact of economic growth on the environment, the technological manipulation of the natural world, or the erosion of social values have no credible, compelling alternative models at hand. Historically we've advocated either the widespread application of external social controls, or the widespread internalization of solidaristic social values, or both. For most of the past century the primary vehicles for externalized social controls have been welfare states of the left or the right. Over the same period the primary vehicles for the widespread internalization of solidaristic values have been either traditional cultures grounded in religion, or socialist cultures grounded in modernism. The success of neo-liberalism has meant the rejection of welfare-statism in favor of libertarian democracy, and the rejection of solidaristic values of both religion and socialism in favor of secular, individualist and market-centered values. As a result, these long-standing foundational

elements of an alternative to neoliberalism are not now as deeply or widely held as they once were.

I believe that in the coming years the inadequacies of neoliberalism will generate increasingly urgent desires for reforms, for structural change, and for changes in the constellation of values that neoliberalism is both supported by and reinforces. This dissertation seeks to present a way that a particularly critical set of such reforms, and structural and normative changes, might be understood as a coherent single project.

The scenario framework

A scenario is a story about how things could turn out in the future. Typically, scenarios consider a collection of factors that are judged to be important, and that can change over time and have some bearing upon one another. For a scenario to be credible, changes over time in the important factors must be internally consistent. The major important factors considered in the scenario developed in this dissertation are economic well-being, ecological integrity and social equity.

The scenario developed in this dissertation is an *advocated* scenario. An advocated scenario is one that its author would like to see happen, believes can happen, and is working, or intends to work, to make happen. Advocated scenarios differ from academic scenarios, which are not necessarily desired by anyone, or, if they are, are not developed primarily as part of an advocacy effort. They also differ from utopian scenarios, which as defined here are scenarios that are not believed to be credible.

My decision to develop an advocated scenario, rather than an academic or utopian scenario, imposes strong constraints on the final product. At a minimum, the quantitative elements of the scenario must be strongly grounded in empirical data, and the narrative or qualitative elements must be intuitively credible to large numbers of people. Beyond this, the

scenario must be compelling, that is, it must be able to motivate large numbers of people to want to help make it happen.

The scenario framework itself helps ensure credibility because it forces the author, and readers, to acknowledge when important values are in conflict and to take stands on how these conflicts are to be resolved.

The scenario framework also helps facilitate criticism and discourse. Any reader who believes that the scenario advocated here is undesirable, non-credible or non-compelling can use the framework to develop an alternative scenario that they would be willing to advocate.[1]

Outline and description

Section I reviews quantitative scenarios of world development constructed by other authors and presents the model for constructing scenarios that I use in this dissertation. I construct a reference scenario and five policy scenarios. Section I continues by evaluating largely narrative scenarios developed in the post-war period that projected world development to 2000. I apply insights from that exercise to assess a large collection of recently prepared scenarios that project world development into the 21st century.

These exercises help us clarify important questions that need to be answered in order to judge the credibility of any attempt to construct scenarios for the coming century. Some of these questions lend themselves to quantitative analysis. Are there true biogeophysical limits to economic growth? If so then scenarios that project unending growth are not credible. Are there limits to growth imposed by social factors? If continued growth generates economic inequalities that cannot be constrained through policy, social cohesion may so erode that further economic growth is impossible. As societies grow do they become so complex that they can no longer function effectively? If so then complexity might serve as a limit to growth.

[1] The Excel spreadsheet program for the scenario model developed for this dissertation, Model A, is available on disk or by email by request.

Other questions require more qualitative, or narrative, treatment. Does the current trajectory of global economic growth and integration—"globalization"—so impact the structures of national and global governance, and so change the relations of political power, that it could become impossible to implement the policies necessary to overcome social and biogeophysical limits? If so then neoliberal globalization sows the seeds of its own exhaustion. Even if a strong case can be made that continued technological innovation should enable us to avoid foreseeable biogeophysical limits on growth, could it be that these same technologies have qualities that make them otherwise unacceptable? If so then biogeophysical limits return as real limits to continued economic growth.

Section I concludes by presenting a framework for integrating quantitative and narrative scenarios. I provisionally identify one integrated scenario as the ideal scenario. I test the credibility of the ideal scenario, and other scenarios, throughout the rest of this dissertation.

Section II addresses critical questions identified in Section I. Section II.A.1 reviews the history and theory behind the "limits-to-growth" debate. Sections II.A.2 and II.A.3 consider the empirical evidence regarding biogeophysical limits, and limits on the ability of technology to overcome these. Section II.A.4 considers the possibility that complexity is a limit to growth. Section II.B considers the reciprocal influence of economic inequality and economic growth. This section also assesses policy proposals for reducing inequality, and public opinion about inequality. Section II.C evaluates the scenario of Green sustainability. This section includes results from a survey conducted at a major conference on Voluntary Simplicity, and reviews results from other surveys. Section II.D considers the challenges of globalization and global governance. Section II.E assesses possible trajectories of technological innovation over short-, middle- and long-run periods. This section pays particular attention to the profound challenges presented by the new human genetic technologies.

Section III pulls together the findings of all the topics considered to this point, presents an integrated quantitative and narrative scenario of global development that seeks to fulfill the stated objective of this dissertation, identifies unresolved tensions, and concludes.

Two central themes

In the course of achieving its stated objective this dissertation focuses attention on two themes that are central to its task and that, in my estimate, have not been as fully integrated into the debate over growth, the environment, and the human future as they need to be. These are:

1) The critical importance of distributional equity - Throughout the quarter century since the publication of *The Limits to Growth*, pro-growth advocates have charged that environmentalism is an ideology of a privileged elite whose construction of "nature" is in fact a covert strategy of domination over less privileged peoples and communities. Environmentalists deny this, but our models of sustainable development rarely grapple with distributional concerns at the level of specificity that reveals a commitment to engage this issue. This dissertation seeks to fully engage the issue of distributional equity and incorporate it into our model of global development.

2) The implications of pending profound technological developments. Technological innovation increases our ability to manipulate matter and energy at increasingly finer scales of space and time. It has impacts on the nature of social life that are far more profound than its celebrated role in allowing output to increase by 2 percent or so per year. Ultimately, the acceptability of a future of continued economic growth through technological innovation will depend on the acceptability of the increasingly more profound manipulation of the natural world. This dissertation attempts to characterize salient features of such a future, and to gain insight into the ways that people understand these features and the concerns they raise.

Concluding note

Do I really believe that it's legitimate to try to specify such values as the desired level of per capita income in 2150 for the fourth population quintile in China? Clearly, the values given in our advocated scenario for any future time are not predictions--they are goals to be worked toward. With this understanding I see no reason why they can't be taken at face value. Of course, every generation can, should and will assess the state of the world they inherit, and ask anew, "what is to be done?" Scenarios such as the one developed in this dissertation can critically inform the values that each of us works to realize in our lives and our communities today, and to pass to our descendents tomorrow.

ABOUT THE TEXT

This dissertation is structured as an analytic narrative. It seeks to establish a strong case for a particular scenario motivated by stated normative values and grounded in thorough empirical analysis. Writing this dissertation was more than an academic exercise. It was an opportunity for me to attempt to address questions that had real and immediate bearing on my vocation as an activist working for a just and sustainable world. The sections of the dissertation are presented in roughly the order that I researched and wrote them, and a narrative arc shapes the text. During my work on the early sections I believed that I would be able to make a good case that the ideal scenario, Scenario 5, was credible and compelling. As my work proceeded, however, this became increasingly difficult to do, and about half-way through I realized that I could not do it. This turning point in my thinking is noted in Section II.C.4, the concluding section of the discussion of Green Sustainability. At that point the focus of the dissertation shifts from Scenario 5 to Scenario 3, a less ideal but, I believed, more credible and still desirable scenario. The two final sections of Part II, addressing governance under conditions of globalization and the social implications of technological change, test further the credibility and desirability of Scenario 3.

This dissertation is long. To assist the reader, I've provided a narrative summary and a quantitative summary of the conclusions, immediately below. In addition, each key section of the main text begins with a summary of the conclusions of that section.

Research for this dissertation began in 1995 and was largely completed by the end of 1998. Writing was largely finished in the first months of 2000. Shortly after that I began a leave of absence from the Energy and Resources Group doctoral program and put the text aside for the better part of three years. During the summer of 2003 I began preparing the text for submission. Although much new information bearing on the topics addressed in the dissertation had become available during my leave, I concluded, after review, that I saw no reason to reconsider the presentation or the conclusions drawn. The current text is largely that of the version prepared in

early 2000. I've added a short Epilogue to reflect on developments pertaining to the dissertation topic during my leave.

NARRATIVE SUMMARY OF CONCLUSIONS

Economic inequality among and within countries is very great. Continued global economic growth is necessary if economic inequality is to be reduced. Efficient markets, technological innovation and comprehensive public policies should be able to allow economic growth to continue for the coming 150 years without critically endangering ecological integrity. Continued growth can be expected to reduce inequality among persons within developing countries, but may increase inequality among persons within developed countries. However, policies can be implemented that should be able to prevent such increases in inequality. Continued global economic integration—globalization—both encourages and is encouraged by continued economic growth and technological innovation. Globalization undercuts the ability of nation states to adopt and enforce the sorts of policies that are needed to ensure ecological integrity and social equity. However, international and global institutions can be established that should be capable of addressing these concerns, and of doing so in a way that is sufficiently accountable to local publics to ensure legitimacy. In order for these institutions to function effectively—that is, to be able to ensure ecological integrity and social equity—there needs to be a global consensus about the desirability of these values, and a commitment to their realization. Continued economic growth and technological innovation make it both easier and more difficult to achieve such a consensus and commitment. To ensure that such a consensus and commitment are realized, concerned leaders and others will need to articulate and live in accordance with social norms that stress the importance of ecological integrity and social equity. If we wish to achieve economic equality among countries within the next 150 years, it will be necessary for the developed countries to grow slowly, and for the developing countries to grow rapidly, for most of that period. If we wish to ensure ecological integrity and avoid dependence upon undesirable technologies, per capita GDP growth in all sectors will need to converge to the same slow rates by 2150. At that time the world can be affluent, income can be equitably distributed, levels of resource use can be sustained indefinitely, and social democratic institutions of global governance

can allow ecological integrity to be maintained and undesirable technologies to be regulated. One set of powerful new technological innovations poses a particular challenge to our ability to generate the sort of global consensus and commitment that would allow economic growth to continue while ensuring ecological integrity and social equity. These are the new human genetic technologies. If these technologies are developed and begin to be used to modify existing human attributes, it is likely that our experience of being part of a common humanity with a shared future will be greatly eroded. Institutions of global governance will need to be able to constrain destabilizing technologies of this sort. An unresolved tension concerns the years beyond 2150. Although high, stable levels of resource throughput can be maintained indefinitely after that time, eventually even slow output growth would require massive technological transformation of the natural world. The scenario of world development that this dissertation constructs and advocates gets us to a point in 2150 that is both desirable in itself, and that will make it easier for us to negotiate the subsequent transitions, whatever they might be.

QUANTITATIVE SUMMARY OF CONCLUSIONS

This dissertation develops and advocates a scenario of global development for the next 150 years that incorporates progressive and humanitarian values concerning economic well-being, ecological integrity and social equity. The advocated scenario includes the quantitative features shown below. After 2150 population, energy use and the distributions of income between and within countries are sustainable at the levels shown in that year. The rate of growth of per capita GDP, while very slow, remains positive and thus presents an unresolved tension.

	2000	2050	2100	2150
world population (billion)	6.2	9	9	9
per capita GDP (1990 US$)				
world	4,877	12,587	42,605	82,000
low income countries	366	3,306	32,980	82,000
high income countries	26,689	49,000	63,000	82,000
ratio, high/low per capita GDP	73:1	15:1	2:1	1:1
per capita GDP growth (%/yr)				
world	1.4	2.5	2.3	0.5
low income countries	3.5	5.0	3.3	0.5
high income countries	1.7	0.5	0.5	0.5
energy use (TW)	13.6	29.2	45.1	60.0
energy intensity (w/$GDP)	.45	.26	.12	.08
per capita income (1990 US$)				
within low income countries				
bottom 20%	113	1,031	10,203	26,000
top 20%	876	7,425	69,435	169,000
ratio:	7.8:1	7.2:1	6.8:1	6.5:1
within high income countries				
bottom 20%	8,303	15,200	19,531	26,000
top 20%	54,208	99,368	127,511	169,000
ratio:	6.5:1	6.5:1	6.5:1	6.5:1
ratio, top 20% high income/ bottom 20% low income	489:1	96:1	13:1	6.5:1

ACKNOWLEDGEMENTS

Nearly every member of the faculty, staff and student body of the U.C. Berkeley Energy and Resources Group contributed in some manner to the development of this dissertation. It has been a privilege to work with them. My dissertation committee Chair, Richard Norgaard, deserves special acknowledgment for his continuing support, insight, and patience. The other members of my dissertation committee - Gene Rochlin and Ignacio Chapela – deserve my heartfelt appreciation, as do Anne Kapuscinski and Steve Weber, who served on my qualifying examination committee. Others who deserve special thanks include Anthony Fischer, John Holdren, Paul Craig, Alexandra von Meier, Eliot Posner, Jesse Reynolds, Gillian Ward and Cecile Andrews. Any errors or shortcomings remain my own.

SECTION I. SCENARIOS OF GLOBAL DEVELOPMENT

Summary

In this section we consider several scenarios of global development. Our purpose is to identify ways in which concerns regarding economic growth, ecological integrity and the distribution of income might support or conflict with one another.

Section I.A begins by comparing seven noted quantitative scenarios of long-range global development. Some address environmental values, and some address income inequality among countries. None address income inequality within countries.

Section I.A continues by presenting a model of global development that addresses income inequality within countries. The model is used to answer the question: what would it take to achieve a world in which annual energy use is limited to 30 terawatts, economic inequality among countries has been eliminated, and economic inequality within countries has been reduced to the level represented by a ratio of 2.5 between the upper and lower per capita income quintiles, within the next 150 years?

We develop a scenario that suggests that such a world could be achieved if global energy efficiency improves by about a factor of five, if low income countries grow at per capita rates of 4-5% for most of this century and then slow to zero over the following half century, if the high income countries reduce their rate of economic growth to zero by the middle of this century, and if households in the top income quintile of the high income countries are willing to undergo an absolute reduction of their incomes of 17% over the century beginning in 2050. We find that the top income quintiles of the high income countries can avoid having to undergo an absolute reduction of incomes if more affirmative steps are taken, earlier, to address income inequality.

Section I.B reviews thirty-three sets of mostly narrative scenarios of global development. We identify four advocated scenarios, distinguished largely by different political-economic

commitments: techno-globo neoliberalism, social-democratic internationalism, Green sustainability, and civilization-of-civilizations.

Section I.B continues by presenting a framework for integrating the various quantitative and narrative scenarios. We identify our ideal scenario, combining Green sustainability and quantitative Scenario 5. Section I.B concludes by noting the many questions that need to be addressed in order to evaluate the credibility of any of the scenarios, and in particular of the ideal scenario. These questions are to be addressed in Section II.

I. SCENARIOS OF GLOBAL DEVELOPMENT

I.A. QUANTITATIVE SCENARIOS OF GLOBAL DEVELOPMENT

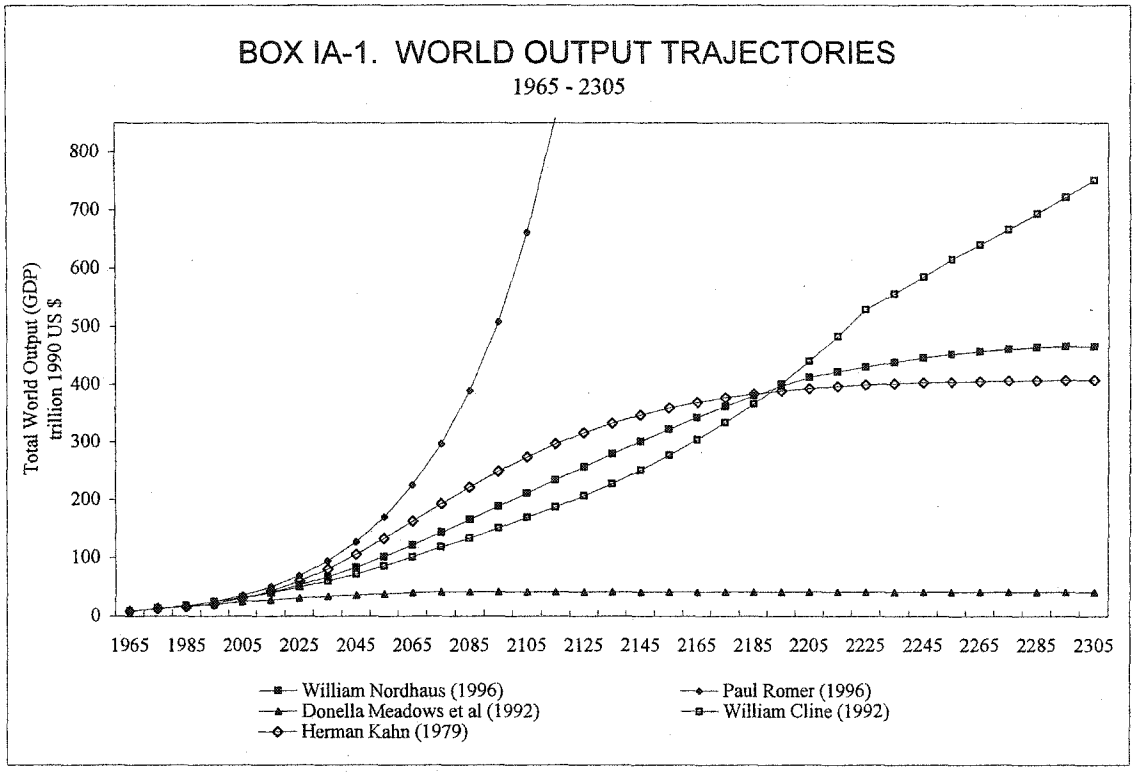
I.A.1. REVIEW OF PAST SCENARIOS

Box IA-1 shows projections of total world output associated with five noted models of world development. The scenarios are described in **IA-2**.

How do the authors of these models motivate these scenarios? Meadows, Nordhaus and Kahn all show economic growth coming to an end, but at different final levels and for different reasons. Meadows believes that biogeophysical limits to economic growth will compel us to live within them. Nordhaus believes that productivity-enhancing technological innovation will become increasingly subject to diminishing returns. Kahn believed that as wealth increases people will become satiated and jaded and lose their entrepreneurial and acquisitive desires. Romer's scenario does not show limits to growth. He believes that increasing returns to technology and knowledge should allow growth to continue indefinitely. Cline's growth projections are extensions of projections made by the Intergovernmental Panel on Climate Change, and are not further motivated.

Different assumptions concerning population growth are not an important reason for the differences among the scenarios. Other than Meadows, all the authors use standard projections prepared by the United Nations. In these, population stabilizes at about 11 billion by the middle of the next century. Meadows uses a lower stabilization value of 7.7 billion.

These globally aggregated projections are a useful initial reference, but if we wish to consider questions regarding income inequality we need regionally disaggregated models. **IA-3** shows projections of economic growth for six scenarios ending in 2100, four of which—by



BOX IA-2. WORLD OUTPUT TRAJECTORIES – DESCRIPTIONS

1. World Output Trajectories, 1965-2305 (Box IA-1)

Box IA-1 shows projections of total world output made by noted economists and other analysts for the period 1965-2305. All figures are in 1990 U.S. dollars.

Nordhaus: This is the reference case output trajectory used by Nordhaus for his RICE model (Nordhaus and Yang, 1996). He uses United Nations mid-range population forecasts, which show stabilization at 10.6 billion. World per capita output reaches $20,500 by 2100 and stabilizes near $42,000 shortly after 2200.

Romer: At the July 1996 Western Economic Association annual convention in San Francisco Paul Romer estimated that the global economy should be able to sustain a per capita output growth rate of about 2 to 3 percent for the indefinite future. The trajectory shown in the chart uses a value of 2.5%, along with the United Nations population projections used by Nordhaus. Per capita output in 2100 is about $60,000.

Meadows: This is the path of global output that Meadows et al., in *Beyond the Limits to Growth* (1992), suggest should be followed in order to avoid the catastrophic reduction in output that would otherwise result as biogeophysical limits are exceeded. Population is limited to 7.7 billion and per capita output is estimated to stabilize at about $5,400.

Cline: This is the reference case output trajectory used by Cline in *The Economics of Global Warming* (1992). It is based on extrapolations of mid-range projections used by the World Bank and the United Nations for the coming century, tempered by Cline's judgment that these rates will slow in later decades. In 2100 population is stable at 10.5 billion and per capita output is about $15,200.

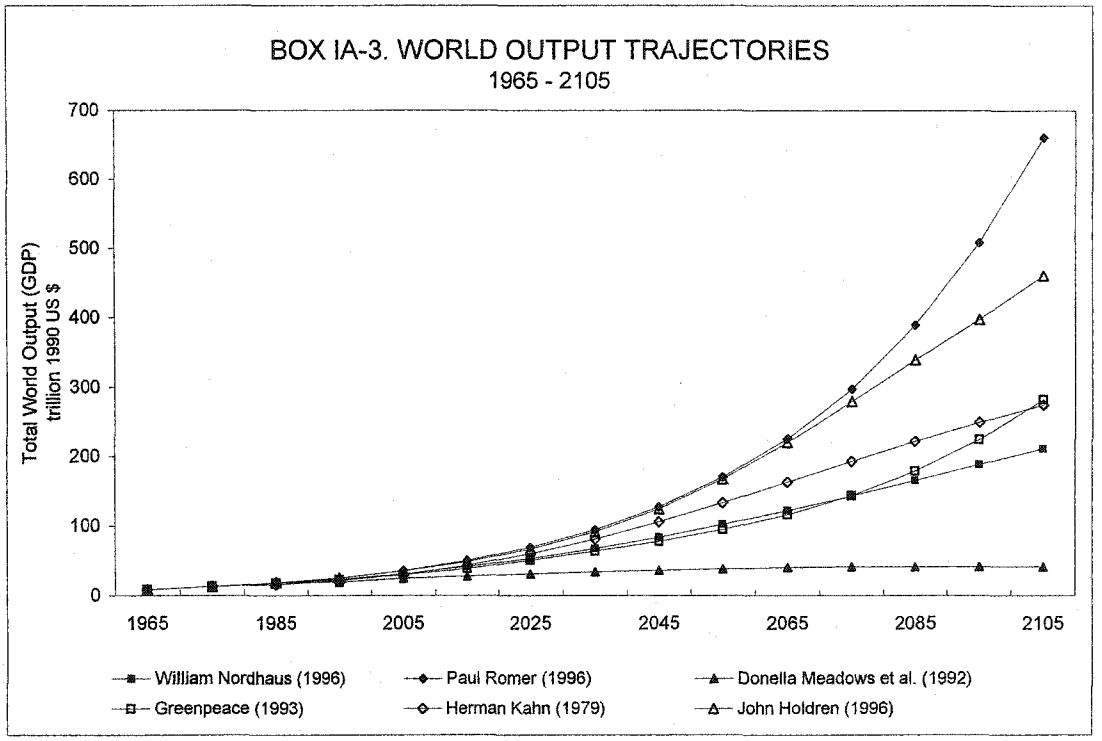
Kahn: This is the output trajectory offered by Kahn in *World Economic Development* (1979) as an alternative to that offered by the authors of *The Limits to Growth.* Population stabilizes at 10 billion. In 2100 per capita output is about $26,000 and it stabilizes a century later at about $40,000.

2. World Output Trajectories, 1965-2105 (Box IA-3)

Box IA-3 shows output trajectories for the period 1965-2105. Four of the trajectories (Nordhaus, Romer, Meadows and Kahn) are the same as those shown in Box IA-1 but here cover only the period through 2105. Cline's trajectory has been deleted and new ones by Holdren and Greenpeace have been added.

Holdren: John Holdren (1996) presented his "best plausible" scenario for reducing reliance on fossil fuels and achieving distributional equity among nations at an April U.C. Berkeley symposium. The trajectory shown in IA-3 is the output trajectory used in this best plausible scenario. In 2100 population has stabilized at 9 billion and per capita output is about $47,700.

Greenpeace: This is the growth path used in the study *Towards a Fossil Free Energy Future* (1993) prepared for Greenpeace by Lazarus et al. of the Stockholm Environmental Institute. It uses the same population and total world output assumptions adopted by the Intergovernmental Panel on Climate Change (IPCC), but modifies per capita output growth rates among regions to reduce inequities. In 2100 population has stabilized at 11.3 billion and per capita output is about $22,400.



Holdren, Nordhaus, Kahn, Greenpeace--are disaggregated on a regional basis.[1] These scenarios are described in IA-2.

Readers familiar with the global futures debate might suspect that I've mislabeled the projections in IA-3. Nordhaus and Kahn present "business-as-usual" scenarios in which world GDP reaches $211 and $274 trillion, respectively, by 2105. Greenpeace and Holdren present "preferred" scenarios in which world GDP reaches $282 and $460 trillion by that date. How can it be that the *preferred* scenarios recommended by two noted environmental advocates show *greater* economic growth than do the *business-as-usual* scenarios presented by two noted pro-growth, neo-classical economists?

The answer is that the Greenpeace and Holdren scenarios incorporate a normative desire that the economic disparities between the rich and the poor countries of the world be significantly reduced, while the scenarios of Nordhaus and Kahn do not. Because income inequality between the rich and the poor countries is in fact so large, Greenpeace and Holdren must show strong, continuous economic growth by poor countries if they are to offer any hope that economic disparities can be reduced by more than a trivial amount within any time less than several centuries.[2]

The Greenpeace and Holdren scenarios also incorporate a desire that total world output does not grow so large that important environmental values are threatened. Holdren sets a limit of 30 terawatts (TW) on the growth of world energy use, which he estimates is the maximum desirable level that can be provided with renewable sources alone. For Greenpeace the limit is set by the desire to eliminate the use of fossil fuels by 2100. In order to live within these limits, while

---

[1] Box IA-3 includes the scenarios shown in IA-1 except for Cline's, and adds new ones by Holdren and Greenpeace. Cline's scenario was not included to avoid crowding. Termination of the time horizon at 2105 allows the main points of this section to be illustrated more conveniently.

[2] Appendix 1 shows that under the conventional business-as-usual assumptions used by Cline, the gap between the developed and the developing countries would be eliminated sometime between 2600 and 2700, at which time mean GDP would be about $2,000,000 per household (1990 US$).

simultaneously reducing income inequality among countries, economic growth in the highest income nations must slow over the coming decades. This can be seen clearly in **IA-4** and **IA-5**.

In the Nordhaus and Kahn scenarios the growth rates of low income countries exceed those of the richer countries by little more than 1-1.5%. The result is that only minimal progress is made in reducing economic inequality among countries by 2100. The Nordhaus regional projections are shown in **IA-6**. Further inspection of the Nordhaus and Kahn scenarios shows that economic growth in all regions slows to zero while substantial economic inequalities still exist. This condition is problematic, to say the least.

The distribution of income between countries has rightly received great attention among global scenario modelers over the past thirty years, but the distribution of income *within* countries has received much less.[3] This is a remarkable omission. Income inequality is arguably the single greatest source of social conflict throughout history and at the present time. Scenarios of global development that are intended to help inform broad world-views of the human prospect cannot do this unless they include projections of income distribution within countries, and describe how these might be expected to change under different conditions and policies.

The topic of income inequality within countries is discussed at length in Section II.B. As we'll see, empirical studies and analytic models suggest that the distribution of income tends to change only slowly over time, and is resistant to policy.

This brief review suggests that there are important ways in which economic growth, environmental protection and distributional equity between and within countries either conflict with or help support one another. In the next section we present a simple regionalized world model that can help us study these relations in more detail.

---

[3] Authors who have sought to model within-country income distributions over time include Chenery, Ahluwalia, et al (1974), Adelman and Robinson (1978), Taylor and Lysy (1979), Chichilnisky and Cole (1978), Moreland (1984), and Bessant and Cole (1985). In general their projections do not show results for periods much longer than several decades.

BOX IA-4. HOLDREN'S SCENARIO

[Holdren 1996]

Figure 1. World Per Capita GDP under Business-As-Usual Scenario

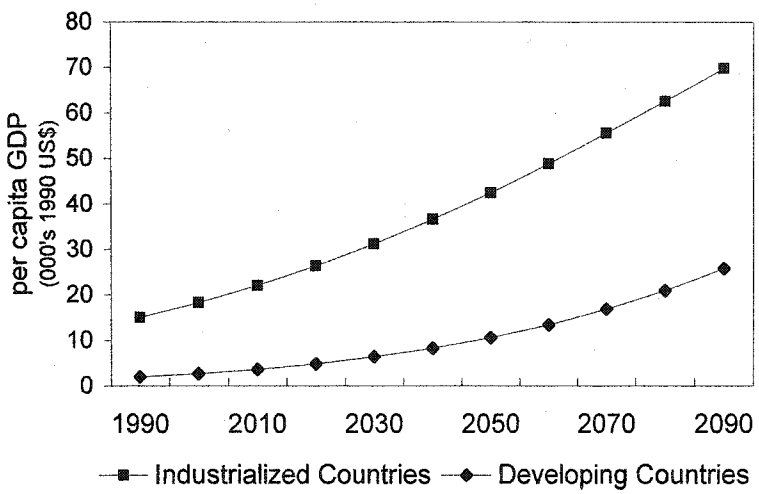
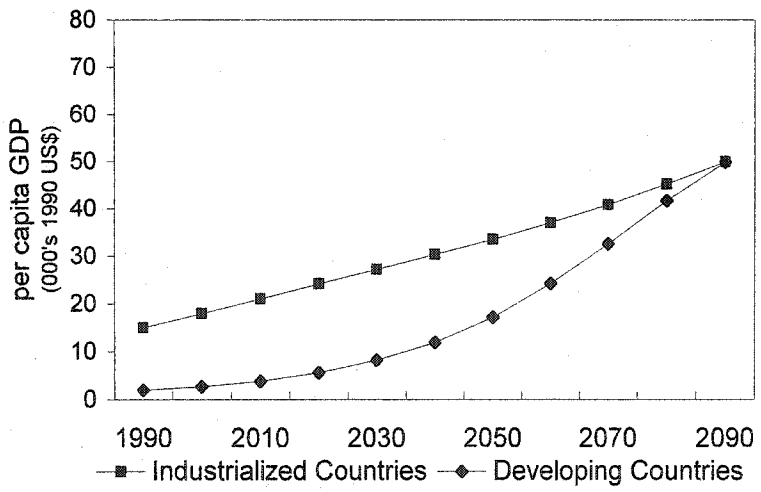


Figure 2. World Per Capita GDP under "Best Plausible" Scenario



BOX IA-5. GREENPEACE SCENARIOS OF PER CAPITA GDP GROWTH

[Lazarus et al., 1993]

Figure 1 shows reference scenario per capita GDP growth for six world regions from 1990 to 2100 adopted by the IPCC (1990). Greenpeace modified this trajectory to give the "Equity Scenario" shown in Figure 2. Under the Equity Scenario:

"[W]e propose an assumption for regional income equity wherein the ratio of highest to lowest average income drops to 2:1by 2100, compared with the current ratio of over 14:1. We maintain the IPCC90 projected regional growth rates over the next 20 years, and then gradually adjust them over the 2010-2100 period to achieve this increased equity objective." (p 23)

Figure 1. Per Capita GDP under the IPCC 1990 Reference Scenario (1985 US$)

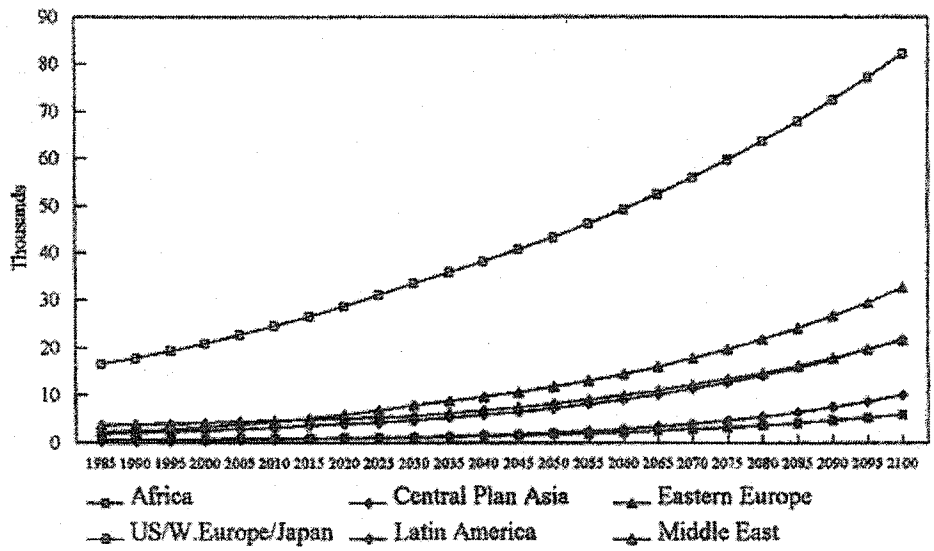
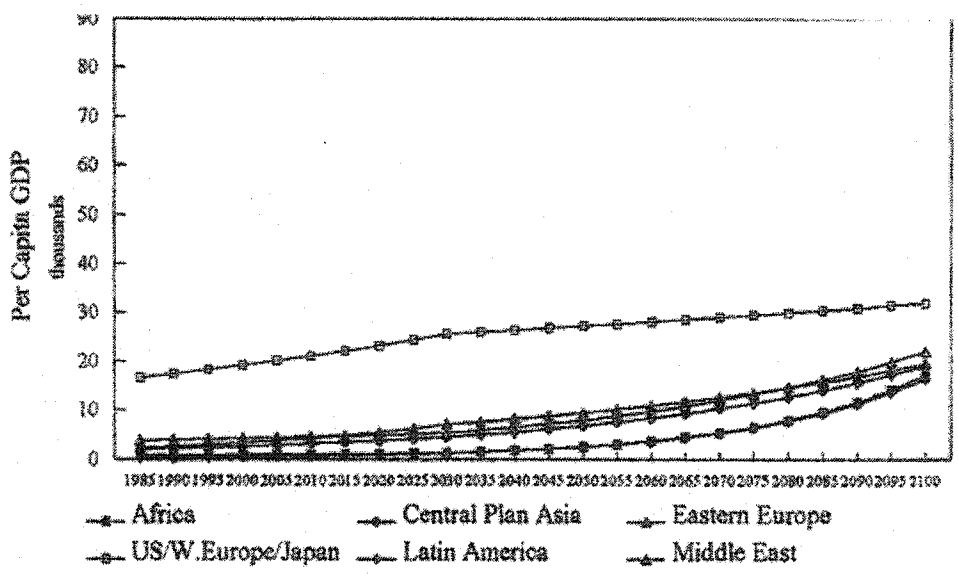
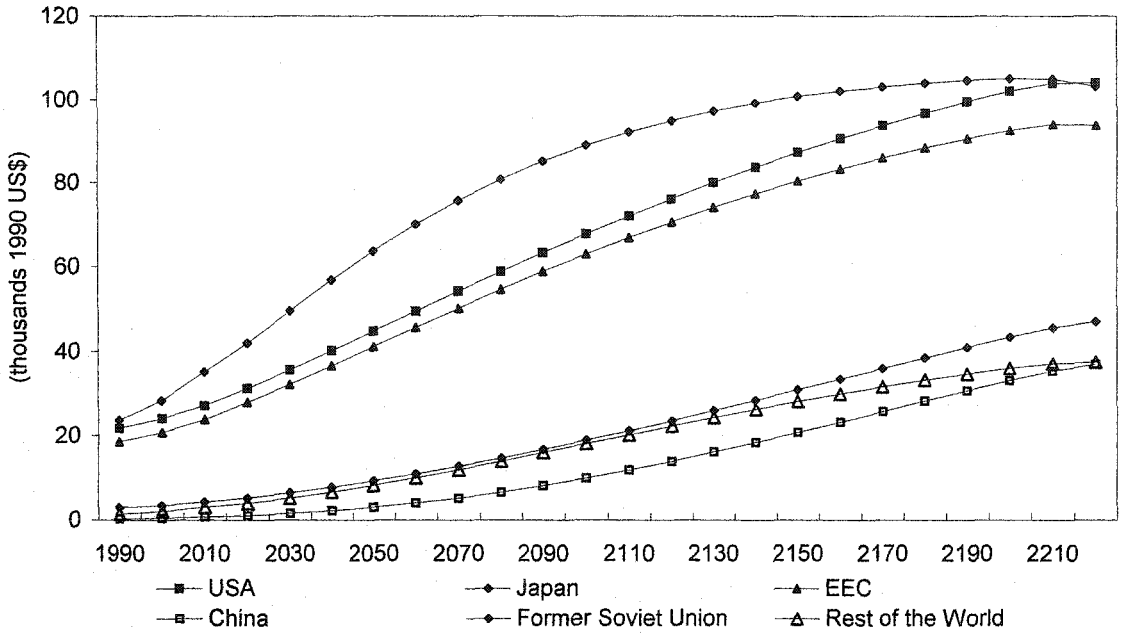


Figure 2. Per Capita GDP under the Greenpeace "Equity Scenario" (1985 US$)



BOX IA-6. RICE REFERENCE SCENARIO PROJECTIONS OF PER CAPIITA INCOME

[Nordhaus 1996]



2. MODEL A

This section describes a model of world development that will be used to study how economic growth, environmental values, and social equity support or conflict with one another. This model is called "Model A."

Model A shows changes in population, economic output, energy use and income distribution within countries over the period 1994-2150. For most purposes we use 2000 as the initial year of reference. Model A aggregates the countries of the world into four sectors: low-income countries, China, middle-income countries, and high-income countries.[4] Decadal rates of change of population, per capita output, energy efficiency and income distribution are specified exogenously.

Below is a brief description of Scenario 1, the reference or business-as-usual scenario, that we use in the remainder of this section. **IA-7, IA-8** and **IA-9** show the values of important variables that make up Scenario 1. All money values are given relative to 1990 US dollars. The equations of the model are shown in **IA-10** and **IA-11**. Appendix 2 describes derivation of the initial values and growth rate projections. A complete print-out of Scenario 1 appears in **IA-26** at the end of this section.

* Population growth: Population growth decreases in all sectors and world population stabilizes at 11.3 billion by about 2090.

* Economic growth: Per capita GDP growth rates in the low income countries increase and are able to stay between 2.5% and 3% for most of the coming century, after which they decline. China's current high growth rates decline over the next several decades, reaching 3% in 2050, at which point the low income countries and China follow the same trajectory. The middle income countries grow at 2% for most of the next century. Growth rates for the high income

[4] These sectors follow the classification used by the World Bank in its World Development Report (1996), with the exception that we show China as a separate sector, while the World Bank groups it with the other low income countries. See Appendix 2, Box A2-4 for the list of countries included in each sector.

BOX IA-7. SCENARIO I - REFERENCE SCENARIO - SUMMARY TABLES

Population (10^9 persons)

	1990	2000	2020	2050	2100	2150
low income	1.8	2.3	3.2	4.4	5.2	5.2
China	1.1	1.3	1.6	1.8	1.9	1.9
mid income	1.5	1.7	2.2	2.9	3.3	3.3
high income	0.8	0.9	0.9	0.9	0.9	0.9
WORLD	5.3	6.2	7.9	10	11.3	11.3

Per Capita GDP (1990 US $)

	1990	2000	2020	2050	2100	2150
low income	346	366	557	1,279	4,883	11,539
China	275	628	1,342	3,541	13,524	31,959
mid income	2,731	2,752	4,065	7,709	18,037	31,577
high income	22,742	26,689	37,497	55,382	91,309	136,217
WORLD	4,514	4,877	6,038	8,624	17,311	31,120

Per Capita GDP Growth Rates (% per year)

	1990	2000	2020	2050	2100	2150
low income	-0.08	1.9	2.6	3	2.1	1.3
China	11.7	4	3.4	3	2.1	1.3
mid income	-1.3	1.9	2.1	2	1.3	1
high income	1	1.8	1.4	1.1	0.8	0.8
WORLD	0.11	1.1	1.1	1.4	1.3	1.1

Ratio of Per Capita Incomes of High Income Countries to Others

	1990	2000	2020	2050	2100	2150
low income	66	73	67	43	19	12
China	83	42	28	16	7	4
mid income	8	10	9	7	5	4
high income	1	1	1	1	1	1

Total Energy Use (TW)

	1990	2000	2020	2050	2100	2150
low income	0.64	0.78	1.7	4.7	16.8	35
China	1.1	1.6	3.4	8.7	26.7	55.7
mid income	3.5	4.1	7.4	16.7	34.6	53.5
high income	6.2	7.1	9.5	12.2	15.9	20.6
WORLD	11.5	13.6	22.1	42.3	93.8	164.8

DISTRIBUTION OF INCOME

(values shown are per capita incomes for each population quintile, in '90 US $)

Low Income Countries	1994	2000	2020	2050	2100	2150
bottom 20%	106	113	176	412	1617	3906
middle 20%	251	267	406	926	3500	8254
top 20%	827	876	1318	2964	10980	25525

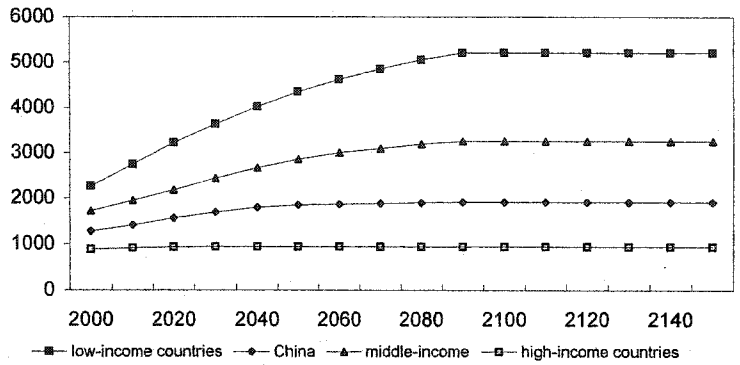
China	1994	2000	2020	2050	2100	2150
bottom 20%	136	194	415	1100	4223	9906
middle 20%	346	491	1037	2701	10164	23839
top 20%	962	1363	2861	7395	27589	64712

Middle Income Countries	1994	2000	2020	2050	2100	2150
bottom 20%	828	887	1349	2656	6245	10899
middle 20%	1911	2032	3006	5707	13286	23187
top 20%	6135	6495	9471	17613	40750	71117

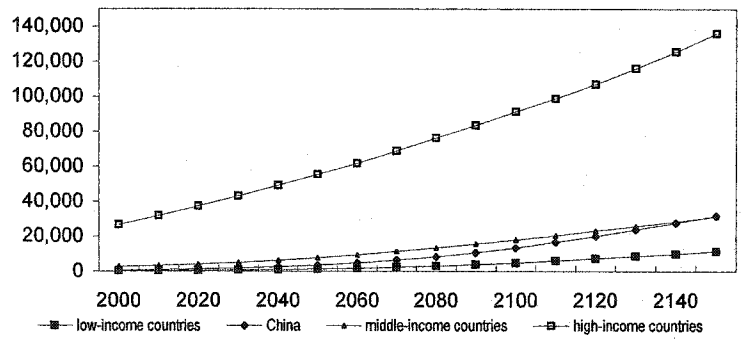
High Income Countries	1994	2000	2020	2050	2100	2150
bottom 20%	7373	8303	11632	17137	28184	41978
middle 20%	20475	23058	32303	47590	78267	116575
top 20%	48135	54208	75941	111881	183999	274058

BOX IA-8. SCENARIO I - REFERENCE SCENARIO - POPULATION AND ECONOMY TRAJECTORIES

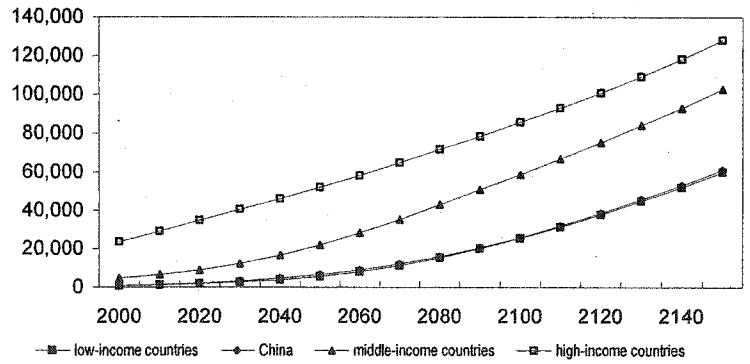
population (millions)



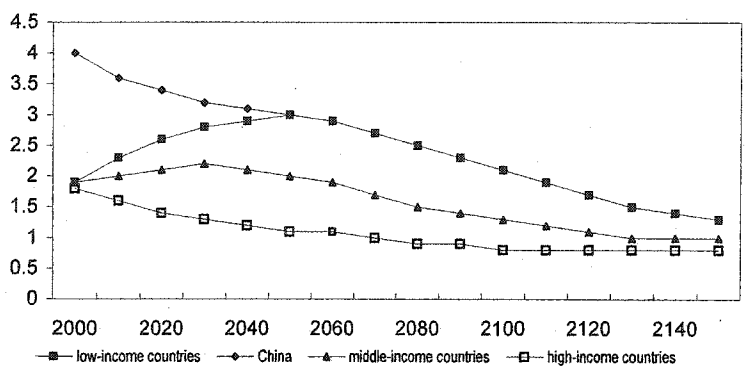
per capita GDP (1990 US $)



Total GDP (billion 1990 US $)



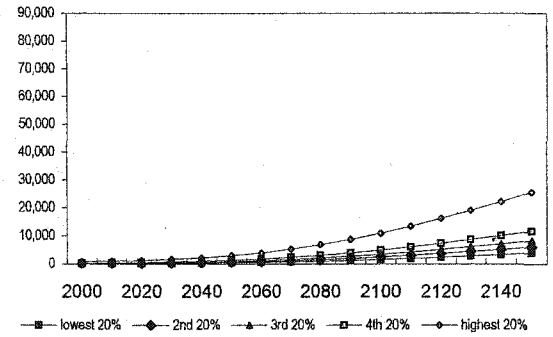
Per Capita GDP Growth Rates (%/year)



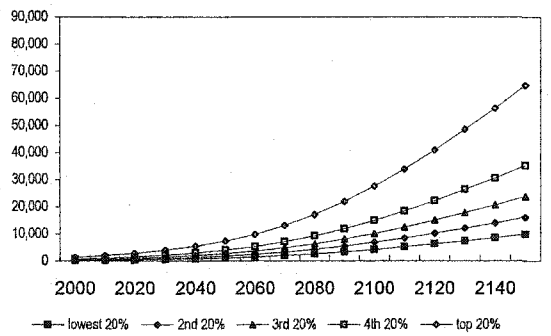
BOX IA-9. SCENARIO I - REFERENCE SCENARIO - INCOME DISTRIBUTION TRAJECTORIES

[All values 1990 US $; all vertical axes to the same scale]

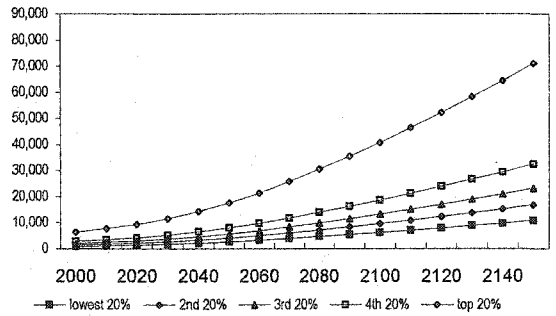
LOW-INCOME COUNTRIES
mean per capita income by quintile



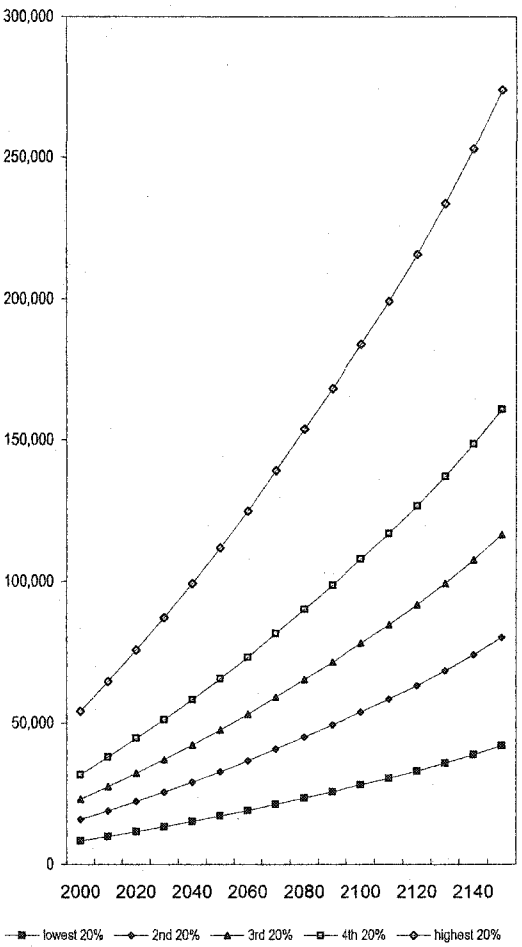
CHINA
mean per capita income by quintile



MIDDLE-INCOME COUNTRIES
mean per capita income by quintile



HIGH-INCOME COUNTRIES
mean per capita income by quintile



BOX IA-10. MODEL A

Equations of the Model

(1) $P_{i1} = P_{i0}(1 + n_{i0})^{10}$ population growth

(2) $y_{i1} = y_{i0}(1 + g_{i0})^{10}$ per capita income growth

(3) $e_{i1} = e_{i0}(1 + q_{i0})^{10}$ changes in energy intensity

(4) $y_{ij1} = y_{ij0}(1 + g_{i0})^{10} + s_{ij} r_{i0}(y_{i40} + y_{i50} - 2\,y_{i0}); \quad j = 1, 2, 3$
$= y_{ij0}(1 + g_{i0})^{10} - r_{i0}(y_{ij0} - y_{i0}); \quad j = 4, 5$
changes in income distribution
[see Box IA-11 and Appendix 3 for discussion]

(5) $G_{i0} = 1.2 - [[\Sigma^{5}_{j=1}(6 - j)\,y_{ij0}] / 12.5\,(y_{i0})^2]$
Gini coefficient
[see Appendix 4 for discussion]

Variables and Parameters of the Model

P = population (billions)
y = per capita income (1990 US $)
e = energy intensity (total terawatts/total GDP)
G = Gini coefficient

n = population growth rate (%/year)
g = per capita income growth rate (%/year)
q = energy intensity growth rate [<0] (%/year)

i = sectoral index: 1, 4 [low income, China, middle income, high income]
j = income quintile: 1, 5 [Q1, Q2, Q3, Q4, Q5]
time subscript = 0, 1, 2... = 2000, 2010, 2020...

s_{ij} = redistributive proportionality factor = $(y_i - y_{ij}) / [3\,y_i - (y_{i1} + y_{i2} + y_{i3})]$
r = rate of redistribution (%)

Initial and Reference Scenario values are shown in Box IA-7. Selection of initial values is described in Appendix 2.

BOX IA-11. MODELING CHANGES IN THE DISTRIBUTION OF INCOME

The equations below model changes in the distribution of income within an income sector. The per capita income of sector i grows at annual rate g_i, compounded decadally. In the absence of redistributive pressure ($r = 0$) all quintiles share equally in this growth. At the end of each decade income can be redistributed from those quintiles in which income is above the sector mean to those quintiles in which income is below the mean. The proportion of the total income above the mean that is redistributed in any period is given by the redistributive variable r, with $0 < r \leq 1$. The value of r can be varied by time period. Meanwhile, the proportionality factor s ensures that the amount which a quintile whose income is below the mean receives from the total amount to be distributed is proportional to the amount by which that quintile is below the mean. If a constant r is maintained over decades the incomes of all quintiles converge. The larger the value of r, the faster the convergence. We can also show $r < 0$, in which case incomes will be redistributed from those quintiles below the mean to those above the mean. Appendix 3 illustrates the derivation and interpretation of the model in more detail. The model is a calculatory convenience that allows scenarios to be generated showing changes in the level and distribution of income. It does not embody a theory of income distribution. This would require that r be made a function of other variables in the model, such as the growth rate g or per capita income, rather than standing as an exogenous variable.

$$(4.1) \quad y_{i11} = y_{i10}(1 + g_{i0})^{10} + s_{i1} r_{i0} (y_{i40} + y_{i50} - 2y_{i0})$$

$$(4.2) \quad y_{i21} = y_{i20}(1 + g_{i0})^{10} + s_{i2} r_{i0} (y_{i40} + y_{i50} - 2y_{i0})$$

$$(4.3) \quad y_{i31} = y_{i30}(1 + g_{i0})^{10} + s_{i3} r_{i0} (y_{i40} + y_{i50} - 2y_{i0})$$

$$(4.4) \quad y_{i41} = y_{i40}(1 + g_{i0})^{10} - r_{i0} (y_{i40} - y_{i0})$$

$$(4.5) \quad y_{i51} = y_{i50}(1 + g_{i0})^{10} - r_{i0} (y_{i50} - y_{i0})$$

where

$$(6) \quad s_{ij} = (y_i - y_{ij}) / [3y_i - (y_{i1} + y_{i2} + y_{i3})]$$

$$(7) \quad y_i = 1/5 \, \Sigma y_{ij}$$

definitions:

y_{ijt} = per capita income of quintile j of income sector i in year t
y_{it} = per capita income of the full income sector i in year t
g_{it} = growth rate of per capita income in income sector i in year t
s_{ij} = redistributive proportionality factor for each quintile j of income sector i
r_{it} = rate of redistribution for income sector i in year t

countries decline steadily over the next century until they reach 0.8%. They remain at this level through 2150. By 2100 world per capita income has reached $17,300, a level 3.7 times its level in 1994. By 2150 per capita income has reached $31,100, a level 6.9 times its 1994 level. In 2150 per capita income is still growing, at a global rate of 1.1%. This represents a doubling time of 63 years. In 1994 the ratio of per capita income in the high-income sector to that of the low-income sector is 69 to 1. By 2100 this difference declines to 19 to 1, and by 2150 it is 12 to 1.

* Energy use: Energy use per dollar of GDP declines steadily in all regions, but most rapidly in China and least rapidly in the low and middle income countries. By 2050 the rate of decline of energy intensity in all sectors has converged on a value of 0.5% per year, remains at that rate until 2100, and continues after that at a rate of 0.25% per year. Total energy use reaches 94 TW by 2100 (8 times the level of world energy use in 1996) and 165 TW by 2150. The trends in energy intensity used in Scenario 1 are shown in **IA-12** and are discussed further in Appendix 2 and illustrated in Appendix Box A2-7. **IA-13** illustrates the relation between energy intensity, total energy use and per capita GDP.

* Income distribution within countries: For Scenario 1 I adopt a simple "no surprises" set of assumptions. In the high income countries the distribution of income does not change from its current values—a Gini coefficient of .32 and an 80/20 ratio of 6.5 to 1--over the 150-year time horizon of Model A.[5] In light of recent trends this might be considered optimistic but until quite recently it would have been considered pessimistic. In the other three sectors income is presently less equally distributed than it is in the high income sector. As these three sectors grow their distributions of income approach that of the high income sector, matches it when their per capita incomes reach $10,000, and remains unchanged after that.[6] In 2000 the mean incomes of the top and bottom quintiles in the high income countries are $54,000 and $8,300 respectively, which

[5] See Appendix 4 for definitions of the Gini coefficient and other inequality measures.

[6] Changes in income distribution in the high income countries during and following World War II had largely stabilized by 1960, at which time per capita income was about $10,000 (1990 US $).

BOX IA-12. ENERGY INTENSITY TRENDS

[See Appendix 2 and Box A2-7 for derivations and notes]

Figure 1. Scenario 1 (Reference Scenario) Energy Intensity Trends

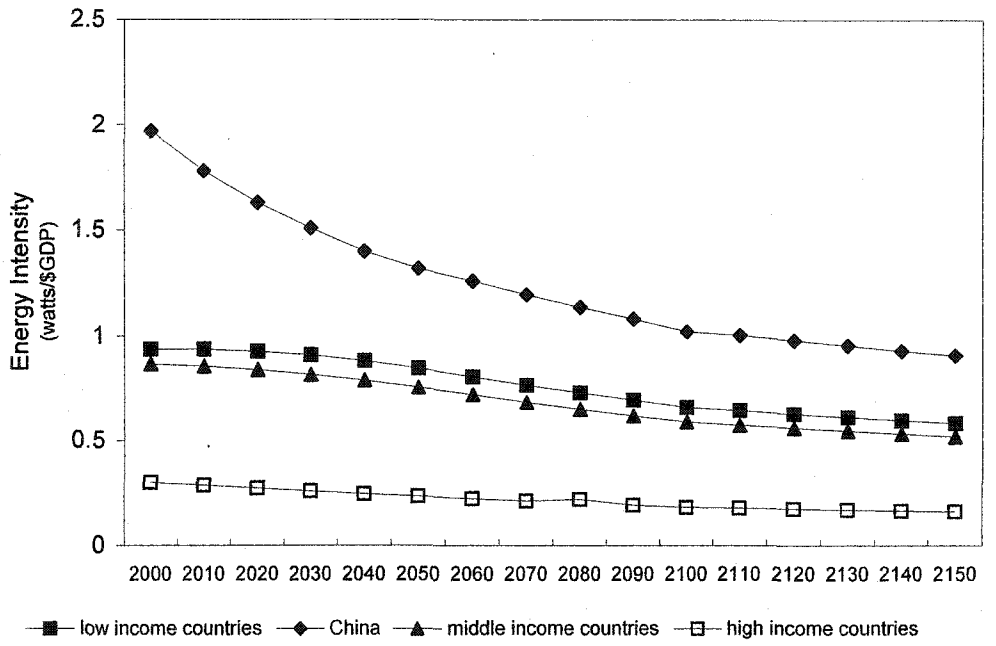
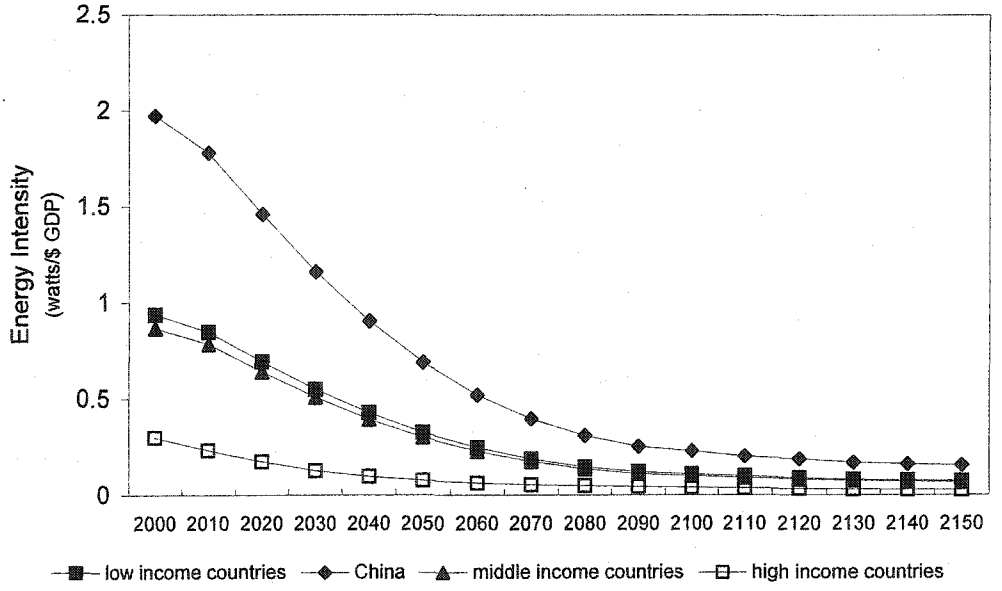


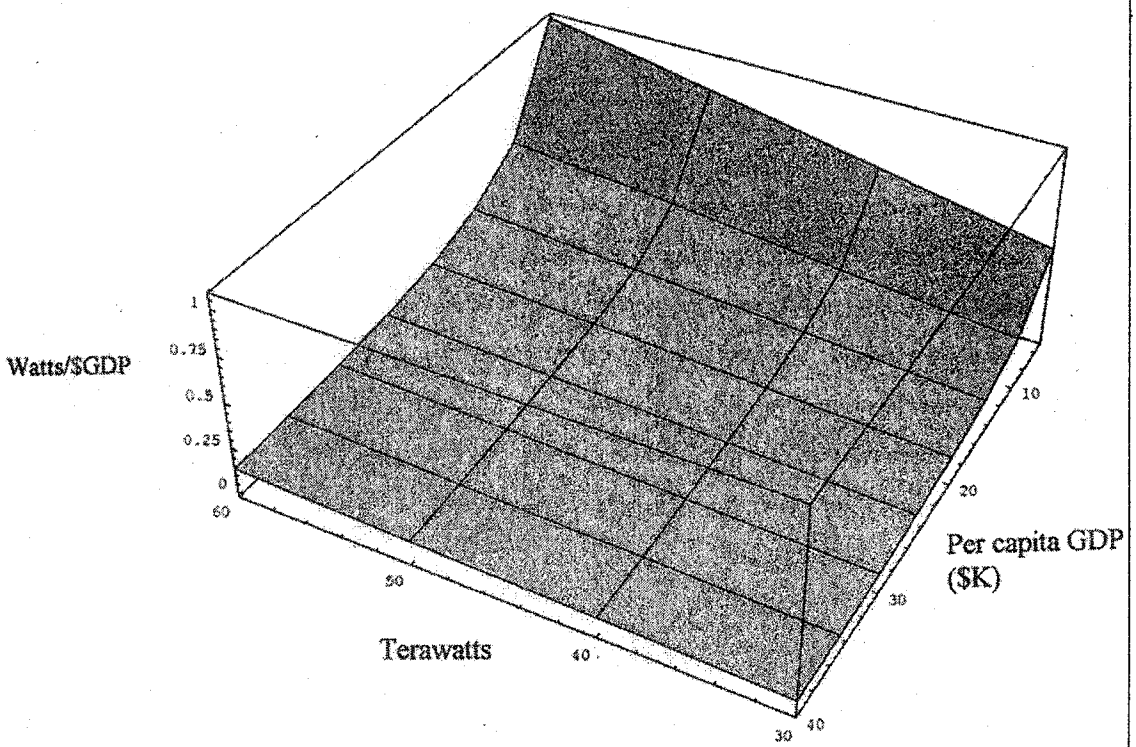
Figure 2. "Maximum Practicable" Improvements in Energy Intensity - Scenarios 3-6



BOX IA-13. TRADE-OFFS BETWEEN TOTAL ENERGY USE, ENERGY INTENSITY AND PER CAPITA GDP

The diagram shows levels of per capita GDP, energy intensity (in watts/$GDP) and total energy use (in terawatts) that can be realized at a point in time. The values shown assume a population of 11 billion, and are consistent with the Reference Scenario for the period around 2040.

Suppose that at a point in time we are using 30 terawatts of energy, at an intensity of .50 watts/$GDP. This supports a per capita GDP of about $5,500. Suppose too that we plan to double per capita GDP, to $11,000, by growing at an average of 1.5% per year over 46 years. We would need to either double total energy use, from 30 to 60 terawatts, or cut energy intensity in half, from .50 to .25 watts/$GDP, or achieve some other combination of higher total energy use and lesser energy intensity shown on the trade-off surface of the diagram.



The diagram was produced with Mathematica software using settings as follows:

In [63]: = enggdp: = {{.531, .708, I885, 1.062}, {.265, .353, .442, .531}, {.177, .236, .295, .354}, {.133, .177, .221, .265}, {.106, .142, .177, .212}, {.088, .118, .147, .177}, {.076, .101, .126, .152}, {.066, .088, .111, .133}}
ListPlot3D [enggdp] - Show [q, ViewPoint -> {-1.3, 2.4, 2}, Meshrange -> {{30, 60}, {5, 40}}, Axeslabel -> {"Terawatts", "pc GDP", "W/$GDP."}]

gives an 80/20 ratio of 6.5. By 2150 these grow to $274,000 and $42,000; the 80/20 ratio is unchanged. The low income countries start out in 2000 with top and bottom mean incomes of $876 and $113, which represents an 80/20 ratio of 7.7. By 2150 these incomes have grown to $25,525 and $3,906. The 80/20 ratio now matches the 6.5 value of the high-income countries.

Evaluation and Discussion

Let's assume for the moment that most people would prefer to live in a world where economic growth continues at some steady pace, a healthy environment is maintained, and economic inequality, both between and within countries, does not exceed some acceptable level. Does Scenario 1 reflect these preferences? Put somewhat differently, are there reasons we would want to have the world develop in a manner other than as shown in Scenario 1?

Clearly, different people would answer this question in different ways.

Some people, perhaps especially those from high-income countries, might object that the annual rates of per capita income growth shown for that sector, which for most decades lie between 0.8% to 1.8%, are too low. They'd like to see growth rates of at least 2.2% (this is the non-inflationary growth rate target identified by the U.S. Council of Economic Advisors in 1995) and preferably closer to the 3.5-4% rates that the industrial nations maintained or exceeded for the two decades after WWII.

Other people, perhaps especially those from lower income countries, might object that the rate of per capita income convergence between the rich and poor nations is too slow. If the growth rates shown in 2150 were to continue unchanged, convergence would take place in about 2500. People who find this unsatisfactory might want to see steady per capita income growth rates in the lower income countries of at least 4 to 5 percent per year.

Still others – for example, environmentalists - might be concerned about the high level of energy use that Scenario 1 shows--14 times today's level in 2150--even given the steady improvement in energy efficiency that the scenario incorporates. They might propose that strong

efforts be made to increase energy efficiency even further, and if necessary, that we learn to live at levels of material consumption below those projected in Scenario 1.

Finally, others might object that the level of income inequality within the high income countries today is hardly acceptable as a final goal, whether to be maintained by the high income countries or aspired to by others. They might call for measures that, for example, would reduce the 80/20 ratio in the high income countries (and thereafter in the rest of the world) from its current value of 6.5 to 1 to something in the neighborhood of 3 to 1, which is the ratio achieved in several Scandinavian countries and in the Soviet Bloc before its dissolution.

It is clear that an attempt to realize all these preferences would be conflictual, but it is not clear how serious these conflicts are. In the next section we use Model A to explore how close we can come to realizing sets of these preferences.

I.A.3. ALTERNATIVE SCENARIOS

Suppose we wish to achieve a lower degree of environmental degradation and a higher degree of economic equality, both among and within countries, than is shown in Scenario 1. What scenarios might enable this to happen?

As our goal for limiting environmental degradation, let's use Holdren's goal in which world energy use does not exceed an upper limit of 30 TW. This represents nearly a 3-fold increase over today's 11 TW.

Let's set 2150 as the year by which we wish to have achieved equality of per capita incomes among countries.

Finally, let's say that by 2150 we want the distribution of income in all countries to be such that the ratio of mean per capita incomes received by the top and the bottom quintiles is no greater than 2.5 to 1.[7]

[7] This is about as close to complete distributional equality as might reasonably be believed to be practicable. A distribution in which all quintiles receive equal incomes would not allow for income

We'll approach our set of goals incrementally, changing only a few assumptions at a time over the course of four policy scenarios. This approach helps us understand the relative impact of each goal as part of the total package.

Scenario 2:

a) faster growth in developing countries
b) greater energy efficiency

In Scenario 2 we assume a) that the growth rate of per capita GDP in the low and middle income countries, and China, can increase to and be maintained at 4-5% per year for most of the coming century. We also assume b) that energy intensity declines along the high efficiency path described in Table 2 of Box A2-7 in Appendix 2.

The results of implementing Scenario 2 are shown in **IA-14, IA-15** and **IA-16**. World GDP in 2100 is $469 trillion, 2.4 times greater than the value shown in Scenario 1. The gap between the high income and the low income countries is reduced quite dramatically, from a ratio of 73 to 1 in 2000 to a ratio of 1.4 to 1 by 2150. If the rates of per capita GDP growth shown in 2150 were to continue unchanged the gap would be completely closed after another 50 years. At that time the per capita income of all countries would be $209,000, (43 times the per capita income in 2000) and would be growing at close to 1.5% per year.

Under Scenario 2 we find that global energy use in 2100 is 73 TW (down from 94 TW in Scenario 1) and in 2150 is 136 TW (down from 165 TW). These are improvements but are still quite far above our goal of 30 TW. Higher rates of energy efficiency improvement have been largely offset by higher rates of economic growth. At the end of 2150 we show world energy intensity decreasing by 0.5% per year in all sectors and world per capita GDP increasing at 1%. This means that at the end of our time horizon energy use is increasing at 0.5% per year, which, although slow, nonetheless represents a doubling time of 139 years.

---

mobility over the course of a lifetime as experience and skills increase. In any event, a ratio of 2.5 to 1 is consistent with a case in which *life-time* incomes are identical among all persons.

BOX IA-14. SCENARIO 2 - SUMMARY TABLES

Population (10^9 persons)

	1990	2000	2020	2050	2100	2150
low income	1.8	2.3	3.2	4.4	5.2	5.2
China	1.1	1.3	1.6	1.8	1.9	1.9
mid income	1.5	1.7	2.2	2.9	3.3	3.3
high income	0.8	0.9	0.9	0.9	0.9	0.9
WORLD	5.3	6.2	7.9	10	11.3	11.3

Per Capita GDP (1990 US $)

	1990	2000	2020	2050	2100	2150
low income	346	366	776	3,306	29,838	94,235
China	275	628	1,707	6,920	37,882	108,252
mid income	2,731	2,752	5,827	17,504	47,581	117,030
high income	22,742	26,689	37,497	55,382	91,309	136,217
WORLD	4,514	4,877	6,685	12,932	41,411	106,652

Per Capita GDP Growth Rates (% per year)

	1990	2000	2020	2050	2100	2150
low income	-0.08	3.5	4.5	5	3	1.5
China	11.7	5	5	4	3	1.5
mid income	-1.3	3.5	4	2	2	1.5
high income	1	1.8	1.4	1.1	0.8	0.8
WORLD	0.11	1.5	2	2.1	2.3	1.4

Ratio of Per Capita Incomes of High Income Countries to Others

	1990	2000	2020	2050	2100	2150
low income	66	73	48	17	3	1.4
China	83	42	22	8	2	1.3
mid income	8	10	6	3	2	1.2
high income	1	1	1	1	1	1

Total Energy Use (TW)

	1994	2000	2020	2050	2100	2150
low income	0.64	0.78	1.7	5.5	24.1	51
China	1.1	1.6	3.9	10.3	23.7	45.3
mid income	3.5	4.1	8.2	17.6	22.2	36.6
high income	6.2	7.1	6.1	4	3.5	3.5
WORLD	11.5	13.6	19.9	37.4	73.4	136.4

DISTRIBUTION OF INCOME

(values shown are per capita incomes for each population quintile, in '90 US $)

Low Income Countries	1994	2000	2020	2050	2100	2150
bottom 20%	106	113	243	1031	9273	29742
middle 20%	251	267	559	2317	20097	62934
top 20%	827	876	1817	7425	63097	194789

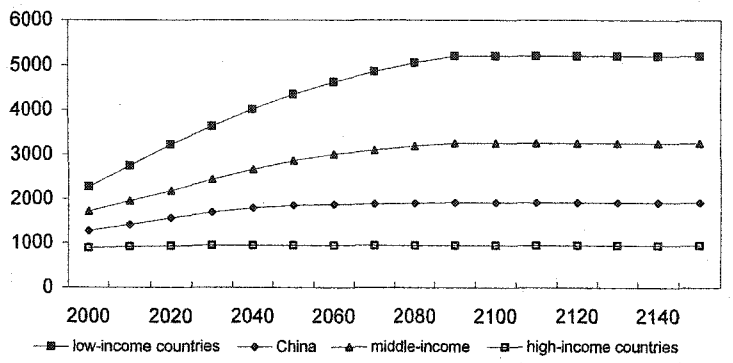
China	1994	2000	2020	2050	2100	2150
bottom 20%	136	194	523	2092	11385	32163
middle 20%	346	491	1306	5139	27413	77446
top 20%	962	1363	3601	14079	74430	210274

Middle Income Countries	1994	2000	2020	2050	2100	2150
bottom 20%	828	887	1913	5882	16035	39120
middle 20%	1911	2032	4266	12657	34147	83306
top 20%	6135	6495	13441	39083	104787	255643

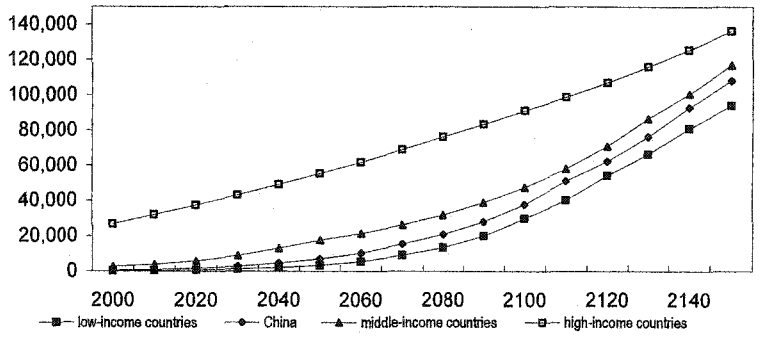
High Income Countries	1994	2000	2020	2050	2100	2150
bottom 20%	7373	8303	11632	17137	28184	41978
middle 20%	20475	23058	32303	47590	78267	116575
top 20%	48135	54208	75941	111881	183999	274058

BOX IA-15. SCENARIO 2 - POPULATION AND ECONOMY TRAJECTORIES

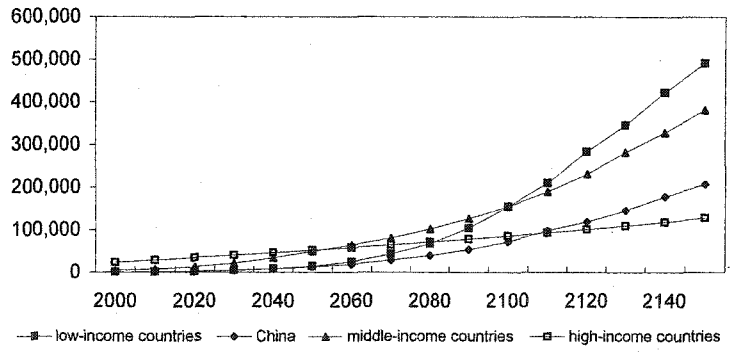
population (millions)



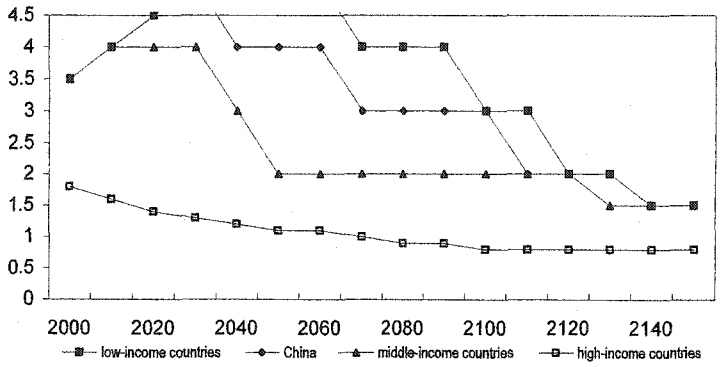
per capita GDP (1990 US $)



Total GDP (billion 1990 US $)

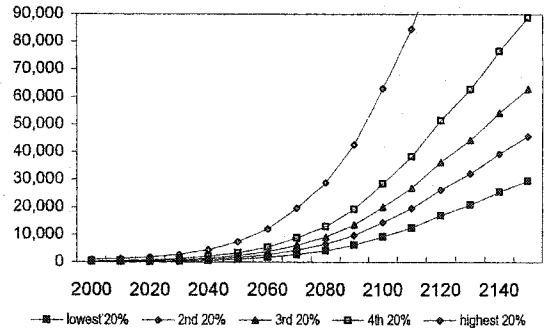


Per Capita GDP Growth Rates (%/yr)

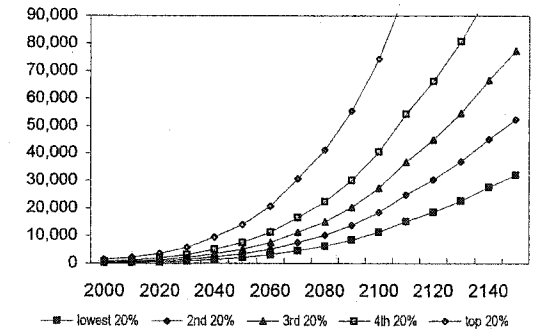


BOX IA-16. SCENARIO 2 - INCOME DISTRIBUTION TRAJECTORIES
[All values 1990 US $; all vertical axes to same scale]

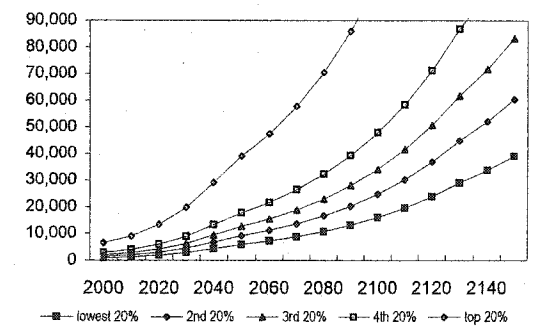
LOW-INCOME COUNTRIES
mean per capita income by quintile



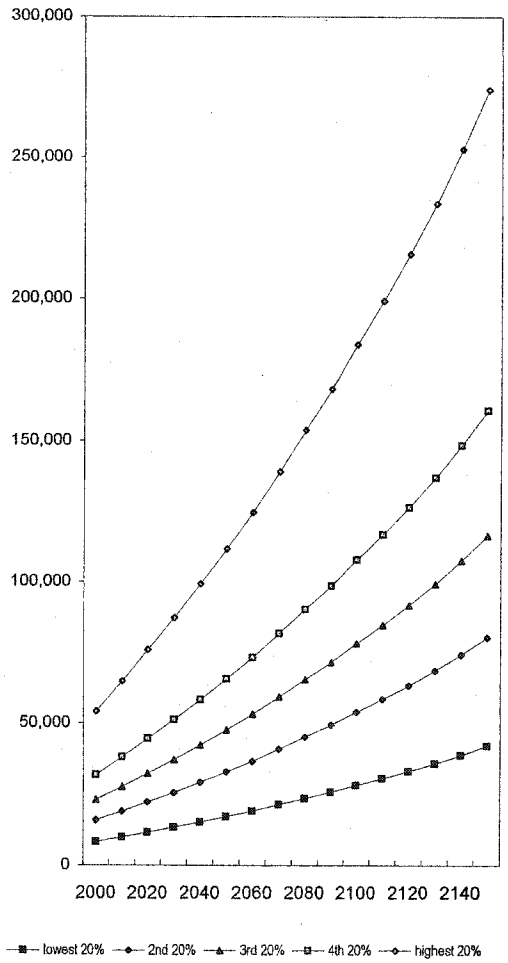
CHINA
mean per capita income by quintile



MIDDLE-INCOME COUNTRIES
mean per capita income by quintile



HIGH-INCOME COUNTRIES
mean per capita income by quintile



Under Scenario 2 the quintile income shares in each sector are unchanged from their Scenario 1 values. However, the absolute difference between quintiles in the three developing country sectors increases markedly, as seen in IA-16. In the low income countries, for example, the absolute difference between the highest and lowest quintile in 2150 was $21,600 in Scenario 1 but $165,000 in Scenario 2.

Scenario 2 represents the conventional responses to the challenge of economic inequality among nations--"increase per capita incomes in the developing countries"--and of environmental sustainability--"increase the efficiency of resource use." The results are encouraging in some ways but disconcerting in others. We've come very close to our goal of eliminating economic inequality among the countries of the world. The distribution of income within the developing countries has improved, but is unchanged in the high-income countries and still far from our goal. Total energy use is still 4.5 times higher than our goal of 30 TW, despite considerable improvements in energy efficiency.

Scenario 3:

a) faster growth in developing countries
b) *maximum practicable* energy efficiency
c) slower population growth
d) slower growth in high income countries

Scenario 3 modifies Scenario 2 by assuming that population will stabilize in mid-century at 9 billion rather than at 11 billion.[8] Scenario 3 also assumes that per capita GDP growth in the high and middle income countries slows at rates sufficient to allow the low income countries to catch up by 2150. Energy intensity declines along the "maximum practicable" energy efficiency path, shown in Figure 2 of IA-12 and described further in Appendix Box A2-7.

[8] A stable world population of 9 billion in the second half of the next century is the low projection made by IIASA (1994).

Results for Scenario 3 are shown in **IA-17, IA-18** and **IA-19**. Per capita GDP in 2150 is $82,000, in all four sectors. For the high income countries this is 40% less than they would have been realized under Scenario 2, but it is still 3.4 times the income they received in 1994.

In Scenario 3 energy use in 2150 is 61 TW. This is a dramatic improvement over the 136 TW of Scenario 2 but still double our goal of 30 TW.

Scenario 4:

a) faster growth in developing countries
b) maximum practicable energy efficiency
c) slower population growth
d) slower growth in high income countries
e) greater income equality within countries

In Scenario 4 we keep the per capita GDP growth and energy-efficiency improvement rates used in Scenario 3, but also model a reduction of income inequality within each of our four country sectors, using the procedure explained in IA-11.[9] Our goal is to reduce the 80/20 ratio of the high income countries, currently 6.5, to 2.5 by 2150. As noted earlier, the developing countries will approach the 80/20 level of the high income countries at a rate proportionate to the convergence of their per capita incomes. We make the simplifying assumption that the rate of growth of per capita GDP is invariant to changes in the distribution of income within the ranges shown in this exercise.[10]

Boxes IA-20 and **IA-21** shows how Scenario 4 compresses the quintile distributions in all four country sectors. In Scenario 3 the mean incomes of the top and bottom quintiles of the high income countries in 2150 are $164,000 and $25,000 (a ratio of 6.5 to 1) but in Scenario 4 these are $126,000 and $50,000 (a ratio of 2.5 to 1). In Scenario 3 all quintiles in each sector grow at

[9] At this point the cause of this improvement in the distribution of income need not be specified. It could be the result of policies of direct redistribution of income from high to low quintiles, of greater support for education and training of low income workers, of market forces unaccounted for in Scenario 1, or of other causes.

[10] The important topic of the relation between levels and rates of economic growth and economic inequality is discussed at length in Section II.B.2. The discussion there supports the simplifying assumption used here.

BOX IA-17. SCENARIO 3 - SUMMARY TABLES

Population (10^9 persons)

	1990	2000	2020	2050	2100	2150
low income	1.8	2.3	3.2	3.9	3.9	3.9
China	1.1	1.3	1.5	1.8	1.8	1.8
mid income	1.5	1.7	2.2	2.5	2.5	2.5
high income	0.8	0.9	0.9	0.9	0.9	0.9
WORLD	5.3	6.2	7.8	9	9	9

Per Capita GDP (1990 US $)

	1990	2000	2020	2050	2100	2150
low income	346	366	776	3,306	32,976	82,747
China	275	628	1,707	6,920	39,035	80,196
mid income	2,731	2,752	5,827	17,504	52,585	82,470
high income	22,742	26,689	36,754	49,119	63,070	80,984
WORLD	4,514	4,877	6,598	12,587	42,605	81,991

Per Capita GDP Growth Rates (% per year)

	1990	2000	2020	2050	2100	2150
low income	-0.08	3.5	4.5	5	3.3	0.5
China	11.7	5	5	4	3	0.5
mid income	-1.3	3.5	4	3	1.5	0.5
high income	1	1.7	1.2	0.5	0.5	0.5
WORLD	0.11	1.4	1.9	2.5	2.3	0.5

Ratio of Per Capita Incomes of High Income Countries to Others

	1990	2000	2020	2050	2100	2150
low income	66	73	47	15	2	1
China	83	42	22	7	1.6	1
mid income	8	10	6	3	1.2	1
high income	1	1	1	1	1	1

Total Energy Use (TW)

	1994	2000	2020	2050	2100	2150
low income	0.64	0.78	1.7	4.2	13.9	23.4
China	1.1	1.6	3.9	8.4	15.8	21.8
mid income	3.5	4.1	8.1	13.1	13.1	13.7
high income	6.2	7.1	5.9	3.5	2.3	2
WORLD	11.5	13.6	19.6	29.2	45.1	60.9

DISTRIBUTION OF INCOME

(values shown are per capita incomes for each population quintile, in '90 US $)

Low Income Countries	1994	2000	2020	2050	2100	2150
bottom 20%	106	113	243	1031	10203	26083
middle 20%	251	267	559	2317	22155	55191
top 20%	827	876	1817	7425	69435	170822

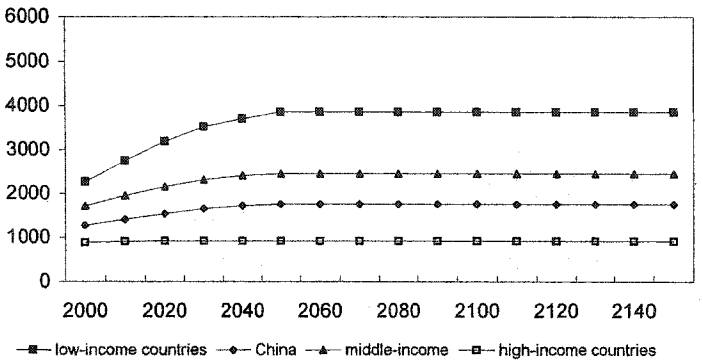
China	1994	2000	2020	2050	2100	2150
bottom 20%	136	194	523	2092	11720	23903
middle 20%	346	491	1306	5140	28222	57556
top 20%	962	1363	3601	14079	76627	156272

Middle Income Countries	1994	2000	2020	2050	2100	2150
bottom 20%	828	887	1913	5882	17676	27656
middle 20%	1911	2032	4266	12657	37645	58900
top 20%	6135	6495	13441	39083	115530	180761

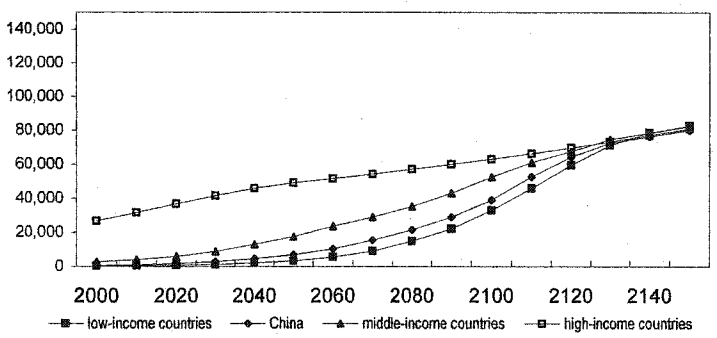
High Income Countries	1994	2000	2020	2050	2100	2150
bottom 20%	7373	8303	11405	15220	19531	25063
middle 20%	20475	23058	31673	42268	54239	69601
top 20%	48135	54208	74462	99368	127511	163626

BOX IA-18. SCENARIO 3 - POPULATION AND ECONOMY TRAJECTORIES

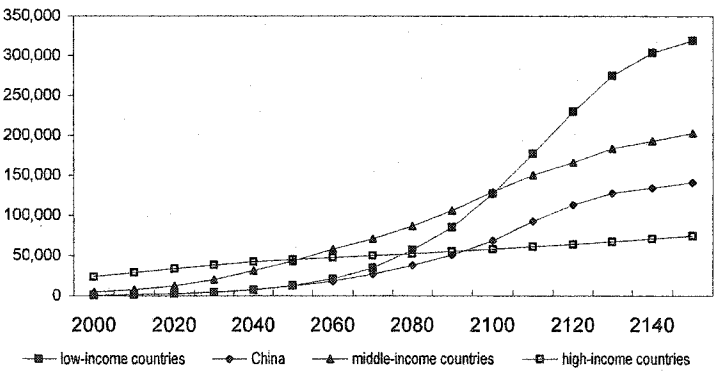
population (millions)



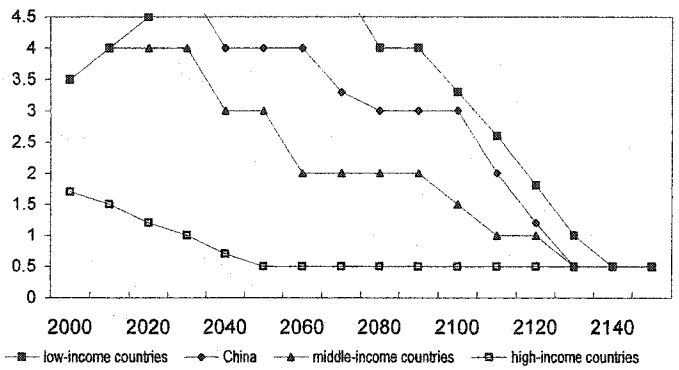
per capita GDP (1990 US $)



Total GDP (billion 1990 US $)



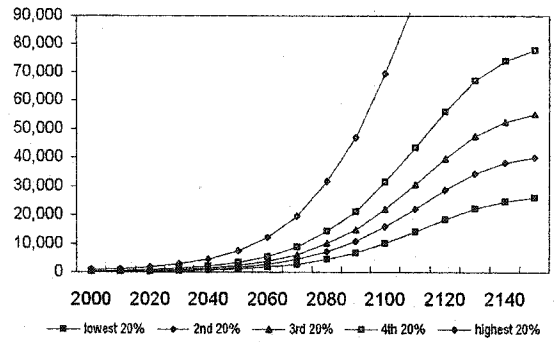
Per Capita GDP Growth Rates (%/yr)



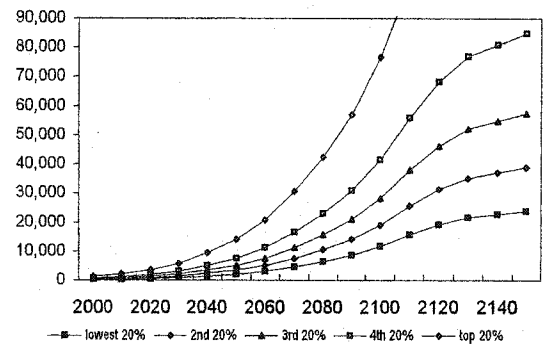
BOX IA-19. SCENARIO 3 - INCOME DISTRIBUTION TRAJECTORIES

[All values 1990 US $; all vertical axes to same scale]

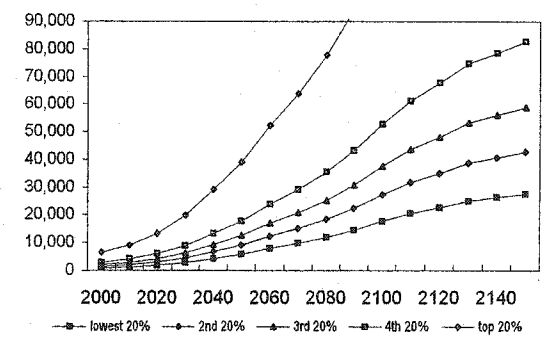
LOW-INCOME COUNTRIES
mean per capita income by quintile



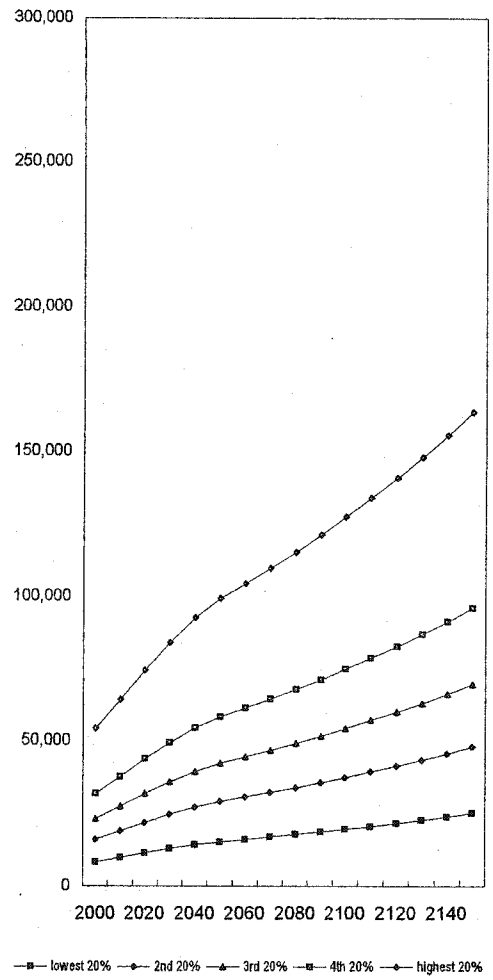
CHINA
mean per capita income by quintile



MIDDLE-INCOME COUNTRIES
mean per capita income by quintile



HIGH-INCOME COUNTRIES
mean per capita income by quintile



BOX IA-20. SCENARIO 4 - SUMMARY TABLES

[note: Scenario 4 differs from Scenario 3 only in the distribution of income]

Population (10^9 persons)

	1990	2000	2020	2050	2100	2150
low income	1.8	2.3	3.2	3.9	3.9	3.9
China	1.1	1.3	1.5	1.8	1.8	1.8
mid income	1.5	1.7	2.2	2.5	2.5	2.5
high income	0.8	0.9	0.9	0.9	0.9	0.9
WORLD	5.3	6.2	7.8	9	9	9

Per Capita GDP (1990 US $)

	1990	2000	2020	2050	2100	2150
low income	346	366	776	3,306	32,976	82,747
China	275	628	1,707	6,920	39,035	80,196
mid income	2,731	2,752	5,827	17,504	52,585	82,470
high income	22,742	26,689	36,754	49,119	63,070	80,984
WORLD	4,514	4,877	6,598	12,587	42,605	81,991

Per Capita GDP Growth Rates (% per year)

	1990	2000	2020	2050	2100	2150
low income	-0.08	3.5	4.5	5	3.3	0.5
China	11.7	5	5	4	3	0.5
mid income	-1.3	3.5	4	3	1.5	0.5
high income	1	1.7	1.2	0.5	0.5	0.5
WORLD	0.11	1.4	1.9	2.5	2.3	0.5

Ratio of Per Capita Incomes of High Income Countries to Others

	1990	2000	2020	2050	2100	2150
low income	66	73	47	15	2	1
China	83	42	22	7	1.6	1
mid income	8	10	6	3	1.2	1
high income	1	1	1	1	1	1

Total Energy Use (TW)

	1994	2000	2020	2050	2100	2150
low income	0.64	0.78	1.7	4.2	13.9	23.4
China	1.1	1.6	3.9	8.4	15.8	21.8
mid income	3.5	4.1	8.1	13.1	13.1	13.7
high income	6.2	7.1	5.9	3.5	2.3	2
WORLD	11.5	13.6	19.6	29.2	45.1	60.9

DISTRIBUTION OF INCOME

(values shown are per capita incomes for each population quintile, in '90 US $)

Low Income Countries	1994	2000	2020	2050	2100	2150
bottom 20%	106	113	265	1365	16843	49448
middle 20%	251	267	568	2448	24723	64369
top 20%	827	876	1773	6751	56028	123640

China	1994	2000	2020	2050	2100	2150
bottom 20%	136	194	566	2740	19327	46749
middle 20%	346	491	1319	5337	30543	64526
top 20%	962	1363	3526	12956	63444	116673

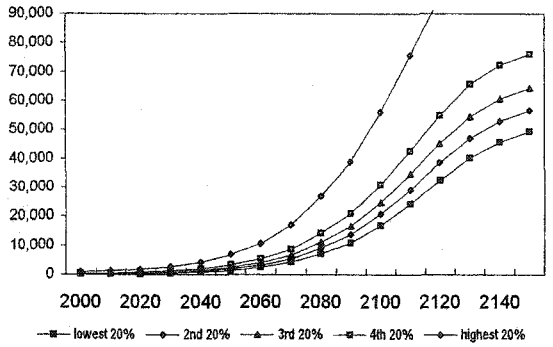
Middle Income Countries	1994	2000	2020	2050	2100	2150
bottom 20%	828	887	2065	7545	28439	52382
middle 20%	1911	2032	4325	13299	41804	68448
top 20%	6135	6495	13136	35743	93916	131108

High Income Countries	1994	2000	2020	2050	2100	2150
bottom 20%	7373	8303	12382	20154	33266	50280
middle 20%	20475	23058	31865	43265	56931	74544
top 20%	48135	54208	72996	91961	106892	125769

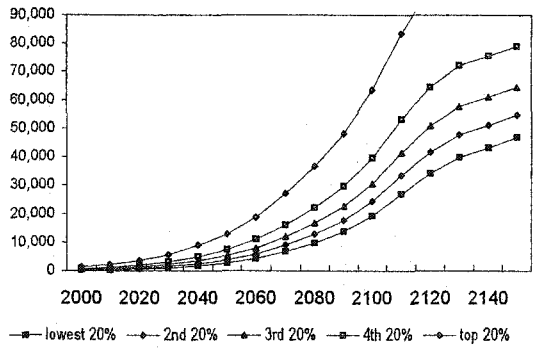
BOX IA-21. SCENARIO 4 - INCOME DISTRIBUTION TRAJECTORIES

[All values 1990 US $; all vertical axes to same scale]

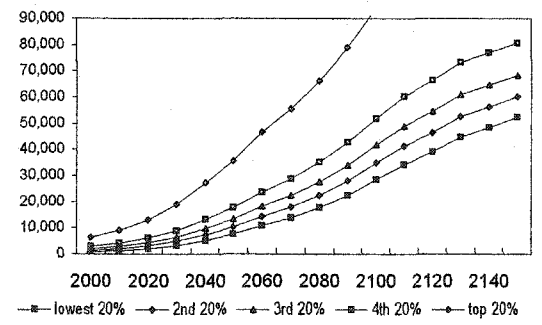
LOW-INCOME COUNTRIES
mean per capita income by quintile



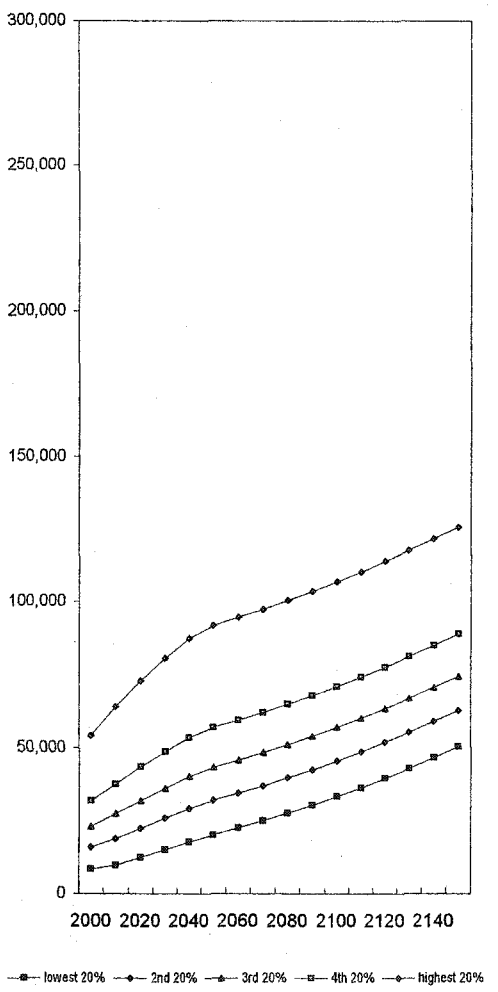
CHINA
mean per capita income by quintile



MIDDLE-INCOME COUNTRIES
mean per capita income by quintile



HIGH-INCOME COUNTRIES
mean per capita income by quintile



the same rate, but in Scenario 4 the higher income quintiles grow more slowly and the lower income quintiles grow more rapidly. For example, in Scenario 3 the growth rate of per capita income at the end of our study is 0.5% for all quintiles, but in Scenario 4 the rates are 0.76% for the lowest quintile and 0.63%, 0.54%, 0.46%, and 0.33% for the others, in ascending order.

Scenario 5:

a) faster growth in developing countries
b) maximum practicable energy efficiency
c) slower population growth
d) slower growth in high income countries
e) greater income equality within countries
f) zero output growth by 2150

In Scenario 4 we found that we are able to meet most of the conditions for a desirable world that we specified at the beginning of this exercise, at least through the year 2150.

However, we were not able to reach our goal of stabilizing energy use at 30 TW – the best we could do was 61 TW.

Scenario 5 models a world in which energy use can be sustained at about 30 TW after 2150. To achieve this we increase the rate of decline of the growth rate of income of the high income countries, such that by 2050 it reaches zero. The developing countries continue to grow for the rest of the century in order to achieve economic equality, but later in the century growth in these countries begins to slow as well, and zero economic growth is reached by 2150 or earlier. No other modifications of Scenario 4 are made.

Boxes IA-22, IA-23 and **IA-24** show the results. World energy use stabilizes at 33 TW, which is close enough, for the purposes of this exercise, to our goal of 30 TW. Per capita income stabilizes at $45,000. This is certainly less than the $106,000 we achieved in Scenario 2, but it is still 10 times the current world per capita income figure of $4,500, and indeed twice as much as the current per capita income of the top quintile in the high income countries ($23,671). Per capita income is the same in all four sectors. Within countries the 80/20 ratio is 2.5 to 1. Per

BOX IA-22. SCENARIO 5 - SUMMARY TABLES

Population (10^9 persons)

	1990	2000	2020	2050	2100	2150
low income	1.8	2.3	3.2	3.9	3.9	3.9
China	1.1	1.3	1.5	1.8	1.8	1.8
mid income	1.5	1.7	2.2	2.5	2.5	2.5
high income	0.8	0.9	0.9	0.9	0.9	0.9
WORLD	5.3	6.2	7.8	9	9	9

Per Capita GDP (1990 US $)

	1990	2000	2020	2050	2100	2150
low income	346	366	775	3,306	22,551	44,513
China	275	628	1,706	6,920	29,799	45,352
mid income	2,731	2,752	5,827	17,504	40,546	44,809
high income	22,742	26,689	34,614	44,892	44,892	44,892
WORLD	4,514	4,877	6,345	12,154	31,177	44,797

Per Capita GDP Growth Rates (% per year)

	1990	2000	2020	2050	2100	2150
low income	-0.08	3.5	4.5	5	2.8	0
China	11.7	5	5	4	1.7	0
mid income	-1.3	3.5	4	3	0.5	0
high income	1	1.4	1.1	0	0	0
WORLD	0.11	1.2	1.9	2.4	1.4	0

Ratio of Per Capita Incomes of High Income Countries to Others

	1990	2000	2020	2050	2100	2150
low income	66	73	45	14	2	1
China	83	42	20	6	1.5	1
mid income	8	10	6	3	1	1
high income	1	1	1	1	1	1

Total Energy Use (TW)

	1990	2000	2020	2050	2100	2150
low income	0.64	0.78	1.7	4.2	9.5	12.6
China	1.1	1.6	3.9	8.4	12.1	12.3
mid income	3.5	4.1	8.1	13.1	10.1	7.5
high income	6.2	7.1	5.5	3.2	1.7	33.5
WORLD	11.5	13.6	19.2	28.9	33.3	35.2

DISTRIBUTION OF INCOME

(values shown are per capita incomes for each population quintile, in '90 US $)

Low Income Countries	1994	2000	2020	2050	2100	2150
bottom 20%	106	113	264	1365	11708	27147
middle 20%	251	267	568	2448	17168	35298
top 20%	827	876	1773	6751	38856	67681

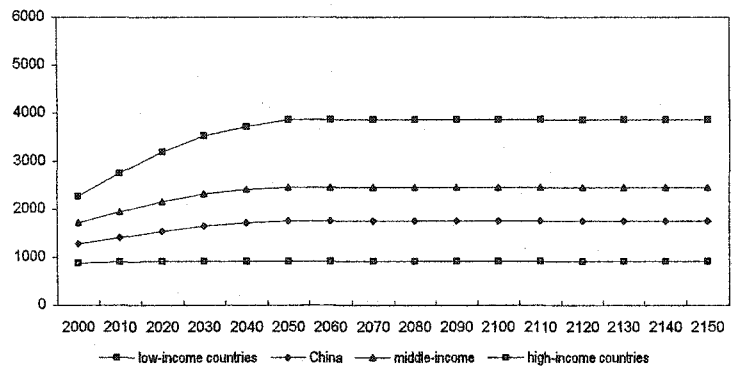
China	1994	2000	2020	2050	2100	2150
bottom 20%	136	194	566	2740	14881	26793
middle 20%	346	491	1319	5337	23497	36938
top 20%	962	1363	3526	12956	48770	66697

Middle Income Countries	1994	2000	2020	2050	2100	2150
bottom 20%	828	887	2065	7545	22034	28877
middle 20%	1911	2032	4325	13299	32364	37431
top 20%	6135	6495	13136	35743	72653	71577

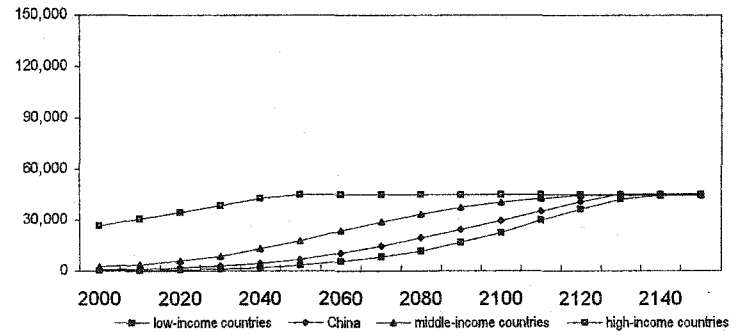
High Income Countries	1994	2000	2020	2050	2100	2150
bottom 20%	7373	8303	11673	18445	23747	27987
middle 20%	20475	23058	30035	39558	40597	41427
top 20%	48135	54208	68800	84129	76170	69818

BOX IA-23. SCENARIO 5 - POPULATION AND ECONOMY TRAJECTORIES

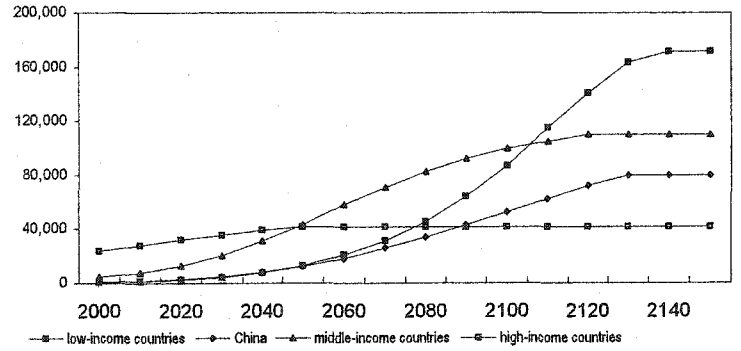
population (millions)



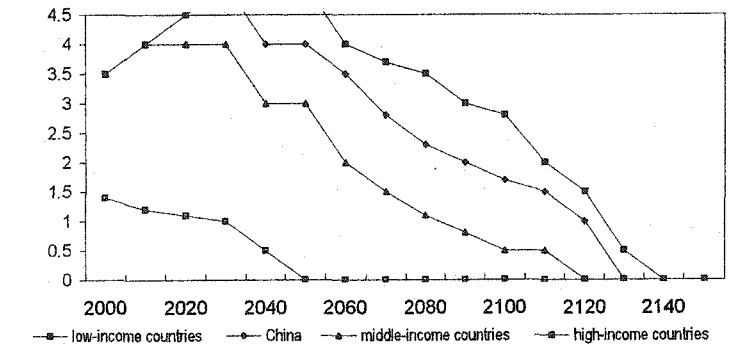
per capita GDP (1990 US $)



Total GDP (billion 1990 US $)



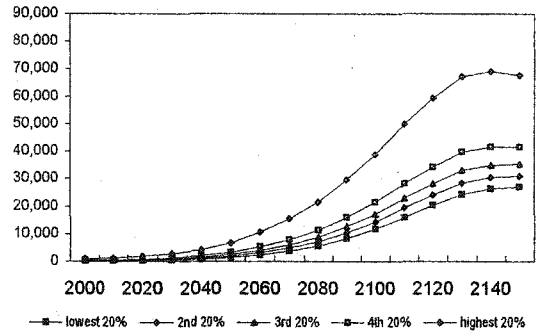
Per Capita GDP Growth Rates (%/yr)



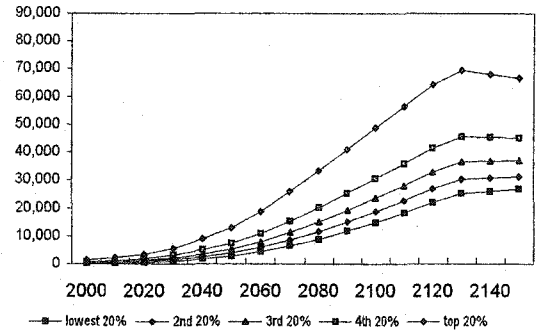
BOX IA-24. SCENARIO 5 - Income Distribution Trajectories

[All values 1990 US $; all vertical axes to same scale]

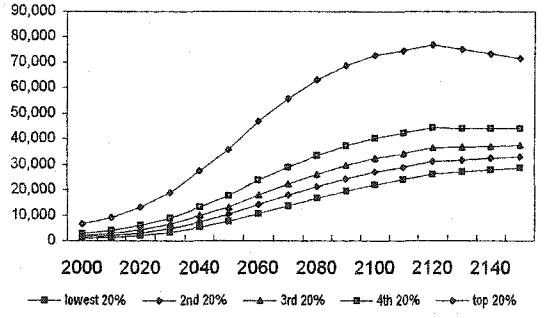
LOW-INCOME COUNTRIES
mean per capita income by quintile



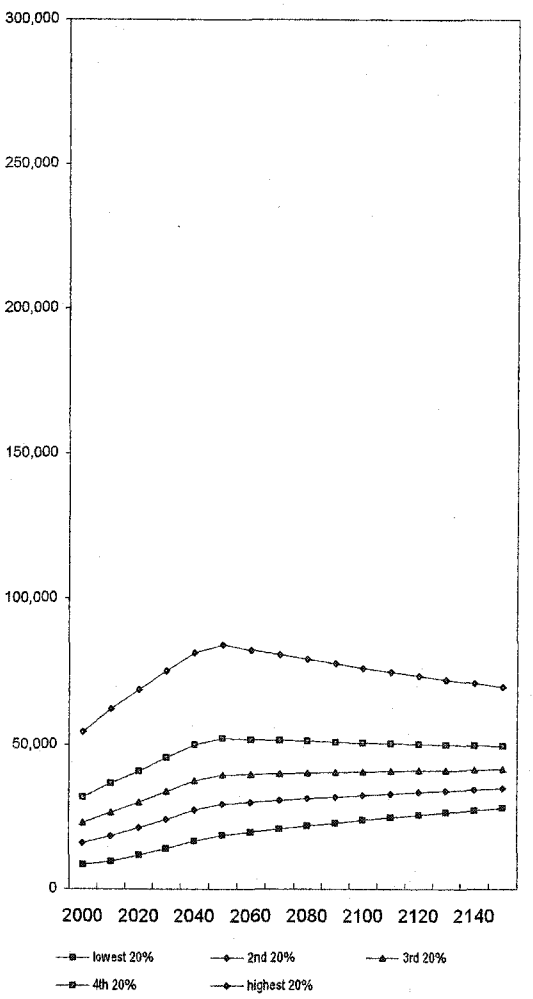
CHINA
mean per capita income by quintile



MIDDLE-INCOME COUNTRIES
mean per capita income by quintile



HIGH-INCOME COUNTRIES
mean per capita income by quintile



capita income for the top quintile in all sectors is about $70,000 and for the bottom quintile about $28,000.

It is important to note that in this scenario the top income quintile undergoes an absolute reduction of income, not just a relative one. In the high income countries this begins in 2050, when per capita incomes in the top quintile are $84,000, and declines to $70,000 by 2150, a decrease of 17%. In the developing countries this decline doesn't begin until the final decades before 2150, and is proportionately much smaller. This absolute reduction in top quintile incomes is an arithmetic necessity if we desire both a level of output consistent with a 30 TW world *and* distributional equity of the degree reflected in an 80/20 ratio of 2.5 to 1. Note that during the period that the incomes of the top quintile in the high income countries are declining, those of the lower quintiles are still increasing. This is precisely the relation that we would expect if distributional equity is increasing at the same time that per capita output growth has come to an end.

Is it realistic to expect that upper quintile households would agree to the protracted reduction in their absolute levels of income shown in Scenario 5? I don't know.[11] Is there any way that this feature of Scenario 5 could be avoided? Yes, but there is trade-off. **IA-25** displays the high-income country income growth trajectories for Scenario 6, which achieves all of the same final goals that Scenario 5 does but does so without requiring that the top income quintiles undergo any absolute reduction of income.[12] We see that in order for this to happen, the gap between the top and bottom quintiles must be reduced much more rapidly than in Scenario 5. Rather than wait until 2050 for significant redistributive policies to come into force, they would

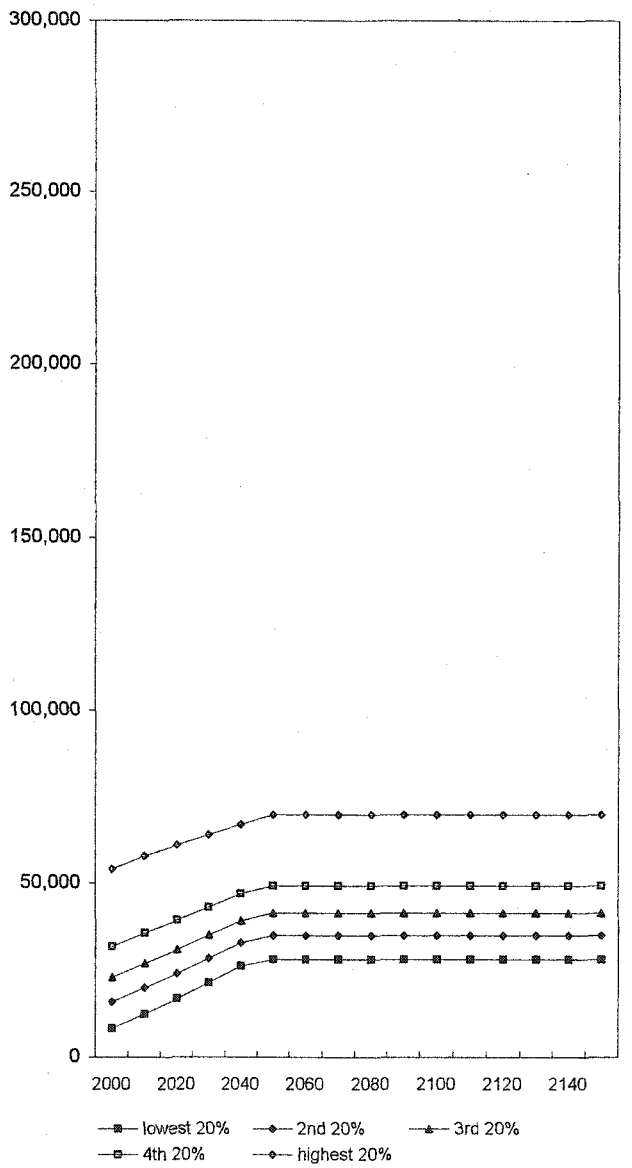
[11] We discuss public opinion and values concerning economic inequality, well-being and growth at length in Sections II.B.4 and II.C.3.

[12] Under Scenario 6 the per capita GDP growth trajectories for the low income countries, China and the middle income countries are very similar to those shown in Box IA-24, except that the final per capita income level of the top quintile--$70,000—is approached and achieved monotonically, in the final two or three decades before 2150.

BOX IA-25. SCENARIO 6 - INCOME DISTRIBUTION TRAJECTORIES

[All values 1990 US $]

HIGH-INCOME COUNTRIES
mean per capita income by quintile



need to be in effect in the very first decades of the 21st century, and we would need to have achieved our stated distributive goals (for the high income countries) by 2050, not 2150.

Scenarios 5 and 6 end in 2150 with steady-state levels of both resource use and per capita GDP. It might be objected that continued efficiency gains, beyond the 500% improvement already assumed, could allow per capita GDP to continue to grow, even while resource throughput remains constant. This is true. But if we showed such growth, the objection could be raised that we were simply refusing to acknowledge that there must be *some* limit to the ability of a constant flow of resources to generate increasingly greater quantities of output, and that by doing so we were avoiding having to deal with the profound social and political implications of any scenarios that call for a steady-state level of resource use. This tension is a set-piece of the growth/environment discourse, and is irresolvable analytically. The critical questions involve our expectations and values concerning the nature of technological change. These topics are discussed at length in Section II.A.3, in Section II.E, and throughout the text. For the time being we leave Scenarios 5 and 6 with steady-state levels of both throughput and output, for the express purpose of forcing us to engage the social and political challenges that such scenarios present.

I.A.4. ASSESSMENT

The purpose of this exercise was to find out what it would take to achieve a 30 TW world in which inequality among countries has been eliminated and inequality within countries has been reduced to the level represented by an 80/20 ratio of 2.5, within the next 150 years.

We found that such a world could be achieved if energy efficiency improves along the maximum practicable path shown in Figure 2 of IA-12, if population stabilizes at 9 rather than 11 billion, if the low income countries grow at per capita rates of 4-5% for most of this century and then reduce their growth rates to zero over the following half century, if the high income countries are willing to reduce their rate of economic growth to zero by the middle of this century, and if households in the top income quintile of the high income countries are willing to

undergo an absolute reduction of their incomes of 17% over the century beginning in 2050. The more rapidly income inequality is reduced, the more easily the top income quintile in the high income countries will be able to avoid an absolute income decline.

Clearly, this exercise is the beginning of an inquiry, not the end. Are the assumptions concerning energy efficiency improvements and population growth too pessimistic, or maybe too optimistic? What would it take, practically, for the lower income countries to achieve the high growth rates shown in Scenario 5?

In our exercise, energy use served as a proxy for a wide range of threats to the environment. How might a fuller analysis of potential environmental dangers change our results? Are there biogeophysical limits that might enforce an end to economic growth, perhaps catastrophically? If so, are these limits close enough to motivate important changes in our lives, or are they so distant that we can afford some period, perhaps a very long period, of conventional output growth?

Are there limits to the ability of technology to generate, decade after decade, the product and efficiency innovations that enable output to grow? If there are, then economic growth would slow to a stop on its own accord. How close to or far from such limits might we be?

How credible is our assumption that there is little dynamic relation between economic growth and economic inequality? This assumption cries out for more study. If continued growth tends to generate greater inequality then our desires to protect the environment and to ensure economic justice could reinforce one another. If continued growth tends to generate greater equality then these desires may be in conflict. But the degree of economic inequality might itself have an impact—either positive or negative--on the rate of economic growth. In that event the question of how the several values we are juggling might reinforce one another, or work against one another, becomes very complicated.

Finally, what would it take for the high income countries to agree to bring their economic growth to an end within the next 50 years, and for the top 20% of income earners to agree to a

reduction of their incomes? What would it take for all of humankind to agree to stable incomes as of 2150?

These are just a few of the questions that we try to provide answers for in Section II of this dissertation. But before we do that, we need to expand and enrich the quantitative scenarios developed in this section by considering a number of important political, social and cultural factors that bear on our concerns for economic well-being, ecological integrity and social equity.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1	**BOX 1A-26 MODEL A SCENARIO 1 - Reference Scenario (pt 1)**																					
2					1990	1994	2000	2010	2020	2030	2040	2050	2060	2070	2080	2090	2100	2110	2120	2130	2140	2150
3	**POPULATION GROWTH (%/yr)**																					
4	low-income countries				2.17	2.2	1.9	1.6	1.2	1	0.8	0.6	0.5	0.4	0.3	0	0	0	0	0	0	0
5	China				1.2	1.2	1	1	0.8	0.6	0.3	0.1	0.1	0.08	0.06	0	0	0	0	0	0	0
6	middle-income countries				1.5	1.5	1.3	1.1	1.1	0.9	0.7	0.5	0.3	0.3	0.2	0	0	0	0	0	0	0
7	high-income countries				0.7	0.7	0.3	0.2	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0
8																						
9	world				1.54157	1.5722	1.32969	1.16826	0.96948	0.79084	0.6	0.42495	0.32723	0.28132	0.20512	0	0	0	0	0	0	
10																						
11	**POPULATION (10^6)**																					
12	low-income countries				1826	1991	2271.95	2747.35	3224.05	3635.1	4017.41	4352.01	4621.12	4858.05	5056.31	5210.3	5210.3	5210.3	5210.3	5210.3	5210.3	5210.3
13	China				1135	1191	1279.91	1414.52	1563.29	1693.49	1798.21	1852.98	1871.6	1890.41	1905.59	1917.06	1917.06	1917.06	1917.06	1917.06	1917.06	1917.06
14	middle-income countries				1479	1570	1717.85	1956.34	2183.82	2437.75	2667.32	2860.73	3007.4	3098.99	3193.37	3257.88	3257.88	3257.88	3257.88	3257.88	3257.88	3257.88
15	high-income countries				827	850	886.46	913.457	931.91	941.276	941.276	941.276	941.276	941.276	941.276	941.276	941.276	941.276	941.276	941.276	941.276	941.276
16																						
17	world				5267	5602	6156.18	7031.67	7903.07	8707.62	9424.22	10007	10441.4	10788.7	11096.5	11326.5	11326.5	11326.5	11326.5	11326.5	11326.5	11326.5
18																						
19	**PER CAPITA GDP**																					
20	**GROWTH RATE (%/yr)**																					
21	low-income countries				-0.08	1	1.9	2.3	2.6	2.8	2.9	3	2.9	2.7	2.5	2.3	2.1	1.9	1.7	1.5	1.4	1.3
22	China				11.7	6	4	3.6	3.4	3.2	3.1	3	2.9	2.7	2.5	2.3	2.1	1.9	1.7	1.5	1.4	1.3
23	middle-income countries				-1.3	1	1.9	2	2.1	2.2	2.1	2	1.9	1.7	1.5	1.4	1.3	1.2	1.1	1	1	1
24	high-income countries				1	2	1.8	1.6	1.4	1.3	1.2	1.1	1.1	1	0.9	0.9	0.8	0.8	0.8	0.8	0.8	0.8
25																						
26	world				0.10617	1.21577	1.08969	1.04574	1.09289	1.17929	1.29409	1.38469	1.4482	1.39796	1.33546	1.40075	1.30442	1.24218	1.16926	1.08732	1.06174	
27																						
28	**PER CAPITA GDP ($/k)**																					
29	low-income countries				346	345	366.334	442.989	557.546	723.098	956.752	1278.63	1725.97	2306.63	3021.61	3879.82	4883.14	6024.23	7284.79	8634.7	10032.1	11539.7
30	China				275	438	627.798	936.565	1342.41	1886.01	2597.28	3541.19	4780.11	6388.27	8368.41	10745.2	13524	16684.2	20175.4	23914	27784.1	31959.3
31	middle-income countries				2731	2592	2752.28	3328.19	4065.07	5014.98	6249.05	7709.32	9416.18	11386.5	13496.5	15680.7	18037.1	20541.1	23160.1	25853.1	28572.1	31577
32	high-income countries				22742	23671	26689	31952.5	37496.6	43131.4	49119.2	55381.8	61821.5	69009.9	76267.8	83450.3	91309.1	98914	107152	116077	125744	136217
33																						
34	world				4514.52	4533.74	4876.82	5438.27	6037.78	6735.05	7578.04	8624.99	9905.92	11449.6	13167.5	15048.7	17311.5	19723.5	22332.2	25102.2	27985.5	31120.4
35																						
36	**GDP GROWTH RATE (%/yr)**																					
37	low-income countries				2.09	3.2	3.8	3.9	3.8	3.8	3.7	3.6	3.4	3.1	2.8	2.3	2.1	1.9	1.7	1.5	0.5	1.3
38	China				12.9	7.2	5	4.6	4.2	3.8	3.4	3.1	3	2.78	2.56	2.3	2.1	1.9	1.7	1.5	1.4	1.3
39	middle-income countries				0.2	2.5	3.2	3.1	3.2	3.1	2.8	2.5	2.2	2	1.7	1.4	1.3	1.2	1.1	1	1	1
40	high-income countries				1.7	2.7	2.1	1.8	1.5	1.3	1.2	1.1	1.1	1	0.9	0.9	0.8	0.8	0.8	0.8	0.8	0.8
41																						
42	world				1.64774	2.78797	2.41937	2.21401	2.06237	1.97013	1.8941	1.80964	1.77543	1.67928	1.54059	1.40075	1.30442	1.24218	1.16926	1.08732	1.06174	
43																						
44	**GDP (10^9 $)**																					
45	low-income countries				631	686	832.29	1217.05	1797.55	2628.53	3843.66	5564.61	7975.91	11205.7	15278.2	20215	25442.6	31388	37955.9	44989.4	52270.2	60125
46	China				312	522	803.528	1324.79	2098.57	3193.95	4670.46	6561.75	8946.45	12076.4	15946.8	20599.3	25926.3	31984.7	38677.5	45844.6	53263.8	61268
47	middle-income countries				4038	4070	4728.01	6511.08	8877.37	12225.3	16668.2	22054.3	28318.2	35286.7	43099.2	51085.7	58762.6	66920.5	75452.7	84226.1	93084.3	102874
48	high-income countries				18797	20120	23658.7	29187.2	34943.5	40598.5	46234.8	52129.5	58191.1	64957.4	71789	78549.7	85947.1	93105.4	100860	109260	118360	128218
49																						
50	world				23778	25398	30022.6	38240.2	47717	58646.3	71417.1	86310.1	103432	123526	146113	170450	196079	223399	252946	284320	316978	352485
51																						
52	**RATIO OF HIGH-INCOME PER CAPITA**																					
53	**GDP TO THAT OF OTHER COUNTRIES**																					
54	low-income countries				65.7283	68.6116	72.8543	72.1294	67.253	59.6481	51.3396	43.3134	35.8184	29.918	25.2408	21.5088	18.6988	16.4194	14.709	13.443	12.5342	11.8043
55	China				82.6982	54.0434	42.512	34.1167	27.9324	22.8691	18.9118	15.6393	12.9331	10.8026	9.11378	7.76625	6.75165	5.92859	5.31104	4.85392	4.52577	4.26221
56	middle-income countries				8.32735	9.13233	9.69704	9.60055	9.22411	8.6005	7.86027	7.18375	6.56545	6.06067	5.65093	5.32185	5.0623	4.81541	4.62659	4.48986	4.40095	4.31381
57	high-income countries				1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
58																						

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
59	**BOX IA-26 (cont.) MODEL A SCENARIO 1 - Reference Scenario (pt 2)**																					
60					1990	1994	2000	2010	2020	2030	2040	2050	2060	2070	2080	2090	2100	2110	2120	2130	2140	2150
61	**REFERENCE CASE**																					
62	**DISTRIBUTIONAL CHANGE (%)**																					
63	low-income countries					0.06	0.06	0.06	0.05	0.05	0.05	0.05	0.05	0.05	0.04	0.04	0.04	0.04	0.04	0.04	0	
64	China					0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.025	0	0	0	0	0	0	
65	middle-income countries					0.08	0.08	0.08	0.08	0.08	0.07	0.07	0	0	0	0	0	0	0	0	0	
66	hi-income countries					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
67																						
68	**REFERENCE CASE QUINTILES (mean $/person)**																					
69	low-income countries																					
70		Q1				106	113.423	138.703	176.344	230.324	306.691	412.302	559.602	752.084	991.176	1278.49	1617.07	2005.54	2438.87	2907.92	3399.37	3906.41
71		Q2				176	187.465	227.554	287.228	372.96	493.779	660.094	891.001	1191.01	1561.32	2005.48	2526.12	3120.2	3779.09	4488	5225.9	6005.38
72		Q3				251	266.796	322.752	406.033	525.783	694.23	925.586	1246.07	1661.29	2172.19	2784.39	3500.09	4314.47	5215.05	6180.94	7182.9	8254.28
73		Q4				364	386.321	466.162	585.032	756.037	996.243	1325.59	1781.04	2369.85	3092.56	3957.96	4967.55	6113.85	7378.55	8731.64	10131.4	11642.6
74		Q5				827	876.055	1053.87	1318.45	1699.47	2233.69	2964.56	3973.01	5273.06	6863.65	8766.47	10980.2	13486.5	16243.2	19182.7	22212.7	25525.8
75	China																					
76		Q1				136	193.888	289.433	415.698	584.364	805.678	1100.04	1487.37	1991.54	2615.12	3364.21	4223.18	5198.73	6275.36	7427.6	8620.03	9905.77
77		Q2				230	326.927	485.607	694.029	972.075	1335.39	1816.78	2447.81	3266.1	4273.93	5482.45	6882.26	8472.04	10226.6	12104.3	14047.5	16142.8
78		Q3				346	491.103	727.695	1037.5	1450.53	1989.08	2701.28	3633.04	4838.95	6320.96	8096.44	10163.7	12511.5	15102.5	17875.5	20745.3	23839.6
79		Q4				517	733.122	1084.57	1543.83	2155.83	2952.71	4005.14	5380.23	7157.56	9338.57	11949.8	15000.9	18466.1	22290.4	26383.2	30618.7	35185.7
80		Q5				962	1362.93	2013.26	2861.46	3991.27	5460.41	7398.25	9927.01	13191.4	17191.4	21977.6	27589.1	33962.1	40995.6	48522.8	56312.7	64712.2
81	middle-income countires																					
82		Q1				828	887.821	1089.29	1349.1	1686.69	2128.71	2654.66	3277.49	3956.24	4682.66	5434.42	6245	7106.03	8006.31	8931.9	9866.37	10898.6
83		Q2				1352	1441.42	1752.3	2151	2666.12	3336.75	4131.59	5065.54	6114.6	7237.31	8399.19	9652	10982.8	12374.2	13804.7	15249	16844.4
84		Q3				1911	2031.99	2459.61	3006.46	3710.97	4625.48	5707.17	6973.02	8417.11	9962.6	11562	13286.6	15118.4	17033.8	19003.1	20991.2	23187.4
85		Q4				2735	2902.54	3502.22	4267.46	5251.14	6525.15	8029.67	9784.77	11811.2	13979.8	16224.2	18644.1	21214.7	23902.4	26665.7	29455.5	32537.2
86		Q5				6135	6494.59	7804.25	9470.63	11606.2	14363.6	17612.8	21386.6	25815.7	30555.8	35461.3	40750.6	46369.1	52243.6	58283.4	64381.1	71116.8
87	high-income countries																					
88		Q1				7373	8303.2	9924.83	11632.2	13367.2	15210.2	17137.2	19118.4	21328.6	23560	25768.4	28183.8	30521.4	33052.9	35794.4	38763.3	41978.4
89		Q2				14120	15901.4	19007	22276.7	25599.4	29128.9	32819.3	36613.5	40846.3	45119.7	49349	53974.7	58451.4	63299.5	68549.7	74235.4	80392.7
90		Q3				20475	23058.2	27561.5	32302.8	37121	42239	47590.4	53092.2	59230	65426.8	71559.5	78267.1	84758.7	91788.8	99402	107647	116575
91		Q4				28245	31808.5	38020.7	44561.3	51207.9	58268.2	65650.3	73240	81707.1	90255.5	98715.4	107968	116924	126621	137124	148497	160814
92		Q5				48135	54207.8	64794.7	75941.1	87268.3	99300.4	111881	124815	139245	153813	168230	183999	199261	215788	233686	253068	274058
93																						
94	**REFERENCE CASE 80/20 ratios**																					
95	low-income countries					7.80	7.72	7.60	7.48	7.38	7.28	7.19	7.10	7.01	6.92	6.86	6.79	6.72	6.66	6.60	6.53	6.53
96	China					7.07	7.03	6.96	6.88	6.83	6.78	6.73	6.67	6.62	6.57	6.53	6.53	6.53	6.53	6.53	6.53	6.53
97	middle-income countries					7.41	7.32	7.16	7.02	6.88	6.75	6.63	6.53	6.53	6.53	6.53	6.53	6.53	6.53	6.53	6.53	6.53
98	high-income countries					6.53	6.53	6.53	6.53	6.53	6.53	6.53	6.53	6.53	6.53	6.53	6.53	6.53	6.53	6.53	6.53	6.53
99																						
100	**REFERENCE CASE GINI Coefficients**																					
101	low-income countries					0.37867	0.37757	0.37682	0.37679	0.37772	0.3791	0.38072	0.38259	0.38423	0.38543	0.38656	0.38732	0.38773	0.38783	0.38765	0.38721	0.388
102	China					0.35361	0.36156	0.36674	0.37067	0.37436	0.37751	0.3804	0.38304	0.38544	0.38739	0.38909	0.3912	0.39296	0.3944	0.39555	0.39644	0.39722
103	middle-income countries					0.37019	0.36868	0.36728	0.36608	0.36507	0.36428	0.36368	0.36293	0.36442	0.36562	0.36654	0.36735	0.36805	0.36864	0.36914	0.36956	0.36997
104	high-income countries					0.32333	0.32437	0.32577	0.32688	0.32772	0.32845	0.32908	0.3296	0.33012	0.33055	0.3309	0.33125	0.33153	0.33181	0.33208	0.33236	0.33264
105																						

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
153	**BOX IA-26 (cont.) MODEL A SCENARIO 1 - Reference Scenario (pt 3)**																					
154																						
155					1990	1994	2000	2010	2020	2030	2040	2050	2060	2070	2080	2090	2100	2110	2120	2130	2140	2150
156	**Energy/GDP change (%/yr)**																					
157	low-income countries					0.00	0.00	-0.10	-0.20	-0.30	-0.40	-0.50	-0.50	-0.50	-0.50	-0.50	-0.25	-0.25	-0.25	-0.25	-0.25	-0.20
158	China					-1.00	-1.00	-0.90	-0.80	-0.70	-0.60	-0.50	-0.50	-0.50	-0.50	-0.50	-0.25	-0.25	-0.25	-0.25	-0.25	-0.20
159	middle-income countries					-0.12	-0.12	-0.20	-0.27	-0.35	-0.42	-0.50	-0.50	-0.50	-0.50	-0.50	-0.25	-0.25	-0.25	-0.25	-0.25	-0.20
160	high-income countries					-0.50	-0.50	-0.50	-0.50	-0.50	-0.50	-0.50	-0.50	-0.50	-0.50	-0.50	-0.25	-0.25	-0.25	-0.25	-0.25	-0.20
161																						
162	world					-0.0552	0.07829	0.13735	0.21697	0.22122	0.14584	0.06888	0.00385	-0.0391	-0.0914	-0.1824	0.04567	-0.0035	-0.0514	-0.098	-0.1195	
163																						
164	**Energy/GDP (W/$)**																					
165	low-income countries					0.937	0.937	0.937	0.92768	0.90931	0.88243	0.84783	0.80648	0.76715	0.72974	0.69415	0.66029	0.64399	0.62809	0.61258	0.59746	0.58271
166	China					2.094	1.97205	1.78439	1.63081	1.50543	1.40365	1.32191	1.25744	1.19611	1.13778	1.08229	1.0295	1.00408	0.97929	0.95511	0.93153	0.90853
167	middle-income countries					0.873	0.86674	0.8564	0.83944	0.81708	0.78898	0.75652	0.71963	0.68453	0.65115	0.61939	0.58918	0.57464	0.56045	0.54661	0.53311	0.51995
168	high-income countries					0.31	0.30084	0.28617	0.27221	0.25893	0.24631	0.23429	0.22287	0.212	0.20166	0.19182	0.18247	0.17796	0.17357	0.16928	0.1651	0.16103
169																						
170	world					0.45382	0.45232	0.45588	0.46218	0.47232	0.48288	0.48998	0.49336	0.49355	0.49163	0.48716	0.47836	0.48054	0.48038	0.47792	0.47326	0.46764
171																						
172	**TOTAL ENERGY USE (TW)**																					
173	low-income countries					0.64278	0.77986	1.14037	1.66755	2.39015	3.39178	4.71785	6.43244	8.59649	11.149	14.0322	16.7996	20.2136	23.8397	27.5597	31.2292	35.0352
174	China					1.09307	1.5846	2.36395	3.42237	4.80825	6.55569	8.67403	11.2496	14.4448	18.1439	22.2943	26.6912	32.1153	37.8766	43.7868	49.617	55.664
175	middle-income countries					3.55311	4.09795	5.57608	7.45202	9.98901	13.1508	16.6846	20.3786	24.1549	28.0639	31.642	34.6219	38.4549	42.2873	46.0389	49.6246	53.4895
176	high-income countries					6.2372	7.11744	8.3524	9.51195	10.5123	11.3879	12.2136	12.9688	13.7708	14.4768	15.0676	15.6826	16.5693	17.5061	18.4959	19.5417	20.6466
177																						
178	world					11.5262	13.5798	17.4328	22.0539	27.6997	34.4862	42.2901	51.0295	60.9669	71.8337	83.0362	93.7952	107.353	121.51	135.881	150.012	164.835
179																						
180	**TOTAL ENERGY USE CHANGE (%/yr)**																					
181	low-income countries					3.2	3.8	3.8	3.6	3.5	3.3	3.1	2.9	2.6	2.3	1.8	1.85	1.65	1.45	1.25	0.25	
182	China					6.2	4	3.7	3.4	3.1	2.8	2.6	2.5	2.28	2.06	1.8	1.85	1.65	1.45	1.25	1.15	
183	middle-income countries					2.38	3.08	2.9	2.93	2.75	2.38	2	1.7	1.5	1.2	0.9	1.05	0.95	0.85	0.75	0.75	
184	high-income countries					2.2	1.6	1.3	1	0.8	0.7	0.6	0.6	0.5	0.4	0.4	0.55	0.55	0.55	0.55	0.55	
185																						
186	world					2.73279	2.49766	2.35136	2.27934	2.19136	2.03993	1.87852	1.77928	1.64022	1.44923	1.21837	1.35009	1.23871	1.11788	0.98937	0.94229	
187																						
188	**ENERGY/CAPITA (kW)**																					
189	low-income countries					0.32284	0.34325	0.41508	0.51722	0.65752	0.84427	1.08406	1.39197	1.76954	2.20498	2.69317	3.2243	3.87954	4.57551	5.28947	5.99375	6.72423
190	China					0.91777	1.23805	1.6712	2.18921	2.83925	3.64567	4.68113	6.01069	7.64109	9.52138	11.6294	13.923	16.7524	19.7576	22.8406	25.8818	29.0361
191	middle-income countries					2.26313	2.3855	2.85026	3.41238	4.09764	4.93035	5.83229	6.77616	7.79444	8.7882	9.71246	10.6271	11.8037	12.98	14.1316	15.2322	16.4185
192	high-income countries					7.33788	8.02906	9.14372	10.2069	11.1682	12.0983	12.9756	13.7779	14.6299	15.38	16.0077	16.661	17.603	18.5983	19.6498	20.7608	21.9347
193																						
194	world					2.05751	2.20589	2.47918	2.79055	3.18109	3.65931	4.22605	4.88723	5.65098	6.47352	7.33113	8.28103	9.47803	10.7279	11.9967	13.2444	14.553
195																						
196	**ENERGY/CAPITA CHANGE (%/yr)**																					
197	low-income countries					1	1.9	2.2	2.4	2.5	2.5	2.5	2.4	2.2	2	1.8	1.85	1.65	1.45	1.25	0.25	1.1
198	China					5	3	2.7	2.6	2.5	2.5	2.5	2.4	2.2	2	1.8	1.85	1.65	1.45	1.25	1.15	1.1
199	middle-income countries					0.88	1.78	1.8	1.83	1.85	1.68	1.5	1.4	1.2	1	0.9	1.05	0.95	0.85	0.75	0.75	0.8
200	high-income countries					1.5	1.3	1.1	0.9	0.8	0.7	0.6	0.6	0.5	0.4	0.4	0.55	0.55	0.55	0.55	0.55	0.6
201																						
202	world					1.16059	1.16797	1.18309	1.30986	1.40051	1.43993	1.45357	1.45204	1.3589	1.24411	1.21837	1.35009	1.23871	1.11788	0.98937	0.94229	
203																						

I.B. NARRATIVE SCENARIOS OF GLOBAL DEVELOPMENT

In this section we review several sets of scenarios that are presented largely in narrative form. First we look at five sets of scenarios prepared during the 1960's, 1970's and 1980's that focused on the period up to 2000. We assess how well these captured important aspects of the relevant history that actually came to pass, and what lessons we can learn from these efforts.

Next we review 26 sets of scenarios constructed after 1990 that look beyond the year 2000. The purpose is to identify those driving forces or trends, and critical topics, that have appeared most frequently when analysts have attempted to project developments over the coming decades. We use these to identify topics for more detailed consideration in Section II, and to identify a set of advocated scenarios that represent, in my estimate, the major contending ideologies and worldviews of our time.

I.B.1. SCENARIOS OF THE 1960's, 1970's AND 1980's, LOOKING TO 2000

Box IB-1 shows the scenarios presented by Kahn and Weiner in their 1967 book, *The Year 2000: A Framework for Speculation on the Next Thirty-Three Years.* This book introduced scenario planning to a wide audience and was very influential. The authors claimed that the trends listed in their Standard World Scenario had been underway for several centuries, largely in the West, and could be expected to continue and to spread to the rest of the world in the coming decades. A set of Alternative Scenarios was presented that had the standard scenario trends in common but reflected different geo-political possibilities, largely turning on the relative dynamism of the Communist world and the West, and on the prospects for war and peace.

Box IB-2 shows projections of economic growth for the period 1965-2000 made by Kahn and Weiner. Their preferred estimates were mostly based on extrapolations of high growth rates following World War II. They also prepared estimates for several major economies based on the longest time series data available, beginning as far back as 1900.

BOX IB-1. KAHN AND WEINER (1967) - *THE YEAR 2000*

I. STANDARD WORLD SCENARIO:

* increasingly empirical, secular, humanistic, pragmatic, utilitarian, contractual, hedonistic
* bourgeois, bureaucratic, meritocratic, democratic (and nationalist?) elites
* accumulation of scientific and technological knowledge
* institutionalization of research, development, innovation and diffusion
* worldwide industrialization and modernization
* increasing affluence and (recently) leisure
* population growth
* urbanization and (soon) the growth of megalopolises
* literacy and education
* increasing capacity for mass destruction

II. ALTERNATIVE SCENARIOS:

1. *More integrated world:* relatively peaceful, prosperous, arms-controlled worlds with relatively high consultation and coordination among nations
    a. *status-quo oriented:* coordination exists among the advanced powers, with little concern for developing nations
    b. *development oriented:* coordination is inclusive of developing nations

2. *More inward-looking:* almost as peaceful and prosperous as above, but with little arms control or coordination
    a. *with an eroded Communist movement*
    b. *with eroded democratic morale and some Communist dynamism*
    c. *with a dynamic Europe and/or Japan*

3. *Greater disarray:* relatively troubled and violent worlds, but in which no large central wars have occurred.
    a. *with an eroded Communist movement*
    b. *with eroded democratic morale and some Communist dynamism*
    c. *with a dynamic Europe and/or Japan*

Note: the "Alternative Scenarios" are alternatives to one another, not to the "Standard World Scenario." The trends shown as the "Standard World Scenario" are common to all of the "Alternative Scenarios."

BOX IB-2. KAHN AND WEINER - PROJECTIONS OF ECONOMIC GROWTH, 1965-2000

[sources: Kahn and Weiner (1967); United Nations Development Program (1997)].

Table 1. By Country	Kahn & Weiner's 1967 forecasts for per capita GDP growth, 1965-2000 based largely on trends since 1945	Actual per capita GDP growth, 1965-l993 (UNDP)	Difference (forecast less actual)	Kahn & Weiner's 1967 growth rate projections for 1965-2000, based largely on trends of the preceding 40-60 years
Japan	6.8	4.3	2.5	3.7
Israel	4.2	2.9	1.3	
W. Germany	4.1	2.6	1.5	1.8
Italy	4.1	2.7	1.4	2.4
OECD	3.7	2.3	1.4	
UK	3.7	2.1	1.6	1.5
France	3.7	2.7	1.0	1.6
China	3.5	6.0	-2.5	3.1
Thailand	3.3	5.3	-2.0	
Canada	3.1	2.4	0.7	1.6
US	3.0	1.8	1.2	1.8
India	2.9	2.2	0.7	2.1
WORLD	2.9	1.5	1.4	
Argentina	2.8	0.7	2.1	
Australia	2.4	1.9	0.5	
Pakistan	2.2	2.4	-0.2	
Mid East/No Afr.	2.2	1.9	0.3	
Sub-Sahara	1.8	0.0	1.8	
So Africa	1.7	1.6	0.1	
Southeast Asia	1.7	3.9	-2.2	
Brazil	1.7	3.5	-1.8	
Latin America	1.6	1.3	0.3	
Nigeria	1.2	2.2	-1.0	
Mexico	1.1	1.7	-0.6	
Indonesia	0.6	4.7	-4.1	

Figure 1. Regression of Forecast and Actual Per Capita GDP Growth Rates, 1965-2000

[forecasts: Kahn & Weiner, 1967; actual: UNEP, 1997. p(.95)= .216; R^2 = .025]

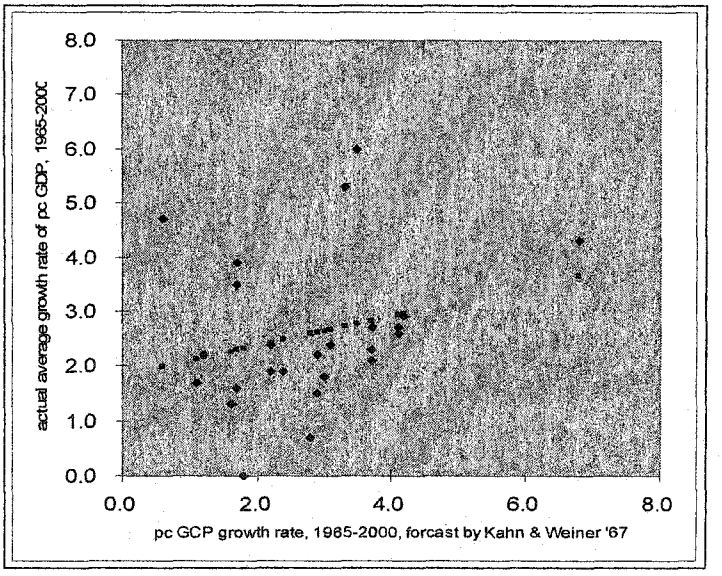


Table 2. By Region	Kahn & Weiner's 1967 forecasts for per capita GDP growth, 1965-2000	Actual per capita GDP growth, 1965-l993 (UNDP)	Difference (forecast less actual)
So.& East Asia, w/o China	4.3	n/a	n/a
OECD	3.7	2.3	1.4
WORLD	2.9	1.5	1.4
Middle East &No. Africa	2.2	1.9	0.3
Sub-Saharan Africa	1.8	0	1.8
Southeast Asia	1.7	3.9	-2.2
Latin America	1.6	1.3	0.3

Notably absent in *The Year 2000* was any consideration of environmental issues. The years immediately following its publication saw an explosion of environmental concerns, and in Kahn's 1976 book, *The Next 200 Years*, these figured prominently. He identified four scenarios, shown in **IB-3**, that reflected different empirical judgments and normative preferences concerning economic growth, the environment, and technology.

Kahn's work inspired new efforts in the field of future studies. Among the most influential were studies done at the Stanford Research Institute (SRI). Whereas Kahn was aligned with military and generally conservative interests, the analysts at SRI were aligned with the liberal movements of the time, in particular the environmental movement. In 1975 SRI analysts prepared a set of scenarios for the US Environmental Protection Agency (EPA) that captured much of the sense of crisis and opportunity of that period. In 1982 a modified version of this set of scenarios was published as *Seven Tomorrows*. The set of driving trends used to construct the EPA scenarios are shown in **IB-4**. Summaries of the scenarios from both efforts are shown in **IB-5.** Quantitative projections from *Seven Tomorrows* are shown in **IB-6.**

Although the analysts at SRI were sympathetic to liberal and environmental values they were by no means anti-capitalist, and their studies tended not to address issues of political economy. Students of future studies in Europe and the Third World, by contrast, gave political economy much attention. **IB-7** shows a set of scenarios prepared in 1984 by British analysts aligned with the European labor-left.

Assessment

A review of these five sets of scenarios prompts these observations:

* The core trends identified in Kahn and Weiner's 1967 Standard World Scenario have indeed continued over the past 33 years, as they predicted. Further, although none of their Alternative Scenarios exactly capture the politico-economic conditions of 2000, Alternative 1b and condition "a" of Alternative 2 can be combined to aptly summarize it: "A more integrated, development-oriented world with an eroded Communist movement."

BOX IB-3. HERMAN KAHN (1976) - *THE NEXT 200 YEARS*

FOUR WORLDVIEWS

1. *Convinced Neo-Malthusian:* Finite resources will reach limits within 50 years; the complexity of natural systems will overwhelm our attempts to manage them; techno-fixes won't work or will back-fire; continued growth benefits the rich more than the poor. Wisdom calls for a rapid transition to a no-growth world. If we don't do this billions may die from starvation, pollution and wars over scarce resources.

2. *Guarded Pessimism:* Resource limits are uncertain but we are better off being cautious. Techno-fixes at best may delay the inevitable. Wisdom calls for a slow but steady transition to a no-growth world. Policies to ensure an equitable income distribution are imperative to avoid class warfare. The LDC's should avoid the mistakes of the developed world and emphasize community-oriented enterprises. The developed world should emphasize Quality of Life rather than further growth in GDP.

3. *Guarded Optimism:* Technology and wise management should to allow growth to continue. Policies to internalize environmental externalities should be adopted. Industrial development is the only real hope for alleviating poverty. Absolute incomes will increase for all but isolated populations. The world economy will need to be carefully monitored so that policies can be adopted to ensure steady, even growth, if necessary.

4. *Technology and Growth Enthusiast:* There is no need for worry, the faster the rate of technological innovation and growth, the more benefit to humankind. A rising tide lifts all boats. At the high levels of material prosperity available to all, distributive differentials are not a major source of social tension. Policies to "soften" the impacts of a dynamic growth economy will do more harm than good.

BOX IB-4. DRIVING TRENDS OF THE SRI SCENARIOS FOR 1975-2000

Source: Alternative Futures for Environmental Policy Planning, 1975-2000. Duane S. Elgin, David C. MacMichael, and Peter Schwartz. Stanford Research Institute, 1975.

A. Energy Use:

1. continued high growth: 4%/yr
2. controlled growth: 1-3%/yr
3 unsuccessful high growth: energy growth begins high but collapses by 2000.
4. zero or declining growth: 0 to -1%

B. Climate:

1. favorable: as usual
2. variable: sometimes good, some bad, unpredictably
3. worsening climate: global cooling leads to drought, floods, shortened growing season

C. Food:

1. high prices/no shortage
2. moderate prices/no shortage
3. high prices/food shortage

D. Values:

1. *achievement values:* population emphasizes material things: status, fame, affluence, on the personal level and growth, bigness, competition on the system level. Mechanistic, materialistic, individualistic, secular, centralized, scientific empirical.
2. *survival values:* achievement values are held but material circumstances prevent them from being readily realized. The consequences are frustration, dogged endurance, emphasis on security and survival aspects of achievement values.
3. *frugal values:* voluntary simplicity of the exterior aspects of life in order to attain greater riches of inner aspects. Includes a self-realization ethic and an ecological ethic, or combinations of these (survival/frugal split; achievement/survival split; three way split; etc.)

The four key variables and the thirteen alternative ways they may change over time define a four-valued matrix of 108 potential scenarios (4x3x3x3=108). Of these the authors chose 10 for elaboration into full narrative scenarios. In Box IB-5 we show nine of these (two are very similar).

BOX IB-5. THE EPA/SEVEN TOMORROWS SCENARIOS

I. Alternative Futures for Environmental Policy Planning, 1975-2000 (1975)

1. *Hitting the Jackpot:* "The Kahnian future: growing prosperity for all through markets and technology."
2. *Not-So-Great Expectations:* "Energy and environmental stresses motivate moderately frugal life-styles and business efficiencies that successfully allow growth to continue."
3. *Apocalyptic Transformation:* "Overconfidence in markets and technology, and rapid climate change, leads to economic collapse in the mid-1980's. From the ruins arises a transformed society based on simple living."
4. *Journey to Transcendence:* "Awareness of pending limits to growth motivates a spiritual evolution that gradually replaces acquisitive values with holistic, frugal values."
5. *The Center Holds:* "Energy and environmental crises nearly topple the established institutions. However, in the late '80's new technological breakthroughs win the day for the establishment."
6. *The Boom Years:* "A protracted recession leads to evolution of a large frugal living population, but by the late 1990's new technological breakthroughs restore prosperity."
7. *The Industrial Renaissance:* "Clumsy attempts to impose energy conservation lead to an extended recession. The technological elite rally and develop techniques that allow both conservation and growth."
8. *The Dark at the Top of the Stairs:* "Clumsy attempts to impose energy conservation lead to an extended recession. Social cohesion is weakened and despair spreads, leading to a depressed, authoritarian world by 2000. "
9. *Toward the Jeffersonian Ideal:* "Large numbers of people realize that the desire for affluence must be tempered if the earth and society are to survive. The transition to a sustainable, frugal world begins in the late '70's, builds through the '80's, and is largely complete by 2000."

II. Seven Tomorrows (1982) Scenarios for 1980-2000.

1. *The Official Future:* "Technological triumph. Soviet power is checked. More people more affluent than ever. More personal computers and world trade. The environment deteriorates and crime rises, but people accept these as tradeoffs."
2. *The Center Holds:* "The '80's begin strong but run into problems of energy supply, recession, food shortages. Survivalist movements flourish but are suppressed. A corporate/state commitment to technology manages to restart the economy by 2000."
3. *Chronic Breakdown:* "The energy crisis of 1983 triggers a cascade of dominos: food shortages, economic recession, international conflict, domestic turmoil. The social fabric is frayed and people withdraw into escapist pursuits. Cults and communes flourish. "
4. *Mature Calm:* "In the face of growing resource constraints conservative Republicans adopt much of the philosophy of the environmental left. Ecological catastrophe is avoided, small town values are revived, children stay in school and stop using drugs. By 2000 everyone wonders what the big scare in the late '70's was all about."
5. *Apocalyptic Transformation:* "By the early 90's both the US and USSR have nuclear-armed space shuttles in orbit. A series of miscalculations brings the world to the brink of nuclear holocaust. The narrow escape sparks a world spiritual revival that leads to disarmament and a commitment to build a peaceful world."
6. *The Beginning of Sorrow:* "After a decade of mounting energy shortages and economic turmoil a catastrophically frigid winter of '87 leads to breakdown of authority. Survivalist militias control large parts of the country and the economy spirals down, with no end in sight."
7. *Living Within Our Means:* "Climate change, soil depletion and mismanagement lead to severe food shortages in the early '80's, which, on top of higher energy prices, leads to a deep recession. People are forced to begin growing their own food, traveling less, buying less consumer goods. A frugal, de-centralized, sustainable rural society and culture evolves.

BOX IB-6. QUANTITATIVE PROJECTIONS FROM SEVEN TOMORROWS

[Hawken, Ogilvy and Schwarz, 1982]

			SCENARIOS for 2000*						
			OF	CH	MC	CB	AT	BS	LWM
	Actual values		1	2	3	4	5	6	7
	1980 (1995 US$)	2000 (1995 US$)							
World Population (millions)	4430	6051	6797	6800	6350	5921	5900	5000	6300
U.S. Population (millions)	227	282	268	268	268	253	253	226	268
World per capita GDP	4,384	5,654	7,195	6,631	7,101	4,760	5,254	3,664	4,473
growth rate, WpcGDP, 80-00 (%/yr)	-	1.3	2.5	2.1	2.4	0.4	0.9	-0.9	0.1
US per capita GDP	21,000	31,730	31,345	20,897	29,942	21,111	21,284	9,531	14,780
growth rate, USpcGDP,80-00 (%/yr)	-	2.1	2.0	0.0	1.8	0.0	0.1	-3.9	-1.8
Average World Energy Prices**	65	25	50	80	60	40	100	100	100
US Energy Consumption (quads)	78	99	123	86	100	78	80	40	70
US Energy Supply (quads):									
oil	35	38	48	30	36	23	26	16	22
gas	20	24	19	16	19	14	16	10	14
coal	17	22	40	23	25	32	20	11	18
nuclear	3	8	11	9	10	4	8	0	3
renewables	3	6	5	8	10	5	10	3	13
Energy Supply (% of total)									
oil	0.45	0.38	0.39	0.35	0.36	0.29	0.33	0.40	0.31
gas	0.26	0.24	0.15	0.19	0.19	0.18	0.20	0.25	0.20
coal	0.22	0.22	0.33	0.27	0.25	0.41	0.25	0.28	0.26
nuclear	0.04	0.08	0.09	0.10	0.10	0.05	0.10	0.00	0.04
renewables	0.04	0.06	0.04	0.09	0.10	0.06	0.13	0.08	0.19
Variance betw. energy supply actual and scenario values***			37	20	16	40	26	58	42
Variance betw. economic actual and scenario values****			0.18	0.28	0.16	0.25	0.28	0.93	0.44

*codes:
1 = OF = "The Official Future"
2 = CH = "The Center Holds"
3 = MC = "Mature Calm"
4 = CB = "Chronic Breakdown"
5 = AT = "Apocalytic Transformation"
6 = BS = "The Beginnings of Sorrow"
7 = LWM = "Living Within Our Means"

** prices shown are for 1 bbl crude

***values shown are the sums of the absolute differences between actual and scenario values for each energy source in 2000.

****values shown are the averages of the absolute percentage differences between actual and scenario values for world and U.S population and per capita GDP, and for energy prices and consumption, in 2000.

Sources:
World and U.S. population and economic growth values for 1980 and 2000 are from World Development Indicators-OnLine (http://publications.worldbank.org/WDI). Scenario values have been normalized using the WDI tables to 1995 US$ from their original presentation in 1980 US$. World energy prices in 2000 are from the Energy Administration Administration's World Oil M and Oil Price Chronologies, www.eia.doe.gov/emeu/cabs/chron.html. Energy consumption and supply figures for 2000 are from the Energy Information Administration at www.eia.doe.gov/emeu/aer/tst/ptb0103.html.

BOX IB-7. COLE AND MILLER - GLOBAL AND REGIONAL SCENARIOS TO 2000

[source: S. Cole and I. Miller (1984)]

I. GLOBAL SCENARIOS

1. *Liberal International Order:* free markets, multinational corporate dominance.
2. *Reformed International Order:* market economy, social contracts between and within countries.
3. *Collective Self-Reliance:* developing nations disengage from inequitable global structures and cooperate for mutual development.

II. REGIONAL SCENARIOS

A. High & Middle Income OECD

1. *Corporate Society*
2. *State Capitalism*
3. *Democratic Socialism*
4. *Decentralism*

B. Centrally-Planned Industrial Economies

1. *Scientific-Technological Revolution*
2. *Stagnation*
3. *Reform*
4. *Democratization*

C. Newly Industrializing Countries, Semi-Peripheral

1. *Military-Authoritarian*
2. *Developmentalism*
3. *Populism*
4. *Socialism*

D. Lower Middle Income and Poor Countries

1. *Neo-Colonialism*
2. *Liberal Developmentalism*
3. *State Capitalism*
4. *Bureaucratic Planning*
5. *Socialist Construction*

E. OPEC

1. *Western-Oriented Development*
2. *State Capitalism*
3. *Neo-Traditionalism*
4. *Endogenous Socialism*

Note: Cole and Miller's presentation suggests a dynamic relation between global and regional scenarios. If all or most of the regions adopt, say, a more or less socialist political economy, or a more or less liberal capitalist one, then the global scenario would be of that same type and might be thought of as the sum of the regional scenarios. On the other hand, if all but one or two regions have adopted a particular political-economic orientation, the non-conforming regions may experience pressure to adopt that orientation as well. In that instance some regional scenarios may be thought of as being influenced by the global scenarios.

* Kahn and Weiner's forecasts for economic growth between 1965 and 2000 were in general too high. They believed that the 3% world per capita income growth rates of the post-war period could be sustained, but after the turbulence of the 1970's and 1980's the average for the period was closer to 1.5%. With the end of ideological contention in the 1990's, analysts envision long term average per capita growth rates of about 2%.

* Kahn's four "worldviews" shown in IB-3 succinctly characterize the range of opinions people hold regarding the growth/environment/technology debate, even today, nearly three decades after they were proposed.

* Of the 1975 Elgin et al. scenarios the one that best described the course that events in the United States actually took over the following 25 years is Scenario #1, "Hitting the Jackpot."

*Of the 1982 Hawkins et al. scenarios the narrative description that best characterized the subsequent events is Scenario #1, "The Official Future," tempered by elements from Scenario #3, "Mature Calm," and Scenario #2, "The Center Holds." Per capita GNP growth rates for the U.S. over the period 1980-2000 were projected at 2% and 1.8%, respectively, for "The Official Future" and "Mature Calm," very close to the historical rate of 2.1%. All the other scenarios projected rates of growth near or below zero. World per capita GDP growth rates for the first three scenarios, which assumed less profound economic disruption over the period 1980-2000, averaged 2.3%, while the final four scenarios, which envisioned various forms of breakdown, averaged close to zero. The historical rate for the period was right between these values, at 1.3%.

* None of the Hawkins et al. scenarios foresaw the dramatic drop in energy prices and the counterintuitive increase in energy efficiency that occurred during the 1980's and 1990's in the wake of the oil crises of the 1970's. In the higher growth scenarios energy prices varied up or down by about 20% from 1980 prices, and in most of the lower growth scenarios energy prices increased by 53%. In actuality, real world energy prices *declined* by 60% over this period.

* The Hawkins et al. "Mature Calm" scenario pegged United States energy consumption in 2000 at 100 quads, almost precisely the value of 99 quads that actually occurred, and came

close to estimating the correct shares of energy supply provided by different sources. However, it underestimated the growing role of natural gas and somewhat overestimated the growth of renewables.

* In the two decades since the Cole and Miller scenarios were developed, neoliberal economics and politics (Cole and Miller's *liberal international order)* have prevailed over Third World socialism (roughly their *collective self-reliance*), over social democracy (their *reformed international order*), and over most of the more particular systems described on a regional basis. Neoliberalism is today partially contested in regions with a tradition of Confucianism, and more strongly so in Islamic regions. Neoliberalism is subject to a large set of reformist demands from working class constituencies in the developed countries, Latin America, and elsewhere. For the most part, however, the set of viably contending political-economic systems sketched in the Cole and Miller scenarios has been dramatically reduced.

Further discussion

To some extent the history of the past 30 years vindicates the judgment of those analysts, such as Kahn and Weiner, who believed that the institutions of Western democratic capitalism would be able to successfully accommodate or repulse various challenges to its ascendancy and dominance. During this period neither the worst fears nor the heartfelt dreams of the left or of the Greens—or for that matter, of the authoritarian right--came to pass. Capitalism did not immiserate the workers, start a nuclear war or trigger an ecological holocaust. The world of 2000 did not find new socialist men and woman collectively managing bustling factories and farms. Neither did it find ecotopian communities living in self-sufficient harmony with the flora and fauna of their bioregion.

Of course, it's a mistake to conclude that the success of neoliberal capitalism over the past thirty years necessarily entails its continued success for another thirty years, much less for 150 years. Without an explicit analysis of the causes and dynamics of stability and change, no firm judgments in this regard are possible.

In the next section we review scenarios that reveal the hopes and fears of various authors regarding political, social and cultural concerns, as well as environmental and equity concerns, for the decades following 2000. This review will help us select topics for further analysis that might cast light on the prospects for global stability and global change during this period.

I.B.2. SCENARIOS OF THE 1990's, LOOKING BEYOND 2000

Box IB-8 shows a general set of scenarios that address many of the critical topics that are commonly evoked when people speculate about the early decades of the 21st century. **IB-9** summarizes three additional sets of scenarios of this sort. **IB-10** shows four sets of scenarios mostly focused on geo-political concerns. **IB-11** shows four sets of scenarios focused on economic systems. The four sets of scenarios in **IB-12** give special attention to culture and gender issues. **IB-13** shows ten sets of scenarios that address a wide range of issues concerning particular nations and regions. In all we show 26 sets of scenarios containing a total of 130 individual scenarios.

What are the major themes that these scenarios address? Some important recurring themes are shown in **IB-14.** We see that to a large extent a scenario of continued economic growth, technological innovation, and global economic integration is taken to be the reference or business-as-usual scenario. Other scenarios are distinguished largely by the extent to which one or another element of this reference scenario falters.

I.B.3. FOUR ADVOCATED NARRATIVE SCENARIOS

In **IB-15** I describe four scenarios that I distilled from the 26 sets of scenarios reviewed, and from consideration of the major themes shown in IB-14. They are: techno-globo neoliberalism, social democratic internationalism, Green sustainability, and civilization-of-

BOX IB-8. HYPERFORUM SCENARIOS ON SUSTAINABILITY

Between 1995 and 1997 the California Institute of Technology, RAND, and World Resources Institute sponsored a collaborative project to develop global scenarios for the period 2000 to 2050 focused on the topic of "sustainability." Fifty experts from thirty-four think tanks, universities and other organizations were involved. Most of the collaboration was done using new Internet technologies. The complete record of the project can be found at www.hf.caltech.edu/HF. Here is a summary of the major scenarios they developed:

1. CONVENTIONAL WORLDS: Industrial development is gradual and steady. The world becomes more integrated economically and culturally. Technology allows productivity to grow and environmental and equity problems to be addressed satisfactorily.
   a) *Reference Case:* Few policy interventions are needed to keep things on track. Consumerism and possessive individualism endure as the primary human motives. Inequality increases and the environment deteriorates, but not enough to motivate people to seek alternative systems.
   b) *Balanced Growth:* comprehensive and vigorous public policies developed by the techno-managerial elite successfully steer the system away from destabilizing social and environmental problems.

2. BARBARIZATION: Conflicts present in the Conventional Worlds scenarios overwhelm the coping capacity of markets and management institutions. Rich/poor tensions dominate national and global affairs. Technological change works to the advantage of the privileged and marginalizes the rest.
   a) *Social Breakdown*: unregulated global competition leads to increased inequality, mass migrations, global crime waves. Instability, xenophobia and police state mentalities follow, causing economic growth and trade to slow and then decline, leading to a general collapse social, cultural and political institutions.
   b) *Fortress World:* Wealthy sectors cooperate to keep the international system functioning for themselves but seek to abandon the rest of the world to poverty.

3. GRAND TRANSITIONS: global society matures to a higher stage of social development, neither stuck in its present adolescent, competitive phase nor descending into anarchic chaos.
   a) *Global Governance:* a growing collective realization of the mutual benefits of cooperation leads to strengthening of global governance institutions and a strengthening of civil society. Leadership is provided by multinational corporations and a dense network of NGO's.
   b) *New Sustainability Paradigm*: the rapid spread of technology and capitalism benefits only a few, but with widespread communications resources the masses are able to inspire and coordinate with one another to work out collective response. A disenchantment with the ethos of competition and materialism is nurtured and matures into a new sustainability paradigm for the planet.

Several participants in the project felt the final scenarios underplayed the positive contribution that technological innovation could make in the decades to come and overestimated the likely severity of environmental degradation. Jesse Ausubel of Cal Tech prepared this additional scenario:

Technology Spares the Environment: "...accelerating technological advances, driven in part by market competition, boost industrial efficiencies, prosperity, and environmental sustainability through most of the world. The world economy meets human needs with less land, pollution and natural resources. Dire warnings of food shortages, pollution, overpopulation and environmental depletion never materialize."

BOX IB-9. THREE SETS OF GENERAL GLOBAL SCENARIOS

Peter Schwartz. Art of the Long View (1991) Three Global Scenarios through 2005.

1. *New Empires:* "Nations protect their threatened cultural identities by regionalizing their interests... they create bureaucratic but decentralized multinational power blocs that dominate world politics."
2. *Market World:* "a free market, entrepreneurial, multi-cultural world run not by governments but by 'associations:' international rule-making, standard-setting, conflict resolution and system management groups that collectively form an informal 'global commons'..."
3. *Change Without Progress:* "the dark side of Market World: fast-paced economic activity, ruthless self-interest runs rampant, environment decays, inequality grows."

Lawrence Wilkinson, Global Business Network. Four Global scenarios to 2020 (1995)

Wilkinson and his clients focused on two critical uncertainties to develop the four global scenarios for the year 2020 shown below: will people be more *individual* or more *community* oriented? and will society provide *coherence* or will it be *fragmented*?

1. *I Will* [individual/fragmented]: The world fragments into a working pandemonium of individuals, organized by jobs rather than geography. Physical infrastructure stagnates, personal spaces and the Net thrive. Technology is the global culture. Ethnic and group differences dissolve into a patchwork of individual variety. Europe is wracked with civil strife as its socialistic civilization unravels.

2. *Consumerland* [individual/coherent]: The world is populated by consumers rather than citizens...served by highly evolved companies conscious of the market's whims. Leisure increases, dissent withers. Governments are virtual corporations, with their heavy lifting privatized. The have-nots get spending vouchers. The US and Europe become large theme parks. Russia exports neo-religious cults and mafioso.

3. *Ecotopia* [community/fragmented]: Communitarian values triumph. Slim, digitized governments win popular trust. Corporations show civic responsibility. High-tech makes urban living very resource-friendly. Europe becomes a moral beacon. Asia and Latin America become lifeboats for the young and restless of the developed world who find the environmentalism and communitarianism too dogmatic and stifling.

4. *New Civics* [community/coherent]: A world of small, powerful city-states. Rural areas are second-class but are heavily wired. Europe breaks into 57 countries. Gangs in developing countries and old inner cities transform into law-and-order machines. General health improves. Civic pride blossoms. Corporations are reigned in by civic regulations. Conglomerates fund most UN-type activities.

Jerome Glenn and Theodore Gordon. 1997 State of the Future (1997)

1. *Cybertopia*: "Free markets, technology and globalization generate unprecedented economic abundance. Individuals act like holding companies, investing their time in diverse activities, inventing careers, granting access to others as nations used to grant visas. A majority of human waking hours are spent in cyberspace."
2. *A Mean World*: "Education and training could not keep up with technology, and joblessness became endemic the world over. Economies tottered, nations formed trading blocs, people turned to fundamentalist ideologies, and economic warfare gave way to lethal warfare. Nineteenth century geopolitics, twentieth century ideological passions, and twenty-first century technology."
3. *The Aftermath*: "The globalized, high-tech economy collapsed in 2010 due to over-confidence, sheer greed, sabotage by a techno-criminal elite, and a weak global regulatory structure. Developing nations that had just begun to grow were reduced to subsistence. In the wealthier nations many reverted to rural, self-sufficient modes of production."

BOX IB-10. FOUR SETS OF GEO-POLITICAL SCENARIOS

Samuel P. Huntington. The Clash of Civilizations (1996)

1. One Harmonious World
2. Two Worlds: Us and Them
3. 184 States, More or Less
4. Sheer Chaos
5. The Clash of Civilizations
    a) peaceful coexistence; respect for civilizational boundaries; self-affirming, unified cultures
    b) conflict; universalist and imperialist pretensions; internal stresses due to multiculturalism

Robert Z. Lawrence et al. A Vision for the World Economy (1996)

1. *Invisible Hand:* the market suffices
2. *Global Fragmentation:* the market does not suffice, and nations pull up the drawbridges to survive
3. *Imperial Harmony:* a hegemonic Triad of the US/Europe/Japan agrees on rules for the global economy
4. *Community of Nations:* gradual evolution of multilateral structures for coordination and accountability

Ann-Marie Slaughter. "The Real New World Order" (1997)

1. *Liberal Internationalism:* straight translation of structures of representative governance from national to international levels, and eventually to some type of world federalism.
2. *The New Medievalism:* hollowing-out of the nation state as its functions, sovereignty and authority are replaced by a patchwork of overlapping private, quasi-private, national, supranational and transnational formal and informal structures.
3. *Transgovernmentalism:* informal but structured cooperation among bureaucrats, technicians and officials of different countries allows necessary coordination in an interdependent world but maintains accountability through the nation-state.

Hugh de Santis. Beyond Progress (1996)

1. *communitarian socialism:* "the self-contained cosmopolitan order of premodern times"
2. *perpetual anarchy/new Dark Age*
3. *ordered chaos:* Huntington's clash of civilizations
4. *perpetual peace and harmony:*
    a. Fukuyama: via liberal democratic techno-capitalism
    b. norm-based transnationalists:
        i. Richard Falk: supranational state, complete with parliament, judiciary, police powers.
        ii. Ervin Laszlo: "resolution of common problems will foster a self-regulating order of peace and international harmony"
        iii. Rajni Kothari: third world unity as prerequisite for world federalism.
        iv. Peace-Studies types:
            a. Johan Galtung: international communitarianism
            b. Richard Smoke: similar to Laszlo.
            c. Harry Hollins
5. *mutualism:* "a community of interests in which diverse peoples and states bounded by geographical, historical and cultural affinities productively commingle in localized social, political and economic associations reinforced by the acceptance of shared risks and rewards."

BOX IB-11. FOUR SETS OF ECONOMIC SCENARIOS

Robert Heilbroner. 21st Century Capitalism (1993) Five scenarios grounded in economic theory, named after their founding analysts.

1. *Adam Smith:* "a world of economic growth, resource restraints, economic decline from a growing population and shrinking resources."
2. *Karl Marx:* "a world of growth with periods of economic crisis and restructuring, with labor ultimately gaining control of the economy."
3. *John M. Keynes:* "a world of market driven societies creating lasting underemployment and the need for social investment."
4. *Joseph Schumpeter:* "capitalism grows through creative destruction but will decline from moral decay."
5. *Robert Heilbroner:* "capitalism can grow with right social investment, if it overcomes tax phobia and reduces the deficit" A "slightly imaginary Sweden."

John Roemer. A Future for Socialism (1994) Four feasible market socialisms.

1. An economy of *revenue-maximizing labor-managed firms.*
2. *"Keiretsu" socialism:* groups of profit-maximizing firms ally with a single large bank and hold shares of each others' stock. Dividends from other firms are distributed to workers.
3. *capitalism without class power* (Fred Block): restrictions on large capital movements across borders; quasi-nationalized banking system; employee/consumer representation on boards.
4. *associative socialism* (Joel Rogers): representative constituency groups (consumer, neighborhood, environmental, union, etc.) have bargaining and quasi-veto rights regarding corporate decisions.

S.P. Udayakumar. The Futures of the Poor (1995)

1. *Hand-outs but no Help-outs:* "donors lack political will or sense of justice to remedy the situation permanently."
2. *Waiting for Godot:* "the poor long for consumerism and comfort; the fittest survive, the rest perish."
3. *Preach the Gospel to the Poor:* "the rich reinvigorate their patronizing policies; states become economies, societies become markets and the poor become more miserable."
4. *Viva Zapata:* "rebels with nothing to lose demand justice" (but gains are few and temporary).
5. *View from the Mountain Top:* "the rich embrace a simple and less selfish lifestyle" (but subtly retain their class prerogatives).
6. *To Be or Not To Be:* "the poor renounce modernity, recognize their cultural roots, and return to former ways of life, with traditional technology."
7. *One Species, One Destiny:* "both the rich and poor realize that the well-being of the poor demands cooperation of the rich, and the safety of the rich relies on justice for the poor."

Fredrick Pryor. Economic Evolution and Structure (1996) Scenarios of alternative capitalisms.

Business as usual:

1. *Steady maintenance*
2. *Stagnation*

Scenarios of change in the organization and control of production:

3. *Remodeled Capitalism*: very highly skilled workers are the source of economic dynamism.
4. *Atomistic Capitalism:* most economic dynamism is provided by smaller, entrepreneurial corporations.
5. *Third Party Capitalism*: institutions, rather than individuals, effectively control most capital
   i) *Finance Capitalism:* Financial intermediaries take over and control corporate policy.
   ii) *Corporatism:* management, government and labor set policy for individual corporations.
   iii) *Nonprofit Dominance:* economic dynamism relies human capital, i.e., on services provided by non-profit education, health, and welfare institutions.

BOX IB-12. FOUR SETS OF SOCIO-CULTURAL SCENARIOS

Benjamin Barber. Jihad vs McWorld (1996)

1. *Jihad*: people find strength and community through intense adherence to the values, norms and life-styles of a particular region, ethnicity, or religion. Outsiders are seen as infidels.
2. *McWorld:* People the world over share a common set of modern, technological, and consumerist values, norms and life-styles. Others are seen as backward.
3. *Both Jihad and McWorld:* an elite trans-national caste lives in McWorld; the rest live in Jihad.
4. *Civil Society:* Global norms of mutual respect allow both modernist and traditional values to co-exist and support one another.

Eleonora Masin (UNESCO). The Future of Cultures (1994)

1. *Pessimistic:* "All cultures becomes bastardized, or reduced to a museum role."
2. *Dual-track Scenario:* "Core elements of cultures remain strong" while societies modernize.
3. *Resistance:* "The many cultures fend off the dominant one."
4. *The Gaia Scenario:* "all cultures recognize that no culture is complete in itself"
5. *Babel:* "fostered by communications and biotechnologies, people will move among cultures."

Walter Truitt Anderson. Reality Isn't What It Used To Be (1990) Seven stories for the future.

1. *The Western story*: steady progress through technology and economic growth.
2. *The Marxist story*: an egalitarian world in which workers control the means of production.
3. *The Christian fundamentalist story*: a society governed by biblical belief and faith in God's love.
4. *The Islamic fundamentalist story:* a society governed by Koranic belief and faith in God's wisdom.
5. *The Green story*: a society grounded in ecological values and a rejection of industrialism.
6. *The New Paradigm story:* a sudden, deep, holistic transformation of human values & ways of living.
7. *The Post-Modern story:* a recognition that stories that justify human endeavor are social constructs; none are objectively privileged over any of the others.

Pamela McCorduck and Nancy Ramsey. The Futures of Women: Scenarios for the 21st Century, (1996). Four scenarios to 2015.

1. *Backlash:* In a depressed, no-growth global economy discrimination against women increases, in both developed and developing countries. The religious right champions back-to-the-home.
2. *Golden Age of Equality:* "Western notions of individual rights, rule of law and personal privacy take hold and prevail in a globally integrated growth economy. A profound shift in consciousness permits both women and men to begin to think of women as different from, but not less than, men. The search for equality in the workplace brings about a new balance between family and work."
3. *Two Steps Forward, Two Steps Back:* "Western notions of individual rights prevail but the world economy is depressed, with huge international migrations as people search for jobs and food. Basic needs of the world's women, including nutrition, child spacing, protection from domestic violence, and workplace safety, are hard-pressed to be addressed.
4. *Separate—and Doing Fine, Thanks:* The global economy booms but in order to maintain stability the developing world adopts the Singapore model and imposes authoritarian social controls, including controls on women's work opportunities and on personal and public behavior. In the West the continuing boom allows affirmative action, training and placement programs to be implemented without resistance.

BOX IB-13. TEN SETS OF REGIONAL AND NATIONAL SCENARIOS

Sohail Inayatullah. The Futures of South Asia [summary] (1992)

1. *continued chaos and collapse*: ethnic violence and breakup into small nations
2. *hegemony* by one or more of the following:
    a. India
    b. market industrialism
    c. bureaucracy-led governance
3. *return to communitarian life*: spiritual values, local knowledge, enviro [basic needs approach]
4. *transformation/rupture:*
    a. new South Asia confederation of autonomous provinces
    b. new identity
    c. new theory of growth/distribution
    d. new theory of knowledge/science
5. *nuclear war scenario*
6. *village high-tech*: by-passing modernity via computers, genetic engineering, etc.

Sohail Inayatullah. The Futures of South Asia (1992) Five scenarios for Pakistan:

1. *Disciplined capitalist society:* "military and strong centrist civil service create conditions for development of a national bourgeois"
2. *Islamic Socialism:* "basic needs met through state control of economy, but cultural and religious needs remain syncretist and personal"
3. *Return of the Ideal:* "return to original intention of Pakistan as the land of the pure and the search for the ideal Islamic polity that existed at the time of the Prophet."
4. *End of Sovereignty:* "military intervention by India, cultural intervention by USA, breakdown into many states."
5. *No Change:* "continuation of the grand disillusionment, grand malaise."

Hans van Zon. Alternative Scenarios for Eastern Europe (1992)

1. *Laissez-Faire/Capitalist Path:* "driving force is the wish to create favorable conditions for free enterprise."
2. *Populist-Authoritarian Path:* "a weak nationalist bourgeois supported by the army pushes market institutions but keeps them protected from the world economy."
3. *Leaning-Upon-The-West:* "weak governments follow the lead of the EC, IMF, other western institutions."
4. *Sustainable Development:* "environmental clean up gets high priority, serves to build national solidarity."
5. *Muddling On:* "market and political reforms are half-hearted; old bureaucracies remain powerful."

Godwin Sogolo. AFRICA: Three Scenarios (1992)

1. *Giving Up:* poverty, war, ethnic struggle continue, and Africans just give up.
2. *Retracing the past:* traditional precolonial institutions are revived, particularly the extended family.
3. *Continuity with Change:* technology is grafted on to local culture. "Core traditional cultures continue but Africa adapts to external cultures. Both traditional and modern medicine coexist."

[More...]

BOX IB-13. Regional/National Scenarios (cont.)

Herbert Adam and Kogila Moodley. Forecasting Scenarios for South Africa (1993)

1. *Another Zimbabwe:* "authoritarian populism, high corruption, pseudo-patronage system where white minority retains economic privilege while a black bourgeois dominates the political scene."
2. *Another Yugoslavia:* "black youths turn away from the liberal, compromising ANC, right-wing whites declare an independent Boerstaat, Natal secedes as Zulu nationalist state."
3. *Another Germany:* "social-democratic pact between business, labor and key state bureaucracies; co-determination with a wage pact to increase exports; in return for increased education, health, and housing, the unions abandon antagonistic labor relations and class warfare. "

William C. Smith. Democracy, Markets, and Structural Reform in Latin America (1993)

1. *Organic Crisis Revisited:* "government failure, stagnant income base, threat of authoritarian regression."
2. *Fragmented and Exclusionary Democracy with Neoliberal Economics:* "majoritarian political coalitions hold, debt renegotiated, state enterprises become private monopolies."
3. *Inclusionary Democracy:* "democratic deepening, state reform, strengthening of collective actors, expansion of citizen rights, more equitable outcomes."
4. *Dual Democratic Regimes:* "state elites establish alliance with a strategic minority of the opposition so as to exclude the majority of remaining social actors. Economy grows but very slowly."

J. H. El-Issawy. The Future of the Arab Nation (1993)

1. *Division*: continuation of current trends
2. *Co-ordination and Cooperation:* regional groupings and agencies
3. *Unity*: one currency, one foreign policy, one army, one school system

Michael Lind. The Next American Nation (1995)

1. US evolves away from status as nation-state, becomes either:
   a) multi-cultural state
   b) democratic universalist state
2. US evolves to enhance its status as a nation-state, becomes either:
   a) nativist state
   b) liberal nationalist state

Hugh De Santis. Beyond Progress (1996) -- regional scenarios

East Asia: conflation of market economics and Confucian authoritarianism (China becomes like Singapore)
Middle East: democracy circumscribed by the laws of *sharia* and power of oligarchies and autocrats
Africa: collectivist, consensual rule of village elders rather than adversarial forms of government
Latin America: democracy will probably be a hybrid of liberalism and statism

Maggie Powell. WRI Hyperforum Scenarios (1997) - Five Scenarios of China to 2030

1. *Revolt of the Urban Masses:* "urban turmoil as growth rate slows"
2. *The Famine Returns:* "turmoil as global warming changes rainfall patterns, agriculture collapses."
3. *Loss of Control:* "continuing economic growth leads to loss of central control and ability to enforce one-child policy. Population explodes, civil war narrowly averted but growth stagnates"
4. *The Siberian Excursion:* "Military assumes control of China, invades Siberia, after a long struggle they retreat but economy is in shambles."
5. *Solar China:* "China invests heavy in solar research following oil price hikes and global warming. Genetic engineering allows China to feed its population."

BOX IB-14. CRITICAL CONCERNS AND TRENDS ADDRESSED IN THE 26 SETS OF SCENARIOS

I. Economic and Political Economic Concerns

1. Economic growth continues steadily	Economic growth falters, could crash
2. Global economic integration continues smoothly and is generally welcomed	Global economic integration generates conflict, and stalls
3. The power of multinational corporations is satisfactorily regulated by institutions of global governance	Multinationals accumulate immense powers and subvert attempts at regulation
4. Inequalities of income and wealth are kept within socially acceptable bounds	Inequalities of income and wealth explode
5. The poorest countries and the transition countries successfully integrate into the growing global political economy	The integration of poor and transition countries stalls and they are left behind.

II. Concerns about Social Structure, Social Relations and Values

1. Diverse social groups successfully cooperate in civil society	Diverse social groups see one another as adversaries
2. The world becomes increasingly individual-centered and materialist	Communitarian and post-materialist values flourish
3. The world becomes increasingly secular/scientific	The world becomes increasingly religious/spiritual

III. Concerns about Technology

1. Technological innovation continues steadily and fuels continued economic growth	Technological innovation stagnates
2. The new technologies are generally safe and socially benign, and where necessary can be successfully regulated	The new technologies are dangerous and socially divisive, and resist regulation

IV. Environmental Concerns

1. Environmental problems are successfully addressed through technology, markets and public policies	Environmental problems explode beyond our ability to contain them

BOX IB-15. ADVOCATED NARRATIVE SCENARIOS

1. Techno-Globo Neoliberalism

Prosperity for most is achieved through an integrated global market economy, free trade and technology. Nation states and collective governance in general have reduced roles, although some global coordination is needed to ensure financial stability. So long as most people experience a steady increase in incomes, distributional equity is not a major problem. People the world over increasingly share common secular values of individualism, consumerism, and tolerance. Environmental problems are successfully addressed mostly through market mechanisms. Technological innovations are welcome for the new opportunities they provide. A high premium is placed on education, entrepreneurial leadership, and professional talents in general. Armed conflict is minimal.

2. Social Democratic Internationalism

Prosperity and a high quality of life are ensured through an integrated global market economy, active governance to ensure distributional equity and the adequate provision of public goods, and a social ethos that affirms community, solidarity and other non-market values. Nation states remain the central units of political allegiance, although regional and global coordinating institutions are important. Powerful technologies are regulated to ensure social benefit. If necessary, slower rates of aggregate economic growth are accepted in order to ensure that other social values are realized.

3. Green Sustainability

This scenario is grounded on doubts that global industrial economic growth is sustainable over very many decades, at least in a manner than avoids a net degradation of well-being. It looks towards achievement of a steady-state level of resource utilization at some point within the coming century. After that time, technological and social innovation can allow the quality of life to continue to increase. However, technological manipulation of natural systems is tightly constrained. Green Sustainability generally looks to smaller scale and decentralized social, political and economic institutions. Global trade and economic integration are less than they are today. Green scenarios generally rely on the widespread adoption of social values that minimize the desire to compete for status and prestige through displays of material ownership and consumption.

4. "Civilization-of-civilizations"

This scenario asserts that as the pressures and dislocations of continued economic globalization continue, nation states will ally strongly with one another both for protection and advantage, and will do so on the basis of long-standing shared values of culture, religion and ethnicity. These new, continent-sized economic blocs will be able to affirm their own economic, social and cultural practices in a way that most individual nations would not find possible. Inter-civilizational rules are adopted to minimize conflict and competition, to regulate trade and communication, and to provide for necessary global public goods such as environmental protection. This scenario is based on that propounded by Samuel Huntington in *The Clash of Civilizations.*

civilizations.[13] These scenarios summarize, in my judgment, very generally, the major political-economic alternatives contending in the world today. I characterize these further as *advocated* scenarios. As used here the phrase describes scenarios that important constituencies are working to make happen. Advocated scenarios are distinguished from the many other scenarios which, although plausible, are not desired and worked for by any active constituencies. Most utopian and dystopian scenarios, for example, are rarely actively advocated. Only a minority of the 130 scenarios noted in Boxes IB-1 through IB-13 are advocated scenarios.

I.B.4. A FRAMEWORK FOR INTEGRATING THE QUANTITATIVE AND NARRATIVE SCENARIOS

In **IB-16** we suggest the extent to which our four advocated narrative scenarios and our six quantitative scenarios from Section I.A might be roughly compatible or incompatible with one another. The shaded polygons indicate the extent of compatibility between two scenarios: the greater the area of each square covered by a portion of a polygon, the greater the compatibility. For example, techno-globo neoliberalism is quite compatible with the unconstrained growth of Scenario 1, but less so with Scenario 2, which calls for focused efforts to increase economic growth in poor countries, and it is barely if at all compatible with any of the remaining quantitative scenarios, which call for growth restraint by the high income countries. The Green sustainability scenario, by contrast, is compatible with the slow growth quantitative scenarios (Scenarios 3 through 6), but not with the exuberant growth of the Scenario 1.

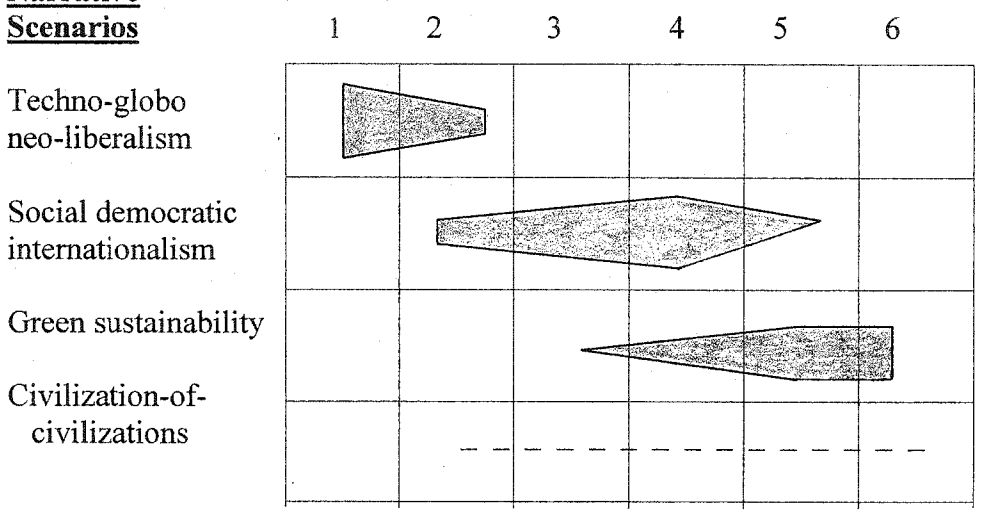
The "civilization-of-civilizations" scenario is somewhat different from the others in that it might contain a mix of quantitative scenarios, each particular to a continent-sized "civilization." Although a set of "civilizations" would generate aggregate global values of economic growth, equity, energy use, etc. approximated by one of the quantitative scenarios, this would be an artifact, unless it had been the intended goal of negotiated inter-civilizational agreements.

[13]The modifier "techno-globo" is not meant to be flippant; rather, it is used to highlight the central roles

BOX IB-16. MATRIX OF QUANTITATIVE SCENARIOS AND NARRATIVE SCENARIOS

Quantitative Scenarios

Narrative Scenarios



Descriptions of the Quantitative Scenarios [see Sections IA.2 and IA.3 for details]

Scenario 1: continuation of present expected trajectories of economic growth, population growth, distributional equity, and energy efficiency.

Scenario 2: faster economic growth in developing countries
greater energy efficiency

Scenario 3: faster economic growth in developing countries
maximum practical efficiency
slower population growth
slower economic growth in high income countries

Scenario 4: faster growth in developing countries
maximum practicable energy efficiency
slower population growth
slower economic growth in high income countries
greater income equality within countries

Scenario 5: faster growth in developing countries
maximum practicable energy efficiency
slower population growth
slower economic growth in high income countries
greater income equality within countries
zero output growth by 2150

Scenario 6: same as 5, but more rapid income inequality reduction within high-income countries

We see that out of the 24 graphically displayed combinations there are perhaps 15 in which the narrative and the quantitative scenarios appear to be compatible. Each of the three narrative scenarios other than "civilization-of-civilizations" has one or at most two quantitative scenarios with which they appear to be uniquely most compatible.

To the extent that the judgments about compatibility reflected in the grid are valid, they can be used to impose some consistency on professed political commitments. A person who identifies with, for example, social democratic internationalism, and who feels that the trajectories of quantitative Scenario 3 are possible and most desirable, holds consistent commitments. But a person who, perhaps, advocates Green sustainability, yet does not believe that Scenario 3 or any of the higher numbered scenarios are feasible, may be holding inconsistent commitments.

The grid can help us identify potential allies and coalitions. If we assume, for the time being, that all four of the narrative scenarios remain more or less viable over the decades to come, then advocates of one or another of these scenarios might seek to increase the chances of success by establishing coalitional alliances with one or more of the others. Potential coalitional allies might include:

1. Neoliberals and social democrats who agree to work together towards the goals of quantitative Scenario 2.

2. Social democrats and Greens who agree to work together towards the goals of Scenarios 3 or 4. [14]

3. Greens and various "civilizations" who agree to work together to advance a regionalist/ decentralist agenda.

---

that continued technological innovation and global economic integration play in scenarios of neoliberalism.

[14] This portion of the text was written in March, 1998. In November 1998 the German Social Democratic Party under newly elected President Gerhard Schroeder formed a coalition government with the Greens. Green Party leader Joschka Fischer became Foreign Minister.

4. Social democrats and "civilizations" who agree to work together by giving the social democrats the portfolio for inter-civilizational contact and coordination, while the various "civilizations" hold on to their local (continental) particularity.

I.B.5. ASSESSMENT

Clearly, the social, cultural and political considerations introduced by our review of narrative scenarios forces us to address an entire additional set of questions along with those raised following our construction of quantitative scenarios in Section I.A. How we answer these questions has a large bearing on the extent to which we believe one or another of the combined quantitative and narrative scenarios are desirable, credible, and compelling.

Examples of the sorts of additional questions we will need to address can be had by rephrasing the dichotomous critical trends identified in IB-14. Will global economic integration continue smoothly and be generally welcome, or will it generate conflict, and stall? Will globalization work to support or impede economic well-being, ecological integrity, and social equity? Can the global economy be satisfactorily regulated by institutions of global governance, or will it subvert attempts at regulation? Will the poorest countries and the transition countries successfully integrate into the global political economy, or with their integration stall? Will diverse groups successfully cooperate in civil society, or will they see one another as adversaries? Will social and cultural practice emphasize individual and material-centered values, or will it emphasize communitarian and post-materialist values? Will the new technologies be generally safe and socially benign, or will they be dangerous or socially divisive? If the latter, will they accept or resist regulation and control?

These and the questions identified at the end of Section I.A are among those addressed in Section II.

In order to focus our analysis I identify here an ideal scenario. This scenario embodies values regarding economic well-being, ecological integrity and social equity that I hold, and

realizes outcomes that I would like to see happen. The ideal scenario is comprised of the political economy scenario of Green sustainability, together with the quantitative Scenarios 5 or 6.[15]

Section II comprises an interrogation of the ideal scenario. Can a credible, compelling case be made for it?

[15] Scenarios 5 and 6 differ in the rate at which inequality within countries declines, but are identical in all other respects, including the final, stabilized, degree of inequality. For ease of exposition, from this point on I identify the ideal quantitative scenario as Scenario 5, but by that I mean Scenario 5 or 6.

SECTION II. EVALUATION OF KEY CONCERNS

II.A. LIMITS TO GROWTH

Summary

Section II.A.1 reviews the analysis offered in *The Limits to Growth (1972),* the neo-classical reaction, and subsequent developments. The results of the economic models featured in the debate over limits to growth depend heavily on assumptions concerning the extent to which technological innovation can generate new resources without generating new disutilities. In addition, many social factors bear on growth dynamics and are difficult to include in quantitative models.

While the limits-to-growth models have usefully focused attention on important questions, answers to those questions lie in analyses external to the models. We address several of these questions in the remaining sections of Section II.A. Section II.A.2 considers biogeophysical limits to growth. Section II.A.3 considers limits to technological innovation. Section II.A.4 considers complexity as a limit to growth.

A discussion of the definitions of "growth," "limits," "well-being" and other important terms, and of the ways these terms can be used to clarify or obscure important distinctions, is found in Appendix 5.

II.A.1. THE LIMITS-TO-GROWTH DEBATE: MODELS AND THEORY

II.A.1.a. The Limits to Growth

The publication of *The Limits to Growth* in 1972 was an epochal event in the evolution of the environmental movement that had been growing steadily in the industrial countries since the second World War. It identified a cause of ultimate concern and provided this cause with a unifying scientific and intellectual framework and vocabulary. Before *Limits* we were backpackers and naturalists. After *Limits* we were agents of world-historical social change.

The Limits to Growth reported exercises conducted using World 3, a computer model inspired by Jay Forester at MIT. World 3 shows how five variables—population, industrial output, agriculture, pollution, and natural resources—might act upon each other as they change over time. On the twentieth anniversary of publication of *Limits* the original authors prepared an updated version of World 3, called World 3-91, but the changes were minor.

The reference scenario for World 3-91 (**IIA-1,** Figure 1) shows industrial output peaking in 2015. After this time resource exhaustion, pollution and over-population cause industrial output and population to begin a catastrophic decline. Scenarios incorporating conventional conservation and population policies proposed to prevent such a collapse show that these serve only to delay its onset, as shown in IIA-1, Figures 2 and 3.

The one scenario that prevents collapse—Scenario 10, shown in IIA-1, Figure 4—requires that average family size is maintained at two children per couple beginning in 1995, that new technologies to increase the efficiency of resource use and to control pollution be developed, and that families decide to limit their consumption to about $5400 per person per year (1990 US dollars). The authors suggest that this level of income could provide a material standard of living

BOX IIA-1. WORLD 3 SCENARIOS (1)

Figures 1-3 were produced using Stella software and settings for each scenario as given in Meadows 1991. Figure 4 is reprinted from Meadows et al 1992.

Figure 1. World 3 Reference Scenario. Industrial output begins to decline in 2015.

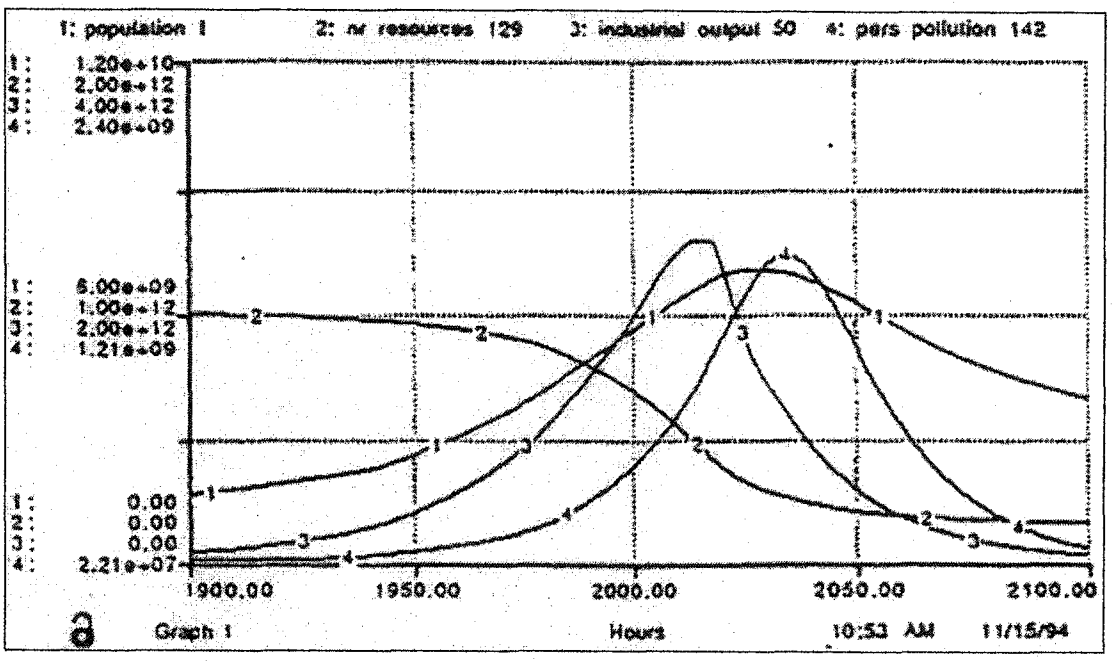
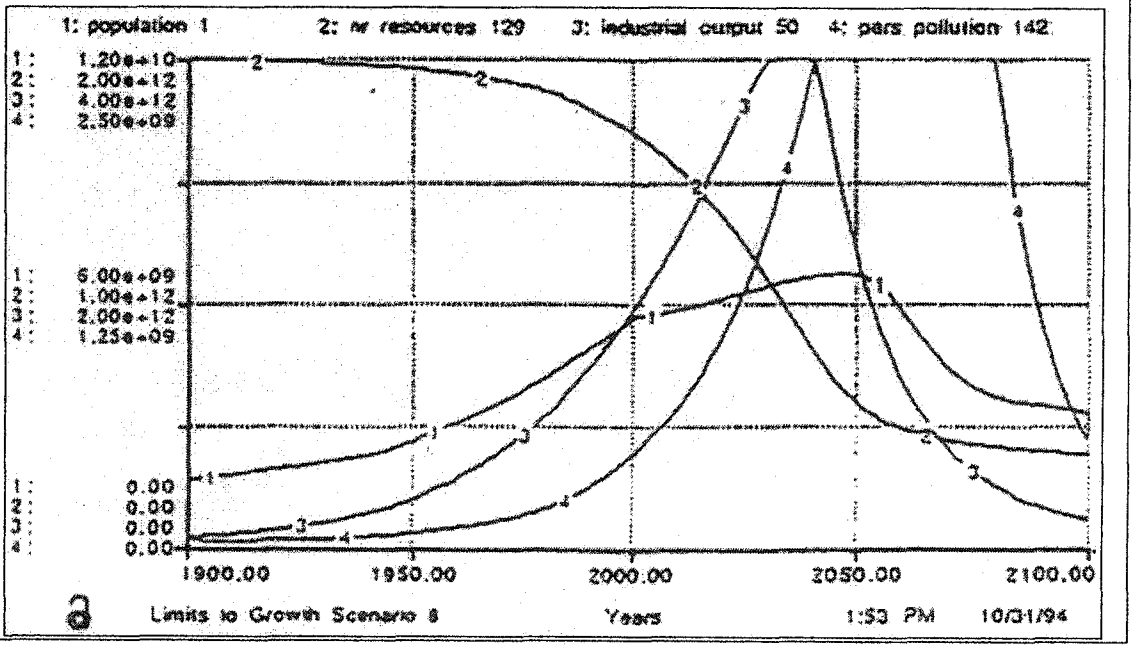


Figure 2. World Three Scenario 8. This scenario calls for achievement of a two child per couple family size by 1996 and assumes that the stock of depletable resources is twice that used in the Reference Scenario.



BOX IIA-1. (cont'd.)

Figure 3. World 3 Scenario 9. This scenario uses the same assumptions as Scenario 8, but adds the assumption that net capital investment declines to zero by 2000.

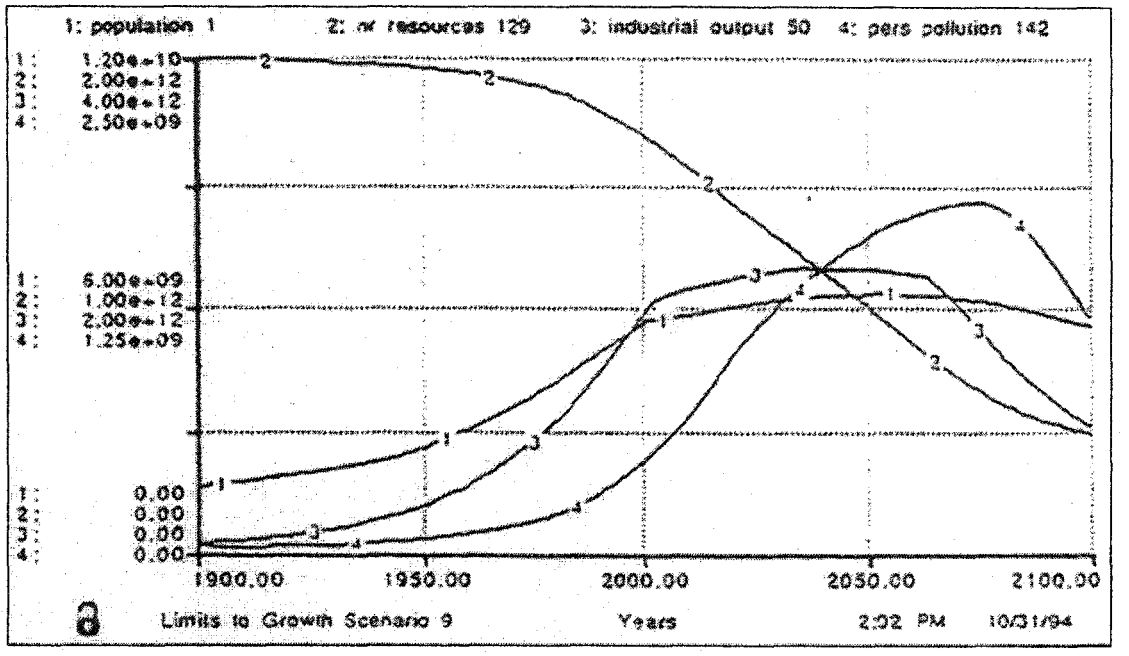
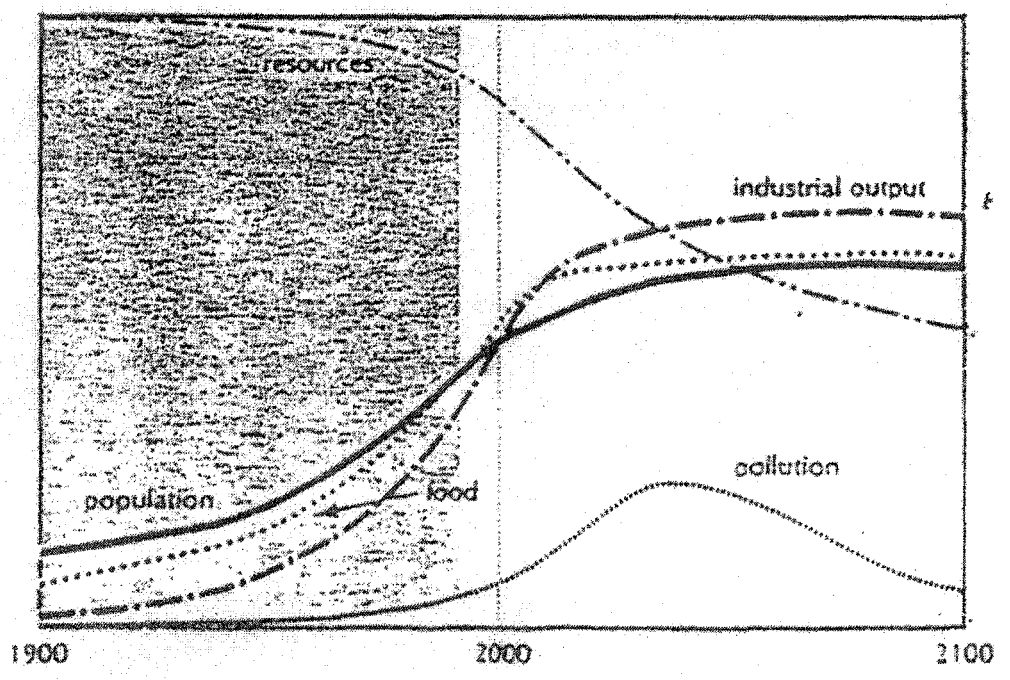


Figure 4. World 3 Scenario 10. This scenario uses the same assumptions as Scenario 9, but adds a large list of technological and policy innovations designed to promote efficient energy use.



equivalent to that of Western Europe in 1990 if "defense spending and corruption" were eliminated (Meadows et al. 1992 p196).[16] [17]

Criticism

Critics found fault with many aspects of World 3.[18] The most frequent criticism was that the model seriously underestimated the extent to which technological innovation could be expected to overcome resource constraints. Nordhaus (1973) demonstrated that small changes in the assumptions concerning expected rates of technological innovation could generate trajectories of growth without limits (see **IIA-2**, Figure 1). Meadows et al. acknowledged this criticism of the structure of World 3 in *Beyond the Limits* (see IIA-2, Figure 2), but reaffirmed their conviction that technological innovation alone would not be able to avoid the damages that they anticipated would arise from resource depletion and pollution. However, they offered no new data or analysis to support this affirmation.

It is important to note that Scenario 10 does not truly represent a solution to the problem of limits to growth as posed by its authors. If Scenario 10 is run beyond the year 2100 output begins to decline and in short order collapses just as resolutely as it does under the reference scenario (see IIA-2, Figure 3).

World 3 is unnecessarily complicated. The majority of its 152 equations are auxiliary equations that simply generate parameter values. These could have been specified exogenously without changing the dynamics of the dependent variables.[19] The pattern of "overshoot and collapse," which the authors of World 3 present as an important result generated by the model,

---

[16] $5,400 is about one-third of the level of per capita consumption in Western Europe in 1990. Defense spending in Europe in 1990 accounted for about 5% of GDP. It appears that Meadows et al. are suggesting that 62% of the national income of Western Europe is generated by "corruption."

[17] I produced Figures 1, 2 and 3 using the version of World 3-91 that can be run on the *Stella* software. Figure 4 is from *Beyond the Limits* (p 199). I haven't yet been able to reproduce this trajectory, but I assume it can be done.

[18] See Cole (1973), Nordhaus (1973, 1992), B. Hayes (1993), Kelly (1994) and Cohen (1995) for criticisms.

[19] Klaassen (1980) shows that the 53 equations of World 2, the precursor to and core of World 3, could be collapsed into a system of 5 linked differential equations.

BOX IIA-2. WORLD 3 SCENARIOS (2)

Figure 1. Nordhaus: World 3 with greater technological change
[Reprinted from Nordhaus 1973]

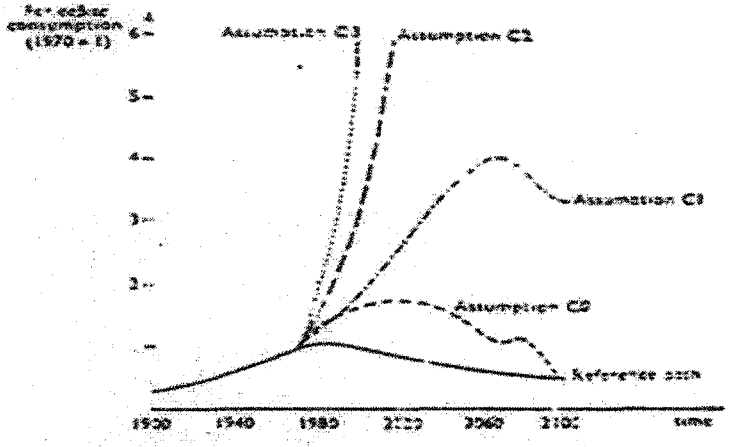


Figure 2. Meadows et al: World 3 with "infinite technology"
[Reprinted from Meadows et al 1992]

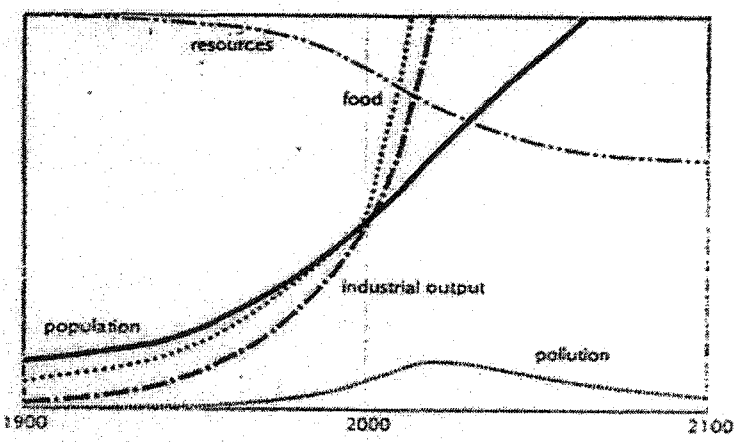
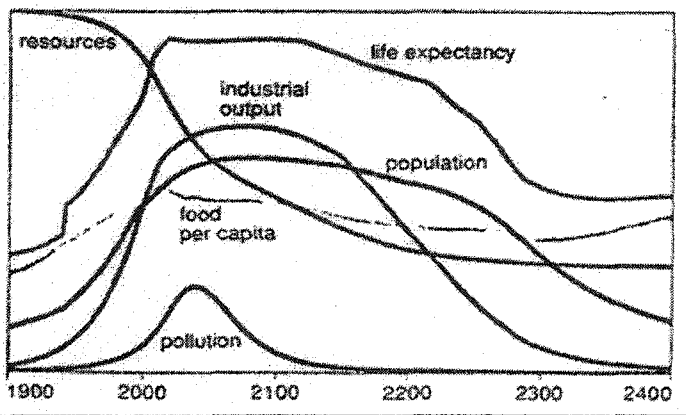


Figure 3. Extension of World 3 Scenario 10 over 300 years.
[Reprinted from B. Hayes 1993]



was in fact hard-wired into it from the beginning. **IIA-3** shows a system of seven equations that captures the essential structure of World 3 and generates similar trajectories over time, as shown in **IIA-4.** The functional relationships specified are all plausible, but because the resource base is fixed, collapse is inevitable.

Assessment

Meadows et al. defend their 1972 study as a first, ambitious attempt to address a very complex set of questions, which they fully expected would be subject to critique and refinement. They say that its success should be measured by the richness and usefulness of the analyses that followed in its wake.

By this criteria *Limits* failed in some ways and succeeded in others. World 3 itself was judged to be too flawed to usefully serve as a framework for subsequent refinement. On the other hand, *Limits* directly inspired a multitude of modeling and other analytic efforts designed to address the challenges that it raised. Beyond this, it put the topic of limits to growth onto the agenda of a wide range of academic and social discourses.

II.A.1.b. The Neo-Classical Response

Economists were among the harshest critics of *The Limits to Growth,* but they had to acknowledge that it drew attention to important questions that mainstream economics had largely ignored. In the years following the publication of *Limits* a great number of papers appeared in the professional journals that attempted to provide a neo-classical treatment of natural resource constraints on economic growth.

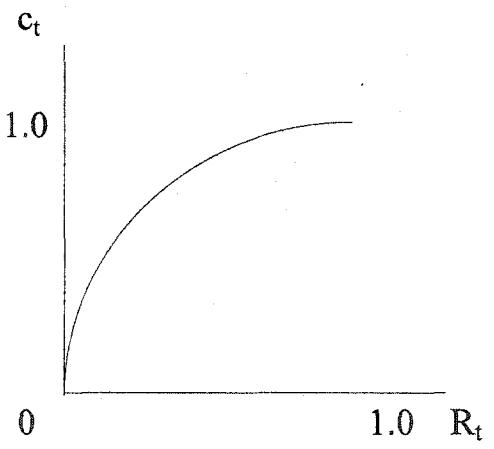
The theory of neo-classical economic growth was given its most succinct expression by MIT economist Robert Solow in the mid-1950's. The core equations of what became known as the Solow model are shown in **IIA-5**. It is important for our purposes to note that the Solow model is in fact a limits-to-growth model. Because of diminishing factor returns output grows until annual savings (sY) equals annual depreciation (δK). After that point an increment of

BOX IIA-3. SIMPLIFIED LIMITS-TO-GROWTH MODEL
[Source: High Performance Systems, 1994]

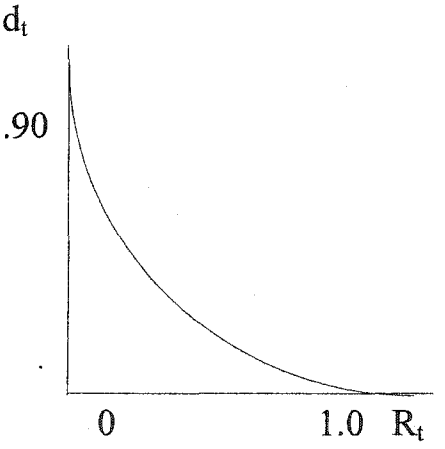
1) $R_{t+1} = R_t - C_t$
2) $C_t = c_t P_t$
3) $P_{t+1} = P_t + (B_t - D_t)$
4) $B_t = b_t P_t$
5) $D_t = d_t P_t$

R = stock of nonrenewable resources ($R_0 = 1000$)
P = population ($P_0 = 10$)
C = total consumption
c = per capita consumption (see 6 below)
B = births
D = deaths
b = birth rate = .25
d = death rate (see 7 below)

6) per capita consumption:

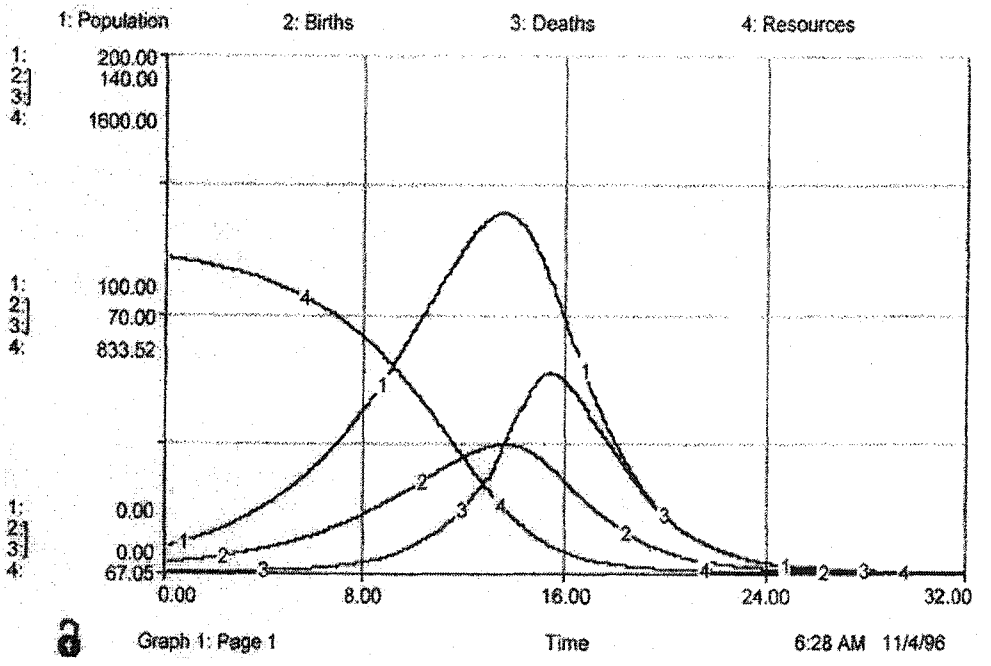


7) death rate:



BOX IIA-4. BEHAVIORS OF KEY VARIABLES OF THE SIMPLIFIED LIMITS-TO-GROWTH MODEL

The figure shows the behavior of the model described in Box IIA-3. It was modeled using Stella software.



BOX IIA-5. THE SOLOW GROWTH MODEL

1. Basic Equations

(1.1) $Y_t = K_t^{\alpha}(A_t L_t)^{\beta}$ $\quad [\alpha + \beta = 1]$

(1.2) $\dot{L}_t = nL_t$

(1.3) $\dot{A}_t = gA_t$ $\quad \frac{\partial Y}{\partial K} > 0\,, \quad \frac{\partial^2 Y}{\partial K^2} < 0$

(1.4) $\dot{K}_t = sY_t - \delta K_t$

Where:

Y = total output
K = capital stock
A = technological innovation
L = labor force
n = population growth rate
g = rate of technological innovation
s = savings rate
δ = rate of depreciation of capital
α, β = elasticity of output with respect to capital, labor

2. Derivation of growth rates of total and per capital output

(2.1) $Y_t = K_t^{\alpha}(A_t L_t)^{\beta}$

(2.2) $\ln Y = \alpha \ln K + \beta \ln A + \beta \ln L$

(2.3) $\frac{d(\ln Y)}{dt} = \alpha \frac{K}{K} + \beta \frac{A}{A} + \beta \frac{L}{L}$

(2.4) $\frac{\dot{Y}}{Y} = \alpha \frac{\dot{Y}}{Y} + \beta g + \beta n$

(2.5) $\frac{\dot{Y}}{Y} = \frac{\beta(n+g)}{1-\alpha} \quad \Longrightarrow \quad \frac{\dot{Y}}{Y} = n + g$

(2.6) $\frac{\dot{y}}{y} = \frac{\dot{Y}}{Y} - \frac{\dot{L}}{L} \quad \Longrightarrow \quad \frac{\dot{y}}{y} = g$

Equation (2.5) shows that the growth rate of output is equal to the sum of the growth rates of population and technological innovation. Equation (2.6) shows that if the rate of population growth is zero, the growth rate of per capita income is equal to the growth rate of technological innovation.

capital investment will not generate sufficient output to cover depreciation of the total capital stock. In the absence of technological change per capita output growth will have stopped. If the growth rate of population at some point reaches zero, total output growth will also stop.

Put differently, the important feature of the Solow model is that if population growth is zero, per capita output grows at the rate of total factor productivity growth, which in turn is conventionally attributed to the growth of "technology" or "knowledge."

The neo-classical response to *Limits* began by incorporating stocks and flows of natural resources and pollution into the standard Solow model, as shown in **IIA-6**. The major finding of these investigations was a conditional one, and not especially profound. Economic output and social welfare can continue to increase, the studies concluded, so long as technological innovation can compensate for any drag on growth, or any direct disutility, caused by the depletion of resources.[20]

A second, often-noted result of the neo-classical analysis of natural resource constraints on growth was to focus attention on the question of how easily different factors could be substituted for one another and still produce the same level of output. **IIA-7** presents a summary of the neo-classical findings regarding substitution. But the ease of substitution is largely a function of technology, so this result is mostly contained within the first, more general result.

Clearly, the model presented in Box IIA-6 hardly begins to depict the full set of economic or ecological interactions that motivate concern over possible resource constraints on economic growth. Neither does it address the process of technological innovation that turns out to be the centerpiece of its analysis.

Can more sophisticated applications of economic theory provide deeper insights? Many analysts have made efforts to do this. A representative example from within the neo-classical tradition is the model presented in 1992 by Pezzey, described in **IIA-8** and **IIA-9**. It provides a

[20] Here the term "resources" includes those resources that serve as sinks for pollutants.

BOX IIA-6. THE SOLOW MODEL WITH FIXED AND DEPLETABLE RESOURCES

1. Basic Equations

(1.1) $Y_t = K_t^{\alpha}(A_t L_t)^{\beta} R^{\lambda} T^{\gamma}$

(1.2) $\dot{L}_t = nL_t$

(1.3) $\dot{A}_t = gA_t$

(1.4) $\dot{K}_t = sY_t - \delta K_t$

(1.5) $\dot{T} = 0$

(1.6) $R = \mu S e^{-\mu}$

Where the variables are defined as in BOX IIA-5, and

T = land
R = resource flow
S = depletable resource stock
λ = elasticity of output with respect to resource flows
γ = elasticity of output with respect to land
μ = rate of resource depletion

2. Derivation of growth rates of total and per capita output

Using the same procedures as used in BOX IIA-5, growth rates of total and per capita output are found to be:

(2.1) $$\frac{\dot{Y}}{Y} = \frac{\beta}{(1-\alpha)}(n+g) - \frac{\lambda}{(1-\alpha)}\mu$$

(2.2) $$\frac{\dot{y}}{y} = \left(\frac{\beta}{1-\alpha} - 1\right)n + \left(\frac{\beta}{1-\alpha}\right)g - \left(\frac{\lambda}{1-\alpha}\right)\mu$$

By rearranging we see that per capita output can grow indefinitely if:

(2.3) $$g > \left(\frac{1-\alpha}{\beta} - 1\right)n + \left(\frac{\lambda}{\beta}\right)\mu$$

Nordhaus (1992) estimates values for the parameters shown above and applies them to a similar model. The values he uses are: $\alpha = 0.20$; $\beta = 0.60$; $\lambda = 0.10$; $n = .01$; $\mu = .005$. He finds that output can continue to grow indefinitely if $g > 0.25\%$ per year. Applying Nordhaus' values to this model, we find that output can continue to grow indefinitely if $g > 0.41\%$ per year. Nordhaus notes that g has historically increased by about 1.0% - 2.0% per year, which is comfortably above 0.25%; it is comfortably above 0.41% as well.

BOX IIA-7. CENTRAL RESULTS OF THE NEO-CLASSICAL ANALYSIS OF LIMITS TO GROWTH

In 1974 The Review of Economic Studies published a collection of journal articles under the heading *Symposium on Growth.* The purpose was to examine the topic of possible limits to continued economic growth using the theoretical framework of neo-classical economics. Key contributors included Solow, Stiglitz, and Dasgupta and Heal.

Two conclusions received special attention:

1. With sufficient technological change, economic growth can continue indefinitely.

2. With sufficient elasticity of substitution between capital and natural resources, a constant level of economic output can be maintained indefinitely.

More precisely, this second conclusion can be summarized as shown below.

Given:
a) $Y = F(K, R)$, where
b) R is an essential, exhaustible resource; and with
c) zero population growth; and
d) zero technological change,

is there a constant level of output that can be maintained indefinitely?

The finding was:

I. If $F(K, R)$ is CES (constant elasticity of substitution between capital and resources), and with s = elasticity of substitution, then:

if a) $s > 1$, then there is no problem; R is not an essential resource.

b) $s < 1$, then there is no hope; output *must* collapse to zero as $R \Rightarrow 0$.

c) $s = 1$, then the production function is Cobb-Douglas, and

if 1) $e_{QK} \leq e_{QR}$, then there is no hope; output *must* collapse to zero.

2) $e_{QK} > e_{QR}$, then yes, constant output can be maintained indefinitely, as $R \Rightarrow 0$.

where:

e_{QK} = elasticity of output with respect to capital
e_{QR} = elasticity of output with respect to resources

BOX IIA-8. Pezzey's Neo-Classical Treatment of Natural Resources and Economic Growth

An example of an attempt to more fully incorporate concerns about natural resources, pollution, technological innovation and amenity values into a neo-classical model of economic growth is that of Pezzey (1992).

In Pezzey's model output is a function of capital, labor, technology, resource flows, resource stocks, and pollution:

(1) $$Q = Q(K, L, T, R, S, P)$$

Changes in the stocks of both capital and technology are equal to investment minus depreciation:

(2) $$\dot{K} = I - \delta_K K$$

(3) $$\dot{T} = I_T - \delta_T T$$

Change in natural resource stocks is the difference between the natural amount of growth of these stocks (which itself depends on existing stock levels and the stock of pollution), less depletion:

(4) $$\dot{S} = G(S, P) - R$$

Change in the stock of pollution is likewise the difference between the amount of net pollution flow in a period and the amount of reduction in the existing pollution stock (with pollution stock reduction being a function of the level of stock and the amount of clean-up effort):

(5) $$\dot{P} = D - A(P, X)$$

Human population growth is a function of the current size of the labor force and of total consumption:

(6) $$\dot{N} = \dot{N}(L, C)$$

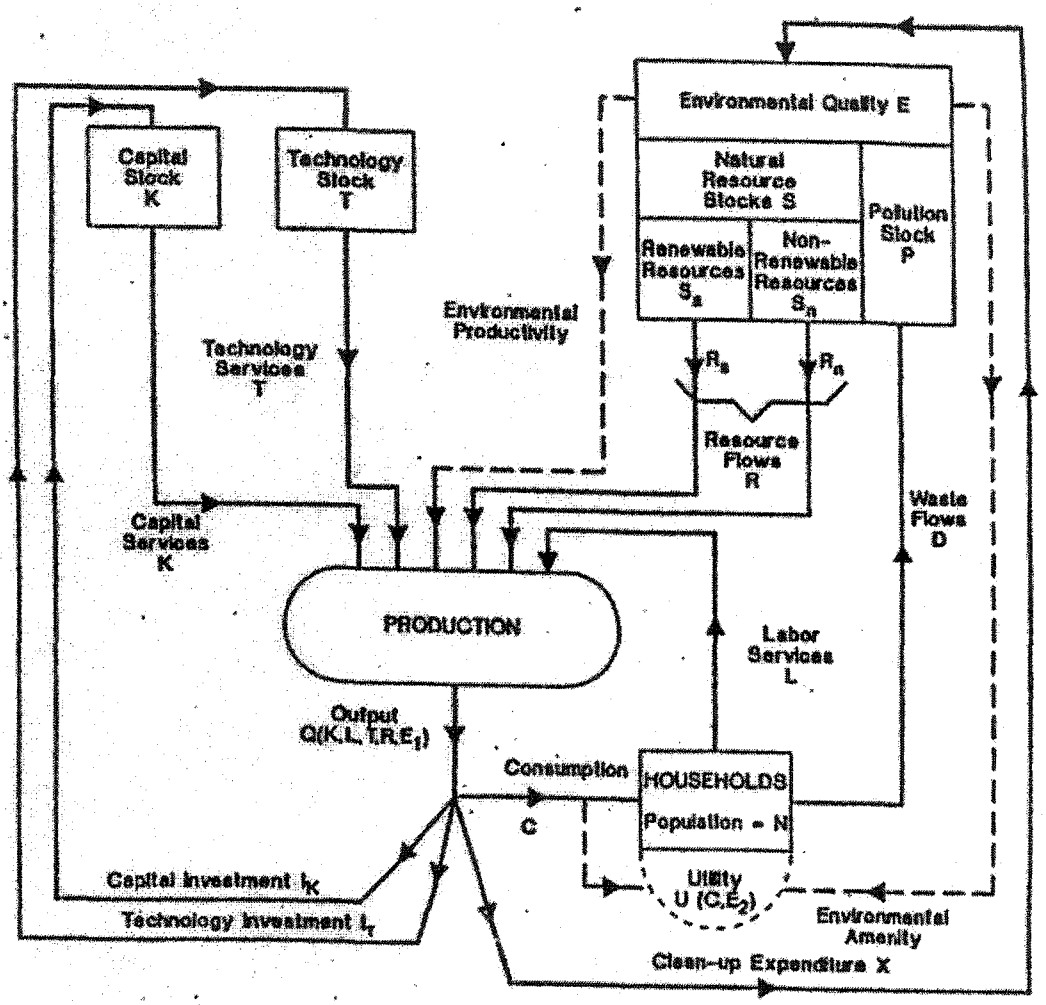
Labor productivity depends upon the levels of consumption, resource stock, and pollution:

(7) $$L = L(C, S, P)$$

Finally, Utility depends upon the same three factors:

(8) $$U = U(C, S, P)$$

BOX IIA-9. Pezzey's Model of Economic and Environmental Stocks and Flows
[source: Pezzey 1992]



richer treatment of resources, pollution, technology, and welfare. After considerable manipulation of the model Pezzey says,

> "The optimistic conclusion of the model is that, given high enough technological progress (and suitable resource conservation policies if environmental effects are important), sustainable development is possible with per capita output, consumption and social welfare growing without limits...The important question concerns the ultimate limits of capital-resource substitution and technical progress... However it is very hard to say what the limits of substitution might be..." (pp 33, 35)

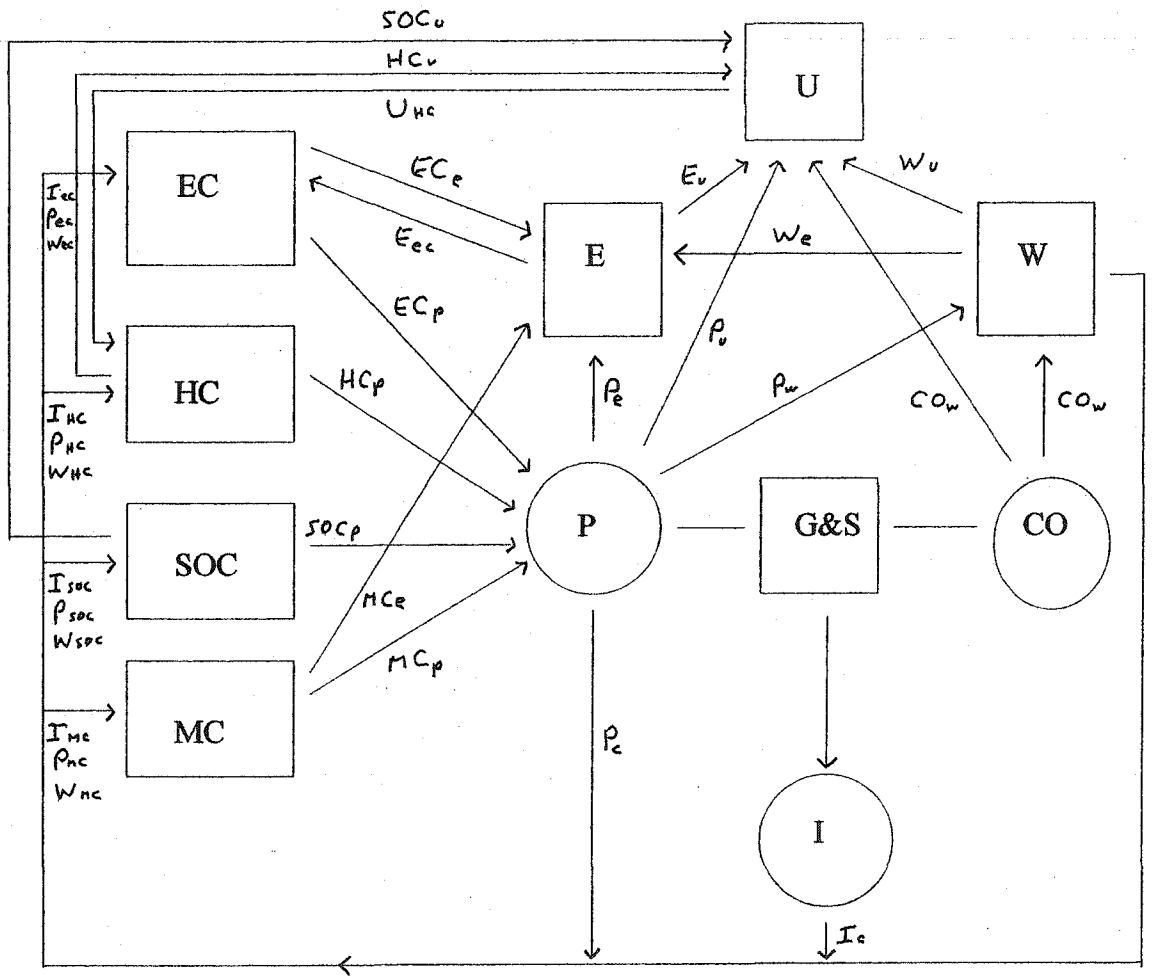
This is precisely the conclusion reached by the first neo-classical analysts to address this topic 18 years earlier. In fact, this conclusion is hard-wired into the structure of conventional neo-classical analysis, simply because there technology is *defined as* an exogenous factor that allows the growth of output to overcome diminishing factor returns.

II.A.1.c. Social Constraints on Growth

The early limits-to-growth literature focused on the intuitively plausible argument that the continued depletion of limited resources would eventually bring economic growth to an end. But suppose we can demonstrate that technological innovation could in fact overcome all resource constraints. Could we then rest assured that economic output could continue to grow indefinitely? No. Technological innovation, and in fact the entire set of activities that generate output growth, are embedded in a dense matrix of social variables, institutions and functions. It is conceivable that the continued growth of economic output could disturb these social factors in ways that impair their ability to support continued growth.

An example of the way in which social constraints on growth might be incorporated into an essentially neo-classical economic framework is shown in **IIA-10** and **IIA-11**. This model, by Ekins (1992), includes human capital and social/organizational capital as factors of production. Human capital is defined as those individual skills and abilities that contribute to economic output. Social and organizational capital refers to social institutions such as law, government, family and community life, as well as to attributes of the culture, that have a bearing on economic

BOX IIA-10. EKINS' "FOUR CAPITAL" MODEL OF WEALTH CREATION (1992)



BOX IIA-11. Ekins' "Four-Capital" Model of Wealth Creation – Definitions

U	=	utility/well-being
W	=	wastes
CO	=	consumption
G+	=	goods and services
I	=	investment
P	=	economic process (production of goods and services, or work)
EC	=	ecological capital
HC	=	human capital (knowledge, skills, health, motivation)
SOC	=	social/organizational capital (law, government, community, organizations, etc.)
MC	=	manufactured capital
E	=	environmental services/amenities
COu	=	contribution to human welfare that derives from consumption
COw	=	wastes generated by consumption
Eec	=	influence of environmental services on the stock of environmental capital
Eu	=	contribution to utility made by environmental services and amenities provided independent of human activity
ECe	=	environmental services and amenities provided independent of human activity (climate regulation, scenic beauty)
ECp	=	natural resources used for production of goods and services
HCp	=	human capital used to produce goods and services
HCu	=	direct contribution of human capital to well-being
Ic	=	flow of investment
Iec	=	investment in ecological capital
Ihc	=	investment in education and training
Imc	=	investment in manufactured capital
Isoc	=	investment in social and organizational capital
MCe	=	direct contribution of manufactured capital to environmental amenities (e.g, beautiful buildings and ugly buildings)
MCp	=	contribution of manufactured capital to the productive process
Pc	=	direct effects on the capital stock from economic processes
Pe	=	impact of productive activities on environmental services/amenities (+/-)
Pec	=	impact of productive activities on ecological capital
Phc	=	contribution of a stimulating work experience to human capital
Pmc	=	impact of the productive process on manufactured capital, i.e., depreciation
Psoc	=	direct impact of productive activity on social/organizational capital
Pu	=	contribution of job satisfaction and work relationships to human well-being
Pw	=	wastes generated by production of goods and services
SOCp	=	contribution of social and organizational capital to production of goods and services
SOCu	=	direct contribution of the level of social and organizational capital to well-being
Uhc	=	direct contribution of being healthy, skilled, and motivated to human well-being
Wc	=	impact of wastes on the capital stock
We	=	influence of wastes on the flow of environmental services/amenities
Wec	=	influence of wastes on the stock of environmental capital
Whc	=	impact of wastes on human capital
Wmc	=	impact of wastes on manufactured capital
Wsoc	=	impact of wastes on social and organizational capital
Wu	=	direct impact of wastes on well-being

output.[21] Commenting on this expanded set of factors, and on the varied ways in which they interact, Ekins says,

> "This richness is not an optional extra. It is absolutely necessary if the model is to reflect the realities of the modern global economy and help us to understand and act within it." (p 60).

Social constraints on growth have been made an explicit focus of study by only a few authors working on issues of growth and the environment, global futures, and the like.[22] Attempts at formal modeling or quantitative analysis of social limits to growth have been even fewer. The difficulty of course is that useful quantitative measurement of such abstract parameters as "the contribution of a stimulating work experience to human capital" is close to impossible. On the other hand, the topic of social constraints on growth is the central focus of a vast historical and political economic discourse. We review social constraints on output growth from a mostly neo-classical economic perspective in Section II.B, dealing with income inequality, and from the broader perspectives of history and political economy in Section II.D.

II.A.1.d. Assessment and Next Steps

While economic theory provides a useful framework for thinking about constraints and limits on growth, any demonstration of whether or not these exist must draw on the results of studies largely outside of the domain of economics per se. Although the neo-classical economists correctly identified serious flaws in *The Limits to Growth* and similar studies, any implication that the central thesis of *Limits* had thereby been disproved is incorrect. What these critics did was focus attention on the important question of whether or not the effects of resource constraints on production and utility could be overcome by continued technological innovation.

---

[21] Ekins' model is notable also for its richer treatment of the determinants of utility. In this section we are primarily concerned with possible constraints on the level of goods and services (output), but we comment on the topic of utility in Appendix 5.

[22] See, for example, Fred Hirsch, *The Social Limits to Growth* (1976).

In the sections that follow we review largely empirical analyses that focus on several possible limits to the growth of output: resource limits, limits to technological innovation, complexity, and the distribution of income.[23]

[23] These possible limits to growth are of course interdependent. A depletable resource is a possible limit only insofar as no technologies are available that can generate substitutes for it. And as we noted, technology is a complex social process. The categories shown here are commonly used in both academic and popular debates, and are convenient to use at this point, but a deeper understanding of growth and its constraints calls for a more general framework.

II.A.2. ARE THERE BIOGEOPHYSICAL LIMITS TO GROWTH?

Summary

In this section we consider possible biogeophysical limits to continued output growth.

In II.A.2.a we evaluate limits imposed by scarce energy resources. We conclude that a "moderate techno-optimist" might judge that world energy use can continue to grow at rates of about 1% per year for perhaps 400 to 600 years, until it reaches an indefinitely sustainable level 20 times today's level, while a "moderate techno-skeptic" might judge that energy use can grow at these rates for maybe 100 to 270 years, until it reaches an indefinitely sustainable level perhaps 5 times as high as today's. This exercise suggests that the value of 30 terawatts (about 3 times today's level) that we used as the practicable upper bound in our ideal scenario, Scenario 5, may be unnecessarily conservative.

In II.A.2.b Nordhaus' DICE model is used to estimate the costs of avoiding catastrophic climate change. This exercise suggests that it should be possible to make a transition to a non-fossil fuel world over the next century while maintaining net positive rates of economic growth.

In II.A.2.c we comment briefly on entropic degradation and human appropriation of biomass as limits to growth.

Section II.A.2.d reviews studies using large scale integrated assessment models of global change. At present these studies do not give evidence that biogeophysical factors constitute limits to continued economic growth. However, most of the global integrated assessment models assume, exogenously, that economic growth will slow, quite dramatically, over the coming century. Formally this is expressed as a decline in the productivity growth rate, or in the growth rate of productivity-enhancing technological innovation. The possibility of limits to growth imposed by limits to technological innovation is discussed in Section II.B.

II.A.2. ARE THERE BIOGEOPHYSICAL LIMITS TO GROWTH?

Introduction

BOX IIA-12 lists resource and environmental problems associated with increasing human activity. How long can we continue to lose topsoil, pollute the ocean, encroach upon arable land or erode the ozone layer, before we breach some critical ecological threshold and irreparably damage the life-support systems of our planet?

Ecologists commonly distinguish two categories of natural resource limits: stock limits and sink limits. Stock limits are reached when a finite resource is exhausted, given available technology. Sink limits are reached when the waste products of resource use exceed the ability of natural or technological systems to prevent them from causing unacceptable harm.

In this section I focus on two instances of possible biogeophysical limits. As an important example of stock limits I focus on energy resources. Energy is important because there are no substitutes for it and because many other resource shortages can be alleviated if sufficient energy is available. As an important example of the possibility of catastrophic impacts caused when sink limits are exceeded, I focus on global warming. I comment briefly on entropic degradation and the human appropriation of biomass as limits to growth. I comment also on the results of large scale integrated assessment models concerning biogeophysical limits to growth.

II.A.2.a. Limits to the Growth of Energy Use

In this exercise we estimate the length of time over which energy use can continue to grow, and the length of time over which a constant level of energy use can thereafter be sustained, under several scenarios. We use annual rates of 0.5%, 1.0% and 1.5% for scenarios of slow, medium and fast energy growth.[24] **IIA-13** shows how these energy use growth rates can

[24] These values approximate the range of forecasts of the growth rate of energy use over the coming century used in many studies (e.g., IPCC 1994.)

BOX IIA-12. ENVIRONMENTAL CONCERNS
[sources: Ekins et al. (1992), Easterbrook (1995), Ausubel et al (1995)]

climate change/global warming
sea level rise
ozone layer depletion
biodiversity loss; species extinction; overfishing
deforestation; clearcutting; stripmining
wilderness loss
wetlands degradation
large dam construction; river siltation
land fills
coastal development
soil erosion; topsoil loss; overgrazing; desertification
acid rain
pesticide overuse
fossil fuel pollution; urban air pollution
marine and water pollution; oil spills
nuclear and chemical accidents
hazardous waste disposal and materials use
indoor radiation

BOX IIA-13. GROWTH RATES OF ENERGY EFFICIENCY, ENERGY USE AND OUTPUT

energy efficiency growth (% per year)	total energy use growth (% per year) 0.0	0.5	1.0	1.5
0	0.0	0.5	1.0	1.5
0.5	0.5	1.0	1.5	2.0
1.0	1.0	1.5	2.0	2.5
1.5	1.5	2.0	2.5	3.0

The table shows the combinations of improvements in energy efficiency and growth of energy use that can support different levels of total output growth, shown as the values in the squares. Thus GDP can grow at an annual rate of 2% if total energy use increases at 1.5% and efficiency increase at .5%, or if total energy use increases at .5% while efficiency increases at 1.5%. If energy use is kept at a constant level GDP can increase at the rate at which efficiency increases.

combine with improvements in energy efficiency (GDP/energy) to support varying growth rates of output (GDP).[25]

Procedure

Our first step is to estimate the total stock of non-renewable energy sources and the maximum practicable flows of renewable energy resources.

Our second step is to quantify the biogeophysical limits on the growth of energy use. For this exercise we focus on two important biogeophysical limits. One is atmospheric warming, which can result from either growing concentrations of greenhouse gases or from thermal pollution. The other is the availability of land.

Our third step is to use these estimates to construct credible scenarios of energy use over time.

Stocks and Flows of Energy Resources

Tables 1, 2 and 3 in **Box IIA-14** show the availability of stocks and flows of various energy resources as estimated in studies by different authors. Details of these studies are shown in Appendix 6. I used the results of these studies to choose the stock and flow values used in this exercise, shown in Table 4.

Biogeophysical constraints

The important biogeophysical constraint on the use of fossil and nuclear fuels, other than stock constraints, is global atmospheric warming. The important biogeophysical constraint on photovoltaic hydrogen and biomass is the availability of land.[26]

---

[25] Consider a scenario that shows energy use increasing at 1% a year for 75 years, ceasing to grow at that time but continuing indefinitely at the level reached at that time. If energy efficiency increases indefinitely at 0.5% per year, then conventional output could increase at 1.5% for 75 years and .5% thereafter.

[26] Nuclear reactions and fossil fuel combustion liberate energy tied up in nuclear and chemical bonds, and thus add heat to the atmosphere. Solar energy systems collect and change the radiant energy of sunlight into new forms, but add no new heat to the atmosphere. However, solar energy systems require large land areas in order to usefully concentrate diffuse radiant energy.

BOX IIA-14. STOCKS AND FLOWS OF ENERGY RESOURCES

TABLE 1. ESTIMATES OF STOCKS OF FOSSIL FUELS

(Terawatt years)

	Kahn 1 (1976)	Kahn 2 (1976)	Freeman (1978)	Holdren (1995)	IIASA/WEC (1995)	IPCC (1995)	EMF (1996)	Hinrichs (1996)
OIL			2564				451	198
conventional	124	482		500	284	270		
unconventional				500	785	511		
Shale Oil	636	66980	1115	30000				29
Tar Sands	60	60	209					57
NATURAL GAS	33	529	1394				519	167
conventional				500	312	292		
unconventional				1000		854		
COAL	3182	5693	7153	5000	4828	3985	9525	1675
TOTAL	4036	73745	12435	37500	6182	5912	10495	2126
w/o shale oil	3400	6765	11320	7500	6182	5912	10495	2097

notes:

Kahn 1	"proven reserves"
Kahn 2	"long term potential resources"
Freeman	"ultimately recoverable resources"
Holdren	"estimated remaining recoverable resources"
IIASA/WEC	"ultimately recoverable energy resources"
IPCC	"resource base"
EMF	"ultimately recoverable resources"
Hinrich	"proven reserves"

sources: see Table 3

TABLE 2. ESTIMATES OF STOCKS OF NUCLEAR FUELS

(Terawatt Years)

	Kahn (1976)	Freeman (1978)	Hafele (1981)	Holdren (1995)	IIASA/WEC (1995)	IPCC (1995)
Uranium in LWR's	502	?	?	3 x 10^3	369	451
Uranium in Breeders	>3 x 10^6	8351	3 x 10^5	3 x 10^6	22067	
DT-Fusion	10717	"virtually	3 x 10^5	140 x 10^6		
DD-Fusion	34 x 10^9	unlimited"	3 x 10^9	250 x 10^9		

notes:

a) IIASA/WEC estimates that 12,000+ TwY of LWR uranium is "ultimately recoverable"
b) Kahn's estimate of 502 TwY of LWR Uranium applies to the "free world." Kahn estimates that 100,470 TwY of LWR Uranium is available in the oceans

sources: see Table 3

[more...]

BOX IIA-14. STOCKS AND FLOWS OF ENERGY RESOURCES (cont'd.)

TABLE 3. ESTIMATES OF PRACTICABLE FLOWS OF RENEWABLE ENERGY

(Terawatts)

	Kahn (1976)	Hafele (1981)	Holdren (1995)	IPCC (1995)
Solar Electric	1005	20-200	50	82
Biomass	40	6	25	41.3
Hydropower	3.3	3	2	4.1
OTEC	670	1	9	0.63
Wind		3	1	4.1
Geothermal		2		
other			all < 1	0.63
total	1718	35-235	109	133
"best plausible" flow:			30	

notes:

a) Holdren's estimate of 50 TW of Solar Electric assumes using 1% of land area at 20% efficiency
b) Holdren's estimate of 25 TW of Biomass assumes using 10% of land area at 1% efficiency
c) Hafele's upper estimate of 200 TW of Solar Electric assumes using 7% of land area

sources for Tables 1, 2 and 3:

Kahn	Herman Kahn (1976). The Next 200 Years
Freeman	Christopher Freeman and Marie Jahoda (1978). World Futures: The Great Debate
Holdren	John Holdren (1995). Course handout for Energy and Resources 200, UC Berkeley
IIASA/WEC	International Institute for Applied Systems Analysis/World Energy Council (1995). Global Energy Perspectives to 2050 and Beyond
IPCC	Intergovernmental Panel on Climate Change (1996). Climate Change 1995: Impacts, Adaptations and Mitigation: Scientific-Technical Analyses
EMF	Energy Modeling Forum (1996). Demographic, Economic and Energy Assumptions for EMF 14
Hinrichs	Roger Hinrichs (1996). Energy: It's Use and the Environment (2nd Edition)
Hafele	Wolf Hafele (1981). Energy in a Finite World: Paths to a Sustainable Future

TABLE 4. ENERGY RESOURCE STOCK AND FLOW ESTIMATES USED FOR THIS EXERCISE

[sources: Tables 1, 2, 3. See Appendix A-6 for estimation procedure]

A. Remaining recoverable stock resources:

(Terawatt Years)

Fossil Fuels:	7,500
Uranium in LWR's:	1,000
Uranium in Breeders:	60,000
Fusion:	10^8-10^9

B. Maximum practicable energy flows from renewables:

(Terawatts)

PV Hydrogen: low	33.8	using 2% of land = 2.7 x10^6 km^2 @ 12.6 TW/10^6 km^2
high	203.0	using 12% of land = 16.1 x10^6 km^2 @ 12.6 TW/10^6km^2
Biomass:	26.8	using 10% of land = 13.4 x10^6 km^2 @ 2 TW/10^6 km^2
Hydro, wind, etc.:	6.0	

*1. **Atmospheric warming:*** Most current estimates of the cost of damages that might follow a 2.5°C warming range from 1 to 4 percent of GDP. No mechanisms have yet been identified which suggest that a 2.5°C warming might precipitate a catastrophe that would bring economic growth to an end. However, as temperatures rise above 2.5°C the possibility of catastrophe does also, as discussed further in Section II.A.2.b. In the absence of firmer data I choose a figure of 4° C as the level of atmospheric warming that would likely produce impacts severe enough to bring economic growth to an end. If we add a precautionary margin of 10% we get a final value of 3.6°C as the level of atmospheric warming that humankind would probably agree with near unanimity should be avoided.[27]

Atmospheric warming above pre-industrial levels can be caused by increased concentrations of greenhouse gases or by thermal pollution.

***a. Warming due to increased concentrations of greenhouse gases*:** A variety of greenhouse gas emissions scenarios exist that prevent warming from exceeding 3.6 °C, as shown in **IIA-15.** One might be for emissions to decline and stabilize at 6 GtC by 2025. Another would allow emissions to increase to 11 GtC by 2025, but decline within the next quarter century to 5.5 GtC. A third would stabilize emissions at 11 GtC from 2025 to 2050, but require reduction to 4.5 GtC by 2075.[28] The amount of coal that produces emissions of 6 GtC can produce about 9 TW of energy. For the remainder of this exercise we'll regard 9 TW as the biogeophysical limit on the production of energy from fossil fuels.

---

[27] The economic rationale is that if a 3.5°C warming runs a strong risk of bringing economic growth to an end, it is very unlikely that if 3.5 °C is exceeded anybody can ever again be made better off, without making someone else worse off.

[28] These scenarios were generated using an extended version of the global warming model developed by Cline (1992), which I prepared for my master's thesis (R. Hayes 1996). The extended Cline model is described in Appendix 7. Note that the sooner that emissions begin to be curtailed, the higher the stable level of acceptable carbon emissions allowable afterwards will be.

BOX IIA-15. Avoiding a 3.6 degree warming

Figure 1. Emissions Scenarios That Avoid A 3.6 Degree Warming

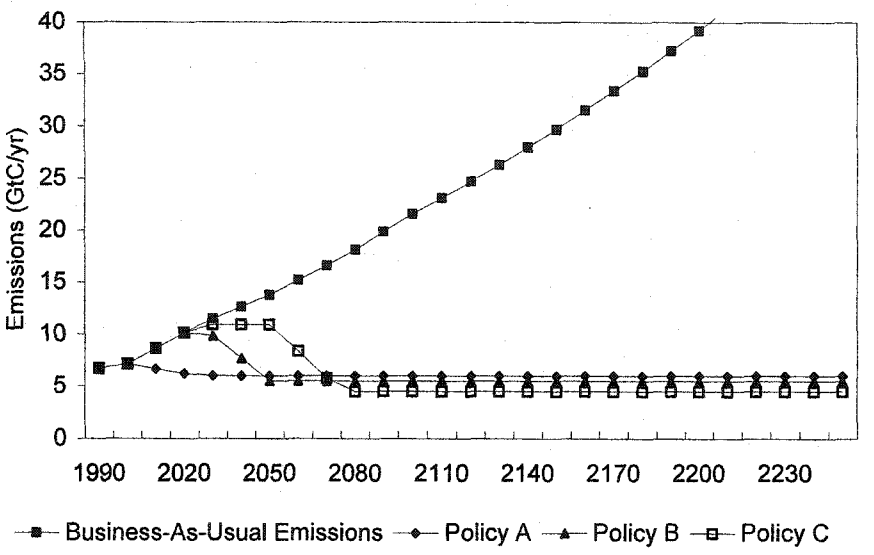
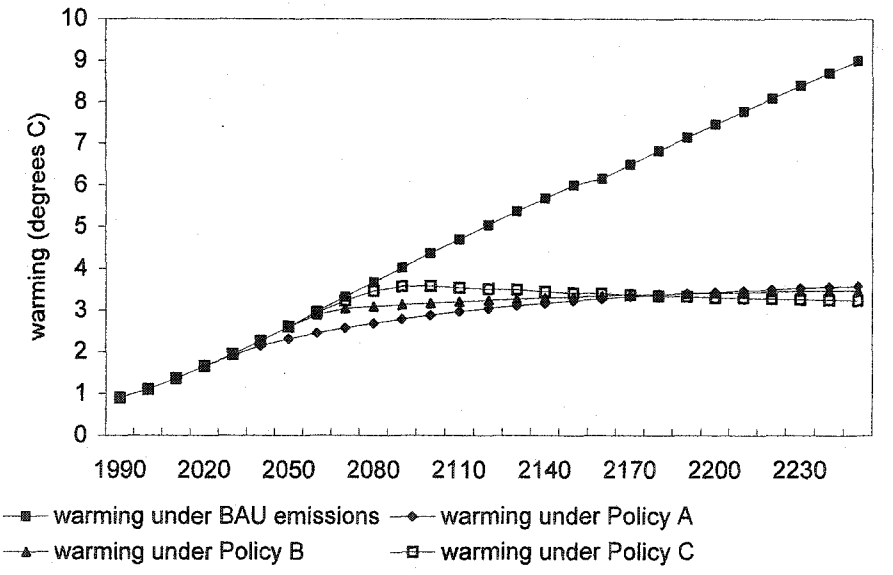


Figure 2. Global Warming < 3.6 Degrees



Emissions Policy Descriptions:

Business-As-Usual: This follows the BAU scenario of Cline (1992)

Policy A: Global emissions begin declining in 2000 and stabilize at 6 GtC by 2025

Policy B: Emissions follow BAU projections until they reach 11 GtC in 2025, then begin declining until they reach and stabilize at 5.5 GtC

Policy C: Emissions follow BAU projections until the reach 11 GtC in 2025, stabilize at that level for 25 years, then decline and stabilize at 4.5 GtC by 2075

b. Warming due to thermal pollution: **Box IIA-16** shows that a global warming of 3.6 °C could be produced by thermal pollution if total energy use grew to 5400 TW. This is 490 times the current level of 11 TW.

2. Available Land

For purposes of this exercise we assume that 2% of ice-free land is currently suitable and available for the production of photovoltaic hydrogen. In addition we suggest that over periods of a century or longer 12% of ice-free land could be used. **IIA-17** shows the global distribution of ecosystem types and includes speculative estimates of the land area of each of these that might be devoted to photovoltaic hydrogen.[29]

SCENARIOS

Given the available stocks and flows of energy resources that we're calculated, and the limited ability of the earth's ecosystems to sustain global warming or conversion of land to energy production, how long can energy use continue to grow at 0.5, 1.0, and 1.5 percent?[30]

---

[29] In this exercise I've made the simplifying assumption that biomass will not serve as a major energy source if fusion or photovoltaic hydrogen are practicable. The purpose of this exercise is to see how long energy use can grow before reaching stock or sink limits. The presumption is that energy growth of this magnitude is desired in order to support a high-tech, industrial world, and fusion or photovoltaic hydrogen are high-tech, industrial enterprises. Biomass energy production is in comparison low-tech. We assume here that biomass would be available as a bridge or fall-back source of energy, but would not form the core of a global energy regime. In any event, if biomass were given a greater role the time over which energy could be expected to grow, or be sustained, would be moderately greater than the figures shown in this exercise. On the other hand, if neither fission nor photovoltaic hydrogen are practicable, biomass could be an extremely important energy source.

[30] The formulas used to construct the scenarios are:

1. To calculate the level of energy use E if it grew at rate r for t years: $E_t = E_0 e^{rt}$
2. To calculate the total amount Q of a depletable energy resource consumed if its use E grew at rate r for t years: $Q_t = \int_0 E_0 e^{rt} = \frac{E_0}{r}\left(e^{rt} - 1\right)$
3. To calculate the time T it would take to exhaust a depletable energy resources stock Q if its initial rate of use E_0 and it grew at rate r: $T = \frac{1}{r}\ln\left(\frac{rQ}{E_0} + 1\right)$

BOX IIA-16. THERMAL POLLUTION

When energy is used to do work it generates heat. The more energy that people use, the more heat is released into the earth's atmosphere. The earth's atmosphere absorbs heat from a variety of sources and releases heat into empty space, as shown in the basic energy balance equation,

$$(1) \quad -\pi R_E^2 S + (M + M_m) = \pi R_E^2 SA + 4\pi R_E^2 \varepsilon \sigma T^4$$

where:

S	solar constant	0.135 watts/cm^2
R_E	radius of the earth	6.37×10^8 cm
A	albedo	0.37
ε	emissivity	0.55
σ	Stephan-Boltzman constant	5.67×10^{-12} watts/cm^2 ^{0}K^4
M	misc. natural energy inputs	27×10^{12} watts (volcanoes, etc.)
M_m	anthropogenic energy inputs	11×10^{12} watts (1995; fossil & nuclear fuel use)

This equation can be used to calculate the amount by which the atmosphere will warm as a result of any level of human energy use (M_m). We manipulate (1) to get:

$$(2) \quad T_1 = [\,((1-A)\,\pi\,R_E^2\,S + M) / (4\pi R_E^2 \varepsilon\,\sigma)\,]^{1/4}$$

where T_1 is the temperature of the atmosphere in the absence of anthropogenic energy inputs (i.e., when $M_m = 0$). Using the constant and parameter values given above we find that $T_1 = 288^0$ K = 15^0 C = 59^0 F. Following Holdren (1971) we note that for small changes in M_m,

$$(3) \quad T_2 - T_1 \sim \Delta T << T_1 = 288^0 K$$

We can manipulate the equations and apply given values to get:

$$(4) \quad \Delta T = .25 M_m T_1 [(1-A)\,4\pi R_E^2\,S]^{-1} = 6.67 \times 10^{-16}\,M_m$$

This expression allows us to generate the table below showing the atmospheric warming generated by higher levels of human energy use:

human energy use (TW)	anthropogenic warming (^{0}C)	date reached; or years until it is reached with 1% and 5% energy use growth rates
5	.0033	1970 - historical
10	.0067	1992 - historical
30	.0200	2035 - reference scenario
100	.0670	2108 - reference scenario
500	.3300	380 yrs (1%) 760 yrs (.5%)
1000	.6670	450 yrs (1%) 900 yrs (.5%)
2000	1.33	520 yrs (1%) 1030 yrs (.5%)
3750	2.5	580 yrs (1%) 1160 yrs (.5%)
5400	3.6	620 yrs (1%) 1230 yrs (.5%)

BOX IIA-17. Land Available for Photovoltaic Hydrogen

ecosystem categories	land area (10^{12} m2)	% of total area	apportionment of 2% of land area for PVH: %PVH	apportionment of 2% of land area for PVH: (10^{12} m2)	apportionment of 12% of land area for PVH: %PVH	apportionment of 12% of land area for PVH: (10^{12} m2)
forest/woods/shrubland	56.5	42.2	0.00	0.00	0.07	3.96
savanna	15.0	11.2	0.02	0.30	0.16	2.40
grassland	9.0	6.7	0.01	0.09	0.16	1.44
tundra/alpine meadows	8.0	6.0	0.00	0.00	0.00	0.00
desert scrub	18.0	13.4	0.10	1.80	0.32	5.76
rock & sand	9.0	6.7	0.05	0.45	0.20	1.80
cultivated land	14.0	10.4	0.00	0.00	0.05	0.70
swamps, lakes, streams	4.5	3.4	0.00	0.00	0.00	0.00
Totals:	134.0	100.0	0.02	2.64	0.12	16.06

source: ecosystem land areas are from Harte (1988); apportionment of land areas for PVH are my own speculations.

1. Fossil fuels

If global warming were not a concern then the available 7500 TWy of fossil fuels would allow energy use to grow at 0.5%, 1.0% and 1.5% for another 271, 191 and 151 years, respectively. At those times total energy use would have grown to 50 TW, 87 TW, or 123 TW, which represent levels of use 3.9, 6.7 and 9.5 times the year 2000 rate of 13 TW. After these dates new energy sources would need to be available in order to avoid a global crash of the sort forecast by the World 3 reference scenario.

However, we've seen that fossil fuels cannot supply more than 9 TW on a long term basis without causing global warming to exceed our 3.6°C limit. If we take 9 TW as the effective sustainable level of fossil fuel use, we see that the stock of 7500 TWy would last for 833 years.

2. Fossil fuels plus light water reactor fission

If we chose to rely heavily on LWR fission, energy use could grow at 0.5, 1.0 and 1.5 percents beyond 2000 for another 162, 125 and 104 years. Together with the 9 TW of sustainable fossil fuel energy, total energy use at these dates would be 18, 23 and 28 TW. However, all uranium fuel would have been exhausted, and new energy sources would need to have been developed if we wish to avoid a return to a 9 TW world.

3. Fossil fuels plus breeder reactors

If we use the available supply of uranium for breeders rather than for fission we would have a total of 67,500 TWy of power available. At rates of 0.5%, 1.0% and 1.5% energy use could grow for 659, 397 and 294 years, reaching total use levels of 351, 689 and 1069 TW, which are 27, 53 and 82 times the 2000 level of 13 TW. At the end of these growth periods alternative sources would be needed if catastrophic collapse is to be avoided.

4. Fusion

If fusion turns out to be a feasible and practicable energy source within the next 50 years or so then the lower estimate of 10^8 TWy of available power would allow growth at 0.5% 1.0%

and 1.5% for 1958 years, 1048 years and 756 years, reaching total use levels of .5 million, 1 million and 1.5 million TW. (Here we assume that fusion begins as a commercial power source in 2050, after total energy use has grown at 1.5% per year to 28 TW.)

Of course, these levels are orders of magnitude above the limit of 5400 TW that we determined earlier would be necessary to avoid a global warming greater than 3.6 °C due to thermal pollution. If we begin in 2050 at 28 TW, energy use supplied by fusion power can increase at 0.5%, 1.0% and 1.5% for 1052, 526, and 351 years before reaching the 5400 TW limit.

After the 5400 TW limit is reached energy use growth will have to end. However, the stock of fusion energy resources would not be exhausted at that time.[31] Using the middle scenario in which an energy use level of 28 TW increases at 1% for 526 years beyond 2050, we find that 537,000 TWy of fusion resources will have been used over that period, with 10^8 - 5.37x10^5 = 99.5x10^6 TWy remaining. At a constant annual rate of use of 5400 TW this stock will last for about 184,000 years. If the higher 10^9 TWy estimate of fusion resources is used a 5400 TW level of energy use can be sustained for 1.8 million years.

5. Photovoltaic Hydrogen

What if we find out that fusion is not a practicable energy source? Photovoltaic hydrogen is an alternative. Thermal pollution is not a constraint on the increasing use of photovoltaic hydrogen, but land use is.

If energy use grows at 0.5%, 1.0% or 1.5% between 2000 and 2050 total energy use will have grown to 17, 21 or 28 TW over that time. For the following exercise we assume that these levels can be supplied at a constant level for a certain period thereafter (see below) by fossil fuels (9 TW), other renewables (5 TW), and nuclear power (3, 7 or 14 TW). [32]

---

[31] Fossil and nuclear fuels, by contrast, reach their limits by exhaustion.

[32] These values are typical of the low, medium and high values of nuclear power use projected for 2050 by many analysts.

If photovoltaic hydrogen becomes available by 2050, how much longer will energy use be able to continue to grow? If we use the lower limit of 2% land availability for photovoltaic hydrogen, we see that energy use can grow at 0.5%, 1.0% or 1.5% for 269, 146 or 103 years beyond 2000. At these times total energy use will be between 51, 55 or 62 TW.

If we use the upper limit of 12% land availability for photovoltaic hydrogen we see that energy use can grow at 0.5%, 1.0%, or 1.5% for 562, 287, or 191 years beyond 2000. At these times total energy use will be 220, 224 or 231 TW.

If fossil fuel use is limited to 9 TW, the 7500 TWy of available fossil fuels would last for about 833 years. If nuclear fuel is limited to 3, 7 or 14 TW it would last for 333, 143 or 71 years if used in conventional fission reactors, or for 20,000, 8,600 or 4,300 years if used in breeders.

If land use for photovoltaic hydrogen is limited to 2%, total energy use is limited to about 60TW, and some alternative energy source will need to be found for the 3, 7 or 14 TW produced by nuclear fuel, if it is used for conventional reactors, after 333, 143 or 71 years. If no alternatives are available then total energy use would have to be reduced to about 57, 53, or 46 TW. After another 800 years additional energy sources would need to be available for the 9 TW supplied by fossil fuels. If no alternatives are available then total energy use would have to be reduced further, to 48, 44 or 37 TW. If the nuclear fuel is used for breeders no alternative sources would be needed before 4300 years at the earliest.

If land use for photovoltaic hydrogen is limited to 12% total energy use will be limited to about 220 TW, and if no alternative is found for the portion supplied by (conventional) nuclear power, total energy use will have to be reduced to about 217, 213 or 206 TW after 333, 143 or 71 years. After another 800 years these levels would need to be reduced to 208, 204, or 197 TW if no substitute for the 9 TW supplied by fossil fuels is found. If we are comfortable using the nuclear fuel in breeder reactors no alternative sources would be needed before less than 4300 years.

Summary

1. If fusion is practicable, there appears to be no reason that energy use cannot continue to grow until it reaches the 5400 TW limit imposed by thermal pollution. This is about 415 times the level of energy use today. This level will be reached in about 300 years if energy use grows rapidly (1.5% per year), and 1000 years if it grows slowly (0.5%). It would be sustainable for perhaps 20,000 to 200,000 years after that.

2. If fusion is not practicable then photovoltaic hydrogen is an alternative. If we are able to use 12% of land surface for photovoltaic hydrogen then energy use will be able to grow until it reaches 220 TW, about 17 times today's level. This level will be reached in about 200 years if we grow rapidly and 500 years if we grow slowly. If we can only use 2% of the land for photovoltaic hydrogen we will be limited to about 60 TW, which is 4.6 times today's level, and would be reached in about 100 years if we grow rapidly and 270 years if we grow slowly.

3. In the two scenarios above fossil and nuclear fuels serve as transitional sources of energy. If neither fusion nor photovoltaic hydrogen are practicable then heavy reliance on breeders would allow us to grow slowly for perhaps 600 years (to a level of 300 TW), or rapidly for 300 years (to 1000 TW). But by the end of these periods we would need to have found substitutes or face catastrophic collapse. Available substitutes such as biomass and other renewables have practicable limits that total in the neighborhood of 33 TW. If we are willing to employ breeder technology we could grow at slow or moderate rates for 200 or 300 years and see if some exotic energy sources might be made practicable; if this does not happen we would have another 200 to 300 years to make a transition to a 33 TW world based on biomass and other renewables.

4. If neither fusion or photovoltaic hydrogen are practicable and we are not willing to employ breeders then we can grow until we reach the 33 TW level that is sustainable with biomass and other renewables. This will happen in about 60 years if we grow rapidly or 180 years if we grow slowly. The fossil fuel share of total energy use is limited to 9 TW, so in the near

term most new energy would be supplied by nuclear fission. Fission sources could be phased out as biomass sources are established. A 33 TW biomass/renewables world would be sustainable as long as the sun shines.

Assessment

What are we to make of these scenarios? A person who expects fusion and large-scale photovoltaic hydrogen to be practicable and socially acceptable might note that combinations of these could comfortably allow energy use to grow at moderate rates for another 400 to 600 years before any biogeophysical limits are encountered; that at a minimum these limits would still represent a 20-fold increase over today's level of energy use; and that these levels would be sustainable for at least tens of thousands of years (if we relied mostly on fusion) and perhaps for as long as the sun shines (if we relied mostly on photovoltaic hydrogen).

A person inclined to be cautious about these matters might judge that since the practicability of fusion is unknown, and since the full impacts of covering 12% of the earth's land area with photocells are likely to entail unacceptable social costs, and since breeder technologies should be rejected from the start, the only scenario about which we can feel reasonably confident is the one in which global energy use reaches its highest practicable, sustainable level at about 60 TW of mostly photovoltaic hydrogen power, using 2% of the land area, sometime within the next 100 to 270 years. This scenario would likely employ biomass and other renewables as well.

Thus a "moderate techno-optimist" might judge that energy use can continue to grow for perhaps 400 to 600 years, until it reaches a sustainable level 20 times today's level; while a "moderate techno-skeptic" might judge that energy use can grow for maybe 100 to 270 years, until it reaches a sustainable level perhaps 5 times as high as today's.

II.A.2.b. Catastrophic Global Warming

Is global warming a limit to growth? Is it possible that continued warming might trigger a biogeophysical catastrophe of such magnitude that economic growth could no longer be sustained?

The integrated assessment models used to study the impacts of global warming generally model damages as smoothly increasing exponential functions of atmospheric warming. An example is Nordhaus' "high estimate" damage function, discussed below. It suggests that a 2.5°C warming might reduce GDP by as much as 2.2% below what it otherwise would have been, that a 4°C warming would reduce GDP by as much as 5.7%, and so on.

However, the fact that these models do not show abrupt climate change, and that the level of damages they show is generally modest, at least for warming levels expected over the next 100-200 years, is as much an expression of our ignorance as it is of our expertise. Because the stakes are so high, most analysts agree that the continued study of possible catastrophic impacts of global warming is a high research priority.

Box IIA-18 lists some of the events that might be triggered by continued global warming and have truly catastrophic impacts. **IIA-19** describes three of these in more detail.

Lempert et al. (1994) conducted one of the few detailed evaluations of potentially catastrophic climate change events. They considered four of the possible events listed in Box IIA-18: collapse of the thermohaline circulation, methane release, saturation of CO2 sinks, and sudden changes in climate sensitivity. In each case they figured conservatively that the abrupt change would be triggered when atmospheric warming exceeded 1.5° C.

Box IIA-20 shows the results of their calculations. While these events do increase the rate of atmospheric warming, their impacts are not especially dramatic, with the exception of event (iv) where the overall sensitivity of the climatic system to greenhouse gas concentrations suddenly doubles. Event (iv), however, is a "dummy" event for which no particular driving mechanism is suggested. On the other hand, each of the scenarios tested assumes that the 1.5° C

BOX IIA-18. POSSIBLE CATASTROPHIC CLIMATE CHANGE EVENTS
[major source: IPCC Working Group III, 1996]

I. Runaway greenhouse effect, due to:

a) Rapid increases in greenhouse gas emissions, due to:
i) destabilization of methane clathrates
ii) melting of permafrost and revival of metabolism of sub-surface organic deposits

b) Shutdown of major greenhouse gas sinks, due to:
i) decreased planktonic activity
ii) a slowdown in the growth of forests
iii) a die-back of forests

c) Changes in atmospheric chemistry

II. Disintegration of the West Antarctic Ice Sheet (WAIS)

III. Collapse of the North Atlantic thermohaline circulation

IV. Unknown mechanisms

BOX IIA-19. THREE POSSIBLE CATASTROPHIC CLIMATE CHANGE EVENTS

1. Methane Clathrates

Methane clathrates are ice-lattice structures with a molecule of methane trapped within them. It is estimated that perhaps 11,000 Gt of carbon lie trapped along the continental shelves in the form of methane clathrates. If ocean waters warm due to climate change these structures could become unstable. Enormous quantities of methane, which as a greenhouse gas is ten times more potent than CO2, could escape into the atmosphere and lead to an abrupt rise in global temperature.

Kvenholden (1988) estimated that destabilization of the off-shore clathrates could generate methane emissions of 120 Mt/yr. Lashof (1989) estimated that a 1 degree warming at the water-sediment interface could generate methane emissions of 220 Mt/yr. This would be sufficient to increase the warming generated by a doubling of CO2 concentrations from 2.5 ^{0}C to 3 ^{0}C, in a very short period of time.

2. Collapse of the North Atlantic Thermohaline Circulation.

Differences in atmospheric temperature are primary drivers of ocean circulation. Warm Gulf Stream waters travel north and become cooler, and thus denser, when they reach the North Atlantic. These waters release their heat and sink, and become part of the deep ocean current that travels south through the Atlantic and around the tip of Africa. As the earth's atmosphere warms northern polar ice is expected to melt and release fresh water into the North Atlantic. Because fresh water is less dense than salt water, this release is expected to weaken the thermohaline circulation. As a result temperatures in much of Northern Europe could drop dramatically. Other ocean-atmosphere phenomena, such as the Asian Monsoon, could be affected as well.

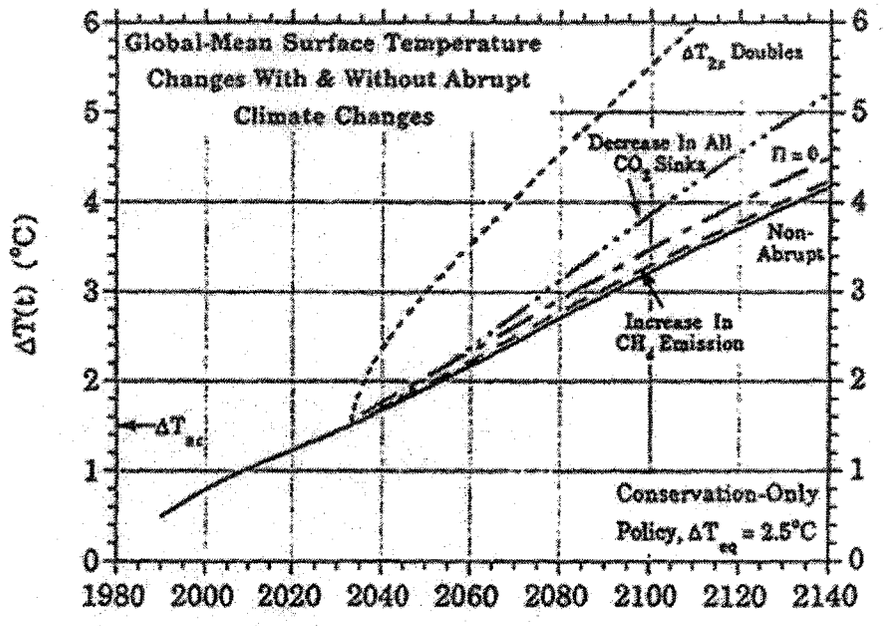
Manabe and Stouffer (1993) showed that under a 2x CO2 warming the intensity of the thermohaline circulation could be reduce by over 50%, although over time it would re-establish itself. But if the concentration of atmospheric CO2 were allowed to rise to 4 times its pre-industrial level, the thermohaline circulation would drop almost to zero, and there establish a new stable equilibrium.

3. Disintegration of the West Antarctic Ice Sheet (WAIS)

The West Antarctic Ice Sheet rests on solid rock and flows towards the sea, but is held back by the large ice flows that extend across the ocean surface. If these ice flows melt due to global warming, the WAIS could surge into the ocean and increase sea levels by as much as 20 feet. Cline (1993) suggests that this could become a threat when global warming begins to exceed 7^{0} C. Some authors suggest that the East Antarctic Ice Sheet would be vulnerable as well, and alone could raise sea levels by 50 feet.

BOX IIA-20. Impact on Atmospheric Warming of Abrupt Climate Change

[reprinted from Lempert et al 1994]



Annual global-mean surface temperature change, $\Delta T(t)$, for Conservation-Only policy and $\Delta T_{2x} = 2.5$ °C for: (a) non-abrupt climate change; and (b) for abrupt change at $\Delta T(t) = 1.5$ °C consisting of: (i) decrease in all CO_2 sinks; (ii) increase in CH_4 sources; (iii) decrease in ocean polar heat transport parameter, Π; or (iv) doubling of climate sensitivity to $\Delta T_{2x} = 5.0$ °C.

warming would trigger only a single event. But there is no reason that several or all of the abrupt events could not be triggered simultaneously.

Suppose we found strong evidence of a biogeophysical mechanism that would be triggered by some predictable degree of warming and would truly cause a global catastrophe that would bring economic growth to an end. The important question then becomes, what are our options? Can technological fixes eliminate the threat at little cost, or maybe even generate some net benefits? Or--at the other extreme--would we need to abandon our industrial modes of production and return to a world of small scale agrarian communities?

Boxes IIA-21 and **IIA-22** show the results of an exercise I conducted that incorporates a truly catastrophic damage function into Nordhaus' DICE model.[33] This function shows damages increasing with the 12th power of warming, once warming exceeds the critical threshold of 2.5°C.

When the model is run to get the optimal solution we find that catastrophe can be avoided if over the next century we begin and complete a transition away from a fossil fuel based economy. In absolute terms this is a costly process. Figure 4 in IIA-22 shows that we would have to sacrifice about 6% of the level of global output that we would have been capable of producing had global warming not been a problem. But notice that over the entire trajectory of this transformation economic growth continues to be positive. Output still grows, although at a (marginally) slower rate. At each point in time we are economically more prosperous than ever. By 2200 per capita GDP is 3.2 times larger than it was in 1994.[34]

---

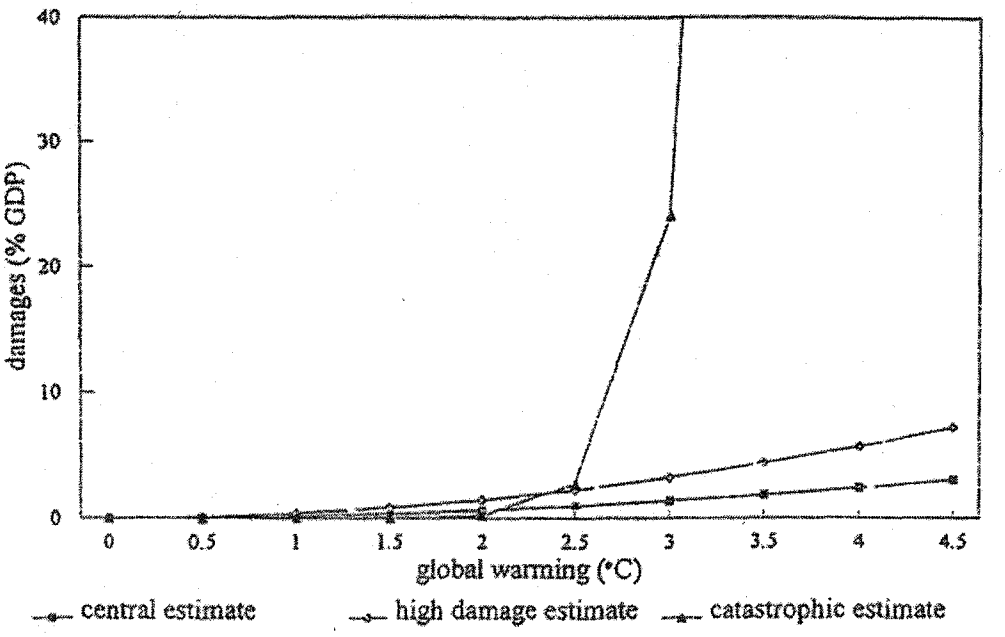
[33] The DICE computer model was kindly made available by Dr. Nordhaus. I ran it using GAMS software made available by the U.C. Berkeley Department of Natural Resources.

[34] Two caveats should be noted. Nordhaus' model does not specify the particular mix of energy technologies that would allow us to move off fossil fuels at a cost of 6% of GDP, but the studies on which his estimates are based typically rely heavily on nuclear power. A scenario that emphasized non-nuclear options might be more costly. On the other hand, it might not. Nordhaus' DICE model does not allow for the possibility—many would say likelihood—that the cost of alternative energy resources will decline over time due to technological development. In that event the cost of a transition away from fossil fuels might be even less than 6%.

BOX IIA-21. DAMAGES FROM GLOBAL WARMING

Figure 1 shows estimates of the extent of damages that might be expected if atmospheric warming increase to the levels shown, using Nordhaus' DICE model (1994) on GAMS software. Damages are defined as the amount of output (GDP) that is lost due to climate change, measured as a percentage of the level of GDP that would have been realized in the absence of climate change.

Figure 1. Damages from Global Warming



Central estimate damage function: $d = .013\left(\frac{\Delta T}{3}\right)^2$

High estimate damage function: $d = .032\left(\frac{\Delta T}{3}\right)^2$

Catastrophic damage function: $d = .027\left(\frac{\Delta T}{2.5}\right)^{12}$

BOX IIA-22. THE ECONOMICS OF CATASTROPHIC GLOBAL WARMING

Figures 1 through 4 show optimal trajectories of atmospheric warming, CO2 emissions, damages and GDP generated by Nordhaus' DICE model (1994) using the central and catastrophic damage functions shown in Box IIA-21.

Figure 1. Reduction of CO2 Emissions

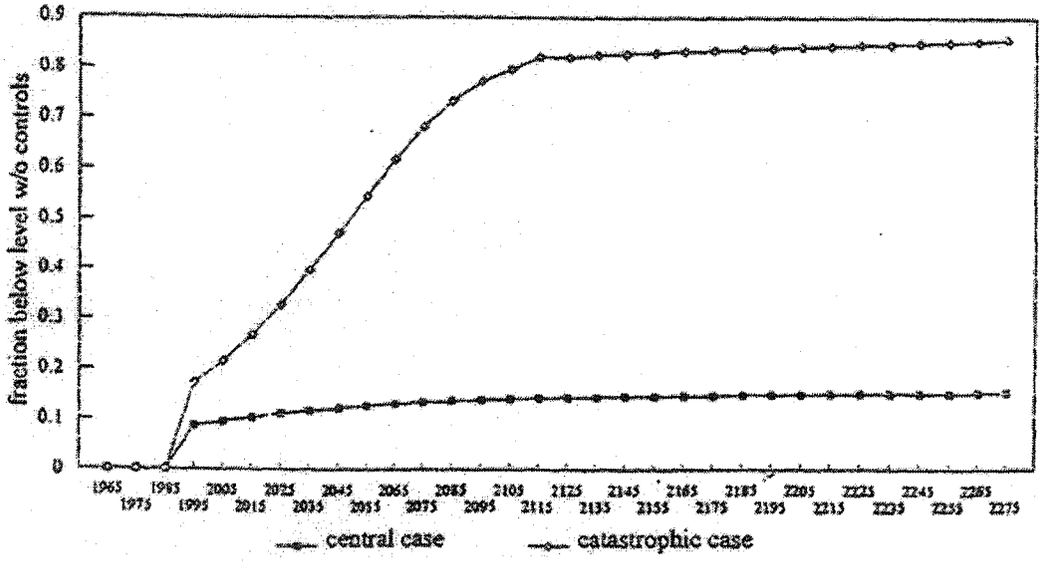
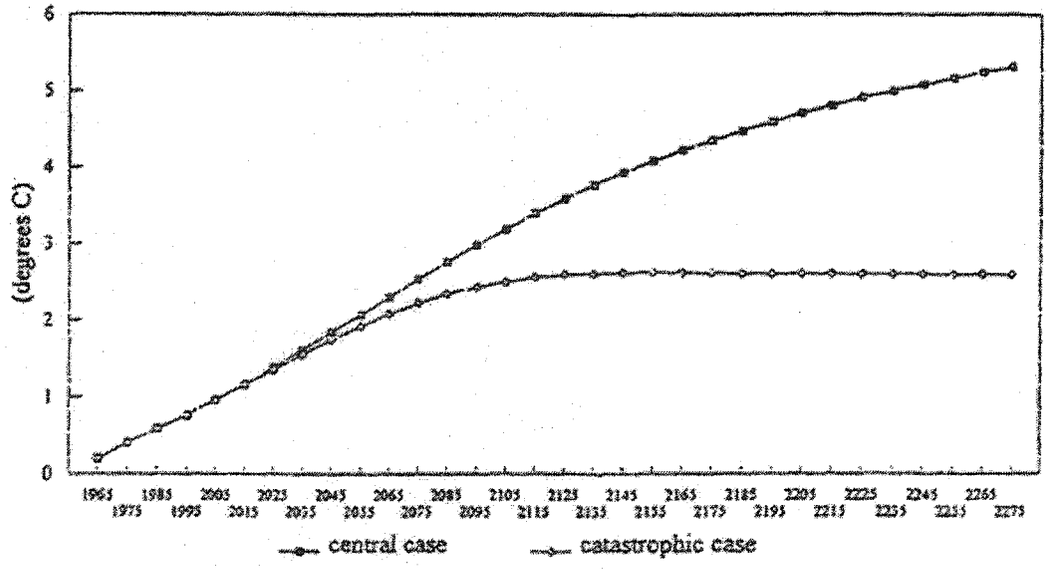


Figure 2. Atmospheric Warming



[more....]

BOX IIA-22. The Economics of Catastrophic Global Warming (cont'd.)

(Figures 1 through 4 show optimal trajectories of atmospheric warming, CO2 emissions, damages and GDP generated by Nordhaus' DICE model (1994) using the central and catastrophic damage functions shown in Box IIA-21.)

Figure 3. Damages from Global Warming

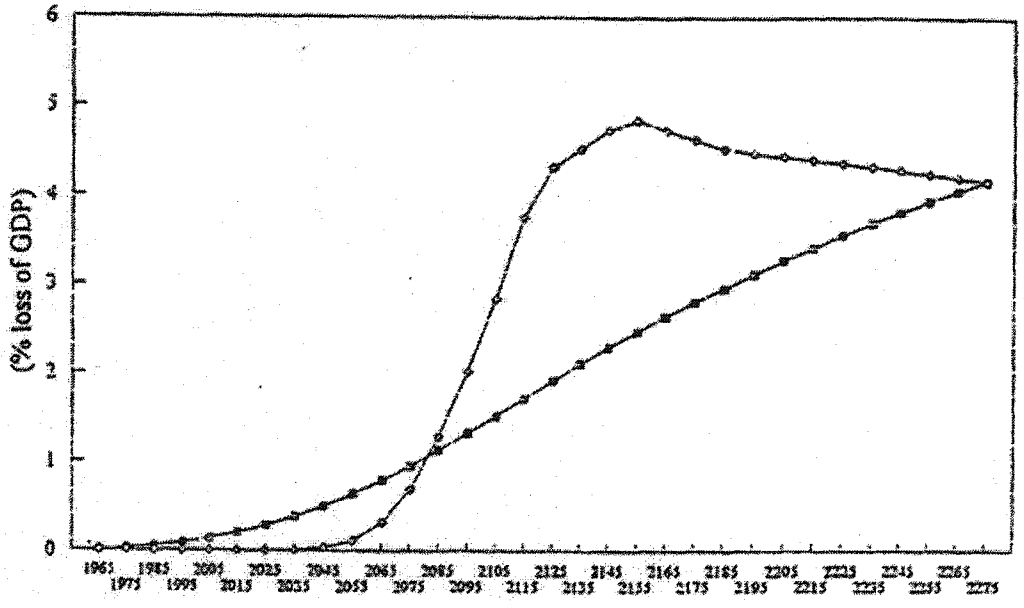
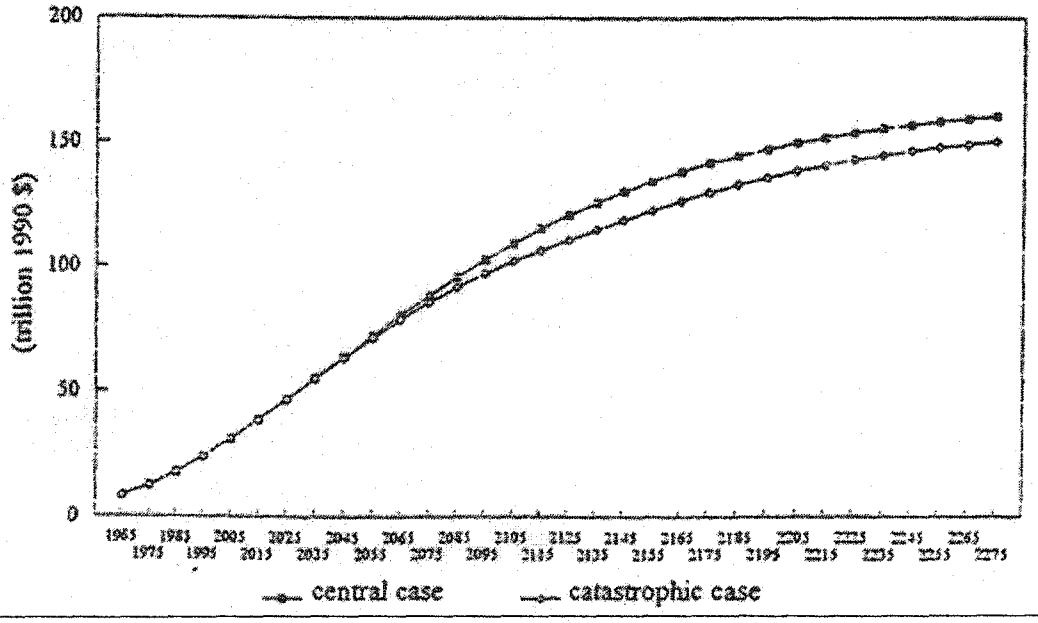


Figure 4. World Output (GDP)



II.A.2.c. Other Biogeophysical Limits

In *The Case That the World Has Reached Limits*, Goodland (1991) offers five main signs "that the limits have been reached." These are: human biomass appropriation, global warming, ozone shield rupture, land degradation and decrease in biodiversity. Daly (1989) and others cite entropic degradation as an additional limit to growth. We saw in II.A.2.b that unacceptable global warming can be avoided without having to bring an end to the growth of economic output. While ozone shield rupture, land degradation and biodiversity loss are serious concerns, it does not appear that the policies necessary to successfully address them require that economic growth come to an end. Here we comment briefly on entropy and the appropriation of biomass:

1. Entropy

The second law of thermodynamics, also known as the Entropy Law, states that in a closed system the available energy, although conserved, necessarily converts from more ordered, "low entropy" forms, to less ordered, "high entropy" forms. The electromagnetic energy carried in the molecular bonds of a lump of coal is more "ordered" than is the kinetic energy carried by the surrounding air molecules after the coal has been burned. Because of this inevitable and continual degradation, energy becomes less able to do useful work, and recycling of materials can never be 100% effective.

Georgescu-Roegen (1971) uses the second law of thermodynamics to argue that economic growth cannot continue indefinitely; indeed, that even a steady-state level of output is unsustainable. As stated this is strictly correct. But the important question then becomes: how long do we have before entropic limits are felt? Solar radiation will provide the earth with a steady input of high-quality (low entropy) energy for as long as the sun shines—perhaps another 6 billion years. The entropic degradation of energy resources will not be a real limit to growth anytime within that period. (Of course, the growth of solar energy use *is* limited by the area of the land available for solar energy collectors, as we just saw.)

2. Human Appropriation of the Products of Photosynthesis

Net Primary Productivity is the energy stored in plants. It is the base of the food chain for nearly all life on earth. Vitousek et al (1986) found that 40% of Net Primary Productivity is currently being "appropriated" for human use. This finding has been interpreted to imply that the human population can increase by, at most, 1.5 times its current level. It has also been interpreted an indicator of near-term limits to the growth of human activity on earth in general (Goodland, 1996).

These interpretations are misleading. The 40% figure does give some insight concerning the extent to which human activity has probably caused changes in patterns of land use over the course of history. But it says little about limits to the growth of population or economic activity. The resource that generates Net Primary Productivity is solar energy. The total solar flux reaching the continental land masses is about 25,000 TW. This is 370 times the 68 TW that is currently embodied in NNP. Food supply for humans can be increased by "appropriating" more of the solar flux, e.g., by increasing the productivity of existing agricultural lands, or by bringing new land into agricultural uses. At the same time energy for continued economic growth is available from many sources other than biomass.

II.A.2.d. Integrated Assessment of Climate Change

Interest in long range global models of environmental and economic change waned after the mid-1970's but revived in the late 1980's in the wake of heightened concern about global warming. Policy makers wanted to know how bad warming might be, what damages it might cause, what preventive measures were available, and what these would cost. Answers required analytic models that included the many indirect and reciprocal influences that economic, climatic, ecological, demographic and other factors could have upon one another. These are now called integrated assessment models. The key components of a typical integrated assessment model of

climate change are shown in **IIA-23.** A classification of integrated assessment models is shown in **IIA-24**. A generalized model is described in **IIA-25.**

None of the many scenarios studied in the course of work with the integrated assessment models have as yet suggested mechanisms that lead to global economic or environmental collapse, in the manner depicted by World 3, over the course of the next 200 years or so.[35]

On the other hand, the reference scenarios chosen for these models do show a generally steady decline in the rate of economic growth over time. This can be seen in the output trajectories for Nordhaus' RICE model shown in IA-6, in the growth paths used by the Energy Modeling Forum shown in **IIA-26**, and in many other studies.

What explanation is given for this? Generally very little. Among the few authors who motivate their reference scenario growth assumptions is Nordhaus (1992), who attributes it to the onset of diminishing returns to productivity-enhancing technological innovation.

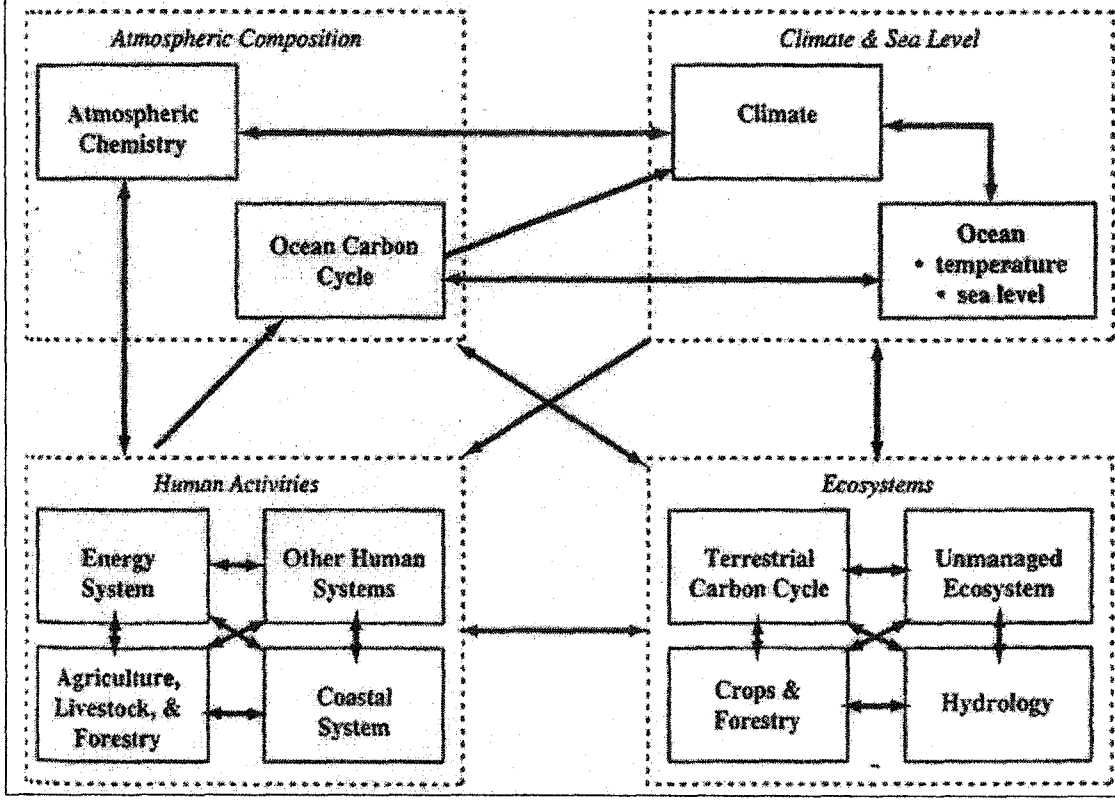
It remains to be seen whether more ambitious efforts to model linkages among biogeophysical processes and economic activity might reveal mechanisms that could bring economic growth to an end. But if the reference scenarios of the integrated assessment models are correct then economic growth might be expected to come to an end in any event—not because of resource depletion or biogeophysical catastrophe, but because of limits to technological innovation.

What are the grounds for such a belief? We discuss this question in the next section.

[35] It's important to note, however, that many of the more simple integrated assessment models are constructed in a way that precludes economic collapse. They model on-going output growth as an exogenous assumption, and measure damages as simple percentage reductions from this level of growing output.

BOX IIA-23. KEY COMPONENTS OF FULL-SCALE INTEGRATED ASSESSMENT MODELS

[Reprinted from IPCC, Climate Change 1995: Economic and Social Dimensions of Climate Change (1996)].



BOX IIA-24. Summary Characterization of Integrated Assessment Models

[Reprinted from IPCC, Climate Change 1995: Economic and Social Dimensions of Climate Change (1996)].

Model	Forcings 0. CO_2 1. other GHG 2. aerosols 3. land use 4. other	Geographic Specificity 0. global 1. continental 2. countries 3. grids/basins	Socioeconomic Dynamics 0. exogenous 1. economics 2. technology choice 3. land use 4. demographic	Geophysical Simulation[a] 0. Global ΔT 1. 1-D ΔT, ΔP 2. 2-D ΔT, ΔP 3. 2-D Climate	Impact Assessment[b] 0. ΔT 1. Δ sea level 2. agriculture 3. ecosystems 4. health 5. water	Treatment of Uncertainty 0. None 1. Uncertainty 2. Variability 3. Stochasticity 4. Cultural Perspectives	Treatment of Decision Making 0. optimization 1. simulation 2. simulation with adaptive decisions
AS/ExM	0	0	0	0	0	1	2
AIM	0,1,2,3	2,3	1,2,3,4	1,2	0,1,2,3,5	0	1
CETA	0,1	0	1,2	0	0	0 or 1	0
Connecticut	0	0	1	0	0	1	0
CRAPS	0	0	1	0	0	1	2
CSERGE	0	0	1	0	0	1	0
DICE	0	0	1	0	0	0 or 1	0
FUND	0,1	1	1,4	0	0,1,2,3,4	0 or 1	0
DIAM	0	0	1,2	0	0	0 or 1	0
ICAM-2	0,1,2,3	1,2	1,3,4	1,2	0,1,3	1,2,3	1,2
IIASA	0	0	1	1	2	0	0
IMAGE 2.0	0,1,2,3	3	0,2,3	2	1,2,3	1	1
MARIA	0	0,1	1	0	0	0	0
MERGE 2.0	0,1	1	1,2	0	0	0 or 1	0
MiniCAM	0,1,2,3	2,3	1,2,3	2	0	0	1
MIT	0,1,2,3	2,3	1	2,3	0,2,3	1	0,1
PAGE	0,1	1,2	1	0	0,1,2,3,4	2	1
PEF	0,1	1,2	1	0	0	2	1
ProCAM	0,1,2,3	2,3	1,2,3,4	2	0,2,3,5	1	1
RICE	0	1	1	0	0	0	0
SLICE	0	1	1	0	0	1	2
TARGETS	0,1,2,3,4	0	1,2,3,4	2	1,2,3,4	4	1,2

[a]TARGETS includes ozone depletion, soil erosion, acid rain, and toxic and hazardous pollutant releases.
[b]In AIM, FUND, IMAGE, PAGE, and ProCAM, the impacts are calculated separately for each sector.
Source: Adapted from Rotmans et al. (1995).

BOX IIA-25. A Generalized Integrated Assessment Model

These equations represent the core elements of a typical integrated assessment model.

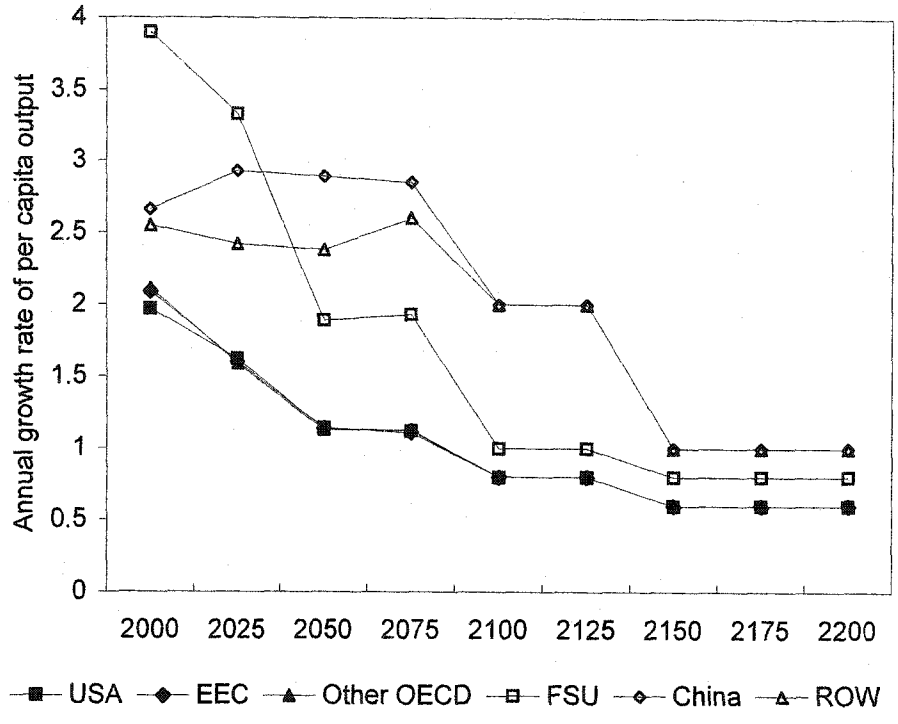
1) Output	$Y = \Omega AK^{\alpha} L^{\beta}$
2) Population	$\dot{L} = nL$
3) Technology	$\dot{A} = g\,A$
4) Capital	$\dot{K} = sY - \delta K$
5) "Pollution"	$P = \theta_1 Y^{\theta_2}$
6) Environmental Damage	$D = \phi_1 P^{\phi_2}$
7) Costs of "Pollution" Abatement	$TC = \sigma_1 \mu^{\sigma_2}$
8) Impact of Damages and Abatement on Output	$\Omega = \left(\frac{1-TC}{1+D}\right)$

Definitions of parameters:

α, β	elasticities of output with respect to capital and labor
n	population growth rate
g	productivity growth rate
s	savings rate
δ	depreciation rate of capital
θ_1, θ_2	proportional and scale constants relating pollution to output
ϕ_1, ϕ_2	proportional and scale constants relating damages to pollution
μ	degree of pollution abatement desired ($0 < \mu < 1$)
σ_1, σ_2	proportional and scale constants relating cost of abatement to the degree of pollution abatement desired

BOX IIA-26. Projected Changes in Productivity, 2000-2200

[source: Energy Modeling Forum 12, 1996]



II.A.3. ARE THERE LIMITS TO TECHNOLOGICAL CHANGE?

Summary

If there are limits to technological change, there are limits to output growth. We review definitions of technological change, attempts at quantitative measurement of technological change, and the literature on technological limits. An engineering perspective suggests the existence of both "ultimate" and "configuration-dependent" limits, but offers no practical way to assess how close to or far from these any particular technology might be. Economic perspectives identify technological change with productivity improvement. Endogenous growth models are frequently cited in support of the contention that technology exhibits increasing returns to scale, but a review shows that this property is an assumption exogenous to these models.

Declining economic productivity in the industrial economies in the years since 1970 is thought by some to be a secular decline that could point to the end of economic growth. Recent studies suggest that the high productivity growth rates of the post-war period may be anomalous deviations from lower but steady long-term rates of productivity growth beginning as far back as the late 19th century. Other studies suggest that quality improvements and new products, which are not reflected in productivity statistics, represent an increasing share of the "output" of technological innovation.

The studies reviewed in this section give little reason to suspect that we are approaching limits to the ability of technology to generate productivity increases or configurational innovations.

II.A.3. ARE THERE LIMITS TO TECHNOLOGICAL CHANGE?

Introduction

We've seen that technological change is necessary if output is to grow over the long term. If there are limits to technological change, then there are limits to growth.

We begin by defining terms. Then we discuss possible limits to technological change from two perspectives: that of engineering, which focuses on the properties of matter and energy, and that of economics, which focuses on rising costs.[36] Next we discuss the apparent decline in productivity among industrial nations over the past quarter century, which has been cited as evidence that technological change may be approaching its limits.

II.A.3.a. Defining and Measuring Technological Change

What is technology, and what is technological change? Convenient answers from the engineering perspective are that technology is the purposeful manipulation of matter and energy, and that technological change is the purposeful manipulation of matter and energy over increasingly more precise dimensions of space and periods of time.

Convenient answers from the economic perspective are that technology is "the sum of knowledge of the means and methods of producing goods and services (Bannock et al 1992), and that technological change is "the introduction of a new production method, yielding product improvements or cost reduction and thereby raising productivity (Samuelson and Nordhaus, 1989).

Many studies distinguish among "technological change," "technical change," "technological innovation" and similar terms. In these notes I use "technological change" as a broadly inclusive term.

---

[36] This is an artificial distinction, because in the final analysis the supply curve of a technology depends importantly upon the properties of materials. But its use at this point is convenient.

Engineering approaches to measuring technological change compare changes in performance characteristics, such as the power of internal combustion engines or the speed of microprocessors. These measures are not generally commensurate, and thus don't allow measurement of technological change in an aggregate sense. Attempts to allow aggregate measurement by defining technological change in term of "services" have not proved generally useful. As discussed below, Ayers (1992) suggests that aggregate measures of technological change might be developed in terms of entropy or information content.

The economic definition that identifies technological change with improvements in total factor productivity allows easy measurement, given an accepted set of national accounts. But changes in productivity do not measure changes in the quality of output, which many analysts suspect accounts for an increasing share of total value. Some authors have tried to use rates of patent approvals, or references in technology journals, as proxy measures for aggregate technological change (Kleinknecht, 1993), but with limited results.

II.A.3.b. Engineering Perspectives on the Limits to Technological Change

An exceptional treatment of the nature of technological change from an engineering perspective is provided by Ayers (1992). His account is particularly useful for our purposes because it explicitly seeks to shed light on questions concerning the limits of technological change.

Ayers begins by formally defining technology as "knowledge, combined with appropriate means, to transform materials, carriers of energy, or types of information from less desirable to more desirable states" (p 35). He goes on to note that "Every transformation initiated by man depends upon either the deliberate enhancement or acceleration of some localized natural equilibrium process, or the creation of a temporary disequilibrium by means of one or more artificial 'drivers.'" He cites the combustion of fossil fuels as an example of equilibrium-rate enhancement, and metal ore reduction as an example of artificial disequilibrium.

Ayers continues,

> "Most modern technologies require artificial environmental conditions to stimulate reactions (or suppress competing reactions)...[These] are created by means of high or low temperatures, high or low pressures or densities (evacuation), chemical potentials, electric or magnetic fields or potentials, electromagnetic radiation, electron, ion, proton or neutron fluxes. Technological progress, in a very fundamental sense, results from the increasing ability to create these conditions on demand, i.e., when and where they are desired." (p 36)

Ayers distinguishes two important limits to technological change: "ultimate limits," which are set by the fundamental laws of physics, and "configuration-dependent limits," which reflect the specific properties of materials in particular configurations. He uses these concepts to motivate a "barrier-breakthrough" model of technological innovation:

> "The basic hypothesis...is that the rate of technological progress tends to be higher when a technology is "far" from its limit, and that it tends to slow down as the technology approaches its limit. Thus, technological progress is most difficult and slowest--and R&D is most expensive...as one approaches a technological 'barrier', or configuration-dependent limit... this, in turn, triggers a more intensive search for a new combination that avoids the limits of the previous technology." Thus we see "...an alternation between inventive "leaps forward" --the adoption of new and better combinations--and subsequent incremental improvements and optimizations." (pp 37, 43)

Ayers suggests an approach to rigorizing the notion of "technological distance" from both ultimate limits and configuration-dependent limits (see **IIA-27**), but has not developed it further.

The pattern shown by Ayers' barrier-breakthrough model is a commonplace of studies of technological change. Different analysts tell somewhat different stories to explain the pattern.[37] A schematic is shown in **IIA-28** and several examples from the literature are shown in **IIA-29.**

Authors who argue that concern over limits to technological change--and thus over limits to growth--is unwarranted commonly invoke the apparent ubiquity of barrier-breakthrough trajectories as support for their position; Brinkman (1980) is an example. These appeals typically

---

[37] For example, Nordhaus (1992) suggests that a technological breakthrough typically opens up application "niches" that were unanticipated before its intended applications began to be realized. This leads to further development of the new technology, with consequent increases in productivity in different industrial sectors. As the new niches fill, however, further development slows. The entrepreneurs who drive innovation begin to decrease their investment in the diminishing number of less promising niche applications, and begin to invest in developing new breakthrough innovations. This further flattens the

BOX IIA-27. Ayers' approach to rigorizing a measure of technological distance
[source: Ayers, 1992]

"[W]hat we seek is a generalizable way of expressing the notion of distinguishability of one reference system (current technology) from another (future technology)...The most general measure of distinguishability--hence of techological distance--is information content in the technical (Shannonian) sense. For thermodynamic systems, this information measure is exactly proportional to the more general thermodynamic potential...; [thus] the higher the temperature or pressure used in an industrial process... the greater the technological distance from ambient conditions--which can be roughly characterized as the technological zero point." (p 38-39)

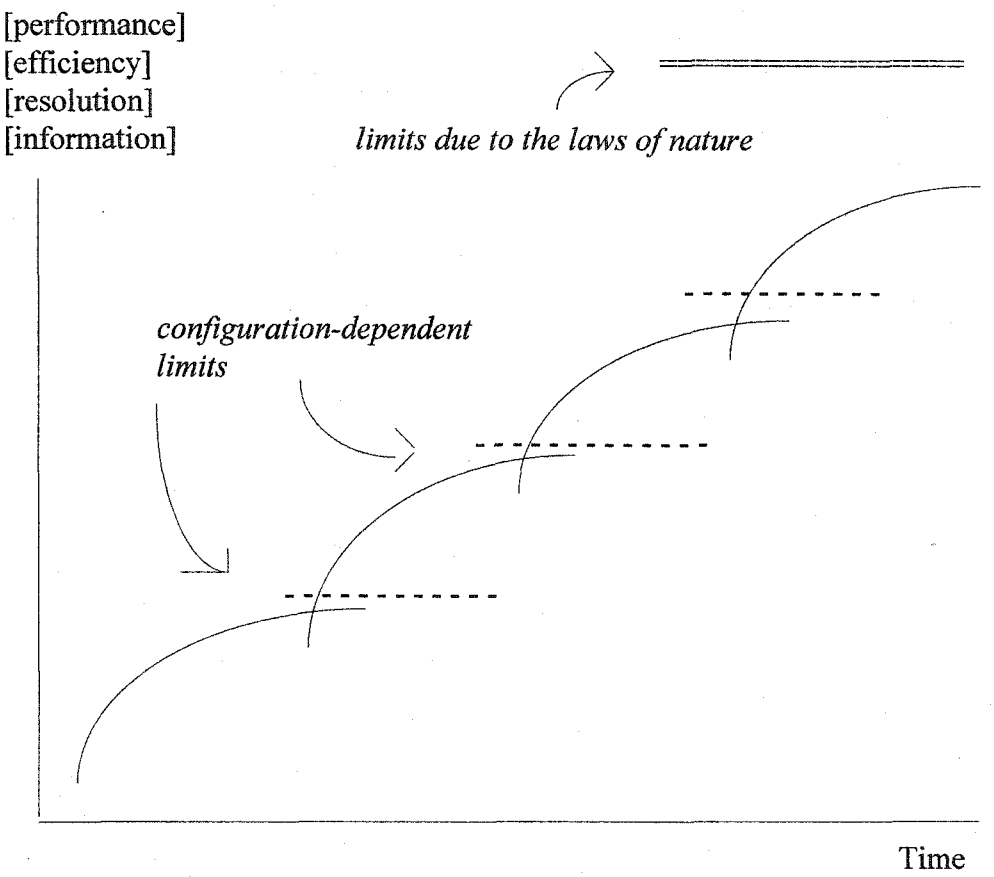
"It is but a short step to envision techniques for computing the information equivalent of non-thermodynamic figures of merit, such as the power-to-weight ratio of prime movers, or the complexity of electronic circuits." (p 39)

Ayers notes his intention to develop such measures of technological distance at a later date. In the meantime he offers "as a somewhat crude substitute, a simple scoring system for technological distance." His approach is to "...assign a difficulty score of 0 for the range corresponding to ambient conditions--presumably achievable without assistance from technology of any sort--and a score of 1 for the first known (or presumed) departure from ambient conditions" (pp 39-40). He applies this method to the case of temperature, as shown below:

score:

0	ambient temperature (a little less than body temp)	=	35 ^{0}C
1	cooking via coal fire	=	550 - 750 ^{0}C
2	ceramics, glass, smelting	=	1100-1300 ^{0}C
3	crucible (and Bessemer, open hearth)	=	1300-1600 ^{0}C
4	practical electric arc (alloys steels, tungsten)	=	2800 ^{0}C
5	plasma torches and cutting lasers	=	3000+ ^{0}C
6	magnetic trapping of ionized gases	=	thermonuclear

BOX IIA-28. The Barrier-Breakthrough Schema of Technological Change



BOX IIA-29. Examples of Uses of the Barrier-Breakthrough Schema

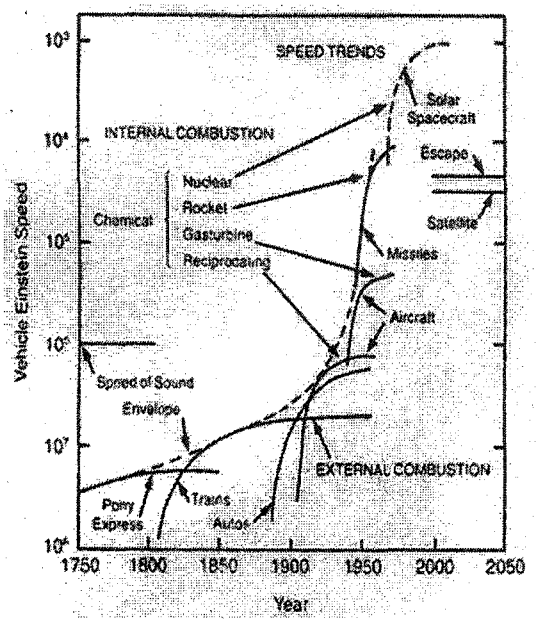


Figure 1. Trends in transportation speed. Source: P. DeVore (1980)

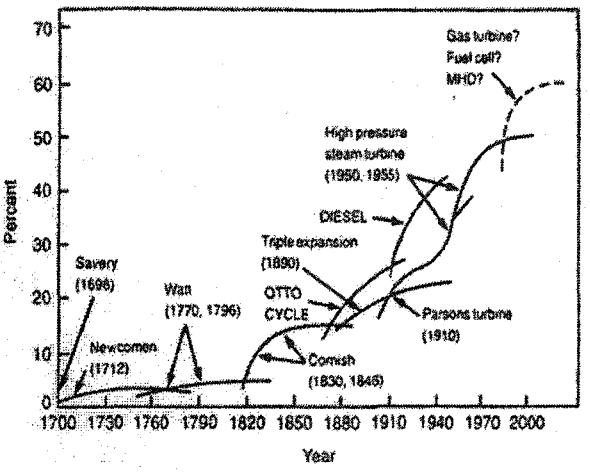


Figure 2. Trends in energy conversion efficiency. Source: H. Thiring (1958)

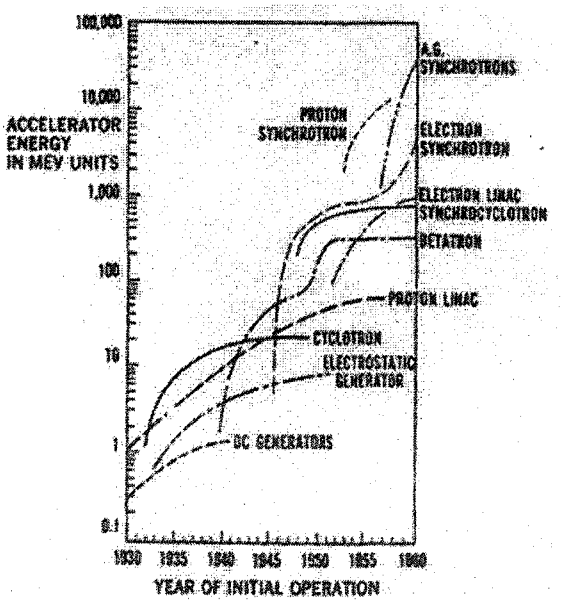


Figure 3. Rate of increase of operating energy in particle accelerators. Source: M.S. Livingston as quoted by Holton (1962)

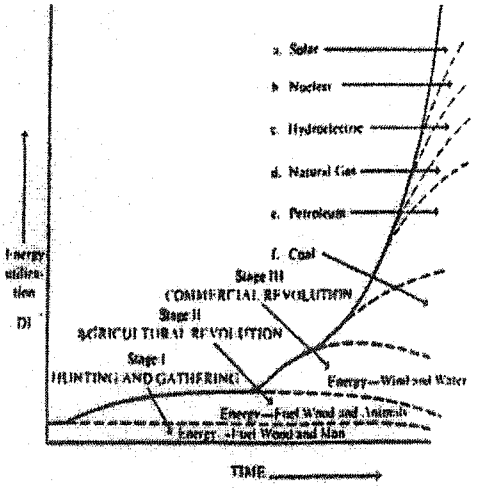


Figure 4. The Energy Paradigm of Logistic Surges. Source: R.I. Brinkman (1980)

lack an analytic justification. The fact that a pattern has repeated itself in the past is not an explanation of why we might expect it to continue in the future.

Irvin (1993) suggests that the barrier-breakthrough pattern may be largely an illusion that results from particular ways of categorizing technological artifacts. He notes that "data-sifting," consciously or otherwise, can generate almost any pre-conceived type of technological trajectory.

Other authors take strong exception to such technological agnosticism. Ausubel (1994) says,

> "The essential fact is that technological trajectories exist. Technical progress in many fields is quantifiable. Moreover, rates of growth or change tend to be self-consistent over long periods of time... Thus, we may be able to predict quite usefully certain technical features of the world of 2050 or 2070 or even 2100." (p 509-510)

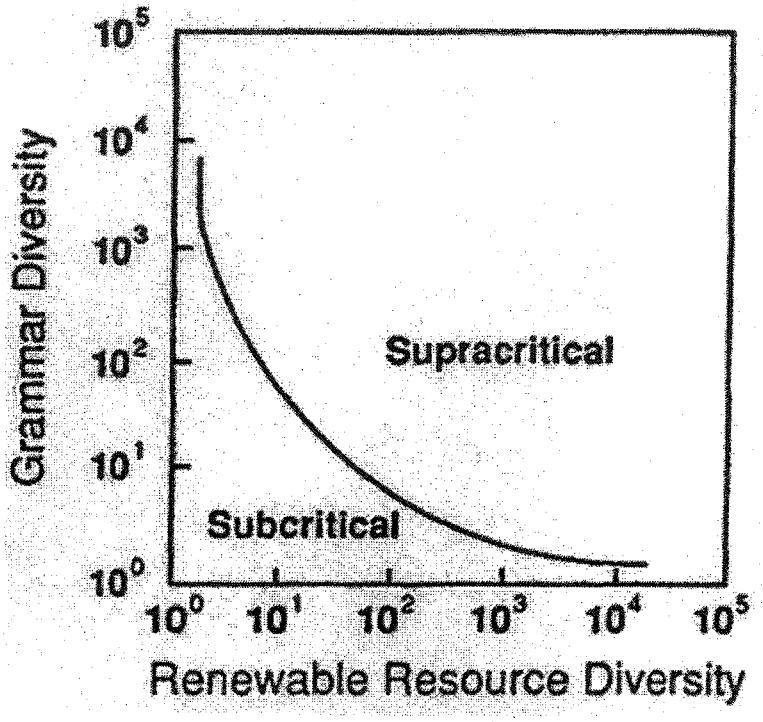
Some authors draw upon work in complexity theory to suggest that not only can breakthroughs be expected to continue but that the envelope of barrier-breakthrough trajectories can be expected to increase over time. Kauffman (1995) proposes that any existing suite of technologies, artifacts or services defines a potential set of additional technologies, artifacts or services that could result from processes that might be thought of as "combinations" of the existing elements of the set. The size of the potential new set depends on the size of the existing set and on the number of ways the elements can be usefully combined (its "grammar"). If either the number of elements or the number of combinatorial rules is large enough the system will exceed a "threshold of criticality" and new technologies, artifacts or services will grow indefinitely at an increasing rate (see **IIA-30**). However, many authors charge that such accounts are at best metaphors for processes that can be better described and understood using more conventional analytic tools.[38]

---

development trajectory of the formerly new, now aging, technology, and increases the likelihood of a new breakthrough.

[38] Complexity theory is discussed further in Section II.A.4.

BOX IIA-30. Kauffman's Schema of "Technological Co-evolution"
[source: Kauffman 1995]



Kauffman says, "The number of renewable goods with which an economy is endowed is plotted against the number of pairs of symbol strings in the grammar, which captures the hypothetical "laws of substitutability and complementarity." A curve separates a subcritical regime below the curve and a supercritical regime above the curve. As the diversity of renewable resources or the complexity of the grammar rules increases, the system explodes with a diversity of products." (p 293)

Most engineers and scientists writing today on the topic of future prospects for technological innovation are "optimists." They believe that breakthroughs in computer and information technologies, molecular biology, genetics, neurobiology, materials sciences, manufacturing technologies and other fields could usher in a period of truly revolutionary technological change.[39]

Contrarian voices are fewer. Horgan (1995) notes that the theoretical studies that occupy the attention of the top scientists in a wide range of fields are increasingly less amenable to testing. He suggests that this is precisely the condition we should observe as we approach the limits of scientific knowledge. Horgan's views have been sharply rejected by many critics [B. Hayes (1996), Gross and Witten (1996)]. In any event, Horgan sees no reason that the application of our (now nearly final) stock of scientific knowledge can't continue to supply us with a steady stream of technological innovations.

The optimists appear to have most of their eggs in a relatively small number of baskets, albeit big ones: information, biology and materials. If these fields don't produce big breakthroughs it is difficult to imagine where else to look. Technological innovation that results in productivity gains is intimately associated with the process of miniaturization. If the manipulation of matter and energy at the molecular level ("nanotechnology") turns out to be prohibitively difficult, further technological innovation will be much constrained.

Assessment

Our attempt to find analytic grounds within the engineering perspective for determining whether or not there are limits to technological change has been largely unsuccessful. Ayers' schema of ultimate and configurational limits is intuitively reasonable, but in the absence of an empirical measure of technological distance it doesn't enable us to devise and test theories that have predictive power. Expert opinion is heavily weighted to the view that our current

[39] We discuss the future of technological change in more detail in Section II.E.

understanding of the natural world points to the possibility—many would say likelihood—of great technological breakthroughs over the coming several to many decades.

II.A.3.c. Economic Perspectives on Limits to Technological Change

The economic perspective looks at technology as both a factor necessary for the production of goods and services, and as something which itself requires goods and services, including technological ones, in order to be produced.

The production of technology itself was for many years schematized in the "linear model." Three versions are shown in Section 1 of **Box IIA-31.** But the linear model doesn't show the complex cross linkages that are central to the process of technological production. Section 2 of IIA-31 displays a recent attempt at a more complete model.

More formally, we might think of the model shown in Section 2 of IIA-31 as a set of linked differential equations. A change in one variable of the model might generate greater or lesser changes in the other variables, and thus in itself. If any one of these variables exhibits decreasing returns, the growth of all the variables will eventually come to a halt unless at least one of them shows sufficiently increasing returns, or grows exogenously.

This observation identifies the critical question at the heart of the current debate over technology and long term economic growth: does an increase in the "stock" of technology imply that the production of further technology is likely to be more difficult or less difficult?

We saw that a defining feature of the neoclassical growth model was the existence of decreasing returns to labor and capital. Continued economic growth was made possible via the *deus ex machina* of an exogenous technology that grew exponentially, indefinitely. This feature had long been recognized by economists as something of an embarrassment, but during the steady-growth decades of the 1950's and 60's there was little motivation to refine it. By the late 1970's growth in the West had begun to slow and in most developing countries had failed to reach expected levels. In the mid-1980's economists began to re-examine the neoclassical growth

BOX IIA-31. Models of the Production of Technology

1. Four versions of the linear model

A and B from Mahdjoubi (1997); C from Mahdjoubi (1996); D from Martino (1993)

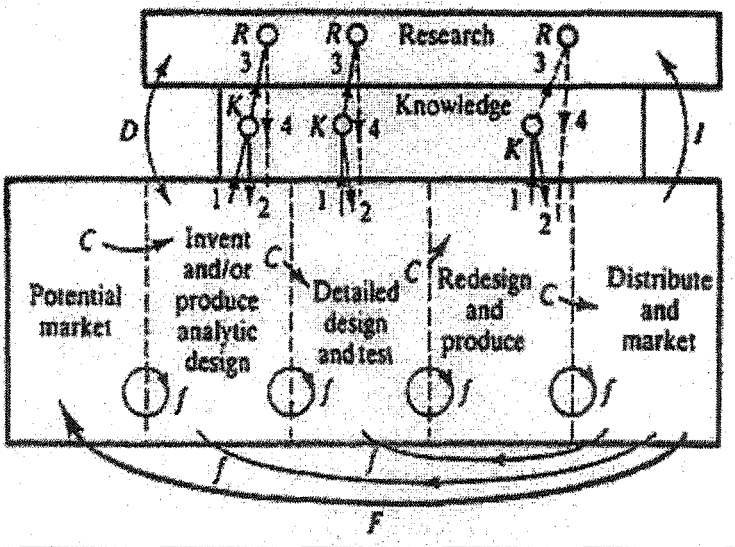
A. Basic Research → Applied Research →Development → Commercialization

B. Research Exploratory Development →Advanced Technology Development→Advanced Development → Engineering Development → Management and Support → Operational Systems Development.

C. Basic (Fundamental) Research →Industrial Research & Development → Design & Development → Industrial Production Enterprises → Market

D. Science Findings → Lab Feasibility → Operating Prototype → Commerical Introduction → Widespread Adoption → Diffusion & Adaptation → Social & Economic Impact

2. *A non-linear model:*
[reprinted from Hall 1994]



model. One important result has been called "new growth theory" or, alternatively, "theory of endogenous growth" or "theory of endogenous technology."

In the notes that follow I review what the endogenous growth models purport to tell us about possible limits to technological change. The models reviewed are those of:

1. D. Romer (1994): Endogenous growth using an R&D production function
2. P. Romer (1990): An R&D production function with human capital
3. Grossman & Helpman (1994): Increasing returns via product diversity
4. Ayers & Miller (1980): Decreasing returns due to natural limits
5. Becker & Murphy (1993): Differential returns to specialization and coordination costs

1. D. Romer (1994): Endogenous growth using an R&D production function

The central ideas of new growth theory can be understood by use of the simple growth model shown in **IIA-32**.[40] It is similar to the Solow model but in addition to the output production function (equation 1) includes a technology production function (equation 2). Labor and capital are treated as a single variable L, here called labor-capital, without loss of generality. A portion of labor a_L produces new technology and the balance produces output.[41] Labor grows exponentially (equation 3).

The technology production function can be logarithmically differentiated to derive formulas for the relative growth rate of technology (equation 4), and for the time rate at which the growth rate might change (equation 5). We can show that the growth rate of per capita output will equal the growth rate of technology, as in the Solow model. But now that value is determined by values endogenous to the model.

As noted, the critical question of modern growth theory is whether greater stocks of technology encourage or discourage the production of additional technology. This relationship is modeled in equation 2. Consider three cases of the parameter θ:

---

[40] This model was presented by David Romer (1994) to illustrate the key concepts of new growth theory, as originally developed by Paul Romer (1990).

[41] In this model the term "technology" can be taken to mean "technological knowledge," or just "knowledge," without harm to the narrative.

BOX IIA-32. Endogenous Growth Using an R&D Production Function [D. Romer 1994]

Equations of the Model:

(1) $$Y_t = A_t[(1-\alpha_L)L_t]$$

(2) $$\dot{A}_t = [a_L L_t]^{\gamma} A^{\theta}{}_t$$

(3) $$\dot{L}_t = nL_t$$

Derived equations:

(4) $$\frac{\dot{A}}{A} = g_A = [a_L L_t]^{\gamma} A_t^{(\theta-1)} = \frac{\dot{y}}{y}$$

(5) $$\dot{g}_A = (\theta-1)[g_A]^2 + \gamma n[g_A]$$

Where:

Y = Output
A = Technology ("blueprints")
L = Labor-capital
a_L = share of labor-capital devoted to producing new technology
γ = elasticity of the growth rate of technology with respect to labor
θ = elasticity of the growth rate of technology with respect to the level of technology
n = growth rate of labor-capital
g_A = growth rate of technology

1) If $\theta < 1$ then the accumulation of technology has a diminishingly positive impact on the growth rate of technology, which will converge on the constant value $g_A = \gamma n/(1-\theta)$. We see that if, for example, $n = .02$, $\gamma = .67$, and $\theta = .30$, the constant growth rate of technology, and thus of per capita income for economy as a whole, would be $g_A = .019$.[42]

2) If $\theta > 1$ then each addition to the stock of technological knowledge makes it easier for new knowledge to be produced. Inspection of equation 4 shows that the growth rate of technology g_A is increasing and the stock of technology is accelerating. Under this assumption economic output will go to infinite in a finite period.

3) If $\theta = 1$ the key equations become: $g_A(t) = [\, a_L L(t)\,]^{\gamma}$ and $\dot{g}_A(t) = \gamma n [g_A(t)]$. If population and capital growth come to an end ($n = 0$) technological knowledge no longer grows explosively but does so at a constant rate.

The notion of increasing returns to the stock of technological knowledge as described in this simple model lies at the core of a great many more sophisticated treatments of endogenous growth. Many growth economists use extensions of the model described in case 3 above, in which $\theta = 1$. This has the simple structure $Y = AK$, and is commonly referred to as the "linear model."[43]

The new endogenous growth models are frequently cited as evidence that technology can overcome resource and other constraints on economic growth (e.g., Wysocki 1997). But the models don't support this claim. In a discussion of his work, Paul Romer (1990) says,

> "Linearity in A [$\theta = 1$] is what makes unbounded growth possible, and in this sense, unbounded growth is more like an assumption than a result of the model... [This specification] was chosen because there is no evidence from recent history to support the

---

[42] This is the average rate of growth of per capita output in the United States over the period 1880 through 1987.

[43] Not to be confused with the "linear models" shown in Box IIA-31 that were considered by a prior generation of technology scholars.

belief that opportunities for research are diminishing. Moreover, linearity in A is convenient analytically..." (p 84)

2. P. Romer (1990): An R&D Production Function With Human Capital

Box IIA-33 shows the central equations of a model of endogenous technology developed by Paul Romer that highlights the important role of human capital.

In this model the economy has three productive sectors. A research sector (equation 4) uses technological knowledge and human capital to generate new designs for producer durables. Capital is modeled as the sum of producer durables (equation 3). At any point in time there are as many types of producer durables as there are number of designs for them. Final output is generated by human capital, labor, and the stock of producer durables (equation 1). Any final output that is not consumed is invested in the production of new producer durables (equation 2). For convenience Romer treats population as constant and assumes that each person has accumulated the maximum possible stock of human capital.

The critical equation for our purposes is (4). As in case 3 of the D. Romer model discussed above, the rate of change of technological knowledge is a linear function of the stock of knowledge. If the stock of knowledge doubles the rate of increase of knowledge doubles as well. There are no diminishing returns. Similarly there are no diminishing returns to the use of human capital with respect to the production of knowledge. Thus the technology production function shows increasing returns: if the stock of both productive factors doubles, the rate of increase of knowledge quadruples.

Note that the growth of technological knowledge has a two-fold impact on the eventual growth of output. It enables new producer durables (x) to be built, which directly increases output, and it increases the marginal productivity of human capital used to produce new technology.

Romer uses a conventional utility function to help compute the optimal growth paths of the key variables. He finds that the growth rate of technological knowledge, and thus per capita

BOX IIA-33. An R&D Production Function with Human Capital [P. Romer 1990]

Equations of the Model:

(1) $$Y = H_Y^{\alpha} L^{\beta} \sum_{i=1}^{\infty} x_i^{1-\alpha-\beta}$$

(2) $$\dot{K} = Y - C$$

(3) $$K = \eta \sum_{i=1}^{A} x_i$$

(4) $$\dot{A} = \delta H_A A$$

Where

Y = output
H = total human capital (= $H_A + H_Y$)
H_A = human capital used to produce technological knowledge
H_Y = human capital used to produce final goods
L = labor
x_i = the quantity of producer durable i used to produce output
C = consumption
K = physical capital (equal to the sum of the producer durables)
η = number of units of foregone consumption used to create one unit of a durable
A = technological knowledge
δ = productivity parameter
α = elasticity of output with respect to human capital
β = elasticity of output with respect to labor

output, is $g = (\delta H - \Lambda\rho) / (\sigma\Lambda + 1)$, where Λ is a constant determined by the technical parameters of the production function, $\Lambda = \alpha / (1 - \alpha - \beta)(\alpha + \beta)$.

This result shows that the rate of per capita output growth is a function of a single productive resource—the stock of human capital, H. We see that positive output growth can be maintained even if the stock of human capital is constant. This happens because technological knowledge can increase the productivity with which a unit of human capital produces new technological knowledge, as shown in equation 4. But this is an assumption of the model, not a result.

3. Grossman & Helpman (1994): Increasing returns via product diversity

Grossman and Helpman present a model in which the driving force of technological innovation is the "preference for product diversity" held by consumers. Profit-maximizing producers will invest in R&D in order to develop new products that satisfy this preference.

Equation 1 in **IIA-34** shows consumer utility as the log function of D, which is a measure of consumption indexed for product diversity. D is given analytic rigor in equation 2, where x(j) is the amount x of product j consumed, n is the total number of products available, and α is a measure of "preference for diversity." Equation 2 shows that \$100 spent on 10 goods at \$10 each gives a higher value of D than does that same \$100 spent on 5 goods at \$20 each.

In the model the level of technology is given by n, the number of product varieties available. Grossman and Helpman derive equation 4, which shows that the rate of innovation in the economy (i.e., the production of new product varieties) is a function of the stock of labor and capital, and of the efficiency of research labs that generate blueprints for new products.

The most important equation in the model is equation 3, which shows that the stock of *general* knowledge in society, K_n, is a linear function of the current level of product-specific knowledge in society, n. This equation is analogous to equation 2 in Romer 1 and equation 4 in Romer II. It expresses Romer's insight that knowledge produced by firms when they engage in

BOX IIA-34. Increasing Returns Driven by the Preference for Product diversity
[Grossman and Helpman, 1994]

Equations of the model:

(1) $$U_t = \int_0^{\infty} \ln D(\tau) e^{-\rho(\tau-1)} d\tau$$

(2) $$D = \left[\int_0^{n} x(j)^{\alpha} dj \right]^{\frac{1}{\alpha}}$$

(3) $$K_n = n$$

(4) $$\dot{n} = \frac{L_n K_n}{a}$$

Derived equation:

(5) $$g = (1-\alpha)\frac{L}{a} - \alpha\rho$$

where:

U = utility
D = consumption index incorporating a measure of product diversity
ρ = subjective discount rate
x(j) = quantity x of each variety of product j consumed
α = preference for diversity (low α = high preference)
n = index of the diversity of products (i.e., of the "number of blueprints")
L_n = labor force employed in the production of blueprints
K_n = stock of general knowledge (i.e., "public knowledge")
g = growth rate of innovation and output
a = efficiency of research labs in generating blueprints for new products

R&D to develop new products for the market generates knowledge spillovers which other firms can use at little cost and which can thereby offset the declining returns to resources as production grows.

Grossman and Helpman nicely summarize their key results as follows:

> "We have studied the economic conditions that give rise to ongoing technological progress. The spillover benefits from research must not decline too rapidly over time, and the economy must be sufficiently large, sufficiently productive in the research lab, sufficiently desirous of new products, and sufficiently patient, for R&D to remain a viable activity through time." (p 74)

Earlier they catalogued these relationships:

> "A larger resource base means...more employment in every activity, (including those) which generate new knowledge. A smaller discount rate means more savings, a lower cost of capital, and so more innovation and faster growth. Finally, a smaller value of α implies a greater taste for variety, thus a less elastic demand for each product, a larger opportunity for monopoly profits, and a higher return to R&D." (p 63)

Note that while the importance of the size of the resource base, discount rate, lab productivity and α are indeed analytic results of the model, the importance of the fact that "the spillover benefits from research must not decline too rapidly over time" was built into the model at the beginning when the production of new knowledge was modeled as a linear function of the current level of knowledge. Grossman and Helpman acknowledge that choices other than this one of constant returns could have been made:

> "The process of knowledge accumulation might be characterized by increasing returns, for example, if there existed important complementarities between different ideas. On the other hand, the relationship between research and knowledge might be one of decreasing returns, if science were characterized by a limited 'store of ideas,' and if earlier contributions were more significant than later ones." (p 58)

Grossman and Helpman give no explicit rationale for their choice of the linear knowledge production function:

> "We choose, however, to concentrate our attention in the main text on a formulation [the linear production function] that ignores these potential complications... After deriving our results for this simplest of specifications, we shall discuss how they would be modified in more general cases." (p 58)

In an appendix Grossman and Helpman do explore the results their model gives if the knowledge production function were characterized by decreasing or increasing, rather than linear, returns. Under decreasing returns the rate of innovation, and thus economic growth, will inevitably slow to zero, while under increasing returns the rate of innovation and economic growth will increase continually. The most important feature of the model depends upon an exogenous assumption for which little justification is given.

4. Ayers and Miller (1980): Decreasing Returns Due to Natural Limits

Ayers and Miller use an unconventional production function (equation 1 in **IIA-35**) to model the fact that some minimum level of natural resource use is essential to the production of a unit of output. As the ratio between output and the stock of available resources increases, the growth of output is increasingly constrained. At the limit, output is shown as a constant fraction of the available resources.

Capital and Labor are modeled in the conventional manner (equations 2 and 3). The amount of available resources R is the sum of the constant flow of renewables and the current flow of exhaustible resources (equation 4). Consumption is equal to output less investment and that portion of output that represents the embodiment of technological knowledge in machine or labor skills (equation 5). The growth rate of technological knowledge depends on the total size of the population and rate of knowledge embodiment per capita (equation 6). Technological efficiency increases with respect to the stock of technological knowledge, towards a fixed asymptotic limit (equation 7).

Ayers and Miller solve for the dynamic equilibrium and show that "...the optimal path leads to a stationary state with finite capital and finite technological knowledge, resulting in maximum technical efficiency less than unity."

This result is largely determined by the assumption implicit in the choice of the production function--that there is a minimum level of resource use beyond which capital, labor

BOX IIA-35. Decreasing Returns due to Natural Limits
[Ayers and Miller 1980]

Equations of the model:

(1) $$Y = F(K,L,R) = \left[1 - e^{\left[\frac{-\pi(K,L)}{R}\right]}\right]R$$

(2) $$\dot{K} = I - dK$$

(3) $$\dot{L} = b\dot{N} = bgN\left(1 - \frac{N}{\overline{N}}\right)$$

(4) $$R = \overline{R} - \dot{S}, \qquad \dot{S} \leq 0$$

(5) $$C = F - I - J$$

(6) $$\dot{T} = J$$

(7) $$E = \left(1 + e^{(T_0 - T)}\right)^{-1}$$

Derived equations:

(8) $$\dot{E} = E(1-E)J$$

(9) $$y = f(k,b,E) = \frac{-\pi(k,b)E}{\ln(1-E)}$$

Where:
Y = total output
K = invested capital
L = labor force
R = available flow of energy resources; $\overline{R}$ = flow of renewable energy resources
I = investment
d = rate of physical depreciation
b = workers/population
N = total population
g = growth rate of population
$\dot{S}$ = flow of exhaustible energy resources
C = consumption
$\dot{T}$ = growth rate of technological knowledge
J = rate of embodiment of technological knowledge in machines or skill
E = technical efficiency
T_0 = accumulated level of new knowledge where E = .5 and T = T_0

and technology cannot substitute--and in the finite limits to technological efficiency imposed by equation 7.

Ayers and Miller motivate their choice of functional forms that show limits to technological change in the same manner as Romer, Grossman and Helpman motivated their choice of functional forms that showed no limits: by anecdote and plausibility appeals. Ayers and Miller say:

> "It is important to emphasize here, that ultimate technological efficiency is inherently limited, even though knowledge *per se* may be accumulated indefinitely. There are definite and well-know limits on physical performance in almost every field...For instance, there is a definite lower limit to the amount of electricity required to produce a horsepower of mechanical work. There is a lower limit, similarly, to the amount of electricity required to produce a given amount of illumination. And, of course, there is a lower limit to the amount of available work derived from fossil fuels that is needed to generate a given amount of electricity... Temperatures and pressures cannot be less than zero. Velocity cannot exceed the speed of light. And so on." (p 359)

5. Becker and Murphy (1993): Increasing returns to specialization, decreasing returns to coordination costs

Becker and Murphy present a model that identifies the specialization of labor as the engine of economic growth. Their production function (equation 1 in **IIA-36**) shows that per capita income will increase along with increases in technology (A), human capital (H), and the degree of specialization among workers (n). But as specialization increases so do coordination costs, here modeled by the term λn^B. Becker and Murphy cite principle-agent conflicts, hold-up problems (in which some members of a team shirk in order to extract concessions from others), and breakdowns in supply and communication, as examples of coordination costs.

Becker and Murphy derive the optimum per capita output (equation 4) and the per capita output growth rate (equation 5). The growth rate is the sum of the adjusted growth rates of technology and the stock of human capital, less the adjusted growth rate of coordination costs.

The mechanism that generates increasing returns in this model is the possibility of a mutually reinforcing relationship between specialization and the stock of human capital. As human capital grows the optimal level of specialization grows, as shown in equation 3. With

BOX IIA-36. Increasing Returns to Specialization; Decreasing Returns to Coordination Costs [Becker and Murphy 1993]

Equations of the model:

(1) $$y_t = A_t H_t^{\gamma} n_t^{\theta} - \lambda_t n_t^{\beta}$$

(2) $$U = \frac{1}{\sigma} \sum_{t=0}^{\infty} \alpha^t c_t^{\sigma}$$

derived equations:

(3) $$n_t^* = \left(\frac{\theta}{\beta \lambda} \right)^{\frac{1}{\beta - \theta}} A_t^{\frac{1}{\beta - \theta}} H_t^{\frac{\gamma}{\beta - \theta}}$$

(4) $$y_t^* = k_t A_t^{\frac{\beta}{\beta - \theta}} H_t^{\frac{\beta \gamma}{\beta - \theta}}$$

(5) $$\frac{\dot{y}}{y} = \frac{\beta}{\beta - \theta} \frac{\dot{A}}{A} + \frac{\beta \gamma}{\beta - \theta} \frac{\dot{H}}{H} - \frac{\theta}{\beta - \theta} \frac{\dot{\lambda}}{\lambda}$$

Where:

y = per capita output (y* = optimal per capita output)
A = technology
H = human capital
U = utility
n = index of specialization/division of labor (n* = optimal level of specialization/division)
λ = coordination cost parameter
γ = elasticity of output with respect to human capital
θ = elasticity of output with respect to specialization/division of labor
β = elasticity of coordination costs with respect to specialization/division of labor
k = a constant of the output parameters (See BOX IIA-37)
σ = elasticity of utility with respect to consumption
α = subjective discount factor
c = consumption

greater specialization, output increases, and this raises the marginal product of additional units of human capital.

Becker and Murphy use a conventional utility function (equation 2) to solve for the optimal paths over time for output, consumption, and human capital stock. They find that in equilibrium these variables change at the same rates, and that they will grow, decline or remain constant depending upon the particular values of the parameters n, B, γ, and θ, as shown in **IIA-37**. Becker and Murphy speculate that $\gamma < 1$, and state that $B > \theta > 0$ for small values of n, but otherwise do not offer opinions about the values that these parameters might take in the real world.

Assessment

Although the endogenous growth models have been hailed as pointing the way to unlimited economic growth, we saw that in one case after the other this feature was produced by assumptions of the model, not by results derived from it. Whether the returns to knowledge, technology, human capital, the division of labor, or other factors, is increasing, decreasing or constant is a complex empirical question that the models themselves do not address.

II.A.3.d. The Post-War Productivity Growth Slowdown

Productivity in the industrialized nations grew steadily in the two decades after World War II, but in 1973 this growth abruptly slowed and has remained at lower levels since, as shown in **IIA-38, IIA-39 and IIA-40**.

Was this slowdown the result of a particular shock or structural change that might be remedied by policy or the passage of time? Or has industrial technology reached a level of development beyond which we can expect only diminishing returns, perhaps forever? A list of explanations of the productivity slowdown appears in **IIA-41**.

In the mid-1980's many analysts believed that the oil price shocks of 1973 and 1978 were the likely cause. The timing was right, the oil shocks had indeed had a global impact, and

BOX IIA-37. Results of the Becker/Murphy Model

Let g = steady-state growth rates of human capital (H), output (y) and consumption (c).

If A and λ are constant, and:	then:	which means:
1) $\beta\gamma < \beta - \theta$	$g = 0$	output slows and comes to a stop
2) $\beta\gamma = \beta - \theta$	$g = \left(R\alpha^{-1}\right)^{\frac{1}{1-\sigma}}$	output grows at a steady rate*
3) $\beta\gamma > \beta - \theta$	$g > 0$	output grows at an accelerating rate

* $R = \dfrac{\beta\gamma}{\beta - \theta} k A^{\frac{\beta}{\beta-\theta}} H^{\left(\frac{\beta\gamma}{\beta-\theta}\right)-1}$ where $k = \lambda^{\frac{-\theta}{\beta-\theta}}\left[\left(\dfrac{\theta}{\beta}\right)^{\frac{\theta}{\beta-\theta}} - \left(\dfrac{\theta}{\beta}\right)^{\frac{\beta}{\beta-\theta}}\right] > 0$

BOX IIA-38. THE POST-1972 SLOWDOWN IN OUTPUT GROWTH

[Sources: Mankiw (1994); World Development Report 1996]

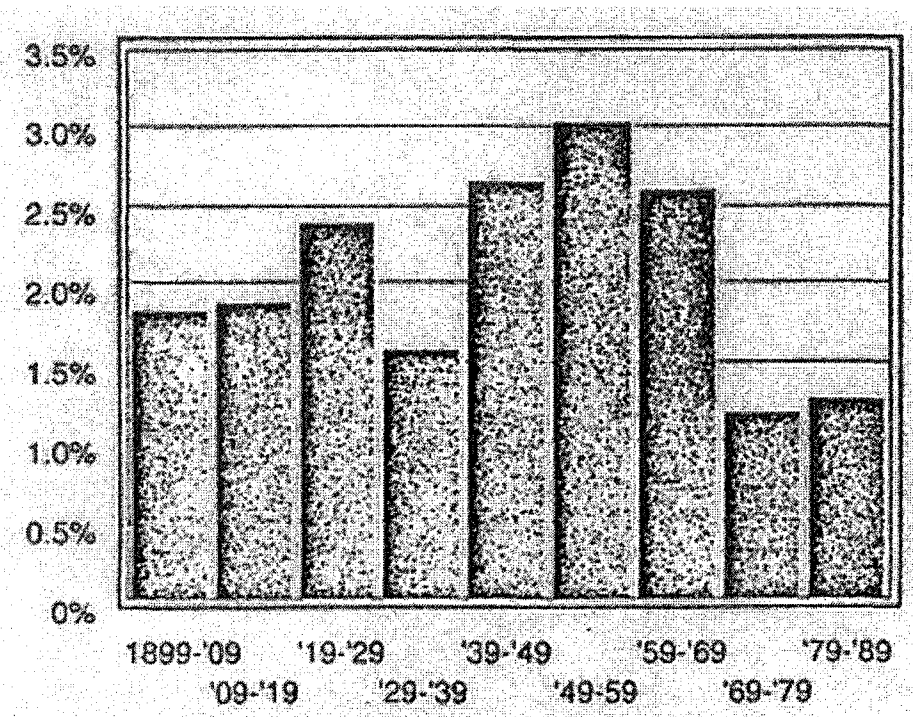
Country	Growth in Output per Person (percent per year)		
	1948-1972	1972-1991	1990-1994
Japan	8.2	3.6	.9
West Germany	5.7	2.3	.5
Italy	4.9	2.8	.5
France	4.3	2.1	.3
Canada	2.9	2.3	.1
United Kingdom	2.4	1.9	.4
United States	2.2	1.7	1.5

BOX IIA-39. ACCOUNTING FOR OUTPUT GROWTH IN THE UNITED STATES

[Source: Mankiw (1995)]

Years	Output Growth	Capital Growth	Labor Growth	Total Factor Productivity
1950-1959	4.0	0.4	0.5	3.1
1960-1969	4.1	0.9	1.2	2.0
1970-1979	2.9	1.1	1.5	0.3
1980-1989	2.5	0.9	1.3	0.3
1990-1992	0.6	0.6	-0.1	0.1

BOX IIA-40. U.S. Productivity Growth, 1899-1989
[reprinted from Krugman, 1994]



The two decades since 1970 have seen the worst U.S. productivity performance of the century.

BOX IIA-41. Suggested explanations for the post-1973 productivity slowdown

1. The composition of the labor force has been changing. Younger workers are less productive.
2. More government regulations, especially environmental regulations, have stifled growth.
3. The 1970's oil price shocks forced early retirement of capital stocks, and sparked a recession.
4. The sectoral shift to a service economy means lower productivity.
5. We are experiencing diminishing returns to technological innovation.
6. Fundamental scientific breakthroughs now require increasing effort to achieve.
7. We have reduced expenditures on R&D from earlier levels.
8. Young people are no longer motivated to pursue productivity-enhancing goals.
9. We are experiencing diminishing marginal utility for goods; persons are choosing leisure.
10. The slowdown represents a return to "natural" rates of growth after a period of "catch-up" following the shocks of the Great Depression and World War II.
11. There is no slowdown; flawed statistics have overestimated the rate of inflation and underestimated the rate of output growth.

plausible mechanisms involving forced retirement of capital stock were available. But oil prices fell dramatically in the late 80's without sparking any return to the high rates of productivity growth. Today the oil price shock hypothesis is not widely supported.

Other explanations invoke demographic changes, increased government regulations, shifts to a service economy, a loss of entrepreneurial and materialistic motivation among young people, the increasing cost of research, cutbacks in funding for R&D, and a declining rate of return on investment in technological skills. Most studies suggest that these mechanisms can only explain a small portion of the growth slowdown.

The figures in **IIA-42** suggest that growing stocks of scientists and engineers appear to have been unable to prevent a decline in productivity in the United States, France and Japan, and have just barely been able to keep Germany at a constant level of productivity. This pattern is consistent with the proposal that the stock of scientists and engineers has now become subject to decreasing returns.

A 1996 study by a commission chaired by Michael Boskin, chief economic advisor to President George H.W. Bush, concluded that the consumer price index (CPI) overstates annual inflation by 1.1 percentage points. The major portion of this error is due to the inability of the CPI to easily account for qualitative changes in output. If the rate of inflation has been overestimated then the rate of economic growth has been underestimated. An increase of 1.1 percentage points in each of the two columns in IIA-40 representing economic growth since 1969 makes the productivity slowdown appear significantly less dramatic. These revised statistics suggest that technological innovation may be playing an increasing role in qualitative improvements in output, even as product prices, and thus the CPI, remain nearly constant. Other analysts disagree with the findings of the Boskin commission and suggest that the CPI overstates inflation by not more than 0.6 percentage points.

Some analysts suggest that the productivity slowdown represents a return to a more typical long-run rate of productivity growth. On this view the high post-war growth rates, not the

BOX IIA.42. Scientists and Engineers as Productivity Factors

[reprinted from C. Jones 1995]

Figure 1. Scientists and Engineers Engaged in R&D

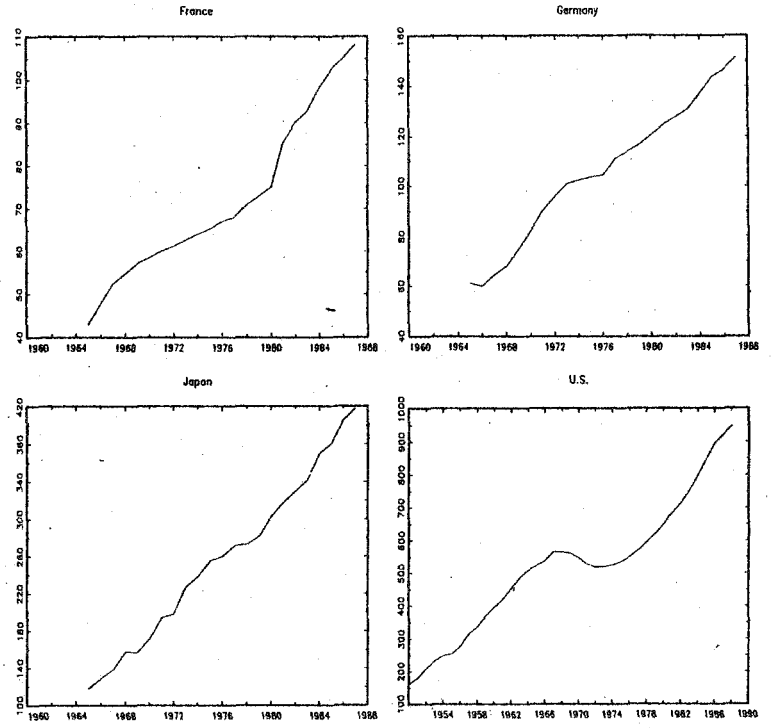
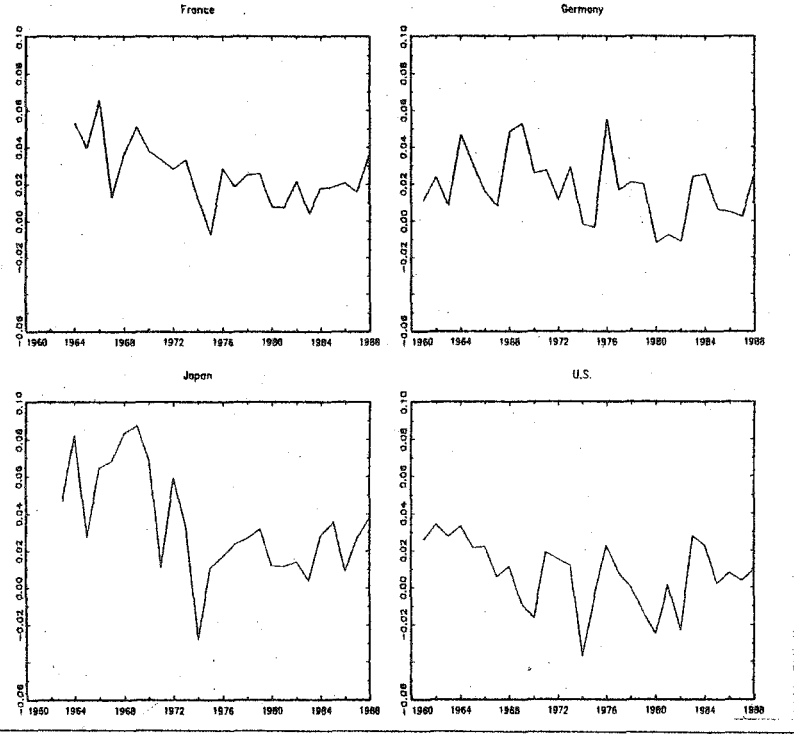


Figure 2. Aggregate Total Factor Productivity Growth



slowdown, are the anomaly. These high growth rates are explained as a "catch up" phenomena following the disruptions of the Great Depression and World War II, further bolstered by a stock of new technologies in communications, transport, electronics, and materials generated by World War II.

Box IIA-43 shows that the growth of per capita GDP for the United States since 1900 (in logs) fits a simple linear trend line quite nicely. This line describes a nearly constant average rate of growth for most intervals over that period of 1.9% per year. The higher growth rates of the post-war period and the slowdown after 1973 are discernible in this figure but do not appear to be great deviations from the trend.

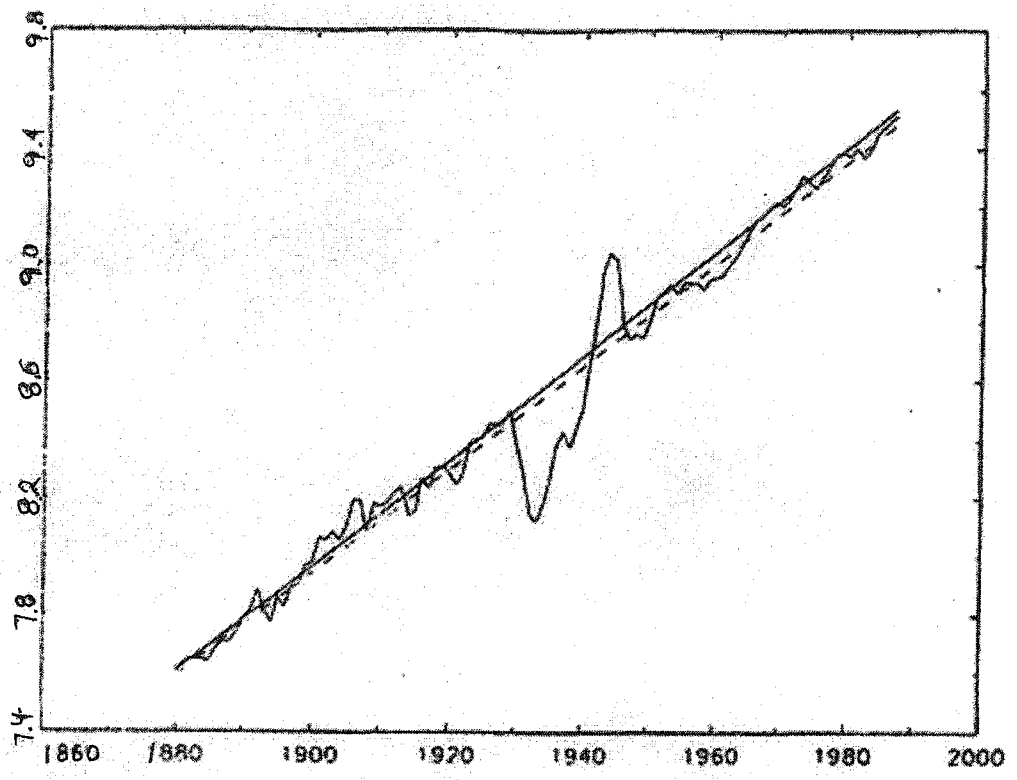
Why should we expect productivity to grow at a constant rate over so long a period of decades, and why should it be 1.9% rather than some other value? One answer is that the growth rate is determined by a so many different factors that a change in any one of them is unlikely to make a big difference. The value of 1.9% just happens to be the one that our mix of resource and technological endowments, time preferences, institutional and/or cultural factors generate.

In a review of theories concurring the post-1973 productivity slowdown, Krugman (1995) declared that "We have no idea" why it happened, or whether it can be expected to continue or not.

Beginning in 1997 the first gains in productivity in the United States since the mid-1970's began to appear in the national income accounts. Some of these were attributed to labor force restructuring in the face of increased global competition. Others were attributed to the new information technologies, which, having passed through a fifteen-year period of high transition and learning curve inefficiencies, were now paying off with real net productivity gains.[44]

[44] See Uchitelle (1997)

BOX IIA-43. Per Capita GDP in the United States, 1880-1987
[reprinted from C. Jones 1995a]



"The solid trend line represents the time trend [in natural logs] calculated using data only from 1880 to 1929. The dashed line is the trend for the entire sample." (p 498)

SECTION II.A.4. IS GREATER COMPLEXITY A LIMIT TO GROWTH?

Summary

Some authors argue that as economies and societies grow they become more complex, that the marginal costs of coordination grow faster than the marginal benefits, and that at the point where the former exceeds the latter economic growth will cease. Others argue that as societies become more complex they generate emergent levels of organization that within themselves are *less* complex, and thus enable growth to continue and perhaps even accelerate. Still other authors propose that complexity is a subjective experience related to the *pace* of technological and social change that accompanies economic growth, and to periods of transition during which new technologies are introduced and old ones abandoned. None of the studies reviewed offered definitions of complexity that allowed it to be measured as a unique independent variable. Thus, testable models of the relation between economic growth and complexity were not available. We conclude that the suggestion that complexity may be a limit to growth is still speculative.

II.A.4 IS GREATER COMPLEXITY A LIMIT TO GROWTH?

Many persons have an intuitive sense that as industrial economies and societies grow they tend to become more complex, and that perhaps they can become so complex that they are no longer able to function. If this is true then complexity would be a limit to growth.[45]

The topic of "complexity" has been controversial. Many authors believe it to be profoundly important. Others are skeptical, even dismissive.[46] Different authors have sought to apply the term in different ways, as shown in **IIA-44.**

In these notes I review studies that suggest there is a relationship between the degree of complexity in a society and the prospects for continued economic growth.

II.A.4.a. Organized Social Complexity

In the mid-1970's Todd La Porte (1975) and others introduced the topic of social complexity as an important, and potentially worrisome, feature of modern life. In particular, they were concerned that as institutions became more complex the ability of people to make good decisions might be severely impaired.

According to these authors the degree of social complexity is determined by three factors: the *number* of system components, the relative *differentiation* or variety of these components, and the degree of *interdependence* among these components.

La Porte cites several reasons to believe that there are limits to the complexity of an institution or set of institutions. He cites research suggesting that as the number of system components increases, so do the "requirements of coordination." In turn, this generates "pressures on the system to differentiate." This differentiation may be either horizontal, in which case coordination is achieved through a process of exchange, or vertical, in which case

---

[45] In economic terms, one would say that the transaction costs necessary to maintain a given level of output might become so great that no output is available for new investment.

[46] For enthusiasts see Lewin (1992) and Prigogine (1989). For skeptics see Horgan (1995).

BOX IIA-44. DEFINITIONS OF COMPLEXITY
[major source: Seth Lloyd, quoted by J. Horgan in Scientific American, June 1995]

1. **ENTROPY.** complexity equals the entropy, or disorder, of a system, as measured by thermodynamics.
2. **INFORMATION**. Complexity equals the capacity of a system to "surprise," or inform, an observer.
3. **FRACTAL DIMENSION**. The "fuzziness" of a system, the degree of detail it displays at smaller and smaller scales.
4. **EFFECTVE COMPLEXITY**. The degree of "regularity" (rather than randomness) displayed by a system.
5. **HIERARCHICAL COMPLEXITY**. The diversity displayed by the different levels of a hierarchically structured system.
6. **GRAMMATICAL COMPLEXITY.** The degree of universality of the language required to describe a system.
7. **THERMODYNAMIC DEPTH**. The amount of thermodynamic resources required to put a system together from scratch.
8. **TIME COMPUTATIONAL COMPLEXITY**. The time required for a computer to describe a system (or solve a problem).
9. **SPATIAL COMPUTATIONAL COMPLEXITY**. The amount of computer memory required to describe a system.
10. **MUTUAL INFORMATION**. The degree to which one part of a system contains information on, or resembles, other parts.
11. **Herbert Simon:** a complex system is one "made up of a large number of parts that interact in a nonsimple way.

coordination is established authoritatively. At the same time, "the relatively inelastic limit of individual information processing capacity prevents nearly complete interdependence." This is due to limited "channel capacity," a "narrow span of immediate memory," and "limitations of absolute judgment" that all persons share to varying degrees. Further, "the development of highly interdependent organized systems is limited by the degree to which members are aware of their interdependence... As the number of potentially inter-dependent actors increase, this awareness relatively declines."

On this view the ultimate limits to the growth of social institutions appear to be hierarchical limits. Hierarchy is necessary to coordinate increasingly complex social components, but as it grows the "awareness of interdependence" between the lowest and highest levels declines. Beyond some point, once again, the system will not be able to function effectively.

Winner (1977) extends La Porte's presentation and evaluates different arguments in support of the view that the growth of complexity does *not* pose serious problems for modern society. He concludes that these arguments are not strong (see **IIA-45**).

Taylor (1975) differs with much of La Porte's and Winner's analysis. He says that it is not clear that "technological advance," defined as the simple improvement in some performance measure of a technology, necessarily generates more complexity. A new, more efficient widget might be of greater, lesser or the same complexity as the widget it replaces. Taylor says that "technological change," on the other hand, *does* lead to greater complexity. By "technological change" Taylor means the changes that a new technological advance might have on production, decision-making, coordination, and other social processes impacted by the new technology. These processes will become more complex simply because introduction of the new technology causes "a temporary increase in the level and novelty of contingencies" during the time it takes to replace the old technology. After this transition is complete, the conditions that generated this new complexity will no longer be in play. Thus Taylor conceives of complexity as a largely

BOX IIA-45. WINNER'S CRITIQUE

[source: LaPorte 1975]

Winner notes that many analysts, while willing to grant that modern society is in some sense becoming more complex, reject the view that this is necessarily a serious problem. The reasons given for this view include:

1) *technology and systems analysis:* Improved information technologies and advanced techniques for anticipating and formulating responses to potential problems will allow us to manage complexity.

2) *ecological thinking:* Ecological systems are far more complex than any human system; indeed they include human systems as a subsystem. We can learn from the study of ecological processes how to mange complexity effectively.

3) *redundancy:* The growth of inefficiency, overlap and redundancy in complex social institutions is in fact part of the solution, not the problem. If one component of a system fails others are in place to fill the gap.

4) *incrementalism:* The rational/comprehensive model of decision-making becomes unworkable at levels of complexity even far less than those of most social institutions today. In truth, decisions are made incrementally, which generate only small advances and small damages. But over time we learn from both of these, and thus the general trajectory is one of improvement.

5) *organicism:* living systems are the most complex systems known, and there is no evidence that more complex systems are any less successful than less complex ones. In fact, complexity might support rather than impede further growth. Growth may entail problems to worry about, but "complexity" is not one of them.

Winner responds by noting that while improved information technologies, systems analysis and ecological thinking can all assist us in gathering more information that might bear on social decisions, in the final analysis the decision itself is normatively grounded He notes that while redundancy might help prevent system failure, this hardly addresses the concerns of those whose are most worried about the consequences of the continued *success* of the system. Winner says that incrementalism reduces to the assertion that "complex things cause less of a problem when they are not changing," but that this view ignores precisely the problem at hand, which is that technology is indeed changing, very rapidly, and is having major impacts. Finally, Winner says that organicism is a metaphor, not an analysis, and serves largely as a rationale for quietism.

subjective experience, rather than as a property inherent in a technology. He goes on to note that if technological advance is an ongoing process, the subjective experience will be that "complexity is increasing." In effect, Taylor identifies the main source of unease as speed: if new technologies are introduced too rapidly, then complexity will be high and could cause problems. But if the same set of technological advances are introduced at some slower pace, adaptation can occur in a way that does not tax individual or social constraints.

II.A.4.b. The Collapse of Complex Societies

In *The Collapse of Complex Societies* (1988) Tainter argues that "complex societies collapse when the marginal costs of complexity exceed their marginal benefits." He supports this view with detailed analyses of the collapse of about two dozen complex societies. These include the Western Chou Empire, the Egyptian Old Kingdom, the Harappan Civilization, the Hittite Empire, the Eastern Woodlands, the Western Roman Empire, the Olmec, and the lowland Maya.

Tainter does not offer a definition of complexity but says that it

> "...is generally understood to refer to such things as the size of a society, the number and distinctiveness of its parts, the variety of specialized social roles that it incorporates, the number of distinct social personalities present, and the variety of mechanisms for organizing these into a coherent, functioning whole." (p 23)

He states that complexity arises as a positive response to stresses between groups, and serves to maintain or expand their joint products. He notes that social stratification is a necessary feature of complex societies. He defines collapse as a process whereby a complex society undergoes a significant reduction in differentiation and stratification.

Tainter proposes that "investment in sociopolitical complexity as a problem-solving response often reaches a point of declining marginal returns." He offers detailed historical accounts of particular societies showing how the costs of various activities necessary to maintain a high level of social organization increased in the periods prior to their collapse. In the case of the Mayan civilization that prospered between the 4th and 8th centuries AD, Tainter records an increase in "vast hydraulic and agricultural engineering...massive public works, and military

competition" just prior to the beginning of its sharp collapse in 790 AD. Similarly, he notes that in the late Western Roman Empire

> "...the combined factors of increased costliness of conquest, and increased difficulty of administration with distance from the capital, effectively required that at some point a policy of expansion must end...By the time of the Principate the marginal return on investment in empire had declined considerably...When the stresses impinging on the Empire grew, it would decline further still. " (p 150)

Tainter considers the prospects for modern societies. He offers a detailed account of resource depletion in the industrialized countries, and states but does not examine further his belief that the returns to technological innovation are declining. He suggests that the marginal costs of information processing and sociopolitical control are increasing. He offers as evidence the facts that that the number of bureaucrats in the British Admiralty has increased while the number of sailors declined, that crime in America is increasing even though public spending on crime prevention is growing, and similar anecdotal items.

Despite these indications that complexity in the industrial world is approaching the level at which its net marginal benefits are zero, Tainter states that collapse is unlikely, perhaps impossible. The reason given is that there is no alternative condition into which an industrial economy can easily "fall." In pre-industrial times complex societies were surrounded by more simple societies. When they collapsed their lower-level social components could continue as part of a looser network of adjacent simple societies. If a modern society were in danger of collapsing, its component parts—cities, communities, occupational groups, families—would integrate into nearby complex societies, by choice or by force. Tainter concludes that the world faces a paradoxical future: the increasing costs of complexity mean that economic growth will slow to a crawl, but the inability of the system to collapse means that we just might be able to hold out long enough until some unexpected technological breakthrough once more allows a positive rate of economic growth.

II.A.4.c. Structural Complexity and the U.S. Economy

Pryor (1996) contends that social and economic life in the United States has become more complex in recent decades and that complexity serves to reduce economic growth. He focuses on structural complexity, which he defines as the complexity of a system at a point in time.[47] He says that an increase in structural complexity can be understood in terms of three main characteristics: an increase in the direct information required for that system to function; more elaborate interactions or internal configurations; and greater differentiation or heterogeneity of units. Pryor suggests that such aspects of complexity can be measured by use of the Theil coefficient (H), defined as

$$H = \Sigma\, p_i \ln (1/p_i)$$

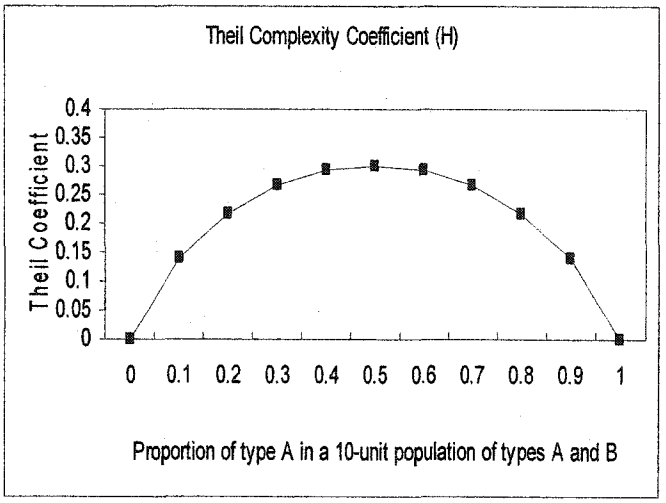
where p_i is the proportion represented by type i of a total population N, i (1... N). The complexity of a system as measured by the Theil coefficient peaks at a point between the extremes of total uniformity ($p_i = 0$) and total randomness ($p_i = 1/N$), both of which have zero complexity. The Theil Coefficient is explained in more detail in **IIA-46.**

Pryor computes Theil coefficients for a large number of social and economic time series, including age, race, religion, family structure, education, wealth and income distribution, occupational categories, and others (see **IIA-47**). He concludes that "structural complexity—the information required for the economic system to function—is generally increasing."

Pryor prepares a detailed spread sheet model of the economy of the United States for the period through 2050. The model shows that economic growth is expected to decline from a rate of 1.5%/yr in the 1990's to 1.29% for the period 2030-2050. Pryor interprets this slower growth as the impact of greater complexity. However, a closer review shows that complexity itself (i.e., the Theil Coefficient) is not a variable of the model. Rather, the trajectory of growth is generated

[47] Pryor distinguishes structural complexity from *behavioral* or *dynamic* complexity, which refer to the self-organizing properties of some systems, and *subjective* complexity, which refers to the experience of a participant in a system.

BOX IIA-46. The Theil Complexity Coefficient



Discussion:

The Theil Coefficient (H) is a commonly used measure of complexity. The standard form is:

$$H = \sum_{i=1}^{N} p_i \ln\left[\frac{1}{p_i}\right]$$

Where p_i is the proportion of component I in the population of N units. A simple example of the behavior of the Theil Coefficient is shown in the diagram above. A population of 10 units has 2 components, A and B. If all 10 units are B, the system is not complex at all (H = 0), but as the proportion of A components increases, so does complexity. Maximum complexity is reached when $p_A = p_B$ (H = 2.7). But as the proportion of A continues to increases, complexity decreases, to the point where when all 10 units are A, H = 0 once more. A greater diversity of components (say, A, B and C), with varying proportions, will show different levels of complexity. Complexity also increases as N increases, even when the diversity and proportions of components remains constant.

BOX IIA-47. Relative Theil Coefficients of US Social & Economic Variables over Time [source: Pryor, 1996]

year	age	religion	education	household type	total wage/salary inequality	male wage/salary inequality	employment structure
1950	0.939	0.54	0.926				
1958							0.113
1960	0.940	0.55	0.912	0.764			
1967					0.337	0.248	0.114
1970	0.945	0.53	0.870	0.787	0.358	0.286	
1977					0.360	0.282	0.113
1980	0.950	0.55	0.823	0.855	0.347	0.276	
1987					0.372	0.325	0.118
1988				0.880			
1990	0.955	0.52	0.795				
2010	0.963						
2030	0.973						
2050	0.981						

Discussion:

The Relative Theil Coefficient is the ratio between the absolute Theil Coefficient of a distribution (see Box IIA-46) and the maximum Theil Coefficient possible for that population, given its size and number of components. The closer a Relative Theil Coefficient is to one, the closer it is to a completely uniform distribution of values among the components of that population. A population of 10 persons, each 30 years old, would have a Relative Theil Coefficient of one.

Example: The distributions used by Pryor to calculate the Relative Theil Coefficient for household type in 1960 and 1988 was as follows:

	Proportions of all households: 1960	1988
married couples w/ children < 18:	.442	.270
married couples w/o children < 18:	.303	.299
other family types children:	.044	.080
other family types without children:	.064	.066
living alone:	.130	.241
other non-family households:	.017	.044

When these values are plugged into the formula for the Theil Coefficient they produce the values of 1.369 for 1960 and 1.577 for 1988. The value of the Theil Coefficient for a completely uniform distribution of 6 components (ie., where the proportion of each component is .1667) is 1.792. Thus the Relative Theil Coefficients are .764 and .880, as shown in the table.

Pryor's calculations show that complexity has increased for all the variables shown except religion and education. However, the extent of increase varies considerably, and the interpretation and significance is unclear.

by such factors as an increase in the proportion of aged persons, increasing inequality of income and wealth, a bottleneck in the supply of technological skills, the shift of labor into the service sector, and higher taxes. It is not clear that the concept of "complexity" makes any independent substantive contribution to the analysis.

II.A.4.d. The Santa Fe Institute

Kauffman (1995) and his colleagues at the Santa Fe Institute (Cowen et al 1994) have sought to establish the study of complexity as an important scientific and intellectual discipline. Their many explorations of this topic are too diverse to try to summarize here, but several themes appear repeatedly in their work. These include:

* Many important phenomena in the world can be understood as *complex adaptive systems.*. Examples include pre-biotic chemical reactions, living organisms, nervous systems, ecosystems, the biosphere, languages, economies, societies and perhaps galaxies. These systems, despite their obvious differences, have common features that explain their growth and development over time.

* Among these features is the fact that upon reaching threshold levels of complexity, systems will "spontaneously" generate new levels of order. This typically means new levels of organization (hierarchy) that can mediate and coordinate exchange between sub-units. This new level of organization is once more "simple." But if more units, more interrelationships, or greater differentiation occurs, additional levels of organization will arise.

* The "region" of complexity in which this new order is generated is in fact the region of *maximum* complexity. As we saw with the Theil Coefficient, this happens at some point between the poles of complete randomness, on the one hand, and the pole of complete order, on the other.

* There may be many possible configurations for any given level of organization. It may be impossible to predict which of these will be realized at the moment that a new level is generated. Thus, the characteristics of each level are emergent and novel, rather than determined.

* Since the region of maximum complexity is most likely to give rise to new and novel configurations that help it (the system) remain intact, it will be more likely to "survive" under stressful, or competitive, situations. Thus a process of evolution may "drive" systems to situate near their points of maximum complexity.

The story told by the Santa Fe theorists concerning economic growth differs dramatically from that told by La Porte, Winner, Trainer and Pryor. According to Kauffman complexity encourages rather than impairs economic growth. This happens because technological innovation, in both the process and product domains, creates new "niches" that contain opportunities for even more innovation.[48] Kauffman constructs models of innovation in which the diversity of innovation resources, and the number of different ways in which they can combine, define an innovation space containing a "sub-critical" and a "supra-critical" region separated by a "phase transition." Above this phase transition technological innovation, and thus economic growth, becomes self-sustaining. In general, the Santa Fe theorists tend to be enthusiastic about the prospects for free-markets, entrepreneurial initiatives, and capitalist institutions.

II.A.4.e Assessment

The efforts by Tainter and Pryor to identify "complexity" as an independent variable whose increase over time can explain, respectively, the collapse of pre-industrial societies and the post-1970 slowdown of economic growth in the industrial countries, are not convincing. The quantitative analysis that supports this effort is either non-existent (Tainter) or weak (Pryor). It is not clear that the concept of "complexity" helps us understand social and economic behavior in ways that previously resisted analysis.[49]

---

[48] This model is described in Section II.A.3.b and illustrated in Box IIA-30.
[49] See Yoffee et al. (1988) for an in-depth analysis of civilization collapse using more the conventional approaches of history and the social sciences.

From the 1970's to the present La Porte has done important work concerning decision-making in large, complex institutions, but his earlier, more ambitious suggestion that complexity might prove to be a useful category of far more general application has not been pursued.

Much of the work of the Santa Fe scholars is too technical for me to assess. Many critics, including friendly ones, believe their treatment of complexity offers useful metaphors but poor models.[50] Much of their discussion of social and political phenomena strikes me as naïve.

Is it obvious that technological innovation and economic growth necessarily generate greater complexity? The contrary story can also be told. In the course of economic growth regional cultures and dialects tend to diminish. In the United States agricultural produce is more uniform today--in size, color, and quality--than it was decades ago. The diversity of diseases has been reduced. It might be argued that the most profound thrust of technological innovation and economic growth is precisely to *reduce* the complexity of the world and make it more uniform, stable and predictable. Indeed, one of the themes of certain environmentalist critiques of industrial civilization is that it destroys the natural complexity, interdependence and richness of the biosphere and imposes thereon a numbing uniformity.

In retrospect it appears that some of Taylor's cautions may have been well considered. What we call "complexity" may be largely a subjective experience that occurs when unfamiliar circumstances impose themselves. In response we take steps to either adapt to or change these circumstances. To a large extend we've found that complexity can be embodied in our technologies and facilitate, rather than obstruct, effective human use of them.

The intuition that *something* is happening that might be described as an increase in complexity is widespread, and the topic deserves continued attention. But to date the attempts to characterize complexity, and to demonstrate that it is a constraint on economic growth, are unsatisfying.

---

[50] See the extended discussion on this point in Cowan et al. (1994)

II.B ECONOMIC INEQUALITY

Summary

In this section we review ways that economic inequality, the rate of economic growth, the level of output, and efforts to reduce inequality, might affect one another. We evaluate proposals to reduce economic inequality and we discuss public opinion concerning inequality. We conclude by re-assessing the income distribution goals of our ideal scenario.

Section B.1 summarizes current data. For most of the last 40 years the distribution of incomes in most countries has been largely stable. Over the past 20 years inequality of incomes has increased, at varying rates, in most, although not all, of the mature industrial countries.

Section B.2 reviews theories of income distribution. Economic growth should reduce inequality in developing countries. A major part of the increase in income inequality in the industrial countries appears to be due to skills-biased technological change. A critical unresolved question is whether the continuing growth of economic output necessarily requires an increasingly skilled labor force. Expanded trade is expected to worsen the distribution of incomes in high income countries and improve it in low income countries, but these impacts may not be large and should lessen over time. Although the aggregate growth of inequality in developed countries has arguably been moderate, the growth of incomes realized by the very highest percentiles has been much greater, possibly as a result of "winner-take-all" dynamics. There is little evidence of any strictly economic mechanism that would necessarily cause higher levels of inequality in an industrial economy to have a seriously retarding effect on economic growth. However, if growing inequality generates political instability, then investment, and consequently growth, could suffer.

In Section B.3 nineteen sets of proposals for reducing the inequality of income and wealth in the mature industrial nations are evaluated. These proposals are broadly grouped into

one of four categories: Conservative, Liberal, Progressive and Green. Proposals to address inequality that are currently endorsed by important political constituencies are not likely to have a large impact.

In Section B.4 nearly 200 opinion survey results concerning economic inequality are reviewed. Although concern about economic inequality is shared by a large majority of Americans, concerted policy initiatives to reduce inequality are supported by much smaller minorities. Americans show far more support for measures to ensure equality of opportunity than for equality of outcomes. Europeans show higher levels of support for public policies that address economic inequality than do Americans.

Section B.5 evaluates the above findings with respect to our long run scenarios of global development. We conclude that it is difficult to make a credible case for reducing economic inequality to the level suggested in our ideal scenario, Scenario 5, which calls for an 80/20 ratio of 2.5. Provisionally, we adopt an alternative goal: inequality should not be allowed to be worse than the mean level currently found in the industrial social democracies, i.e., an 80/20 ratio of about 6.5. Achieving even this more modest goal will likely require major social and political commitment.

Section II.B. ECONOMIC INEQUALITY

Introduction

An important stated goal of this dissertation is to fully and credibly incorporate values concerning the distribution of income into long run scenarios of global development, and to do so in a way that is consistent with concern for economic well-being in the aggregate, and with ecological integrity.

Over the past two decades economic inequality in the mature industrial countries has been growing. Is it possible that the distribution of income could become so unequal that it destroys the prospects for further economic growth? Conversely, could it be that attempts to *reduce* inequality of income could destroy prospects for further growth? If either or both of these are true, what might be the maximum and minimum sustainable levels of inequality and output? If continued growth tends to generate greater inequality then our goals of protecting the environment and ensuring distributional equity might reinforce one another. If continued growth tends to generate greater equality then these goals may be in conflict. Which is it? After we've exhausted the possibilities for analysis, we still need to decide: What is to be done? In the sections that follow we consider these and related questions.

We begin in Section II.B.1 by summarizing current data on the distribution of income and how these have changed over time. In Section II.B.2 we review theoretical and empirical studies that have sought to explain these levels and changes. In II.B.3 we review and assess nineteen proposals propounded from within four general ideological perspectives for addressing concerns about income inequality. In II.B.4 we review the results of nearly 200 public opinion survey questions concerning income inequality. In II.B.5 we bring the results of the four preceding sections to bear in helping decide on values concerning the distribution of income to provisionally include in our advocated scenario.

II.B.1. WHAT THE DATA SHOW

II.B.1.a. Income Distribution Within Countries

Box IIB-1 shows Gini coefficients and 80/20 ratios for 108 countries.[51] The mean of the Ginis is 39.9, with a standard deviation of 9.9. The median is 38.0. Latin American and Sub-Saharan African countries are the most unequal, with mean Ginis in the upper 40's. The Middle East/North African and East Asia/Pacific countries have mean Ginis in the upper 30's, while those of South Asia and the Industrialized Countries are in the low 30's. The countries of Eastern Europe are the most equal in the world, with Ginis in the upper 20's.

II.B.1.b. Changes in Economic Inequality Within Countries

1. Aggregate estimates

Box IIB-2 shows changes in the distribution of income by decile among persons living in the non-socialist nations over the period 1950-1985. The amount of change has been small, although a slight increase in inequality since about 1970 can be seen. When the socialist world is included this increase vanishes.

Box IIB-3 shows changes since 1960 in the unweighted averages of the Gini coefficients of countries within seven regions. In general these changes have been small. Sub-Saharan Africa improved during the 60's and 70's but lost ground during the 80's and 90's. Inequality in Eastern Europe has increased noticeably since the fall of the Soviet Union.

A careful analysis of 49 countries (Li, 1996) found that the distribution of income in 29 of these (59%) showed no statistically significant time trend. Of the 20 countries that did show a

[51] The Gini coefficient is a full-population measure of the inequality of an income distribution. It is usually shown as a number between 0.0, representing perfect equality, and 1.0, representing perfect inequality. Some authors show the Gini coefficient multiplied by 100 to make comparisons easier, in which case 0 still represents perfect equality but perfect inequality is represented by 100. Since there is effectively no overlap between the two scales there is little cause for confusion. The 80/20 ratio refers to the ratio of the total income received by those in the top and the bottom income quintiles of a population; that is, of the incomes of all those above 80% of the population and those equal to or below 20% of the population. Appendix 4 describes these and related statistical measures used in these notes in more detail.

BOX IIB-1. Income Inequality, Selected Countries

[source: Deininger and Squire, 1996a]

rank	Country	Gini	80/20	rank	Country	Gini	80/20
1	Slovak Rep.	21.50	2.87	56	Sudan	38.72	5.58
2	Czechoslovakia	24.51	3.25	57	Algeria	38.73	6.85
3	Ukraine	25.71	3.71	58	Morocco	39.20	7.05
4	Spain	25.91	4.21	59	Armenia	39.39	23.9
5	Finland	26.11	4.34	60	New Zealand	40.21	9.77
6	Belgium	26.92	4.31	61	Guyana	40.22	7.48
7	Latvia	26.98	3.83	62	Tunisia	40.24	7.91
8	Luxembourg	27.13	4.11	63	Jordan	40.66	7.37
9	Canada	27.65	4.54	64	Uganda	40.78	7.10
10	Hungary	27.94	3.92	65	Singapore	41.00	7.15
11	Slovenia	28.20	3.97	66	Australia	41.72	10.09
12	Czech Rep	28.26	3.94	67	Trinidad	41.72	13.08
13	Banglades	28.27	4.05	68	Bolivia	42.04	8.58
14	Belarus	28.53	4.30	69	Fiji	42.50	
15	Romania	28.66	4.29	70	Mauritania	42.53	13.12
16	Rwanda	28.90	4.01	71	Iran	42.90	
17	Netherlands	29.38	5.25	72	Ecuador	43.00	9.82
18	Nepal	30.06	4.34	73	Madagascar	43.44	8.52
19	Laos	30.40	4.21	74	Zambia	43.51	8.92
20	Soviet Union	30.53	5.08	75	Turkey	44.09	9.53
21	Taiwan	30.78	5.42	76	Peru	44.87	10.32
22	Pakistan	31.15	4.73	77	Hong Kong	45.00	10.10
23	Indonesia	31.69	4.69	78	Bahamas	45.29	13.22
24	Yugoslavia	31.88	5.32	79	Philippines	45.73	10.10
25	Egypt	32.00	4.72	80	Costa Rica	46.07	12.68
26	India	32.02	4.67	81	Sri Lanka	46.70	10.35
27	Italy	32.19	4.45	82	Seychelles	47.00	
28	Germany	32.20	5.90	83	Malaysia	48.35	11.73
29	UK	32.40	5.35	84	El Salvador	48.40	10.64
30	Sweden	32.44	5.84	85	Barbados	48.86	22.67
31	Kazakhstan	32.67	5.39	86	Cameroon	49.00	
32	Poland	33.06	6.29	87	Mexico	50.31	13.40
33	Denmark	33.20	6.90	88	Nicaragua	50.32	13.12
34	Norway	33.31	7.69	89	Dom. Rep.	50.46	13.26
35	Korea, R.	33.64	5.72	90	Puerto Rico	50.86	18.34
36	Lithuania	33.64	5.20	91	Colombia	51.32	15.10
37	Ghana	33.91	5.34	92	Thailand	51.50	15.81
38	Bulgaria	34.42	5.87	93	Honduras	52.63	14.67
39	Moldova	34.43	6.06	94	Venezuela	53.84	16.18
40	Ireland	34.60	9.05	95	Senegal	54.12	16.75
41	Japan	34.80	7.09	96	Botswana	54.21	16.36
42	France	34.91	6.38	97	Kenya	54.39	18.24
43	Greece	35.19	6.65	98	Cent. Afr. Rep.	55.00	
44	Kyrgyz Rep.	35.32	6.31	99	Lesotho	56.02	20.90
45	Portugal	35.63	6.58	100	Guinea Bissau	56.12	28.57
46	Vietnam	35.71	5.51	101	Panama	56.47	29.90
47	Niger	36.10	5.90	102	Chile	56.49	17.32
48	Estonia	36.63	6.33	103	Zimbabwe	56.83	15.66
49	Mauritius	36.69	6.48	104	Guatemala	59.06	30.00
50	Cote d'Ivoire	36.89	6.50	105	Brazil	59.60	26.28
51	Nigeria	37.47	12.36	106	Sierra Leone	60.79	22.45
52	China	37.80	6.92	107	South Africa	62.30	32.11
53	Jamaica	37.92	6.63	108	Gabon	63.18	22.86
54	USA	37.94	9.80				
55	Tanzania	38.10	6.63				

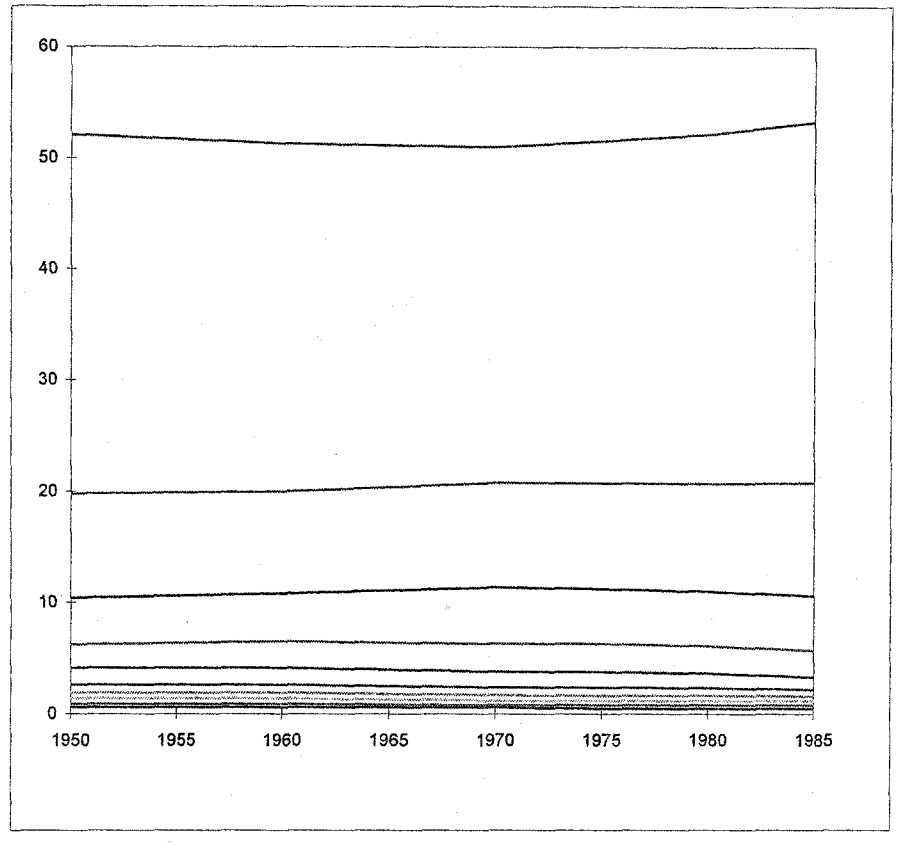
note: Values shown are most recent accepted as high-quality by Deininger and Squire; most are post-1990.

BOX IIB-2. WORLD INCOME DISTRIBUTION

Table 1 World Income Distribution, Excluding Socialist Countries, by Decile
(source: Berry et al., 1991)

	1950	1955	1960	1965	1970	1975	1980	1985
1	0.6	0.6	0.6	0.6	0.6	0.5	0.5	0.5
2	0.9	0.9	0.9	0.85	0.8	0.8	0.8	0.8
3	1.4	1.4	1.4	1.3	1.2	1.2	1.2	1.2
4	1.9	1.9	1.9	1.8	1.7	1.66	1.67	1.6
5	2.6	2.6	2.6	2.5	2.4	2.36	2.33	2.2
6	4.1	4.1	4.1	3.95	3.8	3.76	3.63	3.3
7	6.2	6.35	6.5	6.4	6.3	6.3	6.1	5.7
8	10.4	10.6	10.8	11.1	11.4	11.24	11	10.6
9	19.8	19.9	20	20.4	20.8	20.78	20.73	20.8
10	52.1	51.7	51.3	51.15	51	51.56	52.17	53.3

Figure 1 World Income Distribution, Excluding Socialist Countries, by Decile
(source: Table 1)



note: Berry et al. show decile values for 1950, 1960, 1970, 1972, 1977 and 1986. The additional values shown in Table 1 are linear interpolations of these.

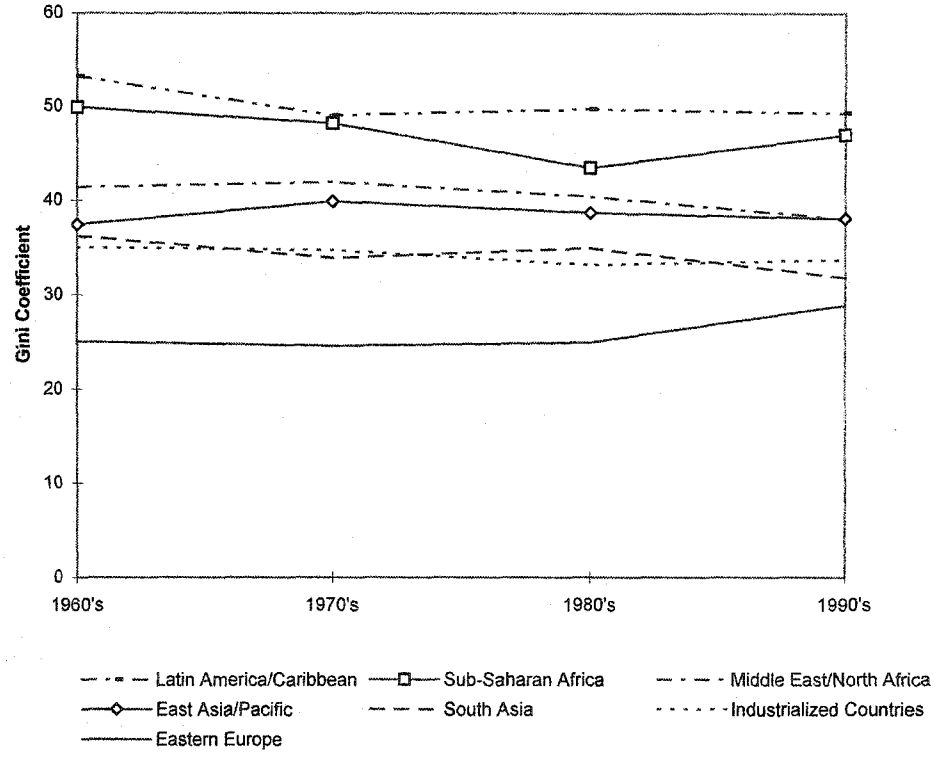
BOX IIB-3. CHANGES IN DECADAL INEQUALITY AVERAGES
[source: Deininger and Squire,1996a]

Table 1 Changes in Decadal Averages of Inequality Indexes (Gini Coefficient), by Region

	1960's	1970's	1980's	1990's
Latin America/Caribbean	53.24	49.06	49.75	49.31
Sub-Saharan Africa	49.9	48.19	43.46	46.95
Middle East/North Africa	41.39	41.93	40.45	38.03
East Asia/Pacific	37.43	39.88	38.7	38.09
South Asia	36.23	33.95	35.01	31.88
Industrialized Countries	35.03	34.76	33.23	33.75
Eastern Europe	25.09	24.63	25.01	28.94

note: figures reported are unweighted averages of Gini coefficients for countries in each region.

Figure 1 Graphic Display of Changes in Decadal Inequality Averages
(source: Table 1)



significant trend, in 16 the changes were very small (less than 1% of the average Gini coefficient per year). In 11 of the 20 countries the trend was towards greater inequality and in 9 towards greater equality. Of the 4 countries in which inequality changed at a higher rate, China became less equal (its Gini increased at 2.9%/yr), while France, Italy and New Zealand became more equal.

On a global average basis the percentage of the world's people living in poverty is declining, but regionally the record is mixed. **IIB-4** shows decreasing poverty in East Asia, South Asia, the Middle East and North Africa, but increasing poverty in Latin America, Sub-Saharan Africa, and Eastern Europe/Central Asia. Whether these rates of change are small or large is a matter of judgment, except perhaps in the case of Eastern Europe/Central Asia, where the growth of poverty has been dramatic.

2. Increasing inequality in the industrial market economies

Box IIB-5 compares changes in the distribution of income and male earnings in 19 major industrial countries. Changes in male earnings are used to track changes in compensation to labor before the direct impacts of taxes and transfers, property income, and demographic and household adjustments are felt. In general, inequality of male earnings has been increasing at a greater rate than has inequality of income.

Box IIB-6 and **IIB-7** show changes in the Gini coefficients for income in 12 major industrial countries. Perhaps half of these show an increase in inequality since the early 70's. The rest show mixed records.

Box IIB-8 shows the relative contribution to overall inequality caused by changes in the upper and lower quintiles. The rich became richer and the poor became poorer in the United States, United Kingdom and Australia. In Germany, Taiwan and the Netherlands the rich held their own while the poor became poorer. In Sweden the rich became richer while the poor held their own.

BOX IIB-4. Changes in Poverty Rates in Developing Countries
[source: Ravallion and Chen, 1996]

Region	Percentage of population consuming less than $1/day (1985 PPP) 1987	1990	1993
East Asia	29.7	28.5	26.0
Eastern Europe & Central Asia	0.6	n.a.	3.5
Latin America	22.0	23.0	23.5
Middle East & No. Africa	4.7	4.3	4.1
South Asia	45.4	43.0	43.1
Sub-Saharan Africa	38.5	39.3	39.1
Total	30.7	n.a.	29.4
Total excluding Eastern Europe & Central Asia	33.9	32.9	31.9

BOX IIB-5. CHANGES IN MARKET INCOME AND MALE EARNINGS INEQUALITY

Table 1: CHANGES IN MARKET INCOME INEQUALITY, ~1980-92
(source: Smeeding & Gottschalk, 1996)

small decrease	no change	small increase	medium increase	large increase
-5% or <	-4 to + 4%	5 to 10%	10 to 15%	16 to 29%
Italy	France Portugal Taiwan	New Zealand Japan Netherlands Norway Belgium Canada Israel Ireland West Germany	Australia Denmark	Sweden USA UK

Table 2: CHANGES IN MALE EARNINGS INEQUALITY, ~1980-90
(source: Gottschalk & Smeeding, 1996)

decrease	no change	increase	large increase	very large increase
-10% or <	-10 to + 10% US	10 to 50% US	50 to 80% US	at least 80% US
	Germany Italy	Sweden Japan Netherlands Finland	Israel France Canada Australia	USA UK

Note: Table 2 shows the change in male earnings inequality as a percentage of the change that occurred in the United States.

BOX IIB-6. GINI COEFFICIENTS FOR INCOME, LARGE INDUSTRIAL COUNTRIES, 1946-1996

[source: Deininger and Squire,1996a]

year	USA	UK	Sweden	Italy	Taiwan	Canada	Japan	Australia	France	Germany	Spain	Netherlands
1946												
1947	34.3											
1948	35.2											
1949	35.3											
1950	36.0											
1951	34.7					32.6						
1952	35.1											
1953	34.5											
1954	35.7											
1955	34.8											
1956	34.2								49.0			
1957	33.6					32.0						
1958	33.9											
1959	34.5											
1960	34.9											
1961	35.6	25.3				30.8						
1962	34.8	24.2					37.2		49.0			
1963	34.7	26.5					35.7			28.1		
1964	34.7	25.5			32.2		35.8					
1965	34.6	24.3			32.3	31.6	34.8		47.0		32.0	
1966	34.7	25.3			32.4	31.5	35.0					
1967	34.4	24.5	33.4		30.7	31.4	35.1					
1968	33.5	24.1			28.9	31.9	34.9					
1969	33.6	24.9			29.2	32.3	35.7	32.0		33.6		
1970	34.1	25.1			29.4	32.3	35.5		44.0			
1971	34.3	25.7			29.2	32.2	36.9					
1972	34.5	26.0			29.0	31.9	33.4					
1973	34.4	25.1				31.6	32.5			30.6	37.1	
1974	34.2	24.2		41.0	28.1	31.0	33.6					
1975	34.4	23.3	27.3	39.0		31.6	34.4		43.0			28.6
1976	34.4	23.2	33.1	35.0	28.4	31.8	33.9	34.3				28.5
1977	35.0	22.9		36.3	28.0	32.0	33.7	36.2				28.4
1978	35.0	23.1		36.0	28.4	31.5	32.9	38.1		32.1		28.3
1979	35.1	24.4		37.2	27.7	31.0	33.9	39.3	34.9	31.6		28.1
1980	35.2	24.9	32.4	34.3	28.0	31.4	33.4	39.6		31.1	26.8	27.4
1981	35.6	25.4	32.5	33.1	28.2	31.8	34.3	40.0		30.6		26.7
1982	36.5	25.2	30.7	32.0	28.5		34.8			31.0		27.6
1983	36.7	25.7	30.1	32.9	28.5	32.8	35.2			31.4		27.6
1984	36.9	25.8	31.8	33.2	28.8	33.0	35.5		34.9	32.2		28.3
1985	37.3	27.1	31.2	33.4	29.2	32.8	35.9	37.6			25.2	29.1
1986	37.6	27.8	31.7	33.6	29.3	32.5		40.6			26.0	29.7
1987	37.6	29.3	31.7	35.6	29.7	32.3		39.5			25.8	29.4
1988	37.8	30.8	32.2	34.2	30.0	31.9		38.4			24.4	29.0
1989	38.2	31.2	31.3	32.7	30.4	27.4	37.6	37.3			25.9	29.6
1990	37.8	32.3	32.5	32.5	30.1	27.6	35.0	41.7				29.5
1991	37.9	32.4	32.5	32.2	30.5	27.7						29.4
1992			32.4		30.8							
1993					30.8							
1994												
1995												
1996												

BOX IIB-7. Changes in Income Inequality, 1947-1994

Figure 1. Changes in Income Inequality, United States and Sweden, 1947-1994
(source: Box IIB-6)

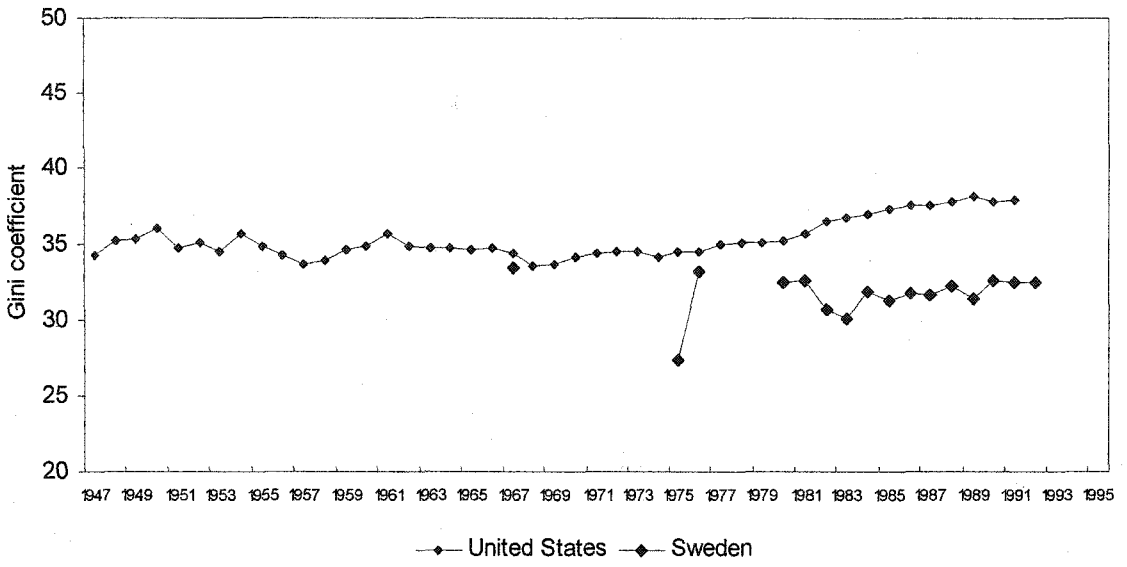
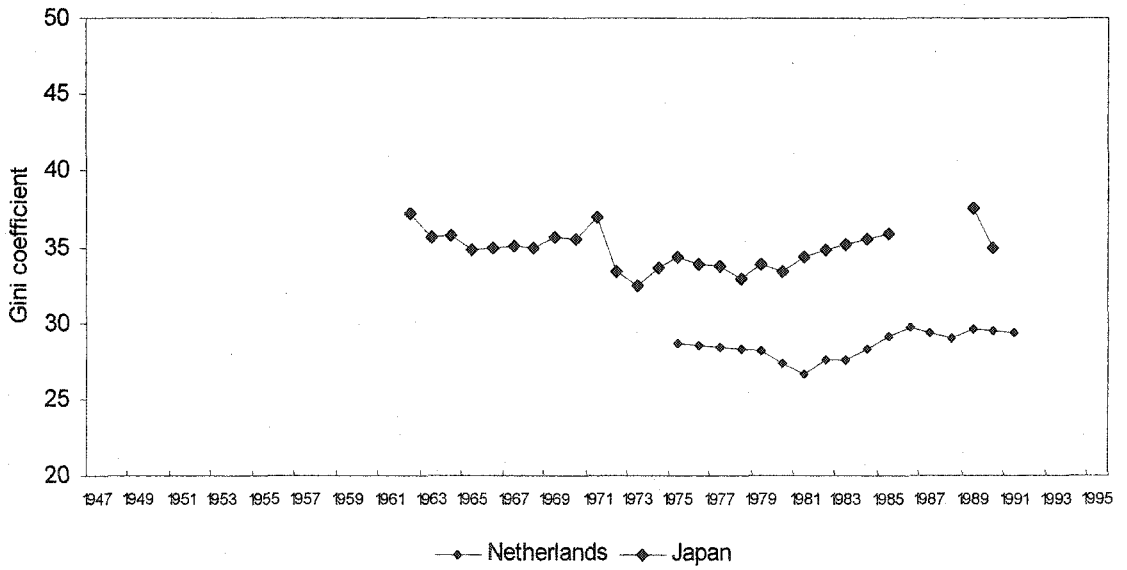


Figure 2. Changes in Income Inequality, Netherlands and Japan, 1947-1994
(source: Box IIB-6)



Box IIB-7. Changes in Income Inequality, 1947-1994 (cont.)

Figure 3. Changes in Income Inequality, Italy and Spain, 1947-1994
(source: Box IIB-6)

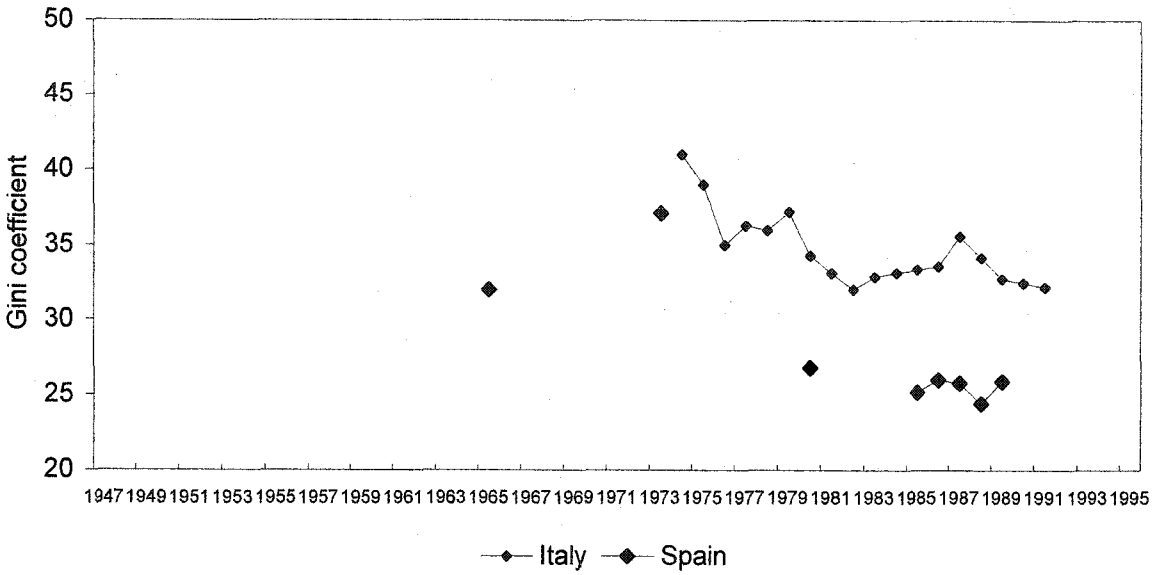
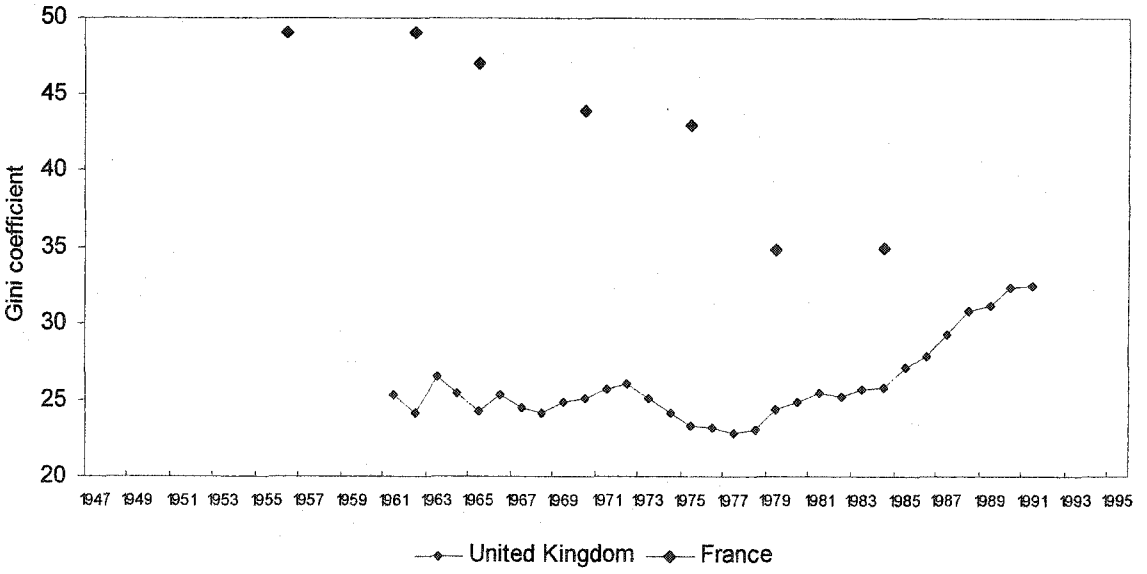


Figure 4. Changes in Income Inequality, United Kingdom and France, 1947-1994
(source: Box IIB-6)



Box IIB-7. Changes in Income Inequality, 1947-1994 (cont.)

Figure 5. Changes in Income Inequality, Taiwan and Canada, 1947-1994
(source: Box IIB-6)

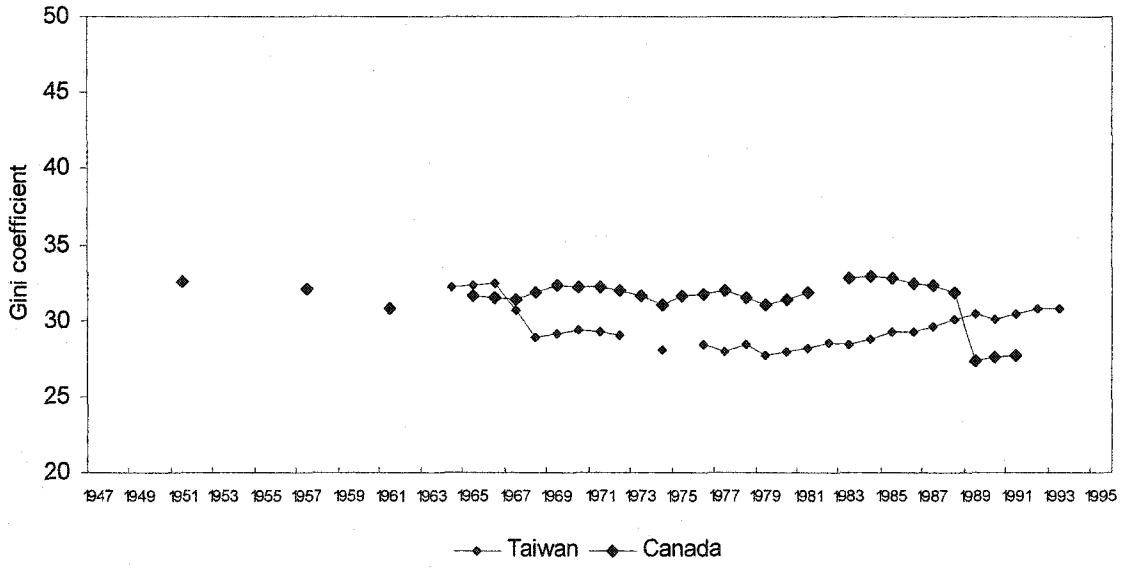
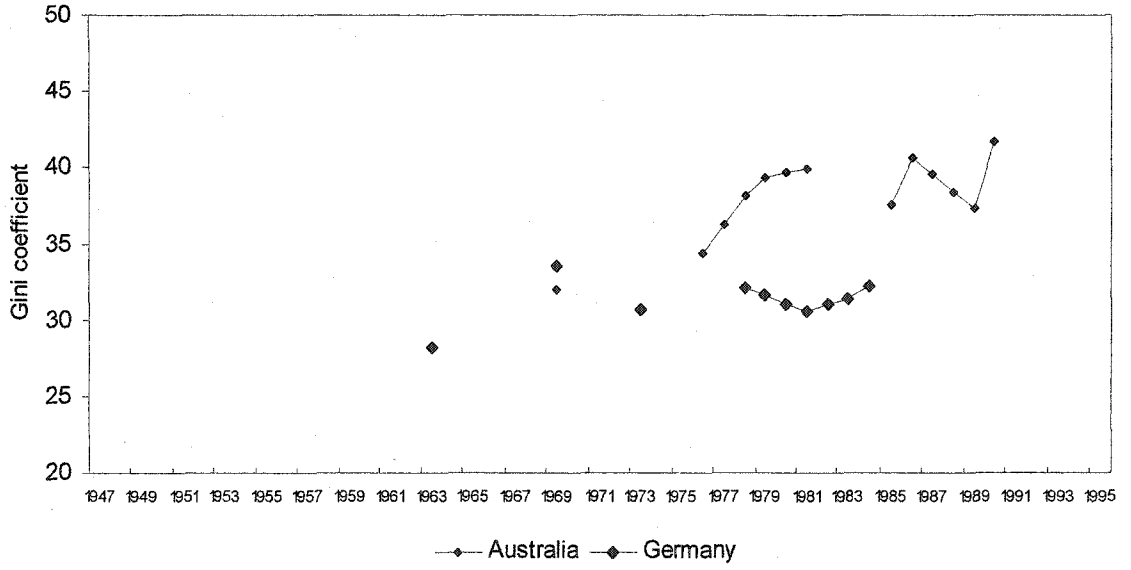


Figure 6. Changes in Income Inequality, Australia and Germany, 1947-1994
(source: Box IIB-6)



BOX IIB-8. CHANGES IN INCOME SHARES RECEIVED BY LOWEST AND HIGHEST 20% OF HOUSEHOLDS

[source: Deininger and Squire, 1996a]

Table 1. SHARES OF INCOME RECEIVED BY THE LOWEST 20% OF HOUSEHOLDS

	USA	UK	Sweden	Italy	Taiwan	Canada	Japan	Australia	France	Germany	Spain	Netherlands	>	<	o
1965	5.2	9.9	4.2		7.8	7.1	6.6				7.2				
1970	5.5	10			8.6	6.6	4.6	7		7.2					
1975	5.5	10.4	7.4	7	9	6.8	6	5.8		7	6.2	8.4			
1980	5.2	10.2	7	7.9	8.8	6.5	6.3	4.6	6.7	6.8	8.2	9			
1985	4.7	8.9	7	8.1	8.3	6.3		5.1	6.6	6.6	9.7	7.6			
1990	4.6	7.8	7.4	8.4	7.8	7.5		4.6			8.4	6.9			
trend, 65	>	>	>	-	>	<	<	-	-	-	>	-	5	2	0
trend, 75	<	<	o	>	<	>	-	<	-	<	>	<	3	6	1

Table 2. SHARES OF INCOME RECEIVED BY THE TOP 20% OF HOUSEHOLDS

	USA	UK	Sweden	Italy	Taiwan	Canada	Japan	Australia	France	Germany	Spain	Netherlands	>	<	o
1965	41.8	35.0	37.5		41.4	38.6	41.9				36.3				
1970	40.9	36.8			38.6	38.5	46.4	39.1		41.1					
1975	41.0	37.3	34.1	41.9	37.7	41.0	43.3	39.5		38.0	39.5	37.2			
1980	41.5	37.7	39.5	39.1	37.0	37.9	39.6	44.2	41.8	37.4	35.0	35.7			
1985	43.5	37.9	38.2	38.1	38.2	39.1		42.2	42.0	38.9	34.4	36.7			
1990	44.2	41.0	38.2	37.4	38.6	33.9		46.4			35.3	36.4			
trend, 65	o	>	<	-	<	>	<	-	-	-	>	-	3	3	1
trend, 75	>	>	>	<	o	<	-	>	-	o	o	o	4	2	4

Figure 1. Changes in the Share of Income Received by Lowest and Highest 20% of Households, 1975-1990

BOTTOM 20%	TOP 20% <	TOP 20% 0	TOP 20% >
>	CANADA ITALY	SPAIN	
0			SWEDEN
<		TAIWAN GERMANY NETHERLANDS	USA UK AUSTRALIA

> = increased share < = decreased share
0 = change in share of 1 Gini point or less

3. Increasing Inequality in the United States

The United States is the world's leading economy and shows the greatest increase in the inequality of earnings among the industrial nations. Between the mid-1970's and the late 1990's,

a) Median family real income changed little;
b) Incomes of families in the higher income brackets increased, and incomes of families in the lower brackets decreased;
c) Incomes of families in the very highest brackets increased dramatically;
d) The percent of Americans living below the poverty level increased.

Box IIB-9 shows the distribution of income in the United States in the early 1990's by income range. **IIB-10** shows the distribution of income by quintiles; the graph displays the corresponding Lorenz curve. **IIB-11** and **IIB-12** show the distribution of wealth by income range and wealth quintile. Wealth is far more unequally distributed than income.

Figure 1 in **IIB-13** shows the general stagnation of median family income that began around 1973. Median family income in the late 1990's was about $31,000.

Figure 2 and Figure 3 show the growth in inequality of family incomes. Figure 2 uses the Gini coefficient and Figure 3 uses the 80-20 ratio. Both show that economic inequality in the US began to increase in the late 1970's, and has continued to grow since then.

Figure 4 shows that the percentage of families whose incomes are less than the poverty level increased from a low of about 11% in the early 1970's to about 15% in the early 1990's. This represents some 40 million Americans. The increase in poverty during 1980-83 was the result of the recession of that time. The poverty level for a family of four in 1994 was $14,763.

Figure 5 and Figure 6 use quintile displays to show that the increase in the inequality of family income has occurred because the upper middle classes and the rich have gotten richer and the lower middle classes and poor people have gotten poorer. Note the especially wide gap that separates the top 1% from even the rest of the top 5%.

Box IIB-14 gives some indication of how "upper" the upper income brackets really are. Table 1 in IIB-14 shows the 25 highest paid chief executive officers of American corporations in

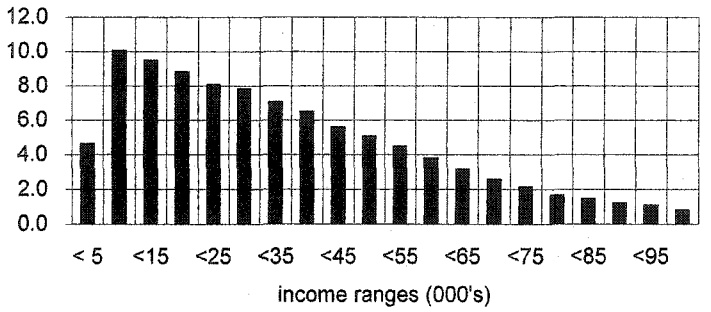
BOX IIB-9. TOTAL MONEY INCOME OF HOUSEHOLDS, 1992

[source: U.S. Department of Commerce, Current Population Report, 1992, P60-184]

Table 1. Total Money Income of Households, 1992

Income Range	Number of Households (000's)	Percent
less than $5000	4,437	4.6
$5,000 t o $9,999	9,675	10.0
$10,000 to $14,999	9,120	9.5
$15,000 to $19,999	8,473	8.8
$20,000 to $24,999	7,763	8.1
$25,000 to $29,999	7,527	7.8
$30,000 to $34,999	6,778	7.0
$35,000 to $39,999	6,243	6.5
$40,000 to $44,999	5,384	5.6
$45,000 to $49,999	4,853	5.0
$50,000 to $54,999	4,306	4.5
$55,000 to $59,999	3,636	3.8
$60,000 to $64,999	3,036	3.1
$65,000 to $69,999	2,464	2.6
$70,000 to $74,999	2,048	2.1
$75,000 to $79,999	1,583	1.6
$80,000 to $84,999	1,376	1.4
$85,000 to $89,999	1,151	1.2
$90,000 to $94,999	1,034	1.1
$95,000 to $99,999	761	0.8
$100,000 and greater	4,743	4.9
Total households:	96,391	100

Figure 1. Total Money Income of Households, 1992



The first polygon along the x axis represents those households with incomes of less than $5,000. The second polygon represents those households with incomes from $5,000 to $9,999; and so on. The vertical axis shows the percent of total households in that income range. The 4.9% of households with incomes greater than $100,000 are not shown.

BOX IIB-10. AGGREGATE HOUSEHOLD INCOME, BY QUINTILES

[source: U.S. Dept. of Commerce, Current Population Reports. P60-184]

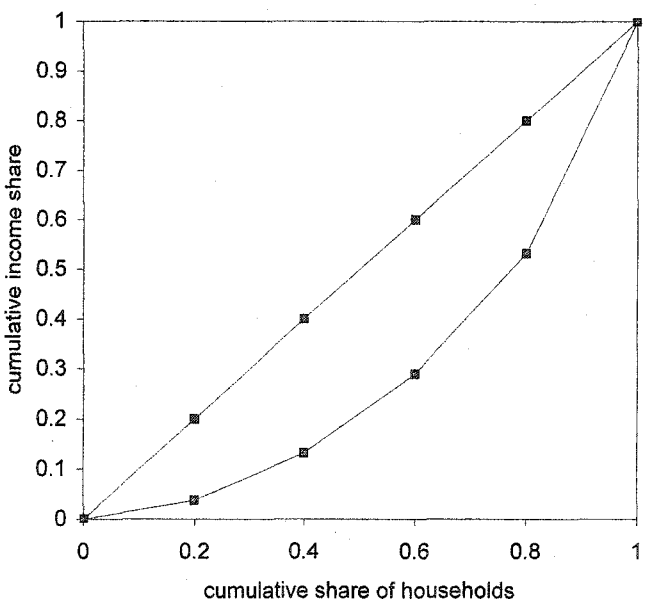
Table1. Share of Aggregate Income by Quintiles and Top 5 Percent of Households, 1992

quintile	number of households	lower limit of household income	mean income	% distribution of aggregate income	cumulative percentage of aggregate income
lowest 20%	19,278	0	7,328	3.8	0.038
2nd 20%	19,278	12,664	18,281	9.4	0.132
3rd 20%	19,278	24,300	30,794	15.8	0.290
4th 20%	19,278	38,000	47,235	24.2	0.532
highest 20%	19,278	58,200	91,494	46.8	1.000
top 5%	4,820		145,244	18.6	

total households: 96,391
total income, all households: 3.76 trillion
mean income,all households: 39,020

Gini coefficient: 0.396

Figure 1. Aggregate Household Income by Quintiles, 1992



BOX IIB-11. Distribution of Wealth by Income Ranges, 1992

[source: Statistical Abstract of the United States, 1995]

Income range	number of families (millions)	percent of families	mean wealth ($ thousand)	median wealth ($ thousand)	total wealth ($ billion)	percent of total wealth
less than $10,000	11.99	17.6	44.3	3.9	531.3	3.6
$10 - $24,999	19.08	28.0	73.0	23.4	1392.8	9.3
$25 - $49,999	18.94	27.8	144.3	58.3	2727.3	18.2
$50 - $99,999	13.15	19.3	283.8	139.6	3732.0	24.9
more than $100,000	4.97	7.3	1324.2	569.0	6581.3	44.0
totals:	68.13	100.0	220.0	52.2	14964.7	100.0

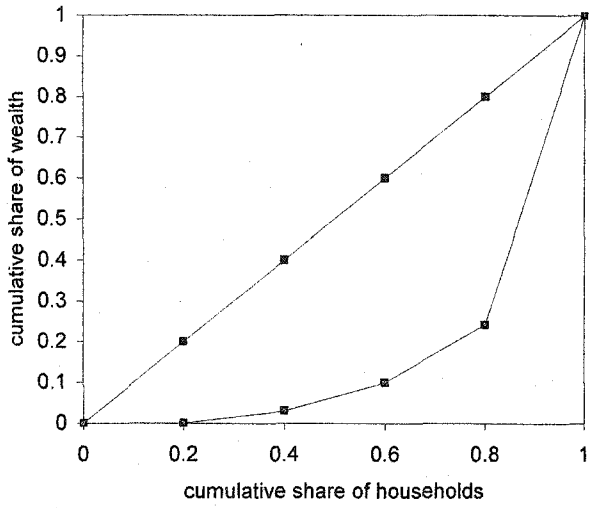
BOX IIB-12. Distribution of Wealth among Families by Quintile, 1983.
[source: Wolff, 1987]

Table1. Distribution of Wealth among Families by Quintile, 1983.

Wealth Percentile	fraction of wealth held	cumulative fraction
0	0	0
0.2	0.001	0.001
0.4	0.030	0.031
0.6	0.069	0.100
0.8	0.142	0.242
1.0	1.000	1.000

top 5% : 49.1 % of wealth
top 1%: 28.3% of wealth
Gini coefficient: .720

Figure 1. Distribution of Wealth by Families, 1983



BOX IIB-13. Income and Inequality Trends

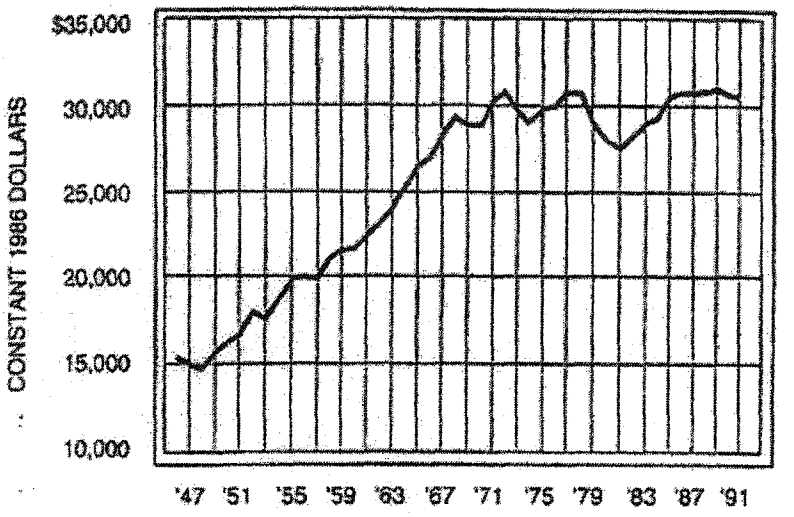


Figure 1. Median family income, 1946-92 [Reprinted from Krugman, 1994]

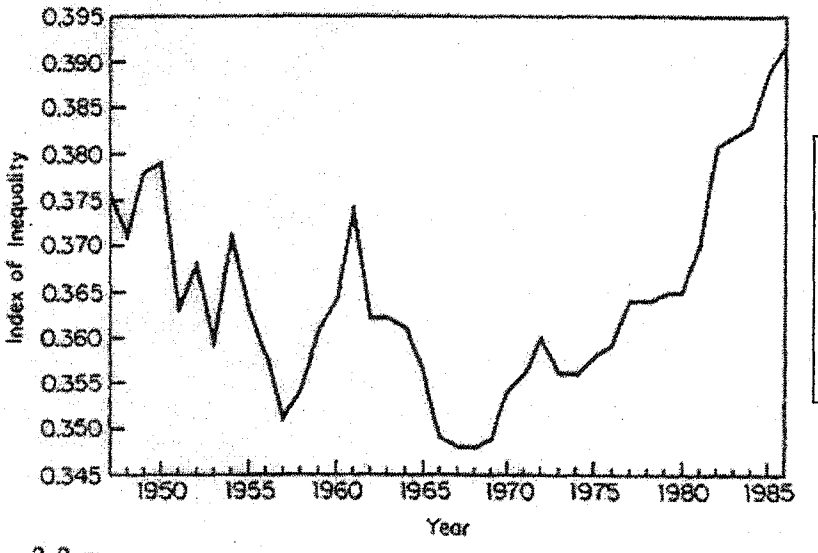


Figure 2. Family Income Inequality, 1947-86 (Gini Index). [Reprinted from Harrison & Bluestone, 1988]

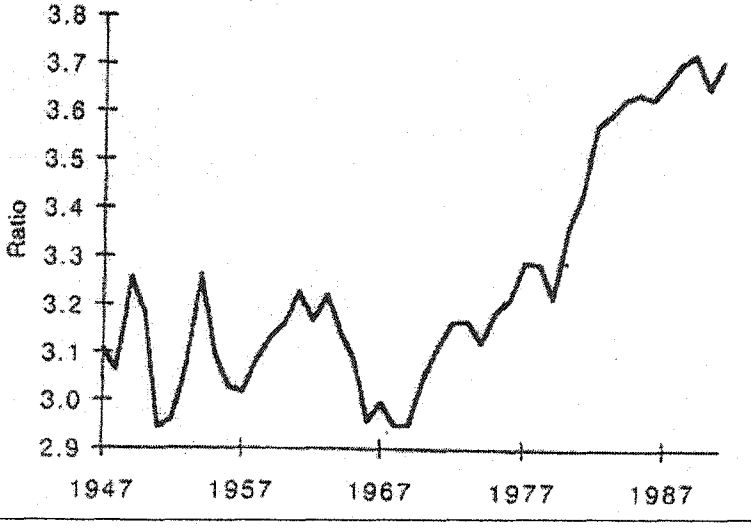


Figure 3. Ratio of family income at 80th percentile to 20th percentile, 1947-91. [Reprinted from Danziger and Gottschalk, 1995]

[more...]

BOX IIB-13. Income and Inequality Trends (cont'd.)

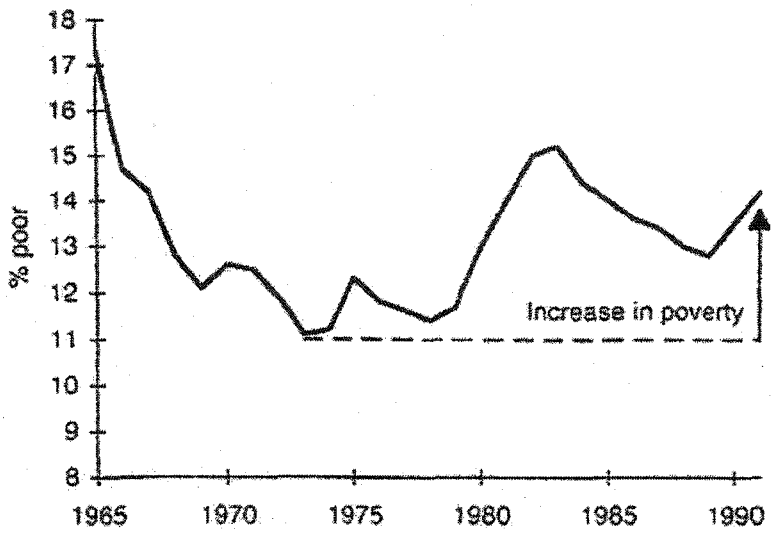


Figure 4. Poverty Rate, 1965-91 [Reprinted from Danzinger and Gottschalk, 1995]

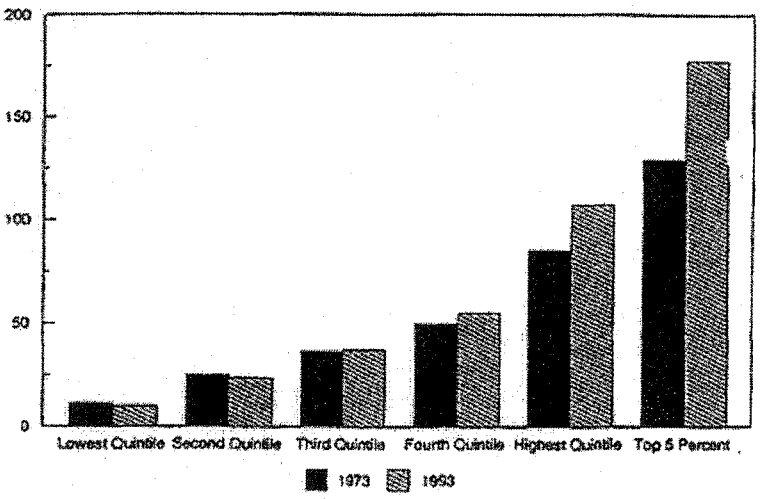


Fig. 5. Average family income by quintile ($ 000's) [Reprinted from *Economic Report of the President, 1995*]

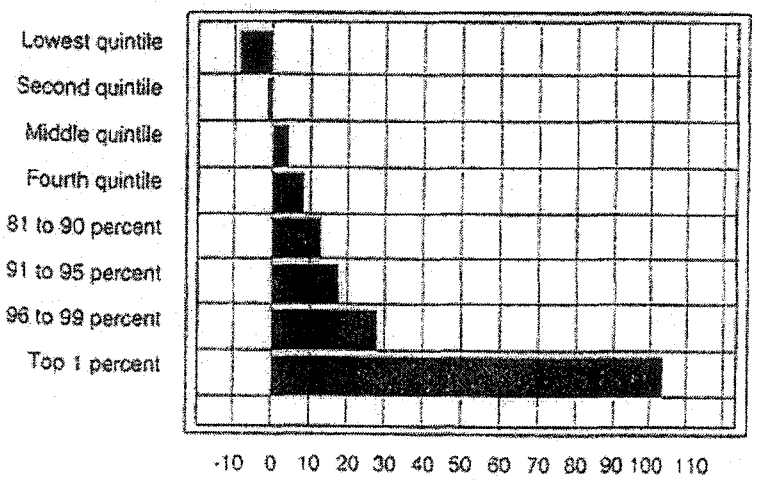


Fig. 6. Change in real income (%). [Reprinted from Krugman, 1994]

BOX IIB-14. Compensation of CEO's

[source: Forbes, May 22, 1995]

Table 1. The 25 best-paid chief executives, 1990-1994

Chief Executive	Company	Annual Compensation ($million; 5-year average)
Michael D. Eisner	Walt Disney	47.04
Sanford J. Weil	Travelers	30.43
Anthony J. F. O'Reilly	HJ Heinz	24.00
Stephen C. Hilbert	Conseco	17.81
Bernard L. Schwartz	Loral	13.15
Howard Solomon	Forest Labs	12.51
Lawrence M. Coss	Green Tree Financial	11.08
Roberto C. Goizueta	Coca-Cola	10.59
Walter J. Sanders III	Advanced Micro	10.14
Stephen A. Wynn	Mirage	9.01
James R. Mellor	General Dynamics	8.38
Ralph J. Roberts	Comcast	8.33
Patrick H. Thomas	First Financial Mgmt	8.26
Reuben Mark	Colgate-Palmolive	8.11
Richard A. Manoogian	Masco	7.60
Ronald K. Richey	Torchmark	7.44
James L. Donald	DSC Communications	7.41
John F. Welch Jr.	General Electric	7.29
Joseph R. Hyde III	AutoZone	7.23
Steven C. Walske	Parametric Tech	7.15
Kenneth L. Lay	Enron	7.12
Ran V. Araskog	ITT	6.83
David J. Fuente	Office Depot	6.74
Daniel P Tully	Merrill Lynch	6.57
Charles S. Sanford Jr.	Bankers Trust	6.49

Median compensation for 800 top CEO's: 1.3

Table 2. "Payday for America's 800 top chief executives"

Industry	Number of firms	Median CEO Compensation ($millions; 5-year average)
Consumer nondurables	23	2.49
Aerospace & defense	16	1.83
Entertainment & information	30	1.44
Business services & supplies	26	1.40
Food, Drink & Tobacco	33	1.75
Computers & communications	77	1.16
Energy	41	1.36
Capital goods	26	2.85
Metals	20	0.62
Chemicals	24	1.50
Insurance	53	2.17
Retailing	49	1.11
Consumer durables	32	1.17
Forest products & packaging	19	1.76
Health	51	1.27
Food distributors	23	1.18
Construction	11	1.38
Financial services	162	1.40
Travel	13	1.37
Transport	17	0.94
Electric utilities	56	0.96

1994. Table 2 suggests that the median income of the 800 top CEO's exceeds $1,000,000 per year. Compare this with the fact that 50% of all American families have incomes of less than $32,000 year. In 1993 the average incomes of the upper 20% and 5% of American families were about $115,000 and $175,000 respectively.

Box IIB-15 shows changes in the income shares of quintiles since 1947. When depicted in this manner the growth of inequality may not appear to be as dramatic as it does in previous figures. The share of the top quintile has clearly increased since the 1970's, and the shares of the bottom two quintiles have decreased, but observers may differ as to whether these changes should be considered large or small.

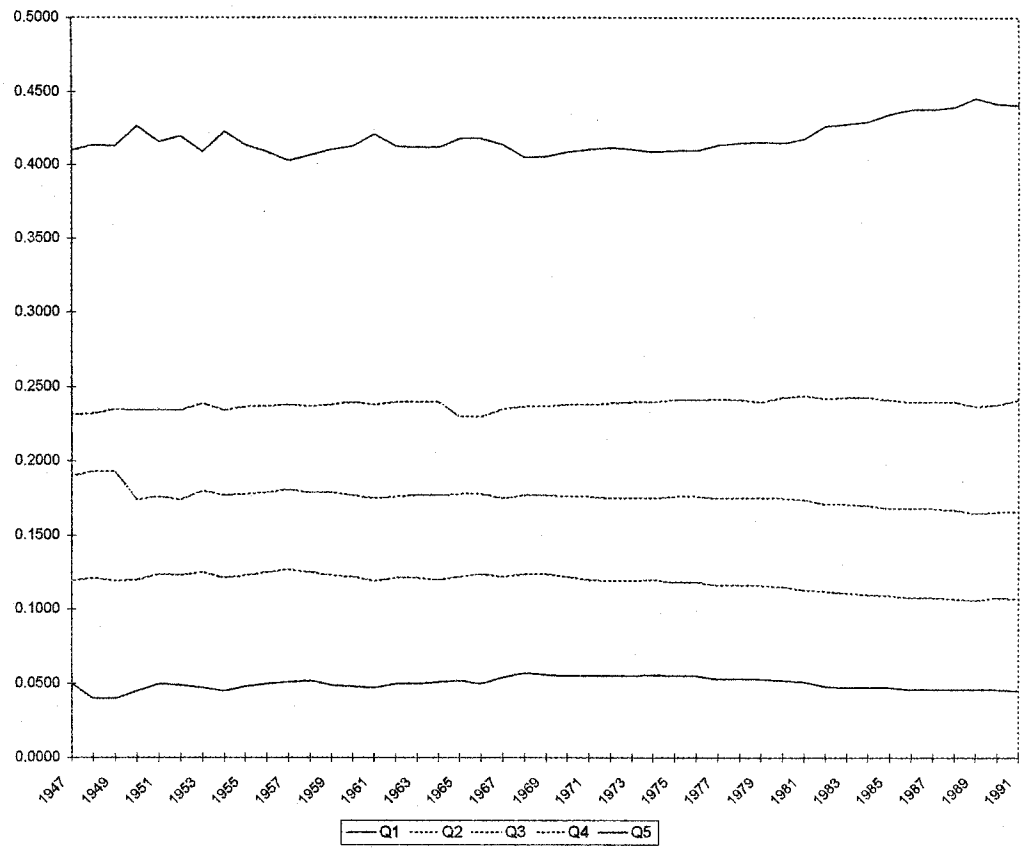
Box IIB-16 shows the notable decline in the share of income received by the top 5% of families since the early years of this century. Some observers might conclude that the recent increase in inequality is by comparison small potatoes, and thus perhaps not deserving of great concern. The decrease in inequality prior to 1950 was likely in large part the result of a singular structural change from a rural agricultural economy to an urban industrial one. The recent increase in inequality is a departure from the experience of the post-WWII decades, and was not anticipated by analysts. Until we determine the causes of the current growth in inequality we can't say whether, and by how much, it is likely to grow, and what sort of challenges it might present.

To gain perspective on income distribution trend data it is important to appreciate the relation between life-time incomes and current incomes. A society with perfect equality of life-time incomes would still show considerable dispersion of annual incomes, simply because earnings differ with age. One economy might show a higher degree of annual income inequality than another but could have the same life-time distribution if mobility rates are greater. Some authors have claimed that the apparent increase in wage dispersion in the industrial countries has been balanced by an increase in mobility (Hinderaker and Johnson 1996). Danziger and

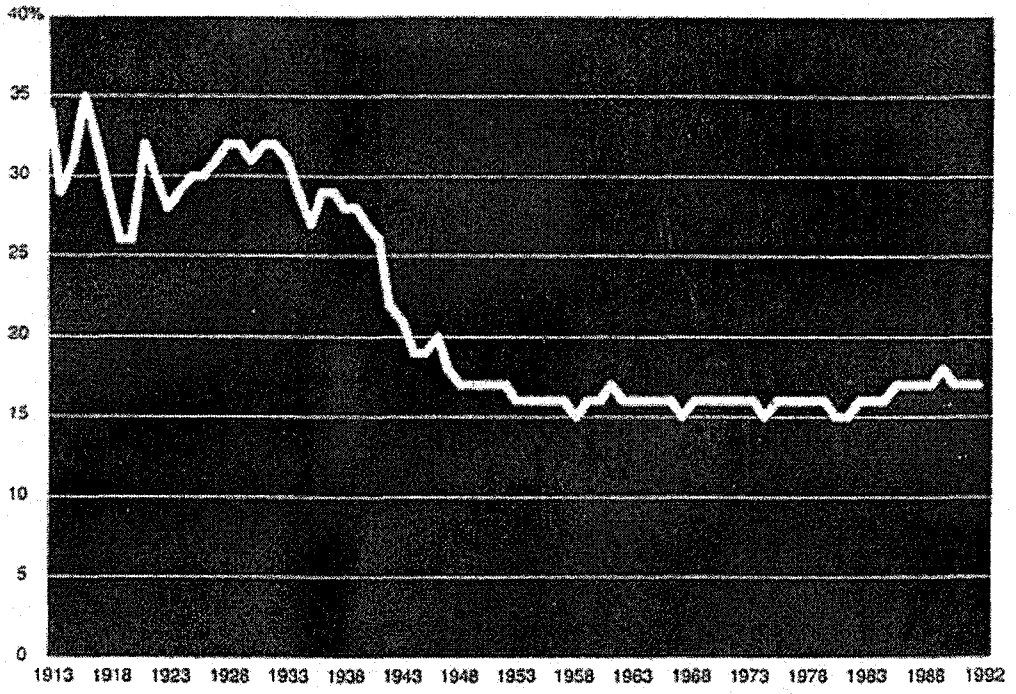
BOX IIB-15. CHANGE IN INCOME SHARES, USA, BY QUINTILE, 1947-1991

[source: Deininger and Squire, 1996a]

[vertical axis = share of total income]



BOX IIB.16. Share of Total Family Income Received by the Top 5%, 1913-1992
[Reprinted from Hinderaker and Johnson, 1996]



Gottschalk (1995) studied this issue with respect to the United States and concluded that there is little evidence of an increase in mobility between income sectors over the period in question.

Box IIB-17 shows how the distribution of income in the United States would change if the average growth rates of income and inequality of the 15-year period 1977-1992 continued unabated over the next century. Per capita income grows annually at 1%. The mean income of the highest quintile grows annually at 1.1%, while that of the bottom quintile declines by .58%. At these rates the US Gini grows from 37.6 in 1992 to 48.7 in 2075, which is approximately equal to the Ginis of the Philippines, Malaysia or Mexico today. The US 80/20 ratio would grow from 10.2 to 25, which is roughly that of Brazil today.[52]

[52] Absolute incomes for all quintiles would of course be higher than they are today in these developing countries.

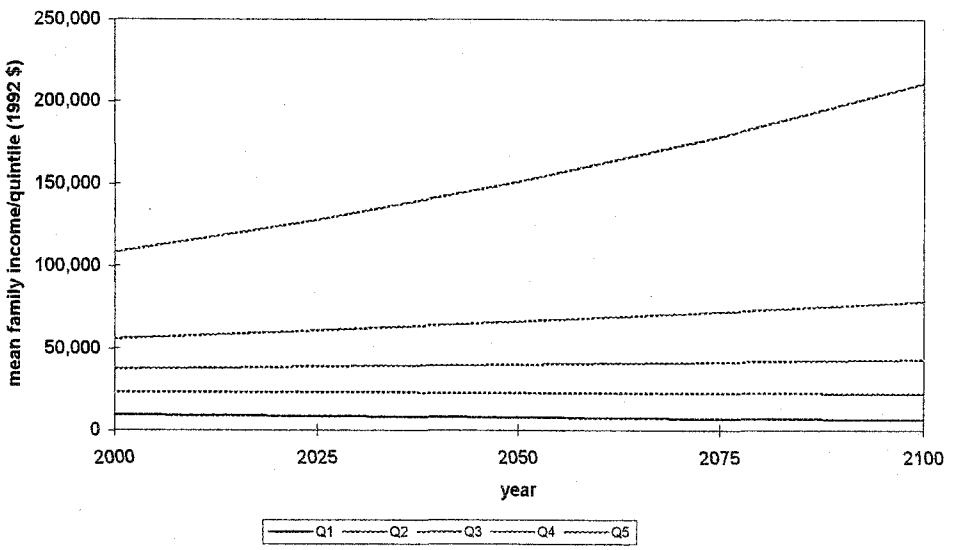
Box IIB-17 Projection of Inequality Trends, 2000-2100

(Income values for 1977 and 1992 taken from Table B-7, Money Income of Households, Families, and Persons, 1992. U.S.Dept. of Commerce, Bureau of the Census. 1993.)

Table 1 - Data

	mean family income per quintile (1992 US$)					mean	Gini	80/20	aggregate annual
	Q1	Q2	Q3	Q4	Q5	income	coefficient	ratio	growth rate
1977	10,591.00	23,554.00	35,521.00	49,021.00	84,040.00	40,545	34.0	7.94	
1992	9,708.00	23,337.00	36,777.00	53,365.00	99,252.00	44,488	37.6	10.22	
growth rate, 77-92	-0.005804	-0.000617	0.002317	0.00566	0.011091	0.00253			0.0101
	Q1	Q2	Q3	Q4	Q5				
2000	9,268	23,222	37,465	55,837	108,461	46,851	39.4	11.70	0.0101
2025	8,495	23,008	38,790	60,785	128,094	51,834	42.7	15.08	0.0101
2050	7,787	22,796	40,161	66,172	151,280	57,639	45.6	19.43	0.0101
2075	7,137	22,586	41,581	72,035	178,663	64,401	48.7	25.03	0.0101
2100	6,542	22,378	43,052	78,419	211,002	72,279	51.5	32.25	

Figure 1: Projections of Inequality Trends, 2000-2100



II.B.2. WHAT IS THE RELATION BETWEEN INEQUALITY AND ECONOMIC GROWTH?

We begin with an overview of income distribution theory and of reasons given for the growth of inequality in the industrial countries. Then we review in more detail the ways in which economic growth and inequality might influence one another. We conclude with a summary and assessment.

II.B.2.a. Overview

1. What determines the distribution of income?

The two major theoretical approaches to the study of income distribution are those of political economics/structuralist analysis and neo-classical economics.[53] In the following notes we focus on the neo-classical approach, broadly defined, although political economic considerations enter at many points.

The neo-classical approach takes endowments as given and assumes that factors earn their marginal products in competitive markets. Utility maximizing agents behave in ways that equate various marginal costs and benefits, and in so doing determine wages, prices, rents and factor income shares. A model of the personal distribution of income would need to include a demographic element that specifies a distribution of factors among individuals, households, or other units of interest. It might also include a public sector that can intervene in markets. A complete model would also need to show household responses to changes in wages, prices, taxes and transfers, concerning especially the allocation of time between labor and leisure.

If the model is to depict changes in the distribution of income over the long run it needs to be embedded within a general equilibrium framework that shows savings, investment and endogenous growth. It would need to include a human capital production function, and show the

[53] Pan (1996) lists additional theoretical approaches and elements that have been used in the study of the distribution of income, including individual choice theory, human capital theory, stochastic theory, educational inequality theory, life-cycle theory, public income distribution theory, distributive justice theory and inheritance theory.

relation of technology and human capital. If the long run of interest is multigenerational, parent utility functions that include some measure of descendants' well-being would be required.

Recent models of income distribution have included external effects, such as that provided by the "average level of human capital" on the ability of any individual to acquire additional human capital. Other recent models have included endogenous policy elements. These allow rational, utility-maximizing political actors to seek to modify market outcomes by referenda, influence or other means.

Analytic models of income distribution have provided insights but a general theory has yet to be realized. More modest research programs use empirical models and statistical analysis to identify variables that appear to be significantly correlated with measures of income distribution. A third approach involves the use of large scale simulation models that attempt to mimic complex economic systems and give numerical results concerning the distribution of income.

2. Why has inequality been increasing in the mature industrial economies?

We saw in Section B.1 that the distribution of earnings or income in most industrial countries has become more unequal in recent years. Explanations for this include:

a) demographic changes, including changes in age distribution, family size, martial status, migration and immigration, and assortive mating

b) greater returns to higher education and skills, including technological skills, "symbolic analyst" skills, and interactive skills

c) globalization, free trade, and increased international competition

d) economic restructuring, de-industrialization, and down-sizing

e) declining union membership and strength

f) governmental policies, including erosion of the minimum wage, social service cuts, and tax cuts favoring high income brackets

g) growth of winner-take-all markets for many goods and services

Clearly each of these might contribute, in different ways and to different degrees, to the growth of inequality. Analysis is complicated by the fact that many of these proposed causes may themselves be causally related.

Changes in age distribution, family size and other demographic variables do not appear to have contributed greatly to inequality (Danziger and Gottschalk, 1995). However, assortive mating may have contributed somewhat to the large income gains realized by upper-middle income households (Pryor, 1996).

Tax and spending policies appear not to have been a major cause of inequality in the industrial countries (Gottschalk and Smeeding, 1996). One study estimated that 85% of the increase in inequality since the late 70's was due to changes in pre-tax wages and salaries, while 15% was due to the Reagan/Bush tax cuts for the wealthy and social service cuts for the poor.[54]

Economic changes associated with increased trade have probably served to worsen the distribution of income, but the magnitude is uncertain. (Danziger and Gottschalk, 1995).

Many analysts believe that the increased demand for, and greater returns to, technological skills and education is perhaps the most clearly significant contributor to growing inequality in the United States. (Murphy and Welch 1993; Bound and Johnson 1992; Berman et al. 1993.)

In a survey of possible causes of the growth in inequality experienced by industrial countries other than the United States, Smeeding and Gottschalk (1996) were unable to find many clear common patterns. They suggested that public sector policies, including centralized wage setting, may have moderated the impact of a growing demand for skilled labor in some of these countries.

The Federal Reserve Bank of New York (1994) surveyed eighteen noted academics and other analysts for their estimate the share of the growth in economic inequality in the United States that might be attributed to different factors. The results were:

technological change that rewards higher education:	50%
decline of union membership:	10%
growth of global trade	10-20%
erosion of the minimum wage:	9%

A review by Danziger and Gottschalk (1995) concluded that for the United States,

> "The literature identifies no single cause for the increased earnings inequality of the past two decades. Many factors moved the economy in the same direction: a shrinking percentage of the workforce belonging to unions; a shift of jobs away from manufacturing; increased global competition and the consequent expansion of the import and export sectors. The introduction and widespread use of computers and other technological innovations also increased demand for skilled personnel who could run the more sophisticated equipment. Simultaneously, demand for less-skilled workers declined, as they were displaced by automation or had to compete with new imports." (p 149)

Finally, no less a figure than Felix Rohatyn of Lazard Freres (1996) has stated that:

> "The big beneficiaries of our economic expansion have been the owners of financial assets and a new class of highly compensated technicians working for companies where profit-sharing and stock ownership was widely spread. What is occurring is a huge transfer of wealth from lower-skilled middle-class American workers to the owners of capital assets and to the new technological aristocracy."

Below we consider the ways that economic growth and inequality influence one another. We look first at ways that economic growth might affect the distribution of income, and second at ways in which the distribution of income might affect growth. This partition is analytically unsatisfying because any compelling account of growth and inequality would focus on the results of their reciprocal influence. But most studies have focused on one or the other causal direction. I include comments on several studies that have attempted to model reciprocal influence.

II.b.2.b. How Does Economic Growth Affect the Distribution of Income?

1. The Kuznets Curve

Kuznets (1955) proposed an intuitive model based on rural-to-urban migration that appeared to be consistent with historical patterns of economic growth and inequality in Europe,

[54] I have not been able to identify the source for this report, but am continuing to try to do so.

and which he believed might apply to modern developing nations as well. [55] Kuznets suggested that in the early periods of rural-to-urban migration new immigrants could be expected to occupy a wider range of income levels than they did in their less stratified rural home regions, and that this would tend to worsen the aggregate distribution of income. However, after a certain portion of the rural population had moved to the cities income inequality would begin to decline. This would happen because as the rural population shrinks it begins to represent an extreme population on one tail of the total income distribution. At that point a move to the city reduces the income inequality of the entire population.

Kuznets' migration-based explanation did not hold up under further study and was replaced by more sophisticated models of development, including dual-economy and labor surplus theories. The existence of the Kuznets curve itself appeared to be confirmed by numerous studies, but these relied heavily on cross-sectional data, rather than time-series data, and were thus open to question. In any event the experience of growth and development from the 1960's on did not conform to the predictions of the Kuznets curve, and today it is regarded as a possible scenario of development, not a likely one.

2. The Deininger-Squire (DS) Data Set

A recent study by Deininger and Squire (1996a), using a high-quality set of tightly comparable time-series statistics, found that for 39 of 48 countries (81%), no significant relation between the level of income and the level of inequality could be found. In four cases (India, USA, UK and Costa Rica), they found a statistically significant U-shaped relation between income and inequality, and in three cases (Mexico, Philippines and Trinidad) they found a statistically significant inverted-U [56].

---

[55] Kuznets supported his account with only a very few empirical data—scattered income distribution estimates for the United States, Germany, and England in the late 19th and early 20th century, and single year distribution estimates for India (1949-1950), Ceylon (1950) and Puerto Rico (1948).

[56] Two other cases--Brazil and Hungary--showed a statistically significant inverted-U but had other data problems that reduced confidence.

Tests using the new data set also revealed little relation between rates of economic growth and changes in the level of inequality. During 88 "periods of growth," inequality decreased during 45 of them and increased during 43. During seven "periods of decline," inequality decreased during two and increased during five.[57] In a companion study Deininger and Squire (1996b) did find that in developing countries a more equal distribution of land was associated with more rapid subsequent economic growth. However, this relationship did not hold for the industrial countries.

Boxes IIB-18 and **IIB-19** show how levels and rates of growth of per capita GDP and inequality for 18 industrial countries vary with one another. IIB-18 shows no significant relation between the level of inequality and the rate of per capita GDP growth during the period 1985-1994 ($p = .06$; $R^2 = .18$; without Hong Kong, $p = .48$). Figure 1 in IIB-19 shows no significant correlation between the level of per capita GDP in 1980 and subsequent changes in inequality ($p = .78$; $R^2 = .01$). Figure 2 in IIB-19 shows that in the period since 1965 there do not appear to be significant correlations between periods of either high or low per capita GDP growth and positive or negative changes in the Gini coefficient ($p = .11$, $R^2 = .15$).

3. Neo-classical Theory

Below we review two neo-classical models of income distribution, with attention to what they suggest concerning the relation between economic growth and inequality.

Von Weizsäcker (1993) presents a model in which disposable earnings depend upon a person's level of human capital, the wage rate, and the costs of further education and training. People can increase their capital stock by investing some of their current capital in education, and by spending income on education services. People seek to maximize the discounted sum of total disposable income over time. This model generates the standard neo-classical human capital scenario: investment in human capital is greatest early in life and continues thereafter at a

BOX IIB-18. Regression of Per Capita GNP Growth Rates Against Level of Inequality

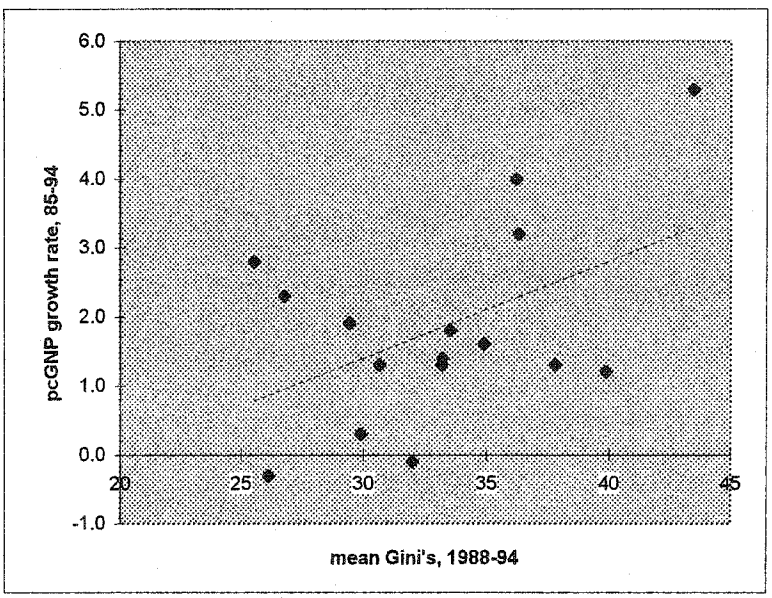
[Gini coefficients are from Deininger and Squire, 1996a. Per capita GNP growth rates are from the World Development Report, 1996, Table 1]

Table 1

Country	average of Gini's, 1988-1994	average annual per capita GNP growth rate, 1985-1994
Spain	25.5	2.8
Finland	26.2	-0.3
Belgium	26.8	2.3
Netherlands	29.4	1.9
Canada	29.9	0.3
UK	30.6	1.3
Sweden	32.0	-0.1
Denmark	33.2	1.3
Norway	33.2	1.4
Italy	33.5	1.8
France	34.9	1.6
Portugal	36.2	4.0
Japan	36.3	3.2
USA	37.8	1.3
Australia	39.9	1.2
Hong Kong	43.5	5.3
means	33.1	1.8

Taiwan	30.2
Germany	32.2

Figure 1 Comparison of Gini's and per capita GNP growth rates



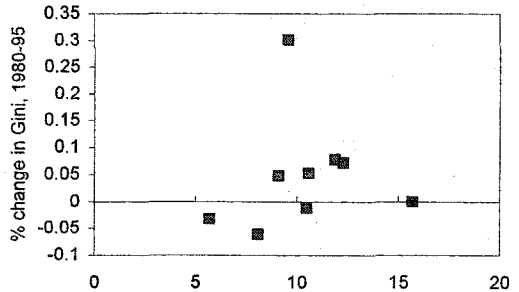
P-value = .06
adj R^2 = .18

BOX IIB-19. Comparisons of Inequality Growth Rates and Level and Growth Rates of per capita GDP

		USA	UK	Sweden	Italy	Taiwan	Canada	Japan	Australia	France	Germany	Spain	Netherlands
% change													
in Gini,													
1965-80	= "A"	0.016	0.025	-0.029		-0.135	-0.007	-0.040	0.238	-0.259	0.105	-0.163	
1980-93	= "B"	0.078	0.301	0.000	-0.061	0.101	-0.119	0.048	0.052			-0.033	0.072

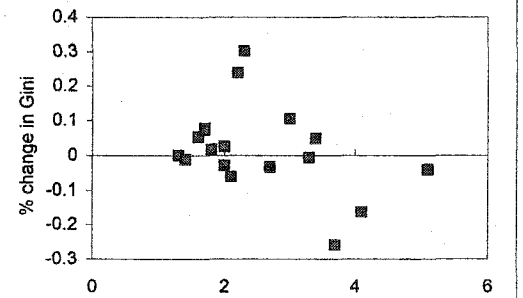
		% change in Gini	pc GDP grth rate/yr	pc GDP 1980 (K)
Sweden	B	0	1.3	15.7
Canada	B	-1.2	1.4	10.5
Austria	B	5.2	1.6	10.6
USA	B	7.8	1.7	11.9
Netherlands	B	0.072	1.7	12.3
USA	A	0.016	1.8	
Sweden	A	-0.029	2	
UK	A	0.025	2	
Italy	B	-0.061	2.1	8.1
Australia	A	0.238	2.2	
UK	B	0.301	2.3	9.6
Spain	B	-0.033	2.7	5.7
Germany	A	0.105	3	
Canada	A	-0.007	3.3	
Japan	B	0.048	3.4	9.1
France	A	-0.259	3.7	
Spain	A	-0.163	4.1	
Japan	A	-0.040	5.1	

Figure 1. Relation of Changes in Inequality during 1980-95 to Level of per capita GDP in 1980



p-value = .78; R^2 = .01

Figure 2. Relation of Changes in Inequality to Growth Rates of per capita GDP [1965-80 and 1980-1993]



p-value = .11; R^2 = .15

sources:
Gini coefficient rates of change were calculated using the Deininger and Squire 1996 (a) data set.
Per Capita GDP growth rates are from the 1996 Human Development Report.
1980 Per Capita GDP values are from the 1996 World Development Report; values are 1980 international dollars.

declining rate. Much of the variability in incomes depends upon two key parameters. One measures the amount of productive human capital a person realizes from a unit investment in education. The other measures the amount by which incomes increase as a result of the acquisition of a unit of new human capital. The initial values of these two parameters are distributed randomly among persons. Key equations of the model are shown in **IIB-20**.

Von Weizsäcker's model predicts that an increase in the wage rate leads to a rise in the overall inequality of earnings; that improvement in the opportunities for increasing the human capital stock by way of practical job experiences (learning-by-doing) causes additional inequalities; and that falling birth rates will increase the overall inequality of earnings. Von Weizsäcker summarizes by noting that:

> "The model... predicts a basic policy conflict between the level of per capita earnings and the level of earning inequality; according to which, the social aims of higher per capita earnings and lower earnings inequality, are not generally compatible with each other." (pp 199-200)

The results noted appear in large part to be due to a general feature of the model, whereby initial (random) advantages that individuals possess at an early age are strengthened by their, and others', optimizing behavior. For example, persons from families that invest heavily in education (initially a random factor) find it relatively less costly to invest in more education in later years than do others.

Fischer and Serra (1996) develop a model in which the average level of human capital in an economy has external effects that have important implications for both growth and inequality (see **IIB-21**). Output is produced by unskilled labor and human capital. Agents live for a single period and derive utility from consumption and from expenditures on their children's' education. The accumulation of human capital depends on education expenditures, on the informal influence of parents (a function of parents' education) and on "social interaction with friends and

---

[57] Ravallion and Chen (1996) used the DS data set for additional studies of growth and distribution and reached similar conclusions.

BOX IIB-20. The von Weizsäcker Model (1993)

Equations of the model:

(1) $$Q_n = b_0 (s_n K_n)^{b_1} D_n^{b_2}$$

(2) $$K_{n+1} = K_n + Q_n + c(1 - s_n)K_n - \delta K_n$$

(3) $$A_n = RK_n(1 - s_n) - PD_n$$

(4) $$V = \sum_{n=0}^{N} A_n (1+r)^{-n}$$

(5) $$K_0 = a_0 + a_1 S$$

(6) $$b_0 = b_0 \left[LA(G, HO, CU); DF(HO, CU); QPC; CR; SQ \right]$$

where:

n = working age/earning period
Q_n = human capital produced by education other than formal schooling or learning-by-doing in period n
K_n = human capital stock at period n
s_n = fraction of human capital stock diverted for investment in period n
D_n = educational goods and services purchased in period n
A_n = disposable earnings in period n
R = wage rate for services from a unit of human capital for 1 period
P = price per unit of D
V = value of disposable earnings discounted from the time of entry into the labor market
S = time spent in full-time schooling
b_1 = elasticity of human capital production with respect to the factor $s_n K_n$
b_2 = elasticity of human capital production with respect to the factor D_n
b_0 = ability of an individual to increase their productive capacities during their working life
c = rate of learning-by-doing
δ = rate of depreciation of human capital
a_0 = stock of human capital at the beginning of the planning horizon
a_1 = human capital production efficiency during the full-time schooling phase
r = interest rate
LA = learning ability of individuals
DF = Lydall's D-Factor: motivation, energy, ambition, etc.
QPC = personality and character traits
CR = class-rank variables (e.g., school achievement)
SQ = schooling quality
G = physical endowments
HO = family background
CU = cultural influences

BOX IIB-21. The Fischer and Serra Model (1996)

Equations of the model

1a) $X_{1t} = L_{1t}^{\alpha} H_{1t}^{1-\alpha}$

1b) $X_{2t} = L_{2t}^{\beta} H_{2t}^{1-\beta}$

2) $H_t = H_{1t} + H_{2t} + G_t$

3) $u_t^z = c_{1t}^{z\tau} c_{2t}^{z\nu} \left(g_t^z + g^*\right)^{(1-\tau-\nu)}$

4) $y_t^z = w_t^z + h_t^z$

5) $h_{t+1}^z = (\bar{h}_t)^{1-\delta} (\rho h_t^z + g_t^z)^{\delta}$

Where

X_i = amount of final good i
L_i = labor to produce final good i
H_i = human capital to produce final good i
H = total stock of human capital
G = aggregate allocation of human capital for education of the next generation by agents living in the present
u^z = utility of agent z
c_i^z = consumption of final good i by agent z
g^z = amount of human capital an agent spends on a descendant;
g^* = utility gained by doing things for a descendant that do not require expenditure of human capital
y^z = income of an agent z
w^t = wages of an agent z
h^z = amount of human capital owned by agent z
α, β = elasticity of output with respect to labor and human capital, respectively
τ, ν = elasticity of utility with respect to consumption of goods 1 and 2, respectively
ρ = human capital depreciation factor
δ = elasticity of next generation's human capital with respect to parents' level of human capital and parents' expenditures of human capital on descendant (i.e., "strength of the externality")
h = average level of human capital in the society

schoolmates." The last represents an externality measured by the average level of human capital in society.

Their model shows two opposing tendencies. As the average stock of human capital increases so does the relative price of unskilled labor, which tends to reduce economic inequality. At the same time wealthier agents spend a higher proportion of their income on education, which tends to raise inequality. The values of the parameters of the model determine which tendency prevails. The authors do not attempt to estimate these values, some of which are quite abstract, but in an exercise a set of empirically plausible parameter values causes inequality to decline.

4. Growth, Inequality, and Technology

Technological innovation is essential for continued economic growth. What bearing might technological innovation have on income distribution?

a. Technology and Factor Shares

Karni and Zilcha (1994) note that technological change can affect income inequality "through its effects on factor prices directly (through productivity) and indirectly (through its influence on the accumulation of factors of production)." They prepare a model to test the distributional implications of three types of technological change: Harrod-neutral [labor-saving], Solow neutral [capital-saving], and Hicks-neutral [factor share neutral]. They find that Hicks-neutral technological change has no effect on the distribution of incomes, and that

> "The impacts of Harrod-neutral and Solow-neutral technologies depend on the elasticity of substitution in production. Harrod-neutral changes increase (decrease) the level of income inequality if the elasticity of substitution in production between capital and labor is larger (smaller) than one. Solow-neutral changes decrease (increase) the level of income inequality if the elasticity of substitution is larger (smaller) than one." (p 280)

What does this mean? In most growth studies technological change is assumed to be Harrod-neutral, i.e., pure labor saving. The justification for this is that the return to labor (wages) has grown continually over the course of the technologically-driven industrial epoch, whereas the return to capital (interest) has been far more constant. Growth studies also commonly employ iso-elastic production functions such as the Cobb-Douglas. This is consistent with the observation

that despite the increasing return to labor, the shares of output going to capital and labor have remained roughly constant; that is, capital has been substituted for labor at the same rate that wages have increased.

It is not clear that this analysis adds much to our understanding of technology and the distribution of income. The determination of whether a particular technological innovation, a network of innovations, or for that matter the technological trajectory of a particular epoch, is labor saving, capital saving or factor neutral is not something that can be readily assessed prior to the operation of that technology in the real world. Rather, we observe certain patterns of behavior regarding capital and labor, and declare *post hoc* the nature of the technology [58].

b. Greater Returns to Skilled Labor

Studies of the causes of the growth of income inequality in the United States have shown that returns to skilled labor have been increasing with respect to those for less skilled labor over the past 20 years. Berman, Bound and Griliches (1993) found that during the 1980's more than two-thirds of the increase in the demand for skilled labor was attributable to the introduction of labor-saving technological innovations in the production process. Less than one-third could be attributed to other causes, such as the decline of less skill-intensive industries due to growing international trade.

Box IIB-22 shows that the premium for college education declined until 1978, at which point it began a steep rise. The widening gap between returns to college and high school education is even greater for young people.

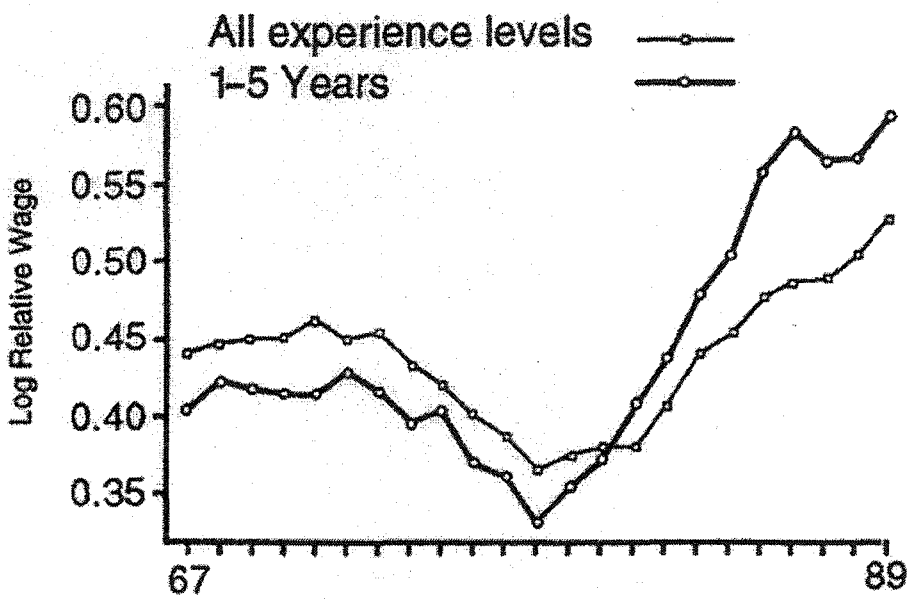
Box IIB-23 shows that within even the traditional blue and white collar sectors the premium for higher education is growing, while persons with no education beyond high-school have experienced an absolute decline in earnings.

---

[58] Bessant and Cole (1985) argue that technologies whose initial impacts are labor-saving might turn out to be capital saving over the long run. Zuboff (1988) argues that many technologies can be either labor or capital saving, depending upon institutional commitment.

BOX IIB.22 Trends in Relative Wages: 1967-1989
[Reprinted from Murphy and Welch, 1993]

College / High School Wage Premium



BOX IIB-23. Median Annual Earnings of Male High School and College Graduates

[Levy and Murnane, 1992; all values 1988 US $]

Figure 1. Median annual earnings of 25-34 year old male High School Graduates

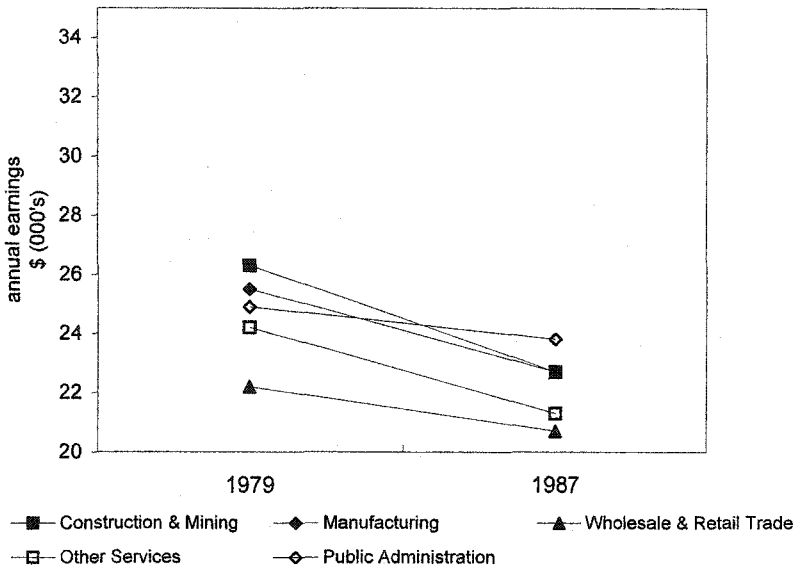
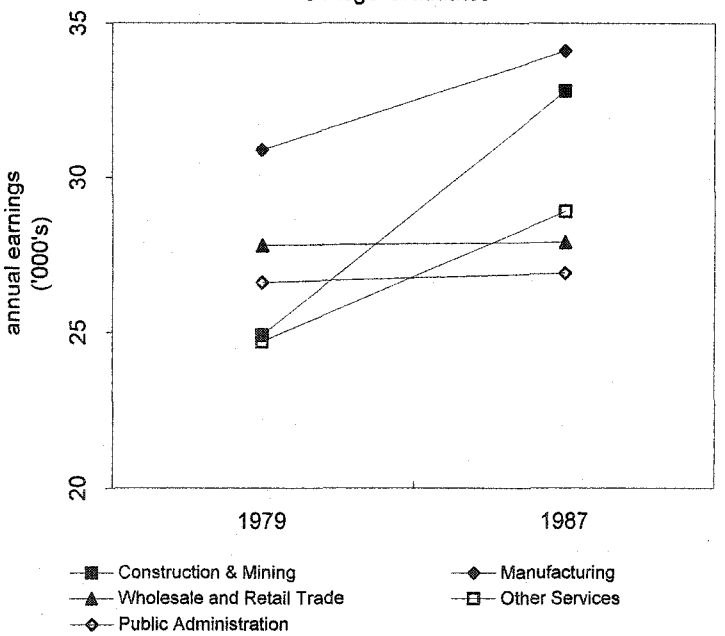


Figure 2. Median annual earnings of 25-34 year old male College Graduates



Box IIB-24 gives some indication of the extent to which educational differences might contribute to income inequality. The charts show that in the United States the median professional earns three times as much as the median high school graduate, but represents a very small segment of the population.

Is a continually growing demand for increasingly skilled labor a necessary feature of continued economic growth in mature industrial economies? Many commentators believe this is so. The rationale seems to be that if economic growth depends on continued technological innovation, and if the contribution of innovation is that it allows "the manipulation of matter and energy over increasingly finer scales of space and time,"[59] then greater skills will be needed to use such technology in the manner needed to exploit its ability to contribute to continued output growth.

Krugman (1994) differs, noting that from the 1920's to the 1970's much technological change was embodied in process technologies, such as assembly lines, that increased the productivity of unskilled labor many-fold. In the future, he says, highly sophisticated information technologies may be able to more readily replace accountants, doctors, and pharmacists in much the same way that skilled wheelwrights were replaced by unskilled auto assembly-line workers. Yet many currently low-paid jobs, such as gardeners or home healthcare workers, might be less easily replaceable.

The arguments on both sides of this question are speculative, not analytic. As of now there is no strong theory of technological innovation that can be used to support either position. But the question of whether future technological change is necessarily increasingly skill-intensive is immensely important.

What about the supply side? If an increased demand for skilled labor elicits an increase in supply, the new premium for skilled labor vanishes. On the other hand, if the demand for

---

[59] See Section II.A.3.a of these notes.

BOX IIB-24. Income and Number of Households, by Educational Attainment of Householder
[source: Census Bureau, Statistical Abstract of the US, 1995]

Figure 1. Household income, by educational attainment of householder, 1993

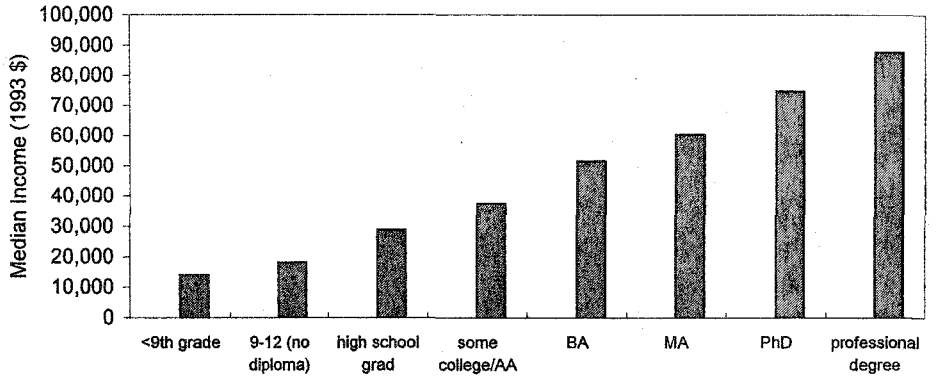
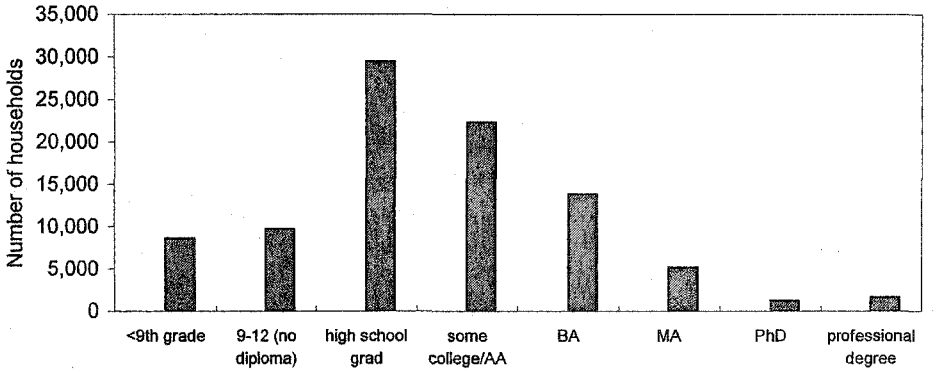


Figure 2. Number of households, by educational attainment of householder, 1993



skilled labor accelerates, supply would have to accelerate as well simply to prevent the existing gap from widening.

5. International trade

The expansion of international trade has been an important factor encouraging strong economic growth in many countries. What bearing does the expansion of trade have on the distribution of income? [60]

Economic theory predicts that in the industrial countries greater international trade should tend to increase the wage rate of high-skilled workers, and lower the wages of low-skilled workers. In developing countries greater trade will hurt high-skilled workers and benefit low skilled workers (Bergstrand et al. 1994; Fischer and Serra 1996). Empirical studies appear to confirm these predictions for the industrial countries, but the results for developing countries are ambiguous.

Estimates of the share of the growth of inequality in the United States that has been caused by the expansion of trade varies from less than 10% (Danziger and Gottschalk 1995) to 30% (Haveman 1994).

Over a period of decades factor prices among trading countries should become more equal and the expansion of international trade should slow. As this happens the contribution of trade to the growth of inequality should decline. Pryor (1996) estimates that the theoretical maximum share of exports in United States GDP is about 20%. If the export share continued to grow at the rate it has over the past 15 years, about 1.4% annually, the maximum level of 20% would be reached in about 75 years. Thus the contribution of international trade to growing economic inequality may be significant in particular industrial countries for greater or shorter periods, but by the middle of this century it will probably not be large.

---

[60] An important study by William Cline, *Trade and Income Distribution*, was published after completion of this section of the dissertation. His conclusions are not inconsistent with the notes that follow. I discuss Cline's TIDES model in Section II.D.4.c.

6. The Bessant-Cole Model

Bessant and Cole (1985) use a multi-sectoral global model to investigate the relation of technological innovation, economic growth, trade and income distribution. They emphasize particularly the role of information technologies. They begin with an exhaustive survey of the state of technological development in 24 3-digit economic sectors (textiles, aerospace, agriculture, construction, chemicals, etc.) to assess the impacts that those new technologies are likely to have in the coming years on jobs, skills, costs and other factors. They find that the direct impacts of projected technological developments would in large part be labor-saving. Next they draw on a variety of methods to assess possible second and third order effects of these labor-saving technological innovations. Their analysis suggests that "the more significant impact of information technology could come from a system-wide reorganizing of production... (resulting in) a more intensive use of existing capital and installation of production systems with greatly improved capital productivity." This restructuring might involve, for example, "greater reliability, reduced down time, and an increase in the number of shifts." They use these studies to determine initial values and parameters for their global model.

Their model divides the world into high, middle and low income countries, and within each of these into wealthy and poor households. A first run of the model includes only the immediate, better understood labor-saving impacts of new technology. GDP in the high income countries increases minimally, and in the middle and low income countries by 1% and 2%, respectively. In the high income countries the income of poor households declines by 5% but those of rich households increase by 9%. In the low and middle income countries, however, the distribution of income improves.

Bessant and Cole next run the model with the possible capital-saving effects included. GDP in the high, middle and low income countries increases by 14%, 9% and 4%. All have done

better than in the first run, but now the between-country distribution worsens rather than improves. The income distribution in the middle and low income countries improves much as it did in the first run. In the high income countries the incomes of the rich and the poor households increase by 22% and 6%. Thus both are notably better off than before, but the relative distribution of income has worsened.

7. Winner-take-All Markets

We noted earlier that a major portion of the increase in earnings inequality in the United States was due to increases at the upper end of the income range, and that the higher the range, the higher the rate of income growth (see Box IIB-13, Figures 5 and 6). Frank and Cook (1995) propose that much of this increase is due to the growth of *winner-take-all* markets. These are different from typical markets in that compensation is determined by relative performance, not absolute performance. Such markets arise when there are very large markets for the product of top performers, or when firms are willing to pay top performers very high salaries.

The significance of winner-take-all markets clearly increases with economic growth. Many products in these markets are consumed in larger proportions as household income increase. Further, the simple expansion of markets, domestically and internationally, magnifies the potential returns to top position.

Frank and Cook maintain that firms pay top performers far more than their apparent marginal product. This is because part of the payment is an insurance premium. When the stakes are very high, and small differences in ability can translate into huge differences in outcomes, firms are willing to pay this premium. The key observation for our purposes is that the reason that "the stakes are very high" is precisely because economic growth, and globalization, have created new, larger markets for the products of firms.

8. Stochastic Processes

A case can be made that as an economy grows, inequality can be expected to increase, simply as a result of the mechanical process known as the *law of proportionate effect.* Suppose

that a variable changes over time, and that the change in the variable is a random proportion of the variables' previous value. An economy with a positive growth rate, within which individual incomes obey the law of proportionate effect, will generate a log-normal distribution of the sort that characterizes most income distributions. The justification for stochastic models is that they may be able to capture the manifold, cascading indeterminancies that pervade any process as complex as an economy better than conventional deterministic models. However they are devoid of economic content and economists have not found them to be especially useful (von Weizsäcker, 1993).

II.B.2.c. How Does The Distribution of Income Affect Economic Growth?

While Kuznets was concerned with the impact of economic growth on inequality, others focused on the ways in which inequality might affect the rate of growth. The Lewis two-sector model (1954) was among the first to address this topic; in fact it addressed both directions of the growth/inequality relationship. It noted first that the accumulation of capital by entrepreneurs was a necessary condition of economic growth. Further, since the labor supply curve of "surplus" rural workers was perfectly elastic, wages would not rise as urban output increased. The Lewis model thus forecast a positive feedback loop between growth and inequality for the early period of development. This unfortunate situation would begin to change after the rural labor force was reduced in numbers to such a level that wages there would begin to rise and force urban entrepreneurs to raise wages as well. The experience of the past two decades has not offered strong support for the Lewis model as a general description of the development process. (Gillis et al.1992).

An analogous set of questions has been posed concerning the mature industrial countries. Throughout the post-WWII decades advocates and opponents of redistributive policies have claimed that their programs would encourage economic growth and that those of their adversaries would discourage it. Many Marxian and Keynesian economists argued that since wealthier

persons have a lower marginal propensity to consume, and that under certain conditions they might withhold savings from productive investment, high economic inequality could lead to a shortage of aggregate demand and cause economic growth to slow, perhaps catastrophically. Neo-classical economists argued that redistributive policies were inefficient and for that reason would be a drag on economic growth.

In this section we survey recent research on the ways in which inequality might affect economic growth, particularly in mature industrial countries.

1. Channels of Influence

A number of studies suggest that economic inequality has a negative impact on economic growth. Several channels of influence, not mutually exclusive, have been suggested. These include the possibilities that inequality 1) creates imperfect markets for human capital; 2) motivates redistributive policies that hurt growth; and 3) creates political instability that reduces investor confidence. We look at representative models that seek to characterize these influences below.

a) Imperfect Markets for Human Capital

Loury (1981) proposed a two period overlapping generations model in which family income in the first period is divided between consumption and education of youth. The central equations are shown in **IIB-25**. "Natural economic ability" is distributed randomly among persons, and is not known to parents until their children are mature. The utility of parents depends on their own level of consumption and on the utility experienced by their children when they in turn become parents in the second half of their lives. Income shows diminishing returns to education and training. Because of this, Loury notes,

> "[P]arents [of different families] making different income-constrained investment decisions face divergent expected marginal returns to training in terms of their offsprings' earnings. If the parent investing less, facing the higher expected marginal return, could induce the parent investing more to transfer to his son a small amount of the other's training resource, then the offspring of both families could on average (through another inter-family income transfer in the opposite direction) have greater incomes in the next

BOX IIB-25. The Loury Model (1981)

Equations of the model

(1) $U_1 = c_1^{\gamma} V^{1-\gamma}$

(2) $x_1 = (\alpha_1 \varepsilon_1)^{\delta}$

(3) $\varepsilon_1 = x_0 - c_0$

Where

U_1 = family utility
c_1 = family consumption
c_0 = parents' consumption
V = descendants' utility
x_1 = earnings of the head of the family
x_0 = earnings of the parents
α_1 = family (head's) ability (randomly endowed)
ε_1 = family (head's) training
γ = elasticity of Utility with respect to consumption
δ = strength of the contribution of abilities and training to earnings

Note: "family" is the current generation; "parents" is the immediate past generation; "descendants" means the children of the family.

period." (p 844)

Loury notes that many low-income parents are unable to borrow money to support the education of their children, and his model incorporates this feature. He finds that initial income inequality leads to an inefficient distribution of training resources and thus a slower rate of economic growth. In a quantitative example he shows that public education could account for a 35% reduction in the dispersion of incomes and a 3.4% increase in the rate of economic growth.[61] Loury comments that while the impact of public education on incomes appears to be significant, the impact on the growth rate is small.

In another study, Galor and Zeira (1993) suggest that when markets for human capital are imperfect low-income persons are not able to take advantage of the technological shocks that may be significant events in the structural evolution of an economy. This prevents the economy from growing as rapidly as it would otherwise.

b) Endogenous Policy

Alesina and Rodrick (1991) develop a model including "endogenous policy," in which output is a function of capital, labor, technology and "the flow of government expenditures on productive investment." Both expenditures and transfers are financed by a tax on capital. Individuals differ along a continuum regarding their relative endowments of labor and capital, and seek to maximize the net present value of consumption. The tax rate is determined by majority vote. Using the median voter theorem, which states that the outcome of a referendum will be that which maximizes the utility of the median voter, the authors find that:

> " ...[D]emocracies with an uneven distribution of wealth should exhibit lower growth than democracies with more equally distributed resources. This is because a large working class with little capital would vote for high taxes on capital; the positive effect on the level of workers' real incomes would be traded off against the adverse growth consequences." (p 29)

The authors ran regression analyses and found that a 10% increase in the share of wealth held by the upper 20% of households in democracies is associated with a subsequent reduction in

the rate of economic growth of perhaps one third of a percentage point. However, Deininger and Squire (1996a) suggest that this relation may disappear when calculated using their new, high-quality data set.

Persson and Tabellini (1991) combine elements of both human capital and endogenous policy modeling. They propose a two-period overlapping generations model in which growth is a function of the accumulation of knowledge capital, a randomly distributed complement of basic skills, and an externality that is proportional to the average endowment of knowledge capital. Accumulation of knowledge capital is determined by an exogenous rate of return and a redistributive policy variable determined by the median voter theorem. Redistribution transfers knowledge capital from those with more to those with less, but also reduces investment and thus the basis for subsequent growth.

Persson and Tabellini find that the more equal the distribution of basic skills, the greater the rate of economic growth. They also find that a lower rate of political participation by the poor, or a higher rate by the rich, increases the growth rate. In a regression analysis they confirm these results empirically. For a large sample of countries they find that a one standard deviation decrease in inequality increases economic growth by just under half a percentage point. However, Deininger and Squire (1996a) question the reliability of their inequality statistics.

c) Inequality, Political Instability and Growth

Beńabou (1996) uses a repeated-game theoretic model to illustrate a possible relation between inequality, social instability, and economic growth. In the model each of two agents face a choice of either moderating their claims to economic output ("cooperate") or seeking vigorously to try to earn the greatest incomes they can ("defect"). If both agents cooperate they each earn the market solution. If one cooperates and the other defects, the cooperator suffers. If they both

[61] That is, economic growth would increase from, e.g., 2% to 2.068% (not from 2% to 5.4%).

defect they both suffer, but not quite as much as a cooperating agent suffers when the other does not. Beńabou interprets (DD) as the outcome based on the raw exercise of political power.

This structure of payoffs defines a Prisoner's Dilemma game. We know that the outcome (CC) is not a Nash equilibrium for a single period PD game. But if the game is indefinitely repeated, (CC) can be the best strategy for both parties if the discounted stream of income earned by cooperating is greater than that earned from defecting. Whether this is so or not depends on the parameters of the model.

Beńabou sets up payoff functions and uses these to conclude that there is a maximum sustainable growth rate constrained by conflict over the distribution of income. This constraint exists because the better-off would have an incentive to transfer some of their capital to the less well-off rather than suffer the greater losses that social conflict would cause.

Alesina and Perotti (1993) test whether political instability caused by inequality might reduce investment, which in turn would reduce economic growth. They regress investment against an index of instability, and instability against economic inequality, for a cross-section of 70 countries over the period 1960-1985. Their measure of inequality is the share of total income of the third and fourth quintiles of the population in or around 1960. Their stability index is:

$$SPI = 1.86\,ASSASS + 1.28DEATH + 7.5SCOUP + 7.09UCOUP + 5.04DICT$$

in which ASSASS is the number of politically-motivated assassinations, DEATH is the number of persons killed in domestic mass violence, SCOUP is the number of successful coups d'état, UCOUP is the number of *un*successful coups d'état, and DICT is a dummy.

The authors find that for both tests the correlations are positive and significant. However, if we run the regression separately for the 18 industrial countries in the sample we find no significant correlation, simply because variability in the index of instability is very small.

d) other channels of influence

If the marginal propensity to save increases with income, then growing inequality could have a dampening effect on economic growth. This idea was used historically by Marx, later by

Keynes and much later by Greider (1997) to argue that higher incomes should be at least more heavily taxed. National accounts suggest that higher income households do save proportionately more than lower income households. However, some economists suggest that this value may be a statistical artifact. Higher incomes vary on an annual basis much more than do moderate and low incomes; thus, an identical percent of income saved over the lifecycle may show as a lower percent for high income households than for lower income households in any given year.

K. Hayes (1994) suggested, but did not explore, the possibility that increased inequality is likely to cause workers to invest in human capital at diverging rates, and that "as the variance of skills of heterogeneous labor increases, workers may not 'mesh' as efficiently, reducing labor productivity." She also suggested that as incomes become more unequal, "workers may become more resentful of the status quo and less cooperative and effective in the workplace." Variables such as "mesh" and "resentfulness" are difficult to define in a way that allows empirical study. However, Hayes' suggestions are clearly relevant to our primary concern with growth and inequality in mature industrial countries.

e) additional quantitative estimates

Beńabou (1996) surveyed 26 studies and estimated that a 1 standard deviation increase in inequality lowers the annual growth rate of GDP per capita by .5 to .8 percentage points. Is this a lot or a little? The mean Gini for 108 countries in the Deininger and Squire data set is 39.9 with a standard deviation of 9.9. The Gini for the United States is 37.94. Beńabou's estimate suggests that an increase in inequality in the United States to about 47, which is roughly equal to that of Malaysia or the Philippines, might reduce per capita GDP growth from its recent level in the neighborhood of 2.3% to something closer to 1.5-1.8%. We saw in Box IIB-17 that the U.S. Gini could grow to that level somewhere between 50 to 75 years from now, assuming a 1% per capita GDP growth rate and no change in the quintile dispersion trends. In any event, Beńabou notes

that the relation he found between inequality and growth vanishes in some studies when dummies for Africa and Latin America are added, or when the stock of human capital is included.

K. Hayes et al. (1994) conducted one of the few studies that tested for mutual causality between economic and inequality growth rates. They compared changes in productivity and the Gini coefficients for the USA over the period 1948 through 1990. They found that mutual causality was positive and significant: "greater productivity growth tends to lead to lower inequality growth" and "greater income inequality growth tends to lead to lower productivity growth." They note that this virtuous circle runs counter to the widespread opinion that efforts to reduce inequality will necessarily lead to *reductions* in productivity.

Note that in Hayes' analysis greater productivity growth does not necessarily imply a *decrease* in inequality; rather, it implies a decrease in the rate at which inequality *increases.* Her results are consistent with the possibility of a secular increase in inequality that may be moderated, but not necessarily stopped, by higher rates of productivity. Also, the use of 1948 as the beginning of the period of analysis may blur the possibility that a structural break of some sort concerning growth and inequality occurred at some point during the mid 1970's (see Raj and Slottje, 1994).

2. Explaining the stability of income distributions

We've noted that the recent data set prepared by Deininger and Squire shows a greater stability of income distribution within countries than earlier data had suggested. If this new data is correct, the burden of analysis of the mutual interaction of economic inequality and growth changes from one of explaining patterns of reciprocal influence to one of explaining the stability of the former in the face of great variation in the latter.

Many analysts have suspected for some time that income distributions are very stable. Yotopoulos (1976) said,

> "The evidence suggests that dualism of the "haves" and "have nots" exists and persists over time. In our opinion, this is explained by the persistence of the market imperfections that originally give rise to dualism. These imperfections usually result

> from the efforts of individual groups to establish rent-maximizing positions... Once these are established, they tend to be reinforced by devoting the rents at least partly to attempts to further reduce effective competition." (p 238)

Li et al (1996) use the Deininger-Squire data and present a model in which wealthy persons have the power to protect their wealth and poor persons have little ability to accumulate wealth. The equations of the model are shown in **IIB-26**. Total output is determined by the human capital possessed by the wealthy and the poor, and by a term representing environmental endowments. The income of the wealthy depends upon their own human capital, the endowment, income from a distortion, or "tax," that they levy on the rest of society by virtue of their economic strength, the costs of accumulating human capital (education), and the costs of levying and enforcing the "tax." The incomes of the poor depend on their own human capital, the endowment, the severity of the "tax" levied by the rich, and the cost of their own education. The more democratic the society, the greater the costs to the wealthy of levying and enforcing the "tax." Both groups maximize the discounted value of income, subject to constraints on the accumulation of human capital, i.e., the cost of education and the "depreciation" of human capital caused by technological change. Imperfect capital markets are incorporated by assuming that the cost of education is proportionately more for the poor than for the wealthy.

Li et al. derive first order conditions for utility maximizing by the wealthy and the poor, and then use these results to find the Cournot-Nash equilibrium. They find that there is a single optimal equilibrium level of income inequality, human capital accumulation, "distortion", and output growth. The level of income inequality is constant over time, even as the economy grows. Changes in the structural variables (level of democracy, initial level of education, initial distribution of collateral assets, and financial market development) lead to new, stable levels of the outcome variables.

They test their results with empirical data via regression analysis and derive quantitative relationships for their key variables. They find that the joint effect of a 10% increase in financial market development and a 10% reduction in asset inequality results in a 7% reduction in

BOX IIB-26. The Li et al Model (1996)

Equations of the model

(1) $$Q(t) = Q(h(t), H(t), \theta(t))$$

(2) $$y(t) = m(h(t), \theta(t)) + \tau M(H(t), \theta(t)) - \alpha\varepsilon(t) - f(\tau, \rho)$$

(3) $$Y(t) = (1-\tau)M(H(t), \theta) - C(\lambda)E(t)$$

(4) $$U^R = \int_0^\infty y(t)e^{-\rho t}\,dt$$

(5) $$U^P = \int_0^\infty Y(t)e^{-\rho t}\,dt$$

(6) $$\dot{H} = \mu E - \delta H$$

(7) $$\dot{h} = \mu\varepsilon - \delta h$$

Where

Q(t) =	total output
H(t), h(t) =	human capital of the poor and the rich
Y(t), y(t) =	total net income of the poor and the rich
θ(t) =	structural variables (e.g., natural resource endowments)
M(t), m(t) =	earned income of the poor and the rich
τ =	income distortion, or "tax," imposed by the rich on the incomes of the poor
α =	unit cost of education for the rich
E(t), ε(t) =	educational services purchased by the poor and the rich
p =	degree of democracy/civil liberties/political freedom/educational opportunity
f(.) =	cost to the rich of lobbying for τ and defending it
λ =	factors that influence the ease of access to the financial credit market
C(.) =	unit cost of education for the poor
U^P, U^R =	utility of the poor and the rich
ρ =	discount rate
μ =	increase in skills or knowledge per unit of educational services purchased
δ =	human capital depreciation rate

inequality. By contrast, the joint impact of a 10% increase in secondary education and in civil liberties yields less than a 2% reduction in inequality. They conclude that "the variables associated with the financial market imperfection argument have a much greater influence on inequality than those associated with the political economy argument" (p 26).

The categories and variables used in this model are very abstract so it is difficult to know how to usefully interpret the results. In any event, the impact of inequality—in this case, of human capital due to market imperfections—is moderate. A 14% decrease in the Gini coefficient of the United States takes it from .38 to .33, roughly the level of Sweden, Germany and Italy. The Li et al. results suggest this might be accomplished by a 10-20% reduction in the inequality of wealth. The current wealth Gini for the US is .65. A 15% reduction would bring it to .55. This could be accomplished via a one-time wealth tax of about 9% on the top quintile with the proceeds transferred to the bottom two quintiles. For a middle-class family with assets of about $250,000 this would come to about $22,500.

II.B.2.d. Simulation Models

Models of changes in income distribution that are simple enough to allow analytic solutions may be incapable of providing results specific enough to inform policy. A complementary approach to learning about economic growth and the distribution of income is to construct models that seek to describe economic behavior in far more particular detail, and achieve numerical, rather than analytic, solutions[62].

Robinson (1979) describes the structural components of such a model. The core would be a computable general equilibrium (CGE) model. These are multi-sector, aggregate input-output models capable of showing how wages, prices, and factor supplies are likely to change when one or more independent variables or parameter values change. The CGE would be expanded to include a social accounting matrix, or SAM, which links the core CGE with

demographic and other social variables. The SAM should allow factor incomes to be converted into household incomes, and larger income aggregates could be built up from these. Robinson also notes that the model must include the laws of motion of a dynamic economy, in order to move the short range adjustments produced by the CGE model over a long range trajectory. Thus a dynamic CGE model is a succession of short range CGE runs, with adjustments (say, for capital investment or technological change) after each run. Further, a comprehensive model of income distribution would also have to include assumptions about human capital formation, education, motivation, expectations, household formation and similar social processes that take place over periods of decades.

Much of the early development of CGE models in the 1970's was motivated specifically by the desire to study issues concerning income distribution and growth (see Adelman and Robinson 1976; Dervis et al. 1982). Interest in distributive issues declined during the 1980's as economic growth in the developing countries faltered and attention turned to the pressing need of its revival by any means necessary.

The income distributions generated by the early CGE models tended to be remarkably stable over long periods of time, regardless of trends in economic growth or for that matter of policies. This came as a surprise to the developers of these models, who appear to have been expecting Kuznets curves.

Results from a typical CGE model are shown in **IIB-27**. This model (Moreland 1984) drew on functional forms and parameter values of an earlier model of the Philippines, and was intended to mimic a representative developing country. Over three decades per capita income increases by a factor of 2.5, i.e., at an average annual growth rate of 3%, but the Gini coefficient is essentially static. An aggressive set of redistributive policies has the effect of increasing the average annual growth rate to 4.7%, but barely nudges the Gini from .614 to .591.

---

[62] The Bessinger-Cole model noted in section B.6 above is a model of this type. I described it there because of its special focus on the question of technology and distribution.

BOX IIB-27. The BACHUE-International Model of Growth and Income Distribution
[source: Moreland, 1984]

The Bachue Model sought to model the impact of distributive policies on income distribution. The Table and Figures below show the impact of the following set of policies:

* Education Completion: + 25%
* Migration propensity: + 50%
* Unemployment Benefits + 25%
* Profit Taxes: + 25%
* Urban Unemployment - 25%

Table 1. Inequality Without and With Redistributive Policies

year	per capita income (no policies)	per capita income (with policies)	year	total Gini (no policies)	total Gini (with policies)
0	1.99	1.99	0	0.614	0.614
5	2.29	2.37	5	0.617	0.606
10	2.59	2.75	10	0.624	0.598
15	2.81	3.13	15	0.628	0.590
20	3.21	3.90	20	0.631	0.590
25	3.90	4.95	25	0.633	0.590
30	4.91	6.16	30	0.635	0.590

Average annual per capita income growth rate:
With no distributive policies: 3.6%
With distributive policies: 4.9%

Figure 1. Per Capita Incomes (Bachue Model)

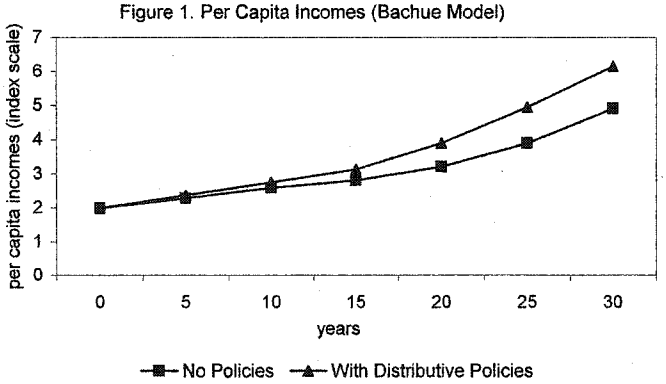
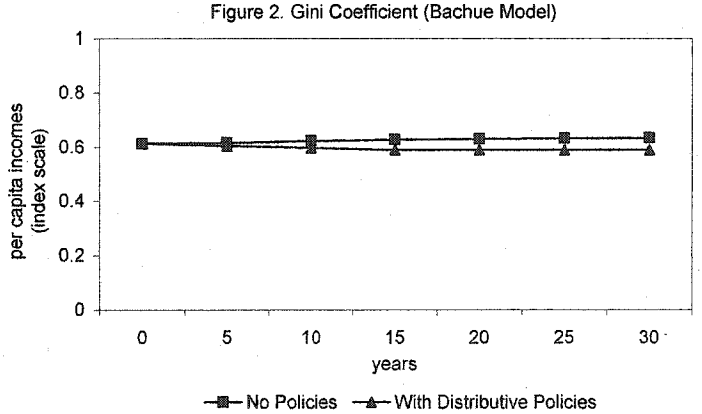


Figure 2. Gini Coefficient (Bachue Model)



Explanations for the stability of the income distributions focused on the use of particular functional forms regarding market closure, on the fact that income received by one sector "leaks" into other sectors over time, and on the omission of important sociological factors. (see Taylor and Lysy 1979 and Dervis 1982). It may or may not be coincidental that the results of the early GGE models now appear to be supported by the Deininger-Squire data set.

II.B.2.e. Review and Assessment

For most of the last 40 years the distribution of income within most countries has been largely stable. Over the past 20 years the inequality of incomes has increased, at varying rates, in most, although not all, mature industrial countries.

A major part of the increase in income inequality appears to have been due to technological change that rewards higher levels of education and skills. A question of critical importance is whether the continuing growth of economic output necessarily requires an increasingly technologically-skilled labor force. It is widely asserted, although not demonstrated, that this is so.

Other factors that have contributed to greater inequality include the growth of trade and deindustrialization, and to a lesser extent changes in demographics and public policies. The expansion of international trade is expected to worsen the distribution of incomes in high income countries and improve it in low income countries, but opinions differ as to whether the magnitudes of these changes will be large or small. In any event the impact should lessen over time as per capita incomes of the higher and lower income countries converge.

Although the aggregate growth of inequality has arguably been moderate, the growth of incomes realized by the very highest percentiles has been much greater. This is less likely to be a result of higher returns to skilled labor than it is of winner-take-all structures resulting from the growth of markets in general and globalization in particular, and from the use of some portion of

upper percentile incomes to influence political, social and cultural behaviors that protect and advance these income shares.

Neo-classical models suggest that there should be stable levels of economic growth, human capital accumulation, and earnings distribution. There is little evidence of any strictly economic mechanism that would necessarily cause higher levels of inequality to have a seriously retarding effect on the rate of economic growth, at least at levels that appear plausible over the next 75 years or so. Of course, even a moderate increase in inequality could elicit social and political responses that could affect growth. Models that include endogenous policy suggest that high income persons would accept some measure of redistributive effort, and low income persons would accept some decrease in the rate of economic growth, in order to achieve a stable equilibrium that is optimal for all. In none of the studies surveyed did it appear that the optimal rate of economic growth would be zero.

The solution values of these models depend upon the nature and distribution of initial endowments and on a host of parameters that reflect largely normative and social factors. These include such factors as the nature of parental utility functions, social externalities to education and skill, and whether the accumulation and use of human capital is subject to increasing, constant or decreasing returns. Because such factors are difficult to define and measure empirically, it is difficult to know whether the results generated by these models are important or not. When speculative but plausible values for these factors are applied to these models, the relation between economic growth and inequality is not shown to be strong.

Based on this review, what patterns of interaction between economic growth and income inequality should we incorporate into our scenarios of long run global development? In our reference scenario, Scenario 1, we showed no relationship between economic growth and income inequality in the high income countries. In the developing countries we showed inequality declining as per capita GDP increased, to the point where both per capita GDP and 80/20 ratios were equal to their respective values in the developed countries as of 1960. After that point the

80/20 ratios continued unchanged, as they did in the developed countries. In retrospect, and quite fortuitously, it appears that these reference case assumptions are as plausible as any others, and maybe more so.

But what advocated goals for distributional equity can we realistically propose, and what do we need to do to realize them? Our provisional ideal scenario calls for the realization of 80/20 ratios of 2.5, in all countries, by 2150. In the next two sections we review policies that have been proposed to reduce income inequality, and discuss public opinion about inequality and ways to reduce it. After that we evaluate our ideal scenario regarding income distributional goals.

II.B.3 PROPOSALS FOR REDUCING ECONOMIC INEQUALITY

Almost any action by any individual, firm, or public sector institution can be shown to have some impact on the distribution of income and wealth. But clearly some actions have larger impacts than others. Private and public sector activities, programs, and policy areas that are thought to have significant impacts on the distribution of income and wealth, and that are typically invoked as potential policy tools, include:

1) Taxes and direct cash transfers (progressive taxes, earned income tax credits, social insurance)
2) In-kind services (health care, social services)
3) Training and education (public and private education, on-the-job training)
4) Economic policy measures (macroeconomic policy; trade policy; minimum wage policy)
5) Institutional mechanisms and regulations (unionization, affirmative action, worker ownership)

For the most part measures such as these take for granted the larger social and economic institutional structure of American society. Some authors believe that more fundamental changes in these institutions may be necessary if inequalities of income and wealth are to be reduced in a significant way.

Box IIB-28 lists a number of books that address the issue of growing economic inequality in one manner or another. The notes that follow summarize what the authors of these books believe should be done about it.[63]

II.B.3.a. Conservatives, Neo-Conservatives, Libertarians and Technocrats

1,2. **Newt Gingrich**'s *To Renew America* and **Alvin and Heidi Toffler**'s *Creating a New Civilization* are notably similar in both the tone and content of their economic vision. They

[63] The proposals reviewed here mostly address economic inequality in the United States. We consider proposals that address inequality outside the U.S., with emphasis on developing countries, in Section II.D.4.

BOX IIB-28. INEQUALITY: WHAT SHOULD BE DONE?

Texts reviewed:

CONSERVATIVES, NEO-CONSERVATIVES, LIBERTARIANS AND TECHNOCRATS

1. Newt Gingrich. 1995. *To Renew America*
2. Alvin and Heidi Toffler. 1995. *Creating a New Civilization: The Politics of the Third Wave*
3. Francis Fukuyama. 1992. *The End of History and the Last Man*

LIBERALS

4. Lester Thurow. 1996. *The Future of Capitalism*
5. Robert Reich. 1991. *The Work of Nations*
6. Mickey Kaus. 1992. *The End of Equality*
7. Sheldon Danziger and Peter Gottschalk. 1995. *America Unequal*
8. Robert Frank and Philip Cook. 1995. *The Winner-Take-All Society*
9. *Economic Report of the President.* 1995.
10. *Report of the Council of Economic Advisors.* 1995. Laura D'Andrea Tyson, Chair
11. Paul Krugman. 1994. *The Age of Diminishing Expectations*

PROGRESSIVES

12. Bennett Harrison and Barry Bluestone. 1988. *The Great U-Turn: Corporate Restructuring and the Polarizing of America*
13. Juliet Schor. 1995. "A Sustainable Economy for the Twentieth Century."
14. Arjun Makhijani. 1992. *From Global Capitalism to Economic Justice*

GREENS

15. Herman Daly and John Cobb. 1989. *For the Common Good*
16. Paul Ehrlich, Ann Ehrlich, Gretchen Daily. 1995. *The Stork and the Plow: the equity solution*
17. Paul Ekins et al. 1992. *The Gaia Atlas of Green Economics*
18. Donella Meadows, Dennis Meadows, Jorgen Randers. 1992. *Beyond the Limits to Growth*
19. World Commission on Environment and Development. 1987. *Our Common Future*

both paint glowing pictures of a libertarian techno-utopia of expanding economic prosperity for all. This new "brain-based economy" will be "dominated" by a "cognitariat" of "super-symbolic leaders" who "thrive on chaos." Gingrich says that in the new Third Wave economy "your livelihood and security are likely to come from becoming an expert--maybe the world's greatest expert--on one small corner of this vast infosphere." Neither Gingrich nor the Tofflers discuss questions of economic inequality in any detail. Both acknowledge that even under conditions of general prosperity some persons may be disadvantaged. As a result, the Tofflers write, "we will need schooling, apprenticeships and on-the-job learning for work in such fields as the human services--helping to care, for example, for our fast-growing population of the elderly, providing child care, health services, personal security, training services, leisure and recreation services, tourism and the like." The Tofflers also write of job opportunities "for domestic workers who are desperately needed in millions of two-income homes."

3. **Francis Fukuyama**'s *The End of History* received much attention, just as the Soviet Union was breaking up, for its thesis that liberal democratic capitalism has decisively shown itself to be able to satisfy complex human needs more effectively than other systems. While Gingrich and the Tofflers are effectively silent about economic inequality, Fukuyama affirms it. He follows Nietzsche and celebrates *megalothymia,* the desire to be recognized as superior to others, as "a necessary precondition for life itself." Fukuyama states that liberal democracy's "long run health and stability rests on the quality and number of outlets for *megalothymia* that are available to its citizens." He suggests that capitalist entrepreneurship, scientific and technological competition, and democratic political contests provide a mutually reinforcing set of *megalothymotic* outlets. He says that entrepreneurship attracts "the most talented and ambitious natures," and that technology "makes possible the limitless accumulation of wealth, and thus the satisfaction of an ever-expanding set of human desires." He warns darkly that *isothymia,* the desire to be recognized as equal with others, "will quickly run into limits imposed by nature itself." He does not address issues of poverty.

II.B.3.b. Liberals and Neo-Liberals

4. In marked contrast to libertarians like Gingrich and the Tofflers, liberals like Lester Thurow and Robert Reich address the topic of growing economic inequality head-on. Both have been among the most consistent and articulate establishment academic voices sounding the alarm as economic inequality has continued to grow. Here is **Lester Thurow**, in *The Future of Capitalism*:

> "A dramatic change has occurred in the distribution of income and wealth over the past twenty-five years and absolutely nothing has been done to reverse it. Policies to reverse current trends are not even being debated... [T]hese trends are produced by forces so fundamental that it is clear that they are not going to be reversed by marginal reforms in economic policies. Massive structural change will be required." (pp 311-312)

It is remarkable then, to find that the concrete proposals put forward by Thurow (and by Reich; see below) for addressing economic inequality are in their most important respects not radically different from those of Gingrich and the Tofflers. In a nutshell, all four authors identify technological change as the driving force of modern economic life, and all four authors say that we are all going to have to accept this and adapt ourselves to it through massive investment in education and training. Here is Thurow's sole specific recommendation concerning what we should do concerning rising economic inequality:

> "The United States should commit to having the most skilled and best-educated labor force in the world. This means finding out who has the best-educated labor force at every level, being willing to chart our progress in catching up with and then passing whoever is best, and committing to doing whatever is necessary to achieve that goal. If something does not work it should be ruthlessly junked and other means adopted--but nothing will be allowed to stop us from reaching that goal." (p 316)

5. In his best-seller, *The Work of Nations,* **Robert Reich** classifies American workers into three groups, "routine producers," "in-service providers," and "symbolic analysts." Routine producers and in-service providers are both suffering, the first because their jobs (on assembly lines or as clerical workers) are moving overseas, and the second because their jobs (as bank tellers or gas station attendants) are being replaced by technology. But symbolic analysts are

having a field day. These are the scientists, engineers, bankers, lawyers, executives, accountants, consultants, planners, administrators, economists, architects, media people, editors, teachers and the rest of the professional strata.

Reich notes forcefully that technological change and globalization are allowing the symbolic analyst class to amass unprecedented wealth, while squeezing the routine producers and in-service workers ever tighter. He paints a picture of the professional top 20% of Americans "seceding" into their exclusive enclaves and withdrawing personal and financial support from the rest of American society and culture.

What is to be done? Reich suggests four things:

1) imposition of a truly progressive income tax, with few loopholes.

2) making sure that "any reasonably talented American child can become a symbolic analyst." This would require such steps as: a) early childhood education and nutrition assistance; b) greater support for public education at all levels; c) "additional investment in universities, research parks, airports and other facilities conducive to symbolic-analytic work; d) greater corporate participation in life-long training of employees.

3) seeking to upgrade lower-level production and service work through application of technology, reorganization, and training.

4) seeking to address the needs of the long-term poor, through a) job training programs; c) free child care for poor, single, working mothers; c) remedial course in reading, writing, and mathematics; and d) intensive pre-school education.

Except for items 1) and 4c) this is a "training" agenda, and differs from the libertarian/conservative agenda primarily in that Reich believes the public sector should play a major role in making it happen, while Gingrich and the Tofflers would rely on private initiatives. This is not a trivial difference, of course, because under Reich the training would serve those persons that the market would leave behind. But the effectiveness of the "training solution" is hotly debated. Schwartz (1995) writes, "...according to generally accepted estimates, an effective education and training program would cost more than $170 billion a year" (p A25). A federal program of this size would be exceeded only by that of Social Security ($336 billion), Health and Human Services ($301 billion) and the Defense Department ($260 billion). My point in making

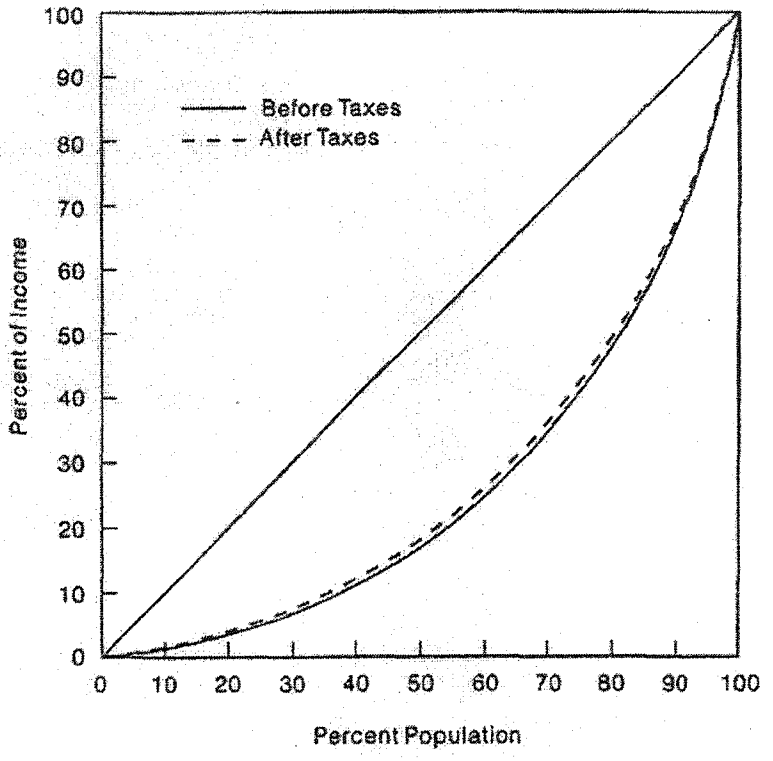
the comparison is not to disparage the "training solution" but to make clear the magnitude of the social/political movement needed for it to be realized.

It may come as a surprise to many to find that Reich's first agenda item, a more progressive, loophole-free tax system, can have only a small impact on the growth of economic inequality. **IIB-29** shows how little the before-tax and after-tax Lorenz curves for 1988 differ from one another. Gramlich et al. (1993) examined the impact that even much more highly progressive tax programs would have on inequality, and found it to be minor.[64] The reason is simply that economic inequality is of such a magnitude that the federal budget, large as it might appear, is too small to counter this in a major way, even if it were paid for almost entirely from among the upper percentiles. Of course, a program of taxes and transfers whose explicit objective was to redistribute income could be designed to effect any desired distribution. But such a program would be much larger than the current federal budget if its objective was to reduce the Gini coefficient by more than a few percent.

6. **Mickey Kaus** was an editor of *The New Republic* and has written for many years about American social and economic policy. In *The End of Equality* he suggests that attempts to engineer greater economic equality will not work, simply because capitalism is *intended* to generate economic inequality (i.e., to facilitate competition for economic status), and there is no alternative to capitalism on the horizon. But he deplores the way wealthy persons are using their resources to impose *social* inequality by retreating into gated communities, withdrawing support for the well-being of the wider public sphere, and influencing public policy to their further advantage. He proposes policies that would insulate the most important qualities of social life from the influence of private wealth. The intent would be to begin building a common social and

[64] Gramlich simulates a new progressive tax package that includes a) an increase in the top marginal tax income tax rate from its current 28 percent to 50 percent; b) a 0.5 percent tax on security transactions; c) elimination of the taxable maximum for Social Security Hospital insurance taxes; d) doubling of the Earned Income Tax Credit; and e) an increase in SSI benefits. He finds that "even this combination would only lower the post-tax, post-transfer Gini by .01, only about 15 percent of the way back to the post-tax, post-transfer Gini in 1980." (p 243)

BOX IIB.29. Lorenz Curve of Income Distribution in the United States, before and after taxes, 1988.
[Reprinted from Young, 1994]



Young writes: "To what extent does the federal income tax lower inequality? The answer is: not by very much. The Gini index decreases from .511 to .492, which represents a very slight decrease in inequality. Although the figure is not detailed enough to show this, the major effect of taxation is to reduce the share of total income enjoyed by the richest one-tenth of the population by about 2 percent, and to increase the share of total income enjoyed by the lower- to middle-income groups by a comparable amount. The effects of the poorest one-tenth of the population and the next-to-richest one-tenth are about neutral." (pp 101-102)

political culture towards which all Americans could feel genuine allegiance, regardless of economic differences. He suggests a three-stage set of initiatives:

Stage I: Reinstitution of the military draft, with no way for the privileged to weasel out, and mandatory national service for those not drafted. Public financing of elections, to eliminate the influence of wealthy contributors. A universal system of national health care, with strong penalties for not participating ("what matters is that everyone wait in the same waiting room"). A comprehensive day-care system (centered at the work place, so that "the toddlers of secretaries mix with the toddlers of bank presidents.")

Stage II: The elimination of poverty. Kaus says that a true common culture cannot emerge in the United States until people of different economic backgrounds feel comfortable living in the same neighborhoods and sending their kids to the same schools. But he acknowledges that this will not happen so long as 15% of Americans live in poverty. He states that the existing poverty programs of income support and services have not been successful, and proposes that they be abolished. In their place he offers what he believes is the only workable alternative: a guaranteed low-wage ($4.00/hr in 1990) but respectable public-sector job for all who are willing to work. In addition an extended Earned Income Tax Credit would bring these and all other workers up to the poverty line. Kaus estimates that this entire program would be called on to provide about 6 million jobs and would require an additional $60 billion above the current amounts spent on poverty relief.

Stage III: Kaus's final stage, in which he speaks of "an ecology of equality," is admittedly more speculative. He envisions a movement for social egalitarianism breaking down the barriers of residence and schooling, "suburb by suburb." He says, "The upper middle class... will have to be bought off or beaten down--or else overcome by an appeal to the compensating virtues of social equality." High quality public services, and especially public schools, are both necessary for such a movement to succeed and will be more easily provided as it builds.

Kaus' program is grounded in what he calls a philosophy of Civic Liberalism, which he opposes to the failed Money Liberalism of both establishment and progressive Democrats. He writes as one of many authors seeking to formulate new norms of Civil Society and clauses for a new Social Contract. As we'll see below, his proposal to end poverty falls comfortably within an emerging consensus opinion among a wide range of moderates, liberals and progressives. More problematic is his contention that a common social culture can be developed and sustained *even while* economic inequality continues to increase. Progressives (and most Greens, although they don't figure in Kaus' discussion) would challenge this. Kaus acknowledges that a major reconfiguring of social values would be needed for his program to succeed. But he claims that this new configuration would draw upon a widely shared set of conventional American values, including patriotism and the work ethic, and therefore has more chance of success, than does a left/progressive value configuration that is less widely shared (and is in fact perceived as threatening by significant numbers of lower middle class Americans.)

7. In *America Unequal* **Sheldon Danziger** and **Peter Gottschalk** tell a story of the growth of economic inequality in America very similar to that told by Thurow, Reich, and Kaus. After an incisive analysis of the many dimensions of inequality they focus their policy analysis on the single topic of how to reduce poverty. They do not suggest ways to address the erosion of stable mid-level incomes, the swelling numbers of very highly paid professionals, or the skyrocketing incomes of the most affluent.

This is disappointing. However, their proposal for dealing with poverty is an important one because it is crafted in sufficient detail, and with sufficient political acumen, that it could serve as a credible vehicle for the development of policy by an Administration truly committed to make a real difference on this issue. The goal of their program is to "ensure that a family with a least one full-time worker earning the minimum wage would have an income above the poverty line, after taxes and child care expenses."

Box IIB-30 offers a concise depiction of the economic dimension of poverty in America. It shows that as of 1991 there were 31.1 million poor persons in the United States. Of these, 30% are in families in which the heads are disabled, institutionalized, over age 65, or otherwise in a situation where they are not expected to work.

Of the remaining 21.6 million poor persons, 19% live in families whose heads are in fact full-time, full-year workers; another 19% have family heads that work more than half time; and an additional 20% have family heads that have at least worked at some point during the year. Of the remaining 8.9 million poor persons, 21% can be identified as having actively looked for work during the year, but with no success.

The Danziger-Gottschalk program "is targeted on... the roughly 14.5 million poor persons in families with heads who are working or looking for work." It has several components:

A. Rewarding Work
    1. An Earned Income Tax Credit (See **IIB-31**)
    2. Refundable Income Tax Credits for the Working Poor
    3. State income tax relief for the working poor

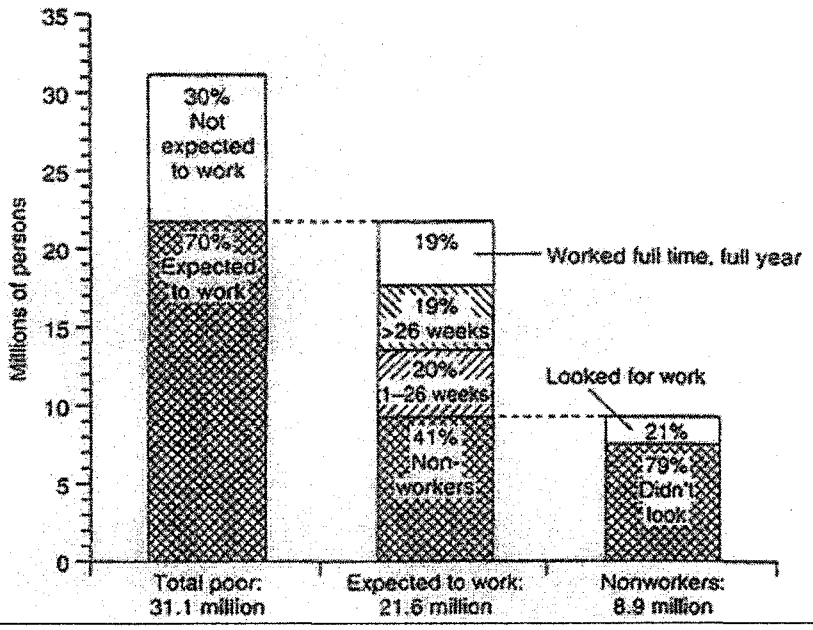
B. Expanding Employment Opportunities
    1. Employer subsidies
    2. Public Service Employment

C. Child Support for Single-Parent Families

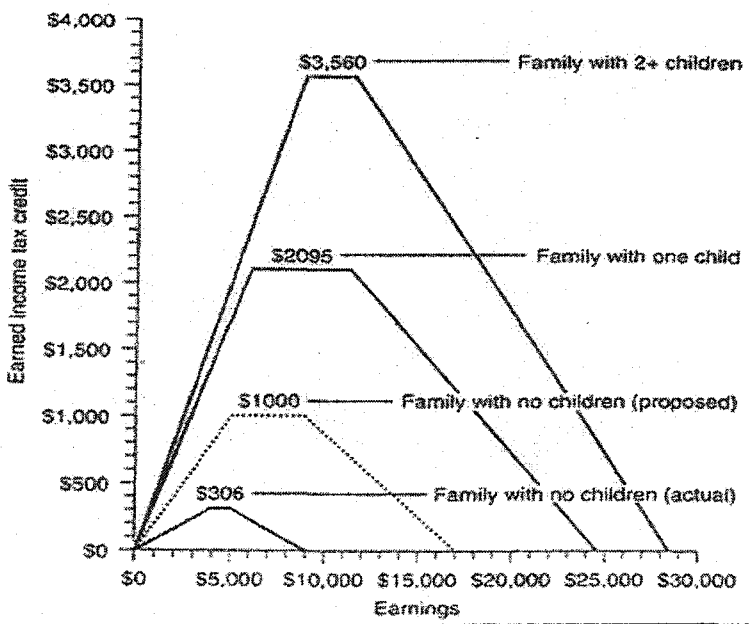
Danziger and Gottschalk estimate that their total program would require some $20 billion in new spending. They suggest that implementation might begin by obtaining "funding to move forward in those areas where we know what works and funds for demonstration projects in those areas where we need more information."

It would have been illuminating to see what authors as thorough as Danziger and Gottschalk would propose be done about the growth of economic inequality among persons other than those living in poverty. A defense of their presentation might be that concern for poor people has an ethical claim over concern for others in situations of less objectively oppressive circumstances. Further, the case can be made that there is more of a chance of assembling a sufficiently powerful political coalition in support of the serious reduction in poverty--say, within

BOX IIB-30. Poor Persons by Work Status of Head of Family, 1991
[Reprinted from Danziger and Gottschalk, 1995]



BOX IIB-31. Earned Income Tax Credit, 1996
[Reprinted from Danziger and Gottschalk, 1995]



the next decade--than there is of doing so in behalf of measures that would dim the economic prospects of the broad professional class and the truly affluent (beyond such symbolic but distributionally insignificant measures such as minimum taxes and luxury taxes.)

8. **Robert Frank** and **Philip Cook** address the third dimension of the growth of economic inequality-- "run-away incomes at the top"-- in *The Winner-Take-All Society.* They note that attempts to understand these high incomes using the conventional human capital framework have been unsuccessful. They suggest that many persons in the very top positions of any field, whether business, entertainment, academia or otherwise, receive the high incomes they do because they are operating within "winner-take-all" markets.[65] These are markets whose payoffs are determined by relative as well as absolute performance. Such markets arise when people are willing to pay substantial premiums to obtain the (relative) "very best," even if "the best" may be only marginally better (in absolute terms) than many other performers just short of the top position. An important contributing factor is the global expansion of markets. The bigger the market, the more people there are to buy a mass market item (e.g., a CD) by a reputed "top" performer, or who are in a position to bid up the price of a professional service (e.g., a lawyer's fee) in order to get "the best in the business."

Frank and Cook suggest that winner-take-all markets encourage an excess number of contestants to attempt to enter these markets and are thus inefficient. They also propose that institutions such as hospitals and universities will engage in "positional arms races" to attract the very top professional talent and thus bid up the prices beyond the economically efficient level. And they believe that extreme inequalities of compensation are socially undesirable, even if they were economically efficient. Thus they recommend adoption of policies that would limit entrance into these markets, call a truce to positional arms races, or just reduce the winners' take. They suggest steeply progressive income or consumption taxes, and a variety of measures appropriate to particular professions: reform of physician fee structures, caps on liability rewards

for attorneys, tuition increases at public universities for students in lucrative professional fields, and the like. But they give no estimates of how big of an impact any of these measures might have on winner-take-all incomes, and thus on the overall extent of economic inequality in society.

9, 10. It's instructive to compare the recommendations of the authors we've reviewed with the policies proposed by the Clinton Administration during this period. The *Economic Report* of *the President* (1995) and the *Annual Report* of the **Council of Economic Advisors** for 1995 acknowledge that the growth of income inequality is a matter of serious concern. The President begins his report by noting with satisfaction that output is rising, the deficit falling, and employment growing, but immediately adds,

> "Still, living standards for many Americans have not improved as the economy has expanded. For the last 15 years, those Americans with the most education and the greatest flexibility to seek new opportunities have seen their incomes grow. But the rest of our work force have seen their incomes either stagnate or fall. An America that, in our finest moments, has always grown together, now grows apart." (p 3)

This is followed by statements that "In our new information-age economy, learning must become a way of life," and that "Technology is the driving force of the new global economy." But the training and other programs proposed to address this situation, while certainly beneficial, are hardly substantial enough to make a noticeable aggregate difference in income inequality.

The President seeks to address eroding mid-range incomes with his "Middle Class Bill of Rights". It provides that:

> * If a family makes less than $120,000 a year, the tuition that that family pays for college, community college, graduate school, professional school, vocational education, or worker training should be fully deductible, up to $10,000 a year.
>
> * If a family makes $75,000 a year or less, that family should receive a tax cut, up to $500, for every child under the age of 13.
>
> * If a family makes less than $100,000, that family should be able to put $2,000 a year, tax free, into an individual retirement account from which it can withdraw, tax free, money to pay for education, health care, a first home, or the care of an elderly parent.

Because all but the top 2 or 3 percent of American households qualify for the biggest part of this "middle class" tax relief (see Box IIB-9) it is unclear whether their effective impact would

---

[65] Winner-take-all markets are also discussed in Section II.B.2.b, above, regarding the causes of inequality.

be to decrease or increase the level of economic inequality. In any event, the overall impact of these proposals on the distribution of income would not be major.

11. **Paul Krugman** begins *The Age of Diminished Expectations* by stating that economic growth and income distribution are far more important to overall human well-being than are deficits, trade policy, inflation, finance, or any of the other economic issues that command so much attention in the public arena. He echoes most of the authors reviewed thus far:

> "Although some people became fabulously rich, and a sizable fraction of the population achieved unprecedented affluence, the typical American family... earned little if any more in real terms in 1990 than they did in the late 1970's... And for Americans in the bottom fifth of the income distribution the years since 1980 have been little short of nightmarish, with real incomes dropping, the fraction of the population in poverty rising, and homelessness soaring." (p 2)

Krugman continues his account by addressing the key question of the stagnation of economic output over the past two decades: "Why did it happen? And what can we do about it? The answer to both is the same: We don't know."

Krugman considers a number of proposed explanations, including the upheavals of the 60's and the energy crisis of the 70's, and shows why these are implausible explanations. He says, "So we really don't know why productivity growth ground to a near halt. That makes it hard to answer the other question: What can we do to speed it up?"

He notes that the conventional answer given by economists is simply to:

> "...give your workers more capital to work with, and better education, and they will be more productive. And how are we to do these things? Simple: Suffer. Consume less now... send your children to school for more hours, and pay for the extra teachers and classrooms this requires. Do these things, and though you may be worse off right now, eventually... ten years from now--or is it 20?--our productivity will be sufficiently higher to make up for present sacrifices." (p 20)

Krugman says that neither the "supply side" theories of Arthur Laffer and Jude Wanniski, which were tried, and failed, during the Reagan years, nor the "industrial policy" theories of Robert Reich and Lester Thurow, which are praised by the Clinton Administration but receive only token support in practice, appear to be very helpful. He concludes:

> "So what are we going to do about productivity growth in the United States? Nothing... [T]he basic political consensus at present is that a low rate of productivity growth is something America can live with. We can hope that something will turn up... [b]ut we won't do much more than wish... Productivity growth is the single most important factor affecting our economic well-being. But it is not a policy issue, because we are not going to do anything about it." (p 22)

Next Krugman considers income distribution. He reviews how growing income disparities are eating away at America's social fabric, but then says,

> "Yet income distribution, like productivity growth, is not a policy issue that is on the table. This is partly because we don't fully understand why inequality soared, but mostly because any attempt to reverse its trend appears politically out of bounds... [And] the problem with poverty, as an issue, is that it has basically exhausted the patience of the general public... any systematic initiative to raise the incomes of the poor seems unlikely for many years." (p 26; 28-29)

As for the rich, he notes that while "a few policy initiatives might cut down on some of their sources of income," these "would make only a small dent in the trend."

Krugman concludes:

> "So income distribution, like productivity growth, is a policy issue with little prospect for serious policy action. The growing gap between rich and poor was arguably the central fact about economic life in America in the 1980s. But no policy changes now under discussion seem likely to do much to narrow this gap." (p 29)

What are we to make of this analysis by one of the most prolific and quoted economists of our time? And a liberal at that?

When he says that no policies "now under discussion" appear likely to narrow the income gap, we need to ask what group of discussants he has in mind. Analysts like Danziger and Gottschalk have developed what amount to pre-drafts of legislation that could importantly address the issue of poverty in America. But Krugman may be correct in so far as the coalitional pre-organizing necessary to mount a legislative drive in support of a poverty initiative of the sort envisioned by Danziger and Gottschalk is not underway. These sorts of reforms require a decade or more of base-building before they become real legislative options.

With respect to the question of growing income inequality among people who are not poor, Krugman is correct. Nothing proposed by Thurow, Reich, Danziger, Gottschalk, Kaus,

Frank, Cook, the Council of Economic Advisors or the President "seem likely to do much to narrow this gap." For our purposes, however, it's premature to conclude, as Krugman does, that discussion of this topic is "politically out of bounds." To judge whether a proposal for addressing inequality among the non-poor is politically practical we need, first, to see the proposal, preferably one as comprehensive as the one Danziger and Gottschalk have offered to reduce poverty. But none of the analysts reviewed above, Krugman included, have offered one.

II.B.3.c. Progressives

What I call "progressives" are what used to be called "democratic socialists" or "left social democrats." The liberals just reviewed accept capitalism as the least problematic of a set of imperfect economic systems. The progressives, by contrast, may acknowledge capitalism's vigor and resiliency but are not yet reconciled to it, and have their antennae deployed to pick up any hints of cracks in the foundations, and any whispers of an alternative in the wings. For many progressives the perpetuation and deepening of economic and social inequality under *laissez-faire* capitalism is the fundamental reason why it should be opposed.

12. **Bennett Harrison** and **Barry Bluestone** were among the very first authors to claim that the slower growth and increasing inequality that began in the early 1970's represented something more than a dip in an otherwise healthy business cycle. In their best-seller *The Great U-Turn: Corporate Restructuring and the Polarization of America*, they put the cause of this squarely in the lap of corporate America. In response to growing global competition, they said, American corporate managers adopted a strategy of "slashing labor costs throughout the economy." Higher wage labor was, logically, the first target. Much of this was located in the industrial sectors of the labor force. Thus a strategy of slashing labor costs became a strategy of deindustrialization. Management also went on the offensive against the unions. Union contracts tend to equalize wage rates among individuals across broad categories of workers. The decline of union labor contributed both to lower wages in general and increasing wage inequality. Finally,

Bluestone and Harris note that "as the economy transfers workers from goods production, where school credentials have relatively little importance to wage differentials, to the service industries, where such differentials are high, the overall degree of wage inequality is destined to increase."

Harrison and Bluestone advocate that instead of this "low road" strategy of global competition in a race to the bottom, we should embark on the "high road alternative":

> "We must work not cheaper, but smarter, with smarter machines. The high road suggests that as a nation we must undertake enormous new investments in science and technology; in applied research and development efforts; in new capital formation; in education, training and retraining; and in new forms of labor-management practices that foster economic democracy and teamwork." (p xxvi)

This high road competitive strategy is one facet of the overall strategy proposed by Harrison and Bluestone to achieve

> "...the promise of an ever-improving standard of living. Americans expect to find and hold high-paying jobs as they get older, and they expect their children to fare even better. As generations pass, we also look forward to more time for leisure without suffering losses in pay...The American Dream has [also] traditionally been infused with a strong social conscience and an abiding belief that a more equal society is a more equitable one." (p vii)

The strategy to accomplish this calls for:

1) industrial policy;
2) democracy in the workplace;
3) renewed public support for the right of unorganized workers to be represented by unions of their choosing;
4) managed international trade;
5) the reconstruction of the nation's physical infrastructure;
6) reregulation of specific private market activities, especially in the runaway financial sector;
7) public fulfillment of the promise of universal social benefits, including health insurance, child care, and care of the aging.

They recognize that this is an ambitious agenda but are confident of success:

> "Essentially, the United States must turn back toward greater planning and away from the treacherous path of *laissez-faire*. Do we believe this will occur? Absolutely. The world of *laissez-faire* is too unstable and its presumed benefits too inequitable. Sooner or later, the pendulum will swing back toward a better balance between unfettered free enterprise and democratic planning. Otherwise, there is no chance at all of reversing the great U-

turn that has undermined both our standard of living and our progress toward a more just society." (p 20)

Notice that the majority of the seven points in Harrison and Bluestone's strategy concern the management of economic outcomes by way of political processes. Once such democratic planning mechanisms have been established, the growth of economic inequality would be curtailed simply by deciding not to do those things that increase it. Any supposed inefficiency that this process might entail would be more than compensated for by the renewed commitment to technological innovation and economic growth on the part of working Americans, now that we are assured that the fruits of our labor will be fully and equitably shared. Thus the structure of political and economic power in Harrison and Bluestones' vision represents a radical break from the status quo structures assumed by the liberals, but the program that they call for is otherwise not that different: education and training for technological change to encourage economic growth.

13. **Juliet Schor**'s article, *A Sustainable Economy for the Twenty-first Century,* presents the economic vision of the New Party. According to Schor,

> "The debate between Republicans and Democrats on economics has narrowed to a marginal one. Both sides now worship at the alter of the market, differing mainly on whether it should be marginally regulated in the public interest or not regulated at all. Both defend the sanctity of the existing distribution of income, wealth and power... We think we've got a better idea." (p 269)

The New Party's vision is based on principles of democratic control, sustainability, equality and efficiency. Many of the policies Schor suggests have an important bearing on the level and distribution of incomes. These include:

> *1. Basic Income Grant (BIG):* "[E]very citizen would be eligible to receive a minimum income from the government, which would be sufficient to provide a modest standard of living. A BIG would allow people to opt out of the labor market for a while, to raise their children or pursue activities that are not lucrative (the arts, community work, or social services). It would enable them to retire when they feel ready, or to pursue schooling or retraining. Eligibility would be tied to a work requirement: the length of eligibility for receiving BIG would be tied to past work, and participation in unpaid community service, as well as child and elder care."
>
> *2. comparable worth:* "[A]ll places of employment [should] be required to institute

comparable worth programs...phased in over a three year period."

3. minimum wage: "We suggest a phased-in increase to $7.00 an hour for adults, with subsequent pegging to the median wage in the economy."

4. progressive taxes: Schor calls for expansion of lower income exemptions, higher marginal rates for higher incomes, removal of the income cap on payroll taxes, and higher corporate income taxes.

5. green tax: A national value-added 'green' tax should be levied on retail commodities such as gasoline; household, lawn and pool chemicals; air conditioners; meat; furniture; jet travel; and disposable products.

6. Corporate Democracy Act: This legislation would:

a) provide that Boards of Directors be filled from outside management to include workers, consumers and other stakeholders, in addition to stockholders;

b) "...erode the legal fiction of the corporation as person, thereby creating increased civil and criminal liability for individual managers."

c) "...transfer corporate chartering to the Federal government and set minimum standards for tax subsidies, pollution and unfair labor practices..."

7. socially responsible firms: "Government should provide significant incentives for democratically controlled enterprises, such as consumer cooperatives, employee-owned firms, and municipally and community-owned enterprises. These include tax incentives, regulatory encouragement, financial schemes, preferential buying, and technical aid."

Schor notes that "many of these reforms will require new economic resources," and that these new resources "will have to be created through productivity growth." Where Krugman pleads ignorance and is silent Schor demurs only briefly:

> "[However]...the recent US record on productivity growth has not been good... Economists don't have a very good understanding of why productivity growth has been so meager, but the likely culprits are low investment, heavy-handed labor management, declining quality of education and training, the short-term perspective imposed by financial markets, and distorted resource use due to uncounted environmental costs. We also believe that the growing inequities of our society are having an impact: unemployment, poor schools, crime, drugs, homelessness. All these problems take their toll." (p 286)

Schor acknowledges that "over the past fifteen years, the steady demise of progressive economic ideas is striking." She attributes this to "the powerlessness that people feel in the context of the globalizing economy," and the exploitation of that sense of powerlessness by corporate interests to inculcate a hegemonic ideology of free-market capitalism. She concludes

by calling on progressives to "confront the myth of economic powerlessness.. and mobilize alternative visions for a sustainable economy in the twentieth century."

14. In his book *From Global Capitalism to Economic Justice*, **Arjun Makhijani** puts forth a vision that is quite similar to Schor's but begins from a global perspective. He begins,

> "The violence, greed and exploitation characterizing capitalism, the violence and authoritarianism characterizing socialism, and the environmental destruction characterizing them both have made people all over the world search for a "third way..." (p 85)

Makhijani draws on the positive aspects of socialism (its commitment to ending poverty and inequality) and of capitalism (its commitment to political democracy and individual initiative) to present an alternative. Key elements include:

1. The establishment of democratic control over corporations and other economic institutions.
2. The establishment of ways to phase out economic activities which are endangering the Earth.
3. Guaranteed employment for all, at minimum wages set to produce above-poverty-level incomes for full-time work.
4. The integration of non-monetized work into the economic calculus in diverse ways and the accompanying empowerment of women in the economic system.
5. The establishment of democratic control over markets from local to global levels.

Makhijani notes that in order to prevent corporations from avoiding democratic control by playing one nation off against another, we will need

> "..an international agency to create and to enforce rules and regulations for multinational corporations, along with a workable, democratic process in which non-governmental organizations as well as governmental institutions have a role." (p 102)

However, because multi-national corporations are inherently difficult to control, Makhijani suggests that we adopt *local self-reliance* as a preferred scale of economic organization. To do this we would need to set up structures of democratic participation, including workers, community members and others, to control corporations at the local level.

As an alternative to both the capitalist and the Marxist constructions of "property," Makhijani suggests that we

> "...borrow from ancient times, and from tribal peoples and from farmers the concept of *usufruct*... Control of property must be used to provide for ourselves, our children, our

families, our communities. But usufruct also means that property is held in trust for future generations, so that it cannot be violated for short-term profit, gain or even income, as is the norm today." (p 110)

Makhijani notes that the redistribution of wealth and income, far from being a disincentive to initiative, can give poor people, who are often fatalistic or demoralized, a sense of hope and confidence that their work efforts can now be fruitful. He says,

> "Redistribution does not mean absolute equality or the abolishing of riches. It means limiting riches and abolishing poverty. The example of the state of Kerala in India shows that a strong commitment to redistribution can enhance both political democracy and improve the human economic condition immensely with very modest resources." (p 93)

The vision put forth by Schor and Makhijani has a name, although they don't use it: economic democracy. This stance was developed most thoroughly by the progressive activists of the 1970's who were trying at that time to articulate a third way between corporate capitalism and authoritarian socialism. Economic democracy would allow the corporate owners and managers to keep their factories, but would set up representative councils and committees, from the shop floor to the community, regional, and national levels and beyond, to oversee and ensure that any decisions made or actions taken would serve the greater social interest. A reformed state structure more open to grassroots participation would guide and direct the economy as necessary.

II.B.3.d. The Greens

The authors reviewed thus far, whether conservative, liberal or progressive, all affirm economic growth as not just a good thing but as almost an imperative of human life. These authors identify the slowdown in economic growth over the past twenty years as having imposed unnecessary and inequitable hardships on the great majority of persons. For these authors the revival of strong, steady economic growth is arguably the single most important economic task today.

Most environmentalists, by contrast, are ambivalent about economic growth. Many believe it to be an unmitigated bad. Others believe that if properly guided economic growth can

be compatible with, and perhaps even support, environmental sustainability. Still others believe that the question of the goodness or badness of economic growth is moot, because whatever we may or may not desire, there are limits to economic growth and at some point, perhaps soon, it will come to a stop. If such limits exist then the task before us is simply to choose the *sort* of steady-state world in which we would like to live.

Questions concerning the distribution of wealth and income may or may not be of major concern to an environmentalist who believes that economic growth can and should continue. But they are of critical concern to any environmentalist who believes that, by choice or by necessity, the future world economy will be a steady-state economy. Under those circumstances the distribution of wealth and income becomes a nearly zero-sum game.

The authors of the books noted below, with the exception of the authors of *Our Common Future,* believe that in order to prevent a far greater, catastrophic end to human well-being, we should begin a conscious transition to a steady-state world, as expeditiously as practicable. For this view to be considered seriously these authors need to be explicit about how they imagine a future steady-state output to be divided among persons and communities.

15. In *For the Common Good,* **Herman Daly** and **John Cobb** propose an "economics of community" as their alternative to capitalism or socialism. They suggest that we should begin a process of successive decentralizations. In the short run nations should seek to become as independent as possible of the global economy. In the longer run regions and communities within today's nations should seek to become as self-sufficient as possible. At all of these levels, people should seek to reduce the scale of economic activity until it has reached a level that is ecologically sustainable. A greater portion of human livelihood would be devoted to agriculture than is currently the case in the developed nations. Necessary industrial production would be conducted as much as possible by worker-owned firms.

Daly and Cobb acknowledge that in an earlier book Daly had suggested that limits on economic inequality should be set such that the incomes of the most well-off were no greater than

10 times those of the poorest. In *For The Common Good* they decline to set such a limit. Rather, they explain,

> "We think that eventually a healthy community might evolve in which a notion of this sort was politically acceptable.... (in the meantime) we hope that over the years a combination of income and inheritance taxes, on the one hand, and social dividends, worker ownership of business, and guaranteed employment on the other, will reduce the spread of incomes from their present exaggerated range." (p 331)

The tax and incomes policies they propose are as follows:

1. Negative Income Tax - A minimum guaranteed income of $9000 would be set for a family of four. An income tax with marginal rates of 50% would be positively applied to all incomes above $18,000 and negatively to incomes below that level. These transfers, along with national health care and a guaranteed job programs would assure that no family lives in poverty.

2. Other Taxes - Daly and Cobb would continue to use inheritance and gift taxes (for redistributive purposes); would adopt pollution and severance taxes (to internalize external costs); and would allow states and localities to raise revenues via sales and property taxes. They would abolish the corporate income tax, but require that all profits be distributed to shareholders.

Daly and Cobb ground their proposals concerning economic inequality in biblical teachings:

> "The goal for an economics of community is not equality, but limited inequality. Complete equality is the collectivist's denial of true differences in community. Unlimited inequality is the individualist's denial of interdependence and true solidarity in community. The principle of limited inequality... is explicit in biblical accounts of the laws of the ancient Hebrews governing landholding, usury, the Sabbath, the jubilee year, and also in the wisdom literature of Proverbs and Psalms... We get no instruction regarding the proper numerical range of permissible inequality, but on the principle itself the biblical teachings are clear." (p 331)

Daly and Cobb acknowledge that realization of their vision of a politically decentralized, biospheric, self-sufficient world will require profound and deep changes in human understanding, motivation, beliefs, values, and behaviors. They are deeply optimistic that this can happen, but they believe it will require a transformation of the sort that is sparked and sustained by religious experience and commitment. They witness as Protestant Christians, saying,

> "[W]e doubt that without that faith we would have either seen what we have seen or persevered in an unwelcoming context in articulating that vision and calling for change... We have tried to make our case throughout this book in a predominantly secular mode... But we also think the *real* possibility for change depends on an awakening of the religious depths in a world whose secularity has gone quite stale." (p 380)

16. In *The Stork and the Plow: the Equity Answer to the Human Dilemma,* **Paul Ehrlich, Anne Ehrlich** and **Gretchen Daily** try to go beyond the conventional environmentalist account and include equity concerns as a core value:

> "Any hope (for a sustainable future)... lies in becoming more resource-efficient and, especially, more equitable than most human societies have been in a very long time. *Efficiency,* broadly speaking, is the amount of satisfaction derived per unit resource. *Equity* is the similarity of people's access to sociopolitical rights, adequate food and other material resources, health, education, and other ingredients of well-being..." (p 6-7)

At the center of the equity debate is the existence of the gap between the rich and the poor nations of the world. The Ehrlichs and Daily say:

> "All nations should cooperate to close the rich-poor gap, with over-developed nations reducing their material consumption in order to make room for needed physical development in less developed countries. Speed is of the essence, since the scale of the transition is vast, and the lead time required for such tasks as reorganization of cities, redesigning transport systems, and deploying new energy technologies is on the order of a half century." (p 264)

In a way that is less commonly seen in the liberal or progressive literature, the Ehrlichs and Daily stress the importance of action at the personal level:

> "Have an absolute maximum of two children; preferably just one. If you want more, adopt. Educate yourself continuously on environmental issues... join a local environmental organization. Support NGO's working on the equity and other issues that are discussed in this book that are not normally viewed as 'environmental,' but which we hope you are now convinced actually are... Change your lifestyle as much as you can to lessen your impact on Earth's life-support systems...eat less meat, walk... be energy efficient." (p 270-271)

The Ehrlichs and Daily do not provide quantitative estimates of how a comprehensive action agenda in support of equity and sustainability might be implemented, what these would cost, or what final impacts these would have. But they do present in some detail estimates made by U.C. Berkeley Professor John Holdren that suggest what a scenario of global equity might entail from a biophysical perspective. The Holdren scenario provided that:

> "...poor nations would develop fast enough to increase their per capita energy use by 2 percent per year between 1990 and 2025, doubling it from 1 to 2 kilowatts. Simultaneously, rich nations would strive to reduce their per capita use by 2 percent annually through increased efficiency, dropping the average use per person from 7.5 to 3.8 kW (while maintaining or increasing benefits.) Rich and poor nations would converge on an average per person energy use of 3 kW during the remainder of the century... Meanwhile the world population peak size of 10 billion people would be reached around 2100; then a slow decline would begin." (p 242)

The scenario as presented in *The Stork and the Plow* requires that the industrial nations stop economic growth in 1990 and reduce their per capita GDP by about 21%, from $15,000 to $11,800, over the next 40 years. This happens because the projected maximum rate of increase in energy efficiency ($GDP/watt) is not sufficient to offset the proposed rate of decrease in annual energy use. Beginning in 2030, however, economic growth resumes, as energy use levels off while energy efficiency continues to increase.[66]

BOX IIB-32. THE HOLDREN SCENARIO (in Ehrlich et al, 1995)

		Population (billions)	x *Energy/Person* (kilowatts)	= *Total Energy Use* (terawatts)
1990	Rich	1.2	7.5	9.0
	Poor	4.1	1.0	4.1
		5.3		13.1
2025	Rich	1.4	3.8	5.3
	Poor	6.8	2.0	13.6
		8.2		18.9
2100		10	3.0	30

17. After cataloguing the failures of both socialism and capitalism to deal with sustainability and equity concerns, **Paul Ekins**, in his book *Green Economics,* offers this outline of the organizing principles of a "Green Mixed Economy":

[66] In 1996 Holdren presented a revised version of the scenario, which allowed economic growth in the industrial nations to continue at a positive rate at all times. This was done after a reassessment of the estimated maximum feasible rate of improvement of energy efficiency.

* Universal small-scale ownership of enough of the four forms of capital (ecological, human, social and manufactured) to permit personal self-reliance for all. Such ownership could be personalized or held at the community level as in many preindustrial societies.

* Cooperative work structures based either on extensive profit sharing by the workforce and industrial democracy, or, better still, full worker ownership.

* A vigorous, decentralized, progressive market in which consumers are informed and motivated enough to base their purchases on ethical, social and environmental, as well as conventional consumer, criteria.

* A state that enforces and enables. It would enforce "polluter pays" principles, anti-monopoly and anti-trust legislation, standards of product and company information, personal and community rights, and conditions of environmental sustainability.

* The state would enforce strict limits on the size of landholdings, provision of high-quality education and health care, training and business advice, and some scheme of inalienable universal share ownership. It would support and encourage household and voluntary economies.

* Beyond enablement, the state should also guarantee a decent minimum standard of living to those who through age or disability, have special needs.

* A concept of "the state" that embraces international and local institutions, as well as national organization, to accommodate processes of globalization and decentralization as appropriate.

The main instrument used to directly address economic inequality would be the Basic Income:

> "Its goal is equality of citizenship, where all can participate in the mainstream life of society...the BI is not 'free income', and will be politically infeasible if it is regarded as such. It is a cost embraced by those of higher-than-average incomes as an expression of commitment to the wider health of their society. In return, those whose BI is greater than their tax payment must express their commitment and make a contribution to their society in other ways... The welfare state will not be sustainable--politically, socially or financially - until it becomes a real welfare community of mutual rights and responsibilities." (p 128-129)

Ekins provides more detail concerning the BI:

> "Costings for the UK indicate that a Full Basic Income (FBI) at a level enabling subsistence would require a 70% income tax rate. A Partial Basic Income (PBI) at half subsistence could be finance by a 35% tax rate, a 20-pound per week tax allowance, and abolition of National Insurance and existing tax reliefs on pensions and mortgages... The first step towards PBI and FBI might be a transitional BI at 40% of PBI to get the system established. Both this and PBI would require other income support benefits for those with special needs." (p 129)

18. When *The Limits to Growth* was published in 1972 critics from developing nations, and from poor communities within the United States, charged that it gave no indication of how distributional issues might be handled under the proposed steady-state or "equilibrium" economy. Until this was made clear, these critics said, persons and communities at an economic disadvantage would continue to support an agenda calling for vigorous economic growth.

In *Beyond the Limits*, published twenty years later, **Donella Meadows, Dennis Meadows** and **Jorgen Randers** address this concern. They begin by making the case that "Economic growth takes place primarily in the nations that are already rich," and thus "... the pattern of economic growth as it has occurred over the past few decades is not helping [poor countries.]"

They then explore possible scenarios of the future using an updated version of their original World 3 model. The scenario they advocate calls for:

1) implementation of a variety of resource conservation and pollution control measures;
2) agreement by all persons to limit their family size to an average size of two children starting in 1995;
3) agreement by all nations to aim for, and then live within, a per capita industrial output equivalent to the 1990 level of South Korea.

Under these conditions world per capita economic output would stabilize by 2100 at the 1990 South Korean level of $5,400 ('90 US $).[67]

Regarding distributional equity, the authors say,

> "A sustainable society would not freeze into permanence the current inequitable patterns of distribution. It would certainly not permit the persistence of poverty... for both moral and practical reasons any sustainable society must provide material sufficiency and

[67] See the discussion of *The Limits to Growth* and *Beyond the Limits to Growth* in Section II.A.1.

> security for all. To get to sustainability from here, the remaining material growth possible--whatever space there is for more resource use and pollution emissions, plus whatever space is freed up by higher efficiencies and lifestyle moderations on the part of the rich--would logically be allocated to those who need it most." (p 210-211)

Put more simply, this means that persons who today earn above "the average level of Europe in 1990" (i.e., about $20,000/year) would not be able to experience any further increases in income. They would continue to work, but any increase in earnings received after this time would be transferred to persons in lesser circumstances or perhaps used for compensatory services. After equalization has been achieved, further increases in economic income would depend on the ability of technological innovation to more efficiently reconfigure the sustainable level of resource flows.

19. The highly praised 1987 report of the **World Commission on Environment and Development**, *Our Common Future,* popularly known as the Brundtland Report, helped legitimize concern for the environment as an integral element of any program for international or domestic economic development. In a well-known passage the Report defines sustainable development as "...development that meets the needs of the present without compromising the ability of future generations to meet their own needs..." (p 43). They reference the limits-to-growth debate as follows:

> "The concept of sustainable development does imply limits--not absolute limits but limitations imposed by the present state of technology and social organization on environmental resources and by the ability of the biosphere to absorb the effects of human activities. But technology and social organization can be both managed and improved to make way for a new era of economic growth." (p 8)

They are explicit concerning the need for continued economic growth:

> "If large parts of the developing world are to avert economic, social and environmental catastrophes, it is essential that global economic growth be revitalized. In practical terms, this means more rapid economic growth in both industrial and developing countries, freer market access for the products of developing countries, lower interest rates, greater technology transfer, and significantly larger capital flows..." (p 89)

The Commission said that significant reduction in poverty in the developing nations was unlikely without economic growth rates of at least 3% in those nations. It noted that economic growth rates for the industrial countries were projected at about 3-4%,

> "...the minimum that international financial institutions consider necessary if these countries are going to play a part in expanding the world economy. Such growth rates could be environmentally sustainable if industrialized nations can continue the recent shifts in the content of their growth towards less material and energy intensive activities and the improvement of their efficiency in using material and every." (p 51)

While the Commission emphasized economic growth as the primary vehicle for the alleviation of poverty, it acknowledges that this could happen more rapidly if it were combined with redistributive policies. It suggests that if the richest one-fifth of the population in a typical developing country were to have 25% of their incremental income redistributed equally to the remaining four-fifths, the percentage of the population below the poverty line could be reduced from 50% to 10% within 24 years if per capita income grew at 3%, 36 years if it grew at 2 percent, and 70 years if it grew at 1%.

II.B.3.e. Concluding Note

What would it take to reduce income inequality in the United States? The crude calculations shown in **IIB-33** give an idea of the magnitudes involved. Table 1 shows the distribution of income by quintile for 1992 (1990 US $). Suppose we wanted to transfer enough income from the top 20% of the population (Q5) to the bottom 20% (Q1) such that the mean income of the bottom 20% was now equal to that of the second quintile (Q2). Such a policy would eliminate poverty. It would require that a tax of about 14% be levied on incomes of the top quintile and the proceeds transferred to the bottom quintile. This tax amounts to about $7,651 on annual incomes of $54,419. The 80/20 ratio drops from today's 9.8 to 3.5. The Gini coefficient drops from the current .37 by a full 10 points, to .27, which is the level today in Belgium (.27), Luxembourg (.27), and Canada (.28).

BOX IIB-33. INCOME TRANSFERS NEEDED TO END POVERTY AND INEQUALITY

	income shares (%)	1992 mean income (1990 US$)	taxes / transfers (%)	taxes / transfers ($)	
Table 1. Current Distribution of Income					
Q1	4.5	5553			Gini = .37
Q2	10.7	13204			80/20 = 9.8
Q3	16.6	20484			
Q4	24.1	29739			
Q5	44.1	54419			
Table 2. Transfers Needed to Bring the Lowest Quintile (Q1) Up To The Level of the Second Lowest Quintile (Q2)					
Q1	10.7	13204	+138%	+7651	Gini = .27
Q2	10.7	13204			80/20 = 3.5
Q3	16.6	20484			
Q4	24.1	29739			
Q5	37.9	46769	-14.1%	-7651	
Table 3. Transfers Needed to Bring the 80/20 Ratio Down to 2.5					
Q1	13.1	16042	+189%	+10,489	Gini = .20
Q2	13.1	16402	+21.5%	+2838	80/20 = 2.5
Q3	16.6	20484			
Q4	24.1	29739			
Q5	33.1	29858	-26.7%	-14, 561	

Table 3 shows what it would take to reduce inequality such that the 80/20 ratio is 2.5. This is the distributional equity goal we chose in the exercises in Part I of these notes. To do this requires a tax of 27% on the incomes of the top quintile, about $14,600 on an income of $54,419. The proceeds are redistributed to bring the bottom two quintiles up to a mean income of $16,042.

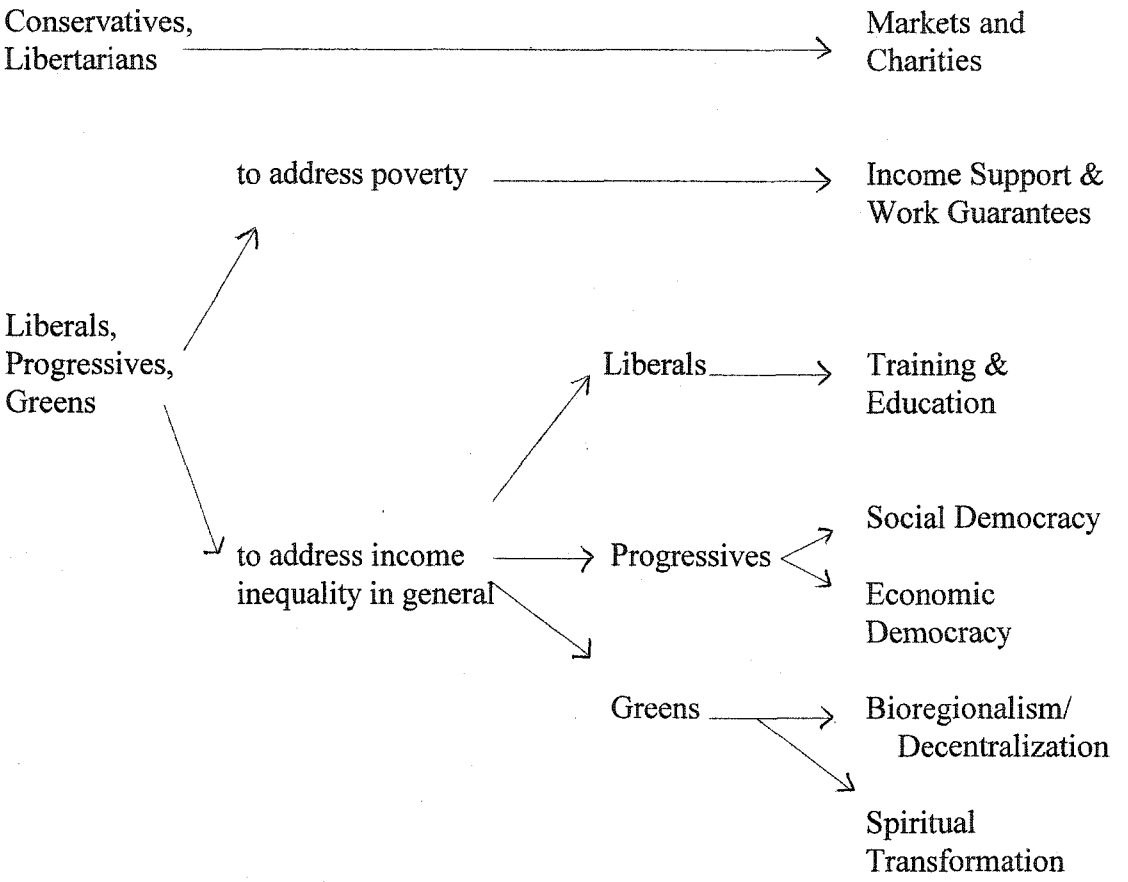
The tax rates and levels of redistribution that these examples suggest would be needed to achieve our equity goals are probably overstated because the exercise doesn't account for acceptable changes in the level of income over the lifecycle. On the other hand, the tax rates shown are probably lower than would need to levied on the very highest percentiles—say, the top 5% and 1% of the population.

Even more importantly, this exercise embodies a number of unrealistic assumptions that might be useful heuristically but not for thinking about policy. It's unlikely that any program to reduce inequality would seek to do so completely by means of direct transfers from one quintile to another. The great share of any tax revenues would likely go to capacity building: education, health and similar services; and these would make their major impacts felt over periods of a generation and longer. This has the advantage of being less immediately costly. However, as we saw in our review, the effectiveness of these services as a means of reducing inequality in a significant way is questionable.

Boxes IIB-34 and **IIB-35** provide a rough summary of the proposals reviewed earlier in this section. Those proposals that are currently viable policy options will not reduce income inequality by significant amounts, although their concerted application could likely go a long way towards keeping inequality from increasing. Those proposals that seem more likely to significantly reduce income inequality are not actively supported by major political parties or institutions at this time.

BOX IIB-34. What is to be done about income inequality?

This diagram shows the sorts of solutions to problems raised by income inequality proposed by analysts holding different political values. See Box IIB-35 for discussion.



BOX IIB-35. What is to be done about income inequality? (Notes)

Box IIB-34 is a schematic display of the positions held by people of different ideologies concerning what should be done about income inequality.

Conservatives and libertarians rely on markets and charities.

Liberals, progressives and greens are united in their espousal of income support and guaranteed jobs as the appropriate response to persistent poverty.

This unity doesn't hold when dimensions of economic inequality other than poverty are at issue. Liberals advocate training and education. Progressives are split, with one tendency advocating social democracy—essentially, the European welfare state—and the other holding out for economic democracy, which calls for structural constraints on the growth of inequality. The social democrats are not upset that market economies produce unequal incomes, so long as these can be equitably redistributed. The economic democrats want to organize productive relations such that they generate equitable incomes directly.

In general the greens despair of the ability of humans to actively manage global-scale institutions in a sustainable and just manner. Decentralism/bioregionalism is a response to these concerns. If human institutions remain small they will not be able to do much ecological damage, and they can be run in accordance with democratic norms that help ensure equitable outcomes.

Many, though not all, greens believe that a transition to a decentralized/bioregional world will only be possible if accompanied by a transformation of the human spirit.

The social democratic progressives and the liberals often share common views, as do the economic democrats and the decentralist greens.

II.B.4 PUBLIC OPINION ABOUT ECONOMIC INEQUALITY

Introduction

At the beginning of this dissertation I made a commitment to fully engage the issue of distributive equity in constructing scenarios of global development. For our ideal scenario I suggested that an 80/20 ratio of 2.5 to 1 is perhaps the lowest practicable degree of inequality towards which a society might aspire. Is this a desirable, credible, compelling level? If not, what is? We've just finished considering empirics, theory and policy that might help us address this question. In this section we review the results of surveys of public opinion that asked people how they felt about income inequality, policies to reduce it, and related topics.

II.B.4.a. Satisfaction with Current and Projected Income Levels

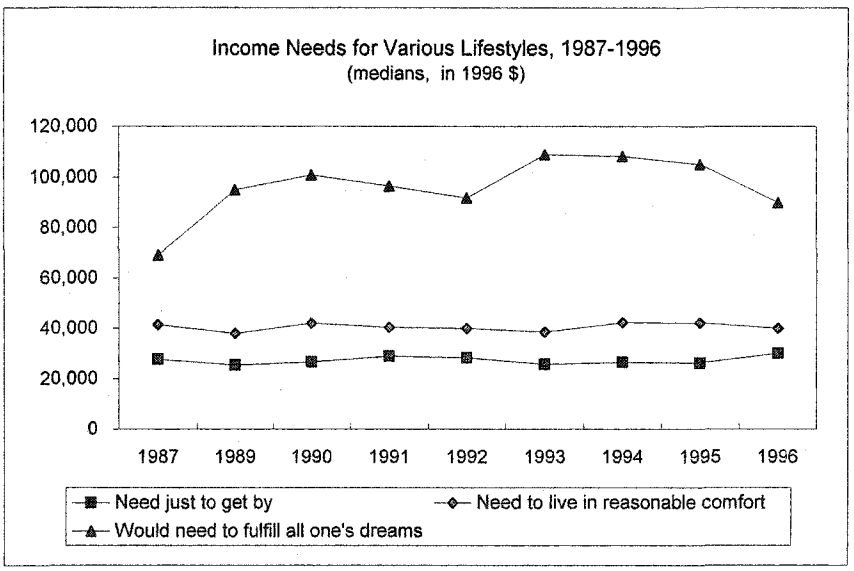
Box IIB-36 shows the levels of income people say they need to enjoy different lifestyles. The $30,000 per year needed in 1996 to "just get by" and the $40,000 needed to "live in reasonable comfort" are essentially unchanged from their levels of eight years earlier. Median family income in 1996 was $44,000, which suggests that a majority of families experienced themselves to be reasonably comfortable. By contrast, the level of income needed "to fulfill all of one's dreams" grew from about $70,000 to about $100,000, an increase of over 4% per year. This pattern is perhaps consistent with the real income trends of the period. Most incomes remained constant but the highest percentiles increased markedly, in effect raising the standard for "dreams." In 1996 about 7% of families had incomes over 100,000.

With respect to our advocated scenarios, the fact that Americans believe a yearly income of $40,000 affords a life of reasonable comfort should be encouraging. This is well below the mean family income of about $112,000 that even the most constrained scenario, Scenario 4, projects for 2150. Of course, to the degree that "comfort" is a function of relative position, either with respect to past incomes or to the incomes of others, this encouragement is dampened. **IIB-**

BOX IIB-36. Income needs for various lifestyles (1)

Question: How much income per year do you think you and your family...

	Need just to get by	Need to live in reasonable comfort	Would need to fulfill all your Dreams	CPI-U (1996 = 1)	Need just to get by	Need to live in reasonable comfort	Would need to fulfill all your Dreams
	(medians, in current dollars)				(medians, in 1996 dollars)		
1987	20,000	30,000	50,000	1.38	27,623	41,435	69,058
1989	20,000	30,000	75,000	1.27	25,306	37,960	94,899
1990	22,100	35,000	84,000	1.20	26,530	42,016	100,839
1991	25,100	35,100	83,800	1.15	28,915	40,435	96,536
1992	25,300	35,800	82,100	1.12	28,293	40,036	91,814
1993	23,700	35,500	100,300	1.09	25,734	38,546	108,907
1994	25,000	40,000	102,200	1.06	26,468	42,348	108,200
1995	25,500	41,000	102,000	1.03	26,253	42,211	105,012
1996	30,000	40,000	90,000	1.00	30,000	40,000	90,000



source: surveys by Roper Starch Worldwide (1987-1995) and by the Roper Center for Public Opinion Research/University of Connecticut, as reported in Ladd & Bowman (1998:14)

source of CPI series: US Dept. of Labor, Bureau of Labor Statistics
Average CPI, all urban consumers (CPI-U)
U.S. City average; all items
ftp://146.142.4.23/pub/special.requests/cpi/cpiai.txt

37 shows that reported income needs for the three lifestyles vary among persons. The ratio of higher and lower estimates of incomes needed to live in "reasonable comfort" is actually very moderate, perhaps not much more than 2 or 3 to one if figured by quintiles, again near the levels projected for Scenario 4. However, perhaps 25% of Americans say they need $1 million or more to fulfill all their dreams. This appears to be unrealistic, considering that the high-growth advocated scenario, Scenario 2, shows mean annual family income of the top 20% in 2150 at about $400,000.

How do people feel about their own economic situation, and that of the country's as a whole? How do they feel about the economic prospects for coming generations? Presumably, people who are dissatisfied or anxious on any of these accounts should be open to considering alternative economic scenarios.

Box IIB-38 shows survey data concerning people's satisfaction with their personal financial situation, their satisfaction with the "way the country is going", and their assessment of whether the "condition of the average man" is getting better or worse. The nearly constant proportion of persons who report "satisfaction" with their personal economic situation is remarkable, especially given the economic turmoil of that period: record inflation in the 1970's, recession in the early '80's, downsizing and restructuring in the early 90's, and steadily increasing inequality. The trends in IIB-38 show that people evaluate their personal situation consistently more favorably than they do the prospects of others or the condition of the country as a whole. Pollsters have long noted that people are reluctant to give responses that might imply personal inadequacy or disgruntlement at one's personal situation, and an admission of dissatisfaction with one's economic situation may be a response of this sort. I won't attempt any further to interpret at this point the levels and trends shown in IIB-38, except to note that the rise in reported satisfaction with the way things are going in the US since 1992 is certainly dramatic and presumably reflects real changes in expectations.

BOX IIB-37. Income needs for various lifestyles (2)

Question: How much income per year do you think you and your family would need...

	percent
just to get by?	
less than $20,000	26
$20-35,000	45
$35-50,000	15
more than $50,000	14
live in reasonable comfort?	
less than $35,000	37
$35-50,000	21
$50-70,000	25
more than $$70,000	17
fulfill all your dreams?	
less than $50,000	12
$50-100,000	28
$100-200,000	28
$200-1 million	14
more than $1 million	18

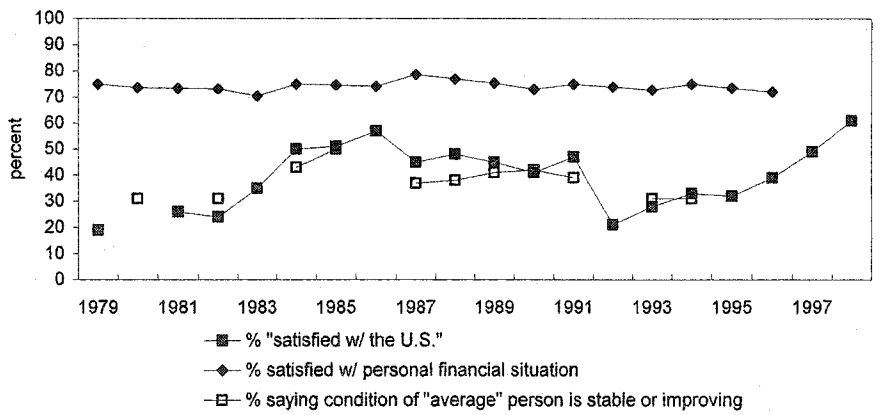
source: Roper Starch Poll, 1995. Cited in Hacker (1997)

BOX IIB-38. Satisfaction in the USA

Table 1

	A	B	C
	% satisfied with conditions in the USA	% saying condition of "average" person is stable or improving	% satisfied with personal financial situation
1979	19		75
1980		31	74
1981	26		73
1982	24	31	73
1983	35		70
1984	50	43	75
1985	51	50	75
1986	57		74
1987	45	37	79
1988	48	38	77
1989	45	41	75
1990	41	42	73
1991	47	39	75
1992	21		74
1993	28	31	73
1994	33	31	75
1995	32		74
1996	39		72
1997	49		
1998	61		

Figure 1. Satisfaction in the USA (1979-1998)



Survey questions and sources:

A: In general, are you satisfied or dissatisfied with the way things are going in the United States at this time? [Gallup Polls, www.gallup.com/poll/satus].

B: Agree/disagree: In spite of what some people say, the condition of the average man is getting worse, not better. Column B shows the percent of all persons who disagree with this statement. [National Opinion Research Center General Social Survey, codebook variable ANOMIA5].

C: We are interested in how people are getting along financially these days. So far as you and your family are concerned, would you say that you are pretty well satisfied with your present financial situation, more or less satisfied, or not satisfied at all? [National Opinion Research Center General Social Survey, codebook variable SATFIN. www.icpsr.umich.edu/gss/codebook]

Further ambiguity concerning economic satisfaction is shown in **IIB-39**. In the most recent survey reported, 41% of respondents say they are satisfied with their level of earnings and 59% say they are not. But of those who are not, 33% percent appear confident that they will be able to earn a satisfactory level in the future. Thus we might broadly characterize 74% as "satisfied", which is the level reported in the GSS survey shown in Box IIB-38.

Additional ambiguity is seen in responses to questions concerning the economic prospects for future generations. **IIB-40** shows responses to two questions worded almost identically, except that one question asks about the future of "your children" and the other asks about "the next generation." An average of only 17% of respondents say that their own children's standard of living will be lower than theirs, but an average of 46% of respondents say that *the next generation* can expect a worse standard of living than we have now. Put differently, 83% of respondents say the standard of living of their children will be the same or better than their own, while 50% of respondents say that the next generation can expect a standard of living the same as or better than today's. A third survey, shown in Table 3, asks whether or not "your children's generation" will enjoy a higher standard of living, without offering an "about the same" choice. In this instance the responses are on the average split nearly 50-50 between "Yes" and "No". It would probably a mistake to try to use these results as evidence of either great optimism or great pessimism concerning future economic prospects.

II.B.4.b. Economic inequality

When given a dichotomous choice, upwards of 60% of Americans say that the distribution of money and wealth in America is not fair and should be more evenly distributed, as shown in **IIB-41**. When given a three-way choice the proportion of respondents that say that income differentials in America are too large is only slightly less—56 %--as shown in Table 3. The survey reported in Table 2 where 59% of respondents said that the distribution of income should either remain as it or be even more *un*equal, seems to contradict these results. However,

BOX IIB-39. EARNINGS SUFFICIENCY AND EXPECTATIONS

Table 1. Do you now earn enough money to lead the kind of life you want, or not?

	Yes, enough money	No, not enough
Jan 1992	39	61
Mar. 1994	44	56
Feb. 1995	41	58
June 1996	44	56
Nov 1997	41	59

Table 2. To those who answered "no" to the above question, do you think you will be able to earn enough money in the future to lead the kind of life you want, or not?

	Yes, enough money	No, not enough
Jan 1992	34	22
Mar. 1994	33	20
Feb. 1995	35	20
June 1996	34	20
Nov 1997	33	24

note: all respondents were currently employed.

sources: Princeton Survey Research Associates for U.S. News & World Report (Jan 1992); Times Mirror-Center for the People & the Press (Mar. 1994, Feb. 1995); and Pew Research Center for the People & the Press (June, Nov. 1997). Compiled by Ladd and Bowman (1997:96).

BOX IIB-40. Standards of living for future generations
[percents]

Table 1

Do you think your children's standard of living will be higher, lower or about the same as your standard of living?

	higher	lower	about the same
1989	52	12	19
1992	47	15	28
1993	49	17	27
1994	43	22	28
1995	46	17	29

source: Surveys by Cambridge Report/Research International. Cited in Ladd & Bowman (1997:61).

Table 2

Do you expect the next generation of Americans will have a better standard of living than the one we have now, a worse standard of living than now or about the same standard of living as we have now?

	better	worse	about the same
Nov. 1991	20	51	23
Oct. 1992	24	36	36
Jan. 1993	23	38	35
June 1993	14	51	32
Dec. 1993	15	47	35
Oct. 1995	13	51	33
Aug 1996	18	46	33

source: Surveys by Los Angeles Times. Cited in Ladd and Bowman (1997:70).

Table 3

Do you expect your children's generation to enjoy a higher standard of living than your generation?

	Yes	No	
May 1990	60	37	
July 1994	45	50	
Sept 1994	49	45	
Dec. 1994	48	46	
Mar. 1995	49	45	
Jan. 1996	41	52	
Mar. 1996	41	51	
June 1996	43	47	(registered voters)
Sept. 1996	43	47	(registered voters)
Apr. 1997	52	44	
June 1997	53	42	

source: surveys by NBC News/Wall Street Journal and Hart/Teeter Research for the Council for Excellence in Government.

BOX IIB-41. Is the distribution of income in this country fair?
[percents]

Table 1

Do you feel that the distribution of money and wealth in this country today is fair, or do you feel that the money and wealth in this country should be more evenly distributed among a larger percentage of the people?

	Distribution is Fair	Should be more evenly distributed
1984	31	60
1685	28	61
1987	27	66
1990	28	66
1996	33	62

source: Surveys by the Gallup Organization (1984; 1987-1996) and the Los Angeles Times (1985). Cited in Ladd and Bowman (1997:110)

Table 2

Some people say that incomes should be completely equal, with every family making roughly the same amount of money; others say that things should stay about the same as they are now; and still others think incomes should be less equal than they are now. Ideally do you think there should be...

Complete equality of income	3
More equality than there is now	38
About the present level of income equality	52
Less equality of incomes than there is now	7

source: survey in 1980 by Kleugel and Smith (1986:112)

Table 3

Do you agree or disagree: Differences in income in America are too large.

Agree	56
Neither Agree nor Disagree	22
Disagree	19

source: National Opinion Research Center General Social Survey, 1983-87, codebook variable INCGAP

the wording of the survey question suggests a different set of choices than are finally prompted, so the results are not conclusive. Even in this case the 41% of respondents who think there *should* be more equality of incomes is hardly a small minority.

Further results suggesting that the distribution of income in America is believed to be unfair are shown in **IIB-42.** Pollsters have said that beliefs about "inequality" and "income distribution" are difficult to assess in a polling context because for many Americans these are abstract concepts. The format used in IIB-42, in which people are asked to assess the relative incomes of different occupations, was devised as a way to elicit opinions about equity in a more concrete manner. We see that strong majorities feel that the first 4 are underpaid and that the last 5 are overpaid. The occupations in the middle group—numbers 4 through 10--are believed to be paid about the right amount.

Box IIB-43 shows an extension of this procedure that assesses income equity in dollar terms. The authors note that the perceived incomes suggested by the respondents were not very different from the actual incomes of the occupations listed. The fair incomes suggested by the respondents represent a rather dramatic decrease in income differentials. If we suppose that the average of the incomes of the top three occupations might crudely approximate the mean income of the top quintile of earners, and that the average of the incomes of the bottom three occupations approximates the mean income of the bottom quintile, we see that the "80/20" ratio of the perceived incomes is 12.6, and that of the "fair" income is 6.2. It so happens that the 80/20 ratio of American family incomes in 1992 was precisely 12.5. An 80/20 ratio of 6.2 is very close to that of France and Poland in 1996, and in fact is close to the average for all industrial nations.

Table 1 in **IIB-44** shows that fully 82% of Americans believe that the "growing divide between rich and poor" threatens the American Dream. This result is supported by Table 2, which shows that 84% of Americans are "concerned about" the "gap between the rich and poor." Both tables show that 38% of respondents are "severely" concerned.

BOX IIB-42. Fair Pay (1)
[percents]

I'd like you to tell me about the amount of income that different kinds of people receive. For the contribution that they make to society, do (occupation) receive... (too little income, about the right income, or too much income) ?

	Too little	About the right amount	Too much	Don't know
1. teachers in elementary and high schools	62	31	5	2
2. lower level white-collar workers	62	33	2	4
3. non-unionized factory workers	61	28	2	9
4. teachers in colleges and universities	53	34	7	7
5. owners of small businesses	40	49	4	8
6. middle-level managers in business	18	58	8	16
7. unionized factory workers	14	53	28	5
8. skilled blue-collar workers	8	47	42	3
9. stockholders of large corporations	4	34	47	15
10. landlords	5	39	49	8
11. government officials	4	24	67	4
12. professional athletes	3	18	77	2
13. medical doctors	2	27	69	1
14. owners & execs of large corporations	1	23	71	5
15. movie stars and top entertainers	1	18	78	4

Source: 1980 poll conducted by Kleugel and Smith (1986:120)

BOX IIB-43. Fair Pay (2)

In 1976 Verba and Orren polled a group of 2762 leaders of the constituencies listed below for their opinions about distributional equity. The leaders were asked to note the income they believed each of the listed occupations received, along with the incomes that they believed would otherwise be fair. The perceived incomes were very close to actual incomes.

The results of the exercise are shown here:

	absolute levels (1985 $)		ratios	
occupation	perceived income	fair income	perceived income	fair income
Top executive	167,070	95,230	13.8	7.9
Professional athlete	112,703	42,612	9.3	3.5
Doctor	74,374	52,798	6.1	4.4
Cabinet secretary	48,062	48,119	4.0	4.0
Engineer	24,916	24,705	2.1	2.0
Professor	20,268	22,766	1.7	1.9
Plumber	18,845	15,575	1.6	1.3
Auto Worker	12,100	12,100	1.0	1.0
Police Officer	12,012	14,385	1.0	1.2
Teacher	10,474	12,812	0.9	1.1
Bank Teller	9,083	10,454	0.8	0.9
Elevator Operator	6,877	7,954	0.6	0.7
average, top 3:			9.70	5.40
average, bottom 3:			0.77	0.87
ratio:			12.60	6.20

The leaders chosen by Verba and Orren were selected from organizations associated with "Business, Labor, Farmers, Intellectuals, the Media, the Republican and Democratic Parties, Blacks, Feminists and Youth." Income values are logged to adjust for extreme estimates.

Source: Verba and Orren (1985:156)

BOX IIB-44. Concern about the Gap between Rich and Poor

Table 1.

I am going to read to you a list of things people have said may pose a threat to the future of the American Dream. As I read each one please tell me if you find it severely threatens the future of the American Dream, somewhat threatens it, or doesn't threaten the future of the American Dream at all...a growing divide between rich and poor.

Severely	38
Somewhat	44
Does Not	14

source: Roper Starch Worldwide, December 1995. Cited in Ladd and Bowman (1997)

Table 2.

I'm going to read a list of concerns people might have about the way we live today in the United States. For each one, please tell me whether you personally are Very concerned, Somewhat concerned, a Little concerned, or Not concerned at all... The gap between rich and poor.

Very concerned	38
Somewhat concerned	35
A little concerned	12
Not concerned	14
don't know	2

source: Merck Family Fund Survey on consumption/Materialism (Feb. 1995:1)

What is to be done? Although the survey results just reviewed point to concern about income inequality, they haven't addressed the question of whether anything should actually be done about it, and if so, what.

Box IIB-45 shows that over the 18 years beginning in 1978 an average of about 47% of Americans have consistently agreed that government should "do something to reduce income differences between the Rich and the Poor," while an average of about 32% have said that it should not so concern itself. The sentiment in favor of action is clear and consistent, although not overwhelming.

When specific programs and policies are suggested Americans are in general less supportive of taking action to address income inequality. However, significant minorities continue to support strong redistributive policies. This pattern is illustrated in **IIB-46.** A majority of Americans are opposed to a guaranteed annual income (by 57%), wage controls (by about 50%), proposals that governments should be involved in redistributing wealth (by 52%), and increased inheritance taxes (by 73%). But 20-30% of Americans consistently support these policies. Further, fully 81% of Americans call on corporations to distribute more of their profits to workers and less to shareholders.

Support or opposition to policies draws on complex sets of values that people hold. In **IIB-47** we see that when publicly-financed jobs are described as a "responsibility" that government owes to "everyone who wants one," only 45% of Americans are supportive. But if the same program is described as a way that government might "help the economy," support increases to 70%.

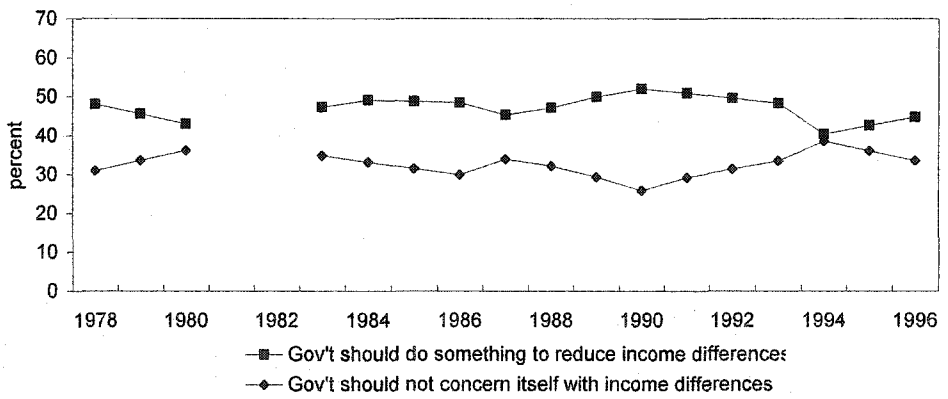
Further rejection of government efforts to take steps to redistribute income is shown in **IIB-48**. In recent years fully 74-80% of respondents oppose "a law limiting the amount of money any individual is allowed to earn in a year," or wording to that effect. More ambivalence is shown in response to the question of whether people "should be allowed to accumulate as much wealth as they can even if some make millions while others live in poverty." It can be interpreted

BOX IIB-45. Should the government act to reduce income inequality?
[percents]

Question: Should the Government Do Something To Reduce Income Differences Between Rich and Poor, OR Should the Government Not Concern Itself With Income Differences?

Table 1	Should Do Something	Should Not Concern Itself
1978	48	30.9
1979	45.5	33.55
1980	43	36.2
1981		
1982		
1983	47.3	34.8
1984	49.1	33.2
1985	48.75	31.55
1986	48.4	29.9
1987	45.3	33.9
1988	47.1	32.2
1989	49.9	29.4
1990	52	25.9
1991	50.9	29.3
1992	49.6	31.4
1993	48.3	33.5
1994	40.4	38.6
1995	42.6	36.1
1996	44.8	33.6

Figure 1. Should the Government Act to Reduce Income Differences?
(NORC surveys results, 1978-1996)



Source: National Opinion Research Center General Social Survey, codebook variable EQWLTH.

BOX IIB-46. What should the government do about income inequality?
[percents]

Table 1

Do you agree or disagree: The government should provide everyone with a guaranteed basic income.

	1987
Agree	20
Neither Agree nor Disagree	20
Disagree	57
Can't choose	3

Source: National Opinion Research Center General Social Survey, 1983-87; codebook variable GOVMINC

Table 2

What is your opinion of the following statement? It is the responsibility of the government to reduce the differences in income between people with high incomes and those with low incomes.

	1985	1990	1993	1994
Agree	28	34	32	29
Neither Agree nor Disagree	21	27	21	19
Disagree	50	40	47	52

Source: National Opinion Research Center General Social Survey, codebook variable EQUINCOME.

Table 3

Here are some things the government might do for the economy. Circle one number for each action to show whether you are in favor of it or against it... Control of wages by legislation.

	1985	1990
Agree	22	25
Neither Agree nor Disagree	21	25
Disagree	56	50

source: National Opinion Research Center General Social Survey, codebook variable SETWAGE.

Table 4

Tax laws should be strengthened to limit the amount of wealth that can be inherited.

	1980
Agree	26
Disagree	73

Source: Kleugel and Smith (1986:164)

Table 5

Corporations should pay more of their profits to workers and less to shareholders.

	1987
Strongly agree	22
Agree	59
Disagree	17
Strongly disagree	1
Don't know	6

source: National Opinion Research Organization General Social Survey, 1983-87, codebook variable PROFITS2.

BOX IIB-47. Contrasting opinions about job creation
[percents]

Table 1

On the whole, do you think it should or should not be the government's responsibility to provide a job for everyone who wants one?

	yes	no
1985	35	66
1989	48	52
1990	44	56
1991	45	55

source: National Opinion Research Center General Social Survey, codebook variable JOBSALL.

Table 2

Here are some things the government might do for the economy. Circle one number for each action to show whether you are in favor of it or against it... Government financing of projects to create new jobs.

	in favor	neither in favor nor against	against
1985	68	16	15
1990	70	20	10

Source: National Opinion Research Center General Social Survey, codebook variable MAKEJOBS.

BOX IIB-48. Limits on earnings and wealth?
[percents]

Table 1

Do you think there should be a law limiting the amount of money any individual is allowed to earn in a year?

	Yes	No
1980	21	79
Mar. 1981	20	75
Jan. 1992	9	83
Aug. 1994	22	74

Note: Question wording varied. 1980: Agree/disagree: There should be an upper limit on the amount of money any one person can make. Mar. 1981: Agree/disagree: There should be a limit on incomes so that no one can earn more than $100,000 a year. Aug. 1994: Should there be a top limit on incomes so that no one can earn more than $1 million a year?

sources: 1980: Kleugel and Smith (1986); 1981: Civic Services; 1992: Roper Starch Worldwide; 1994: Roper Center for Public Opinion Research/University of Connecticut for Reader's Digest. Cited in Ladd and Bowman (1997:108)

Table 2

People should be allowed to accumulate as much wealth as they can even if some make millions while others live in poverty.

	Agree	Neither Agree Nor Disagree	Disagree
Total	56	11	30
Income			
< $15,000	51	12	33
$15,000-19,999	59	7	33
$20,000-29,999	54	11	34
$30,000-49,999	60	11	27
$50,000-74,999	60	10	27
>75,000	65	12	22
Party			
Republican	66	10	22
Democrat	50	10	36
Independent	56	13	29

Source: National Opinion Research Center General Social Survey, codebook variable RICHPOOR

as a clear rejection of any sentiment for redistribution: majorities of even the lowest income groups *affirm* the statement. On the other hand, the fact that 30% of all respondents *reject* it shows that this position is hardly a marginal one.[68]

Some differences in the survey results reviewed appear difficult to reconcile. Table 1 in **Box IIB-49** shows overwhelmingly strong agreement, by upwards of 72% of respondents, that "high-income families" pay "too little" in taxes. But the survey shown in Table 2, worded only slightly differently, suggests that the lesser majority of about 55-60% of Americans would like to see taxes on high incomes increased, while 40% would actually like to see them *reduced*; that is, they'd prefer a "flat tax" over the present system of progressive taxes. An interpretation that might reconcile the results of these two surveys is that many the 40% of respondents supporting the flat tax might believe that it will generate higher net payments from high income families, perhaps by eliminating tax loopholes.

Another tension is seen in comparing **IIB-50** with IIB-47. IIB-47 shows that people believe that non-unionized factory workers, teachers, and lower-level white collar workers all receive too little compensation for their work. Yet IIB-50 suggests that one of the obvious means by which this could be remedied--stronger unionization--is opposed by large majorities of Americans.

The general resistance to income redistribution seen in these surveys appears to be supported by some very basic judgments people hold concerning human nature and human behavior, as shown in **IIB-51.** The only response that can be interpreted as supportive of redistributive policies is the response to statement number 8. However, these questions appear to have been intentionally worded to elicit a positive response. The second question, for example, could have been worded, "Although it is human nature to always want more than others have, it is

[68] It would not be difficult to design a set of questions that would explore the conditions under which successively larger shares of respondents, beyond the initial 30%, might come to disagree with the statement.

BOX IIB-49. Fair Taxes?
[percents]

Table 1

For each one would you tell me whether you think they have to pay too much in taxes, or too little in taxes or about the right amount?... High-income families?

	Too Much	Too Little	About Right
May 1977	8	75	10
May 1978	7	76	9
July 1978	8	76	9
May 1979	8	75	9
Jan. 1985	5	80	10
Apr. 1986	7	77	10
Jan. 1992	9	72	10

source: Surveys by Roper Starch Worldwide. Compiled by Ladd and Bowman (1997:97)

Table 2

Some people think those with high incomes should pay a larger proportion (percentage) of their earnings in taxes than those who earn low incomes. Other people think that those with high incomes and those with low incomes should pay the same proportion (percentage) of their earnings in taxes.

Do you think those with high incomes should pay a much larger proportion, pay a larger proportion, pay the same proportion as those who earn lower incomes, pay a smaller proportion, pay a much smaller proportion?

	larger/ much larger	same	smaller/ much smaller
1985	56	42	1
1990	61	38	1

source: National Opinion Research Center General Social Survey, codebook variable PROGTAX

BOX IIB-50 Do unions have too much power?
[percents]

Do you think that labor unions in this country have too much power or too little power?

	too much	about right	too little
1985	64	28	8
1990	47	40	13

source: National Opinion Research Center General Social Survey, codebook variable LABORPOW

BOX IIB-51. Beliefs about the Sources and Consequences of Income Inequality

Statements	Agree (%)	Disagree (%)
Incomes cannot be made more equal since people's abilities and talents are unequal	85	15
Incomes cannot be made more equal since its human nature to always want more than others have	82	18
Making incomes more equal means socialism, and that deprives people of individual freedoms	74	26
Incomes should not be made more equal since that would keep people from dreaming of someday becoming a success	70	30
If incomes were more equal, nothing would motivate people to work hard	63	27
If incomes were more equal, life would be boring because people would all live in the same way	61	39
Incomes should not be more equal since the rich invest in the economy, creating jobs and benefits for everyone	55	45
More equality of incomes would avoid conflicts between people at different levels	55	45
More equality of incomes would allow my family to live better	42	58
Incomes should be more equal, because every family's needs for food, housing and so on, are the same	39	62

source: Kluegel and Smith (1986:106)

still possible for societies to agree on policies that could make incomes more equal." And the first question is subtly ambiguous, in effect asking respondents to first decide whether they believe that peoples' abilities and talents are unequal, and then to decide whether, if that is so, it constitutes a *necessary* reason that "incomes cannot be made more equal."

Similar caution needs to be taken when interpreting survey results such as those shown in **IIB-52**. Depending on how "poverty" is defined, and what is meant by "done away with" or "finally solved", the pattern of responses shown may be trivially obvious and hardly objectionable, or profoundly disturbing. As a rhetorical counter one might cite the survey shown in which only 18% of respondents say that the government should *spend less* to reduce poverty. In any event a more informative survey would ask people about the levels of poverty reduction that they believe can and should be achieved, and by what means.

II.B.4.c. Opportunities and Outcomes

Much of the tension implied in the survey results reviewed here traces to ambivalence among Americans concerning the relative importance of procedural equity and outcome equity. The problem is that fair procedures can generate unfair outcomes, and equal opportunities can generate unequal results. When asked directly, as shown in **IIB-53**, Americans overwhelmingly endorse equality of opportunity (84%) over equality of result (12%) as a principle of equity. This preference is part of the American civil religion the roots of which go back to the founding of the Republic. But a separation of concern for equality of opportunity from concern for equally of results cannot be strictly maintained in the real world. It is possible that otherwise fair procedures could generate inequality of such magnitude that many persons would no longer be able to effectively avail themselves of them. Conversely, it is possible that the regulation of otherwise fair procedures in order to ensure more equitable outcomes might destabilize expectations upon which whole other sets of procedures depend for their legitimacy. So the conflict is very real and very complex.

BOX IIB-52. Will poverty ever be done away with?
[percents]

Table 1

Do you think poverty will ever be done away with in this country?

	Will be done away with	Will always be a major problem
1964	9	83
1967	7	89
1985	8	89
1987	14	82
1988	9	89
1989	6	92

Wording of the questions varied: 1964, 1967, 1989: as shown above (The Gallup Organization);
1985: Do you think poverty in the United States is a problem that will be finally solved, or do you think it will always be a major problem for our society? (Los Angeles Times);
1987, 1988: Do you think... an end to poverty in America... will happen in your lifetime or not? (Harris)
Compiled by Ladd and Bowman (1997:100).

Table 2

Do you agree or disagree: The government should spend less on benefits for the poor.

	Agree	Neither agree nor disagree	Disagree	don't know, etc.
1987	18	22	58	2

source: National Opinion Research Center General Social Survey, 1983-87, codebook variable GOVLESS.

BOX IIB-53. Equality of opportunity or equality of outcomes?
[percents]

Table 1

Some people think America should promote equal opportunity for all, that is, allowing everyone to compete for jobs and wealth on a fair and even basis. Other people think America should promote equal outcomes, that is, insuring that everyone has a decent standard of living and that there are only small differences in wealth and income between the top and the bottom in society. Which do you favor: promoting equal opportunity or promoting equal outcomes?

	1993
should promote equal opportunity	84
should promote equal outcomes	12
other/don't know	4

source: National Opinion Research Center General Social Survey, codebook variable OPOUTCME

Table 2
[source: Verba and Orren (1985:72)]

In 1976 Verba and Orren polled a group of 2762 leaders of the constituencies listed below for their opinions concerning distributional equity. They were asked about the desirability of equality of opportunity and equality of results as guiding principles. They responded as shown here.

		How best to deal with inequality		What is a fair economic system	
Constituency leaders	N	equality of opportunity	equality of result	earnings based on ability	all earnings about the same
Republicans	~154	98	0	99	0
Business	312	98	1	98	1
Media	318	96	1	93	3
Farm	266	93	2	90	4
Intellectuals	296	89	3	89	7
Youth	374	87	7	74	14
Labor	266	86	4	80	11
Blacks	266	86	7	67	17
Democrats	~153	84	8	79	12
Feminists	367	84	7	71	15
total	2762				

N = number of leaders from each constituency participating in the survey.

Is the equality of opportunity in fact available? Survey results in which respondents say that the average person is falling behind, or that they don't expect their children to enjoy as high a standard of living as themselves, might suggest not. But when asked directly, Americans generally affirm their faith in the availability of opportunity, as shown in **IIB-54**. They acknowledge, however, that some people have better opportunities than others, as shown in Table 3 of IIB-54.

Further survey results concerning inequality show even more complexity. Americans simultaneously admire and distrust those who have high incomes. **IIB-55** shows that 89% of Americans admire rich people who "worked hard" to get their money; that 62% believe that the country benefits from having a class of rich people; and that only 21% feel there are too many rich people. On the other hand, **IIB-56** shows that Americans believe "the wealthy" have too much power and influence and that a strong plurality believe inequality continues to exist because it benefits the rich and powerful.

Box IIB-57 shows a mix of positive and negative assessments of "millionaires." Note that the negative assessments are due to violations of procedural norms. Note also that even where majorities have a positive assessment of some characteristic of "millionaires", a significant portion, near 30%, has consistently negative assessments. Finally, Table 2 of IIB-57 shows very divided feelings about whether or not social difference in the United States "are justified," with 52% believing they are and 44% saying they are not.

II.B.4.d. Other Countries

Box IIB-58 shows that American attitudes are markedly less "egalitarian" than are attitudes of people in other industrialized countries. Of the 66 survey responses obtained from

BOX IIB-54. A land of opportunity?
[percents]

TABLE 1

America is the land of opportunity where everyone who works hard can get ahead.

strongly agree	14
agree	56
disagree	27
strongly disagree	4

TABLE 2

Compared to the average person in America, do you think the chance of getting ahead for you yourself is:

Much better than average	5
Better than average	33
Average	54
Worse than average	7
Much worse than average	2

TABLE 3

Compared to the average person in America, do you think the chance of getting ahead for..... is....

	better	average	worse
people who grew up in rich families	83	14	3
people who grew up in poor families	19	47	34
people who grew up in working class families	23	69	8
Blacks	28	45	28
a woman working fulltime compared to a man at the same job	14	46	39

Source: 1980 survey by Kleugel and Smith (1985)

BOX IIB-55. How we feel about rich people (1)
[percents]

Table 1

I am going to read you a series of statements about a number of different things. For each, please tell me whether you completely agree with it, mostly agree with it, mostly disagree with it, or completely disagree with it... I admire people who get rich by working hard.

	Completely Agree	Mostly Agree	Mostly Disagree	Completely Disagree
1991	57	35	5	2
1992	47	42	7	3
1994	51	37	8	3
1997	52	37	7	3

source: Surveys by Princeton Survey Research Associates for the Times Mirror Center for the People & the Press (1991-1994) and for the Pew Research Center for the People & the Press (1997).
note: Question wording varies slightly. Compiled by Ladd and Bowman (1997:53).

Table 2

Does America benefit from having a class of rich people or not?

	1990
Yes	62
No	32

This question was asked of those people who did not consider themselves rich--1,249 of 1,255 respondents.
source: Survey by the Gallup Organization, May 1990. Cited in Ladd & Bowman (1997:17).

Table 3

As far as you are concerned do we have too many rich people in this country, too few, or about the right amount?

	1990
Too many rich	21
Too few	15
About the right amount	55

source: Survey by the Gallup Organization, May 1990. Cited in Ladd & Bowman (1997:16).

BOX IIB-56. How we feel about rich people (2)
[percents]

Table 1

Of course, the job of running the country is given to the President and Congress. However, there are those who say that other groups in our society also have power and influence over how our country is run. Would you call off the groups on that list that you feel have too much power and influence over our country's policies... the wealthy.

	Too much power/influence	Rank
1979	58	2 of 23
1982	63	1 of 24
1992	45	1 of 26

Note: In 1979 the Arab oil nations ranked first as having too much power and influence over our country's policies. In 1989 large business corporations were ranked second, and, in 1992, the press was a close second to the wealthy.
Source: Surveys by Roper Starch Worldwide. Compiled by Ladd and Bowman (1997:17).

Table 2

Do you agree or disagree: inequality continues to exist because it benefits the rich and powerful.

	1987
agree	46
neither agree nor disagree	25
disagree	22
can't choose	6

Source: National Opinion Research Center General Social Survey, 1983-87, codebook variable INEQUAL3.

BOX IIB-57. How we feel about rich people (3)
[percents]

Table 1

Question: Here is a list of things you may hear said about millionaires from time to time. Would you read down it and for each one tell me whether you think it is generally true or generally untrue of most millionaires?

	Generally True	Generally Untrue
(negative assessments)		
Use their wealth mostly to protect their own positions in society	67	15
Don't pay their fair share of taxes	61	28
Make illegal contributions to political campaigns	45	25
(positive assessments or "non-negative" assessments)		
Investments create jobs and help provide prosperity	55	27
Spending gives employment to a lot of people	54	29
Are responsible for many of society's ills	29	48
Keep the common man from having his proper share of the wealth	30	50
(mixed assessments)		
Worked hard to earn the wealth they have	46	37
Got where they are by exploiting people	38	35

source: survey by Roper Starch Worldwide, January 1992. Cited in Ladd and Bowman (1997:18).

Table 2

Here are different opinions about social differences in this country. Please tell me for each one whether you strongly agree, somewhat agree, somewhat disagree, or strongly disagree... All in all, I think social differences in this country are justified.

	1987
Strongly/somewhat agree	52
Strongly/somewhat disagree	44
don't know	4

source: National Opinion Research Center General Social Survey, codebook variable USCLASS8 (1983-87).

Box IIB-58. International Comparisons Regarding Economic Inequality

[selected years, 1990-1993)

US	UK	W. Germ.	E. Germ.	Japan	Hungary	Poland	Sweden	Australia
1. In [country] people have equal opportunities to get ahead. (% who agree)								
66	42	55	25	41	18	27		
2. The government should guarantee everyone a minimum standard of living. (% who strongly agree)								
27	50	57	80	61	81	55		
3. The government should place an upper limit on the amount of money one person can make. (% who agree)								
17	39	32	60	36	58	47		
4. The government should provide a job for everyone who wants one. (% who strongly agree)								
30	37	46	84	66	80	66		
5. The fairest way to distribute wealth and income would be to give everyone equal shares (% who agree)								
19	30	22	24	39	23	20		
6. It's fair if people have more money or wealth, but only if there are equal opportunities (% who strongly agree)								
43	23	37	37	21	40	24		
7. The way things are in [country], people like me and my family have a good chance of improving our standard of living (% who agree)								
55	29	34	39		11	12	23	49
8. Large differences in income are necessary for [country's] prosperity. (% who agree)								
26	19	21	14		21	36	30	25
9. Inequality continues to exist because it benefits the rich and powerful (% who agree)								
58	65	75	87		53	73	54	59
10. Differences of income in [country] are too large. (% who agree)								
77	81	84	98		84	86	60	63
11. It is the responsibility of government to reduce the differences in income between people with high incomes and people with low incomes (% who agree)								
38	66	66	89		75	77	53	43
12. The government should provide everyone with a guaranteed basic income (% who agree)								
35	68	58	88		85	87	46	51
13. Gini Coefficients (top series) and 80/20 ratios								
0.38	0.32	0.32		0.35	0.28	0.33	0.32	0.42
9.8	5.3	5.9		7.1	3.9	6.3	5.8	10.1

note: choices available for each question were: strongly agree, somewhat agree, neither agree nor disagree, somewhat disagree, strongly disagree, can't choose. "% who agree" means the sum of the percents for "strongly agree" and "somewhat agree." "% who strongly agree" means the percent just for that single response category.

sources: items 1-6, International Social Justice Survey, 1991, via IUCPS; items 7-12, International Social Survey Program, 1992. Compiled by Ladd and Bowman (1997:118-123). Item 13: Table 1, Part II-E of these notes; values given for united Germany.

eight other countries, only 3 are more "inegalitarian" than are the corresponding responses from the United States [69]

Box IIB-59 shows opinions about the distribution of wealth in eight Latin American countries.[70] With the exception of Peru, strong majorities in all countries believe their distributions of wealth to be unfair. This is understandable, given that Latin America has the worst distribution of income of any region in the world.[71] Interestingly, the unweighted mean of Latin Americans who believe the distribution of wealth to be unfair (67%) is less than the corresponding value for the eight industrialized countries shown in Box IIB-58 who agree that "differences of income in [country] are too large" (79%). It's not clear whether this difference is real or if it is a result of differences in survey wording, context, methodology, or other factors.

Box IIB-60 shows a dramatic difference between Swedes and Americans regarding distributive norms. Swedish business executives appear to have preferred far more equal pay scales than have American union leaders. [72]

A crude estimate of what an acceptable distribution of income might be in a European country that puts a higher priority on distributive equity than does the US can be had by use of the figures in **IIB-61.** These show the results of a Dutch study, similar to the study noted in IIB-43, in which respondents offered their opinions of what a just income for the listed occupations would be. Under the "just" distribution the incomes received by the top 3 selected categories would decrease by about 22-26%, while those in the 3 lowest selected categories would increase

---

[69] Responses that are seemingly more "inegalitarian" than those of the US are those in item #8 by Poland and Sweden; item #9 by Hungary and Sweden, and item #10 by Australia and Sweden. But the three Swedish responses may actually reflect the high degree of distributive equity that now exists in that country.

[70] The countries surveyed are the five members of MERCOSUR (Argentina, Brazil, Chile, Paraguay and Uruguay), the two members of the Andean Pact (Venezuela and Peru), plus Mexico, which belongs to NAFTA.

[71] See country and regional income inequality comparisons in Boxes IIB-1, IIB-2 and IIB-3.

BOX IIB-59. Opinions about Inequality of Wealth in Latin America
[percents]

In your opinion, is the distribution of wealth in the country fair or unfair?

	very fair/ somewhat fair	neither fair nor unfair	unfair/ very unfair	no answer
Argentina	9	19	66	6
Brazil	7	11	78	4
Chile	7	30	61	2
Mexico	7	13	78	2
Paraguay	6	11	76	7
Peru	13	29	48	10
Uruguay	8	18	66	8
Venezuela	13	13	66	8
unweighted mean	8.8	18.0	67.4	5.9

source: Latinobarometer 1995. In IIPO 1995-1996:622.
sample sizes: Argentina (N=1200); Brazil (N=1200); Chile (N=1240); Mexico (N=1204); Paraguay (N=587); Peru (N=1226); Uruguay (N=1212); Venezuela (N=1200).

BOX IIB-60. Commitment to income equality in Sweden and the United States

Leaders in Sweden and the United States were asked to state what they believed were equitable levels of compensation for different occupations. The figures below show the ratios between the levels that were believed to be equitable for business executives and for dishwashers (used in the Swedish survey) and elevator operators (used in the US survey).

leaders	ratios
Swedish blue-collar union leaders	2.2
Swedish Social Democratic Party leaders	2.4
Swedish business executives	4.7
US union leaders	11.3
US Democratic Party leaders	15.2
US business executives	26.0

source: 1976 survey conducted by Verba & Orren (1985:255)

BOX IIB-61. Attitudes towards Income Inequality in The Netherlands

The figures in the "A" columns show the results of a 1980 opinion survey of Dutch that first asked them to estimate the current levels of compensation for different occupations, and then asked what levels of compensation they believed would be "just". The figures in the "B" columns show the ratios of the figures in the "A" columns tothose of a reference occupation, the "unskilled factory worker."

	A. Estimates (in 1980 Guilders)			B. Ratios		
	actual income	estimated income	"just" income	actual income	estimated income	"just" income
Prime Minister	189531	207451	152635	7.9	8.3	5.2
Director of a large company	186000	202607	138812	7.7	8.1	4.7
General Practitioner	160572	157717	120397	6.7	6.3	4.1
Secondary school teacher	62869	68312	59027	2.6	2.7	2.0
Head of personnel department	62640	65429	58156	2.6	2.6	2.0
Self-employed plumber	69012	53561	51781	2.9	2.1	1.8
Typewriter salesman	54270	45344	43203	2.2	1.8	1.5
Policeman	35764	43884	45236	1.5	1.8	1.5
Shopkeeper with no employees	36600	42834	46887	1.5	1.7	1.6
Construction worker	33746	36321	37524	1.4	1.5	1.3
Car mechanic	29886	33525	36502	1.2	1.3	1.2
Typist	26450	28255	30238	1.1	1.1	1.0
Unskilled factory worker	24143	24954	29496	1.0	1.0	1.0
Old age pensioner	19558	19027	23423	0.8	0.8	0.8
Person on welfare	17090	18310	20860	0.7	0.7	0.7

average, 3 highest (excl PM):	136480	142879	106079
average, 3 lowest (excl welfare):	23384	24079	27719
high/low ratio:	5.8	5.9	3.8

	actual ---> "just"	estimated ---> "just"
percent decrease of 3 highest	22%	26%
percent increase of 3 lowest	19%	15%

source: Szirmai (1986:107,192).

by about 15-19%. The net result is to lower the ratio between the highest and lowest categories from about 5.8 to 3.8.

If the ratio between the higher and lower categories chosen here is at all analogous to the 80/20 ratio, it would appear that an 80/20 ratio of about 3.8 was be the preferred ratio of the Dutch people in 1980. This is the level present in Lithuania today.

Applied to the United States, an 80/20 ratio of 3.8 could be achieved if the mean family income of the bottom quintile rose from its 1992 level of $9,708 to $26,120, while the top quintile's mean family income of $99,250 remained unchanged. Alternatively, it could be achieved if the top quintile decreased from $99,250 to $36,900, while the bottom quintile remained unchanged.

Regarding our scenarios, and our desires for a more equitable world, the European results are in general encouraging. They show that countries whose citizens hold strong egalitarian values can be dynamic, productive and democratic. On the other hand, its not clear that Europeans, whose 80/20 ratios mostly fall into the 4:1 to 6:1 range, would necessarily support policies to reduce the 80/20 ratio to our ideal level of 2.5:1.

An important question is whether Europe's values regarding social and economic equity remain intact, or whether they get cast aside, under the impact of globalization and cultural change. The conventional view is that Europe will not be able to maintain its equity norms in the face of global competition. But this is too pat a position. A unified European Community might conceivably be able to maintain its historical social commitments while participating fully, as a bloc, in the global economy. If such an effort succeeds it might serve as an alternative to the United States as a model of modern economic development. [73]

---

[72] These survey results are 15 years old, and since that time the Scandinavian model has evolved in ways that may put less priority on distributive equity.

[73] Possible impacts of globalization are discussed at length in Section II.D.

II.B.4.e. Summary

Americans mostly say that they are satisfied with their income situation and prospects for their and their children's futures. However, large majorities (~80%) are concerned about growing income disparities. Lesser but still comfortable majorities (~60%) agree that the distribution of income in the US is currently unfair. None of the surveys reviewed asked what a fair distribution might be. Pluralities (~45%) say government should take steps to reduce income inequality. However, specific policy measures that would reduce inequality were only supported by minorities (~25%-35%) of people surveyed. Americans show far more support for measures to ensure equality of opportunity (~80%) than for measures to directly ensure equality of outcomes. Europeans show higher levels of support for public policies that address economic inequality.

II.B.5. ASSESSMENT[74]

For our ideal scenario, Scenario 5, we suggested that an 80/20 ratio of 2.5, to be attained by all countries by 2150, was a desirable, credible and compelling goal. Per capita GDP of the top and bottom income quintiles in 2150 would be about $70,000 and $28,000, respectively. As absolute levels of income these values are very high.[75] But for the currently developed countries they actually represent quite *low* rates of economic growth-- only 0.2% and 0.8% per year, for the top and bottom quintiles, respectively, over the period.[76] This low, and ultimately zero, rate of economic growth was motivated by the coupled desires to close the per capita GDP gap between the rich and poor countries, and to do so in a way that the final level of GDP was not so high that it threatened the ecological integrity of the planet or forced upon us the use of unacceptable technologies. In turn, these low rates of growth require that heightened attention be given to within-country distributional concerns. This follows from the assumption that people are willing to tolerate higher levels of income inequality when their absolute incomes are increasing rapidly, but are less tolerant of inequality when their absolute incomes are growing slowly or not at all, or are shrinking.

The material covered in Sections II.A and II.B.2 suggests that it is not clear that economic growth must of *necessity* slow as dramatically as called for in the ideal scenario. On examination neither biogeophysical limits, limits to technological innovation, limits due to

---

[74] This Assessment of our distributional goals is based largely on conditions in the currently industrialized countries. As noted earlier, the process of economic growth should allow the developing countries to achieve that level of distributional equity currently enjoyed in the industrial countries, as they achieve the levels of per capita GDP that the industrial countries reached in 1960.

[75] If we assume an average household size of 2.5 persons, average annual household incomes in 2150 would be about $175,000 and $70,000 for the top and the bottom quintiles.

[76] Actually, as Boxes IA-22 and IA-23 show, growth rates in Scenario 5 vary over the 150 years, being higher in the early decades and declining to zero by 2150.

complexity, nor limits imposed by growing inequality appeared to be so consequential that ingenuity, planning and leadership should not be mobilized to allow per capita GDP to continue to grow over the period of concern at levels comparable to historical levels, say between 1% - 2% per year. [77]

Absent the argument from necessity, the case for making a commitment to greater distributional equity must be based more heavily on preference. What light might the material presented thus far throw on the question of the extent of people's preference for greater income equality?

For those, like me, who feel strongly that a more economically equal society would be a more desirable one, the material presented in the three preceding sections presents a challenge. The survey data in Section II.B.3 suggest that large numbers of people tend to believe that the current distribution of income is unfair, and that there is a high degree of concern about the prospects of growing inequality. But there appears to be very little support for those policies that would actually *reduce* inequality.[78] This conclusion is reinforced by our review of policy proposals in Section II.B.4. The most redistributive of the policy packages that have any political support today are those of the liberals, which emphasize training and education. But as we saw, the real impact of these policies is likely very small. The more strongly redistributive policies advanced by the Progressives and the Greens are not in contention as serious proposals.

In short, it's difficult to make a case that large numbers of people would consider an 80/20 ratio of 2.5 to be a desirable, credible and compelling real-world policy goal.

---

[77] The reference scenario, Scenario 1, shows global per capita income growing at 1.5% annually in 2050, and falling to 1.1% annually by 2150.

[78] We focus in this Assessment on survey results for Americans. It's true that Europeans show more support for redistributive policies, but they also *have* less inequitable distributions of income. It's not clear from the survey data how strongly they would support *further* reductions in income inequality. An important question, discussed in Section II.D below, is whether or not in coming decades Europe is more likely to adopt American social and economic norms, or vise-versa.

Of course, conditions could change. If the Progressive forecasts of economic crisis or the Green forecasts of ecological crisis come to appear more likely, then support for more egalitarian economic policies would be likely to grow. Further, it's not inconceivable that new religious or socio-cultural movements that embrace egalitarian values could come to global prominence, even in the absence of economic or ecological instability.

Our review of possible limits to growth in Section II.A suggests that continued economic growth need not generate critically dangerous ecological instability, at least over the coming 150 years and possibly much longer. In Section II.D we address the possibility that continued growth under conditions of globalization could lead to greater economic instability. In the immediately following section, II.C, we consider a possible candidate for the sort of socio-cultural movement just noted that could embrace egalitarian values, even in the absence of necessity. This is the global Green movement, which for simplicity I identify here with the scenario of Green sustainability. At the conclusion of that section we revisit and assess our ideal scenario, identified earlier as the combination of quantitative Scenario 5 and the narrative scenario of Green sustainability.

II.C. GREEN SUSTAINABILITY

Summary

In II.C.1 we assess the narrative scenario of Green sustainability. This scenario presents a vision of the human future that integrates values of ecological integrity, social justice and cooperation. Two special burdens of Green sustainability are that it is justified to an important extent by appeals to necessity rather than inherent desirability; and that the near universal adoption of its main tenets is required if it is to be realized at all. If its necessity is difficult to establish, its inherent desirability needs to be nearly universally affirmed.

Section II.C.2 reviews the results of public opinion polls concerning environmental protection, economic growth and consumption. Support for environmental protection among Americans is very broad but may not be especially deep. Americans express a high willingness-to-pay for environmental protection in the abstract, but when specific dollar commitments are solicited this support weakens. Americans show strong support for modifying particular consumption practices to avoid harming the environment, but reject suggestions that their aggregate levels of consumption should be reduced. Analogous patterns appear in surveys conducted in countries other than the United States.

Section II.C.3 presents the results of a survey of participants at a major conference on voluntary simplicity, held in 1998. For the respondents, voluntary simplicity means reducing consumption, leading a peaceful inner life, and living in harmony with the planet. The respondents were middle-aged, middle class, and highly educated. Just over half (52%) said that the "desirable and achievable" rate of economic growth for the United States for the next 50 years was zero or negative; the other 48% believed that a positive growth rate was desirable and achievable. Most respondents favored higher incomes for families in the lowest income quintile, and anticipated higher incomes for themselves. Respondents' household incomes were higher

than the average for all households but somewhat lower than the average for persons with similar levels of formal education.

Section II.C.4 evaluates the findings of the three preceding sections. We conclude that the scenario of Green sustainability, as presently developed, is not likely to be sufficiently inherently desirable to enough people to serve as the core advocated narrative scenario of a global future. However, many tenets of Green sustainability may be realizable as elements within other scenarios. Although a "no growth" imperative may be difficult to argue for as an empirical imperative, and is not considered inherently desirable, a "slow growth" preferential option may be more credible on both counts. We reconsider our choice of quantitative Scenario 5 as a possible advocated scenario, and suggest that Scenario 3 be considered instead. We also suggest that the narrative scenario of social democratic internationalism be considered in lieu of Green sustainability.

II.C. GREEN SUSTAINABILITY

II.C.1. IS GREEN SUSTAINABILITY A NECESSITY OR A CHOICE?

In Box IB-15 the scenario of Green sustainability is characterized as being grounded in doubts that large, global economic, political and technological systems committed to continual growth are sustainable. Advocates of Green sustainability call for low consumption, cooperative human relations, and greater respect for nature, among other things. The scenario of Green sustainability is important because it stands as a clear alternative to the trajectories that would be followed both by techno-globo neoliberalism, and by most versions of social-democratic internationalism.

Green sustainability as an advocated scenario for the future sprang from the social and intellectual ferment of the late 1960's and was fully formed by 1973, a period of barely five or six years. Remarkably, the core elements of the Green sustainability scenario have not changed in any important ways in the more than three decades since that time. **IIC-1** shows important texts that have informed and marked the development and popularization of Green sustainability.

In these notes I consider the tenets of Green sustainability to include but go beyond those of environmentalism. I use "environmentalism" to suggest a commitment to protecting the earth's natural systems. This commitment can be stronger or weaker, and can be held by persons otherwise holding to a wide variety of political and social points of view. By contrast, Green sustainability puts environmental concerns at the very center of its commitment, and joins to this a number of other fundamental commitments. **IIC-2** shows "Ten Key Values" espoused by Americans active in the Green Party.[79] An expanded statement of what "being Green" means is shown in **IIC-3**.

[79] These "Ten Key Values" were developed in the mid-1980's by the German Greens and are generally adopted, with minor differences (e.g., "post-patriarchal values" instead of "feminism") by the several hundred Green Party organizations around the world.

BOX IIC-1. Fifty Years of Green Sustainability: A history in texts

Wolfgang Sachs et al.	1998	*Greening the North*
Paul Shepard	1998	*Coming Home to the Pleistocene*
Hartmut Bossel	1998	*Earth at a Crossroads: Paths to a Sustainable Future*
Amory Lovins, et al.	1997	*Factor Four*
Stephanie Mills	1997	*Turning Away from Technology*
Brian Tokar	1997	*Earth for Sale*
Tom Athanasiou	1996	*Divided Planet: The Ecology of Rich and Poor*
Herman Daly	1996	*Beyond Growth*
Richard Peets, Michael Watts	1996	*Liberation Ecology*
President's Council for Sustainable Development	1996	*Sustainable America: A new consensus for prosperity, opportunity, and a healthy environment*
Bill McKibben	1995	*Home, Human and Wild*
Paul Ehrlich et al.	1995	*The Stork and the Plow*
Wuppertal Institute	1995	*Towards a Sustainable Europe*
M. Wackernagel & W. Rees	1995	*Our Ecological Footprint*
Richard Norgaard	1994	*Development Betrayed*
Cliff Cobb and Ted Halstead	1994	*The Genuine Progress Indicator*
Paul Hawkin	1994	*The Ecology of Commerce*
David Pepper	1993	*Eco-Socialism: from Deep Ecology to Social Justice*
Wolfgang Sachs	1993	*Global Ecology: A New Arena of Political Conflict*
D. Meadows & D. Meadows	1992	*Beyond the Limits*
Alan Durning	1992	*How Much Is Enough?*
Joe Dominguez & Vicki Robin	1992	*Your Money or Your Life*
Al Gore	1992	*Earth in the Balance*
Richard Douthwaite	1992	*The Growth Illusion*
Carolyn Merchant	1992	*Radical Ecology*
Paul Ekins	1992	*Green Economics*
Jerry Mander	1991	*In the Absence of the Sacred*
Lester Brown et al.	1991	*Saving the Planet*
Bill Devall	1990	*Simple in Means, Rich in Ends*
Herman Daly, John Cobb Jr.	1989	*For the Common Good*
Bill McKibbin	1989	*The End of Nature*
Earthworks Press	1989	*50 Simple Things You Can Do To Save The Earth*
Lester Milbrath	1989	*Envisioning A Sustainable Society*
Stephen Schneider	1989	*Global Warming*
Bill Devall, George Sessions	1988	*Deep Ecology: Living as if Nature Mattered*
Thomas Berry	1988	*The Dream of the Earth*
World Commission on Environment & Development	1987	*Our Common Future*
Brian Tokar	1987	*The Green Alternative: Creating an Ecological Future*
Fritjof Capra and Charlene Spretnack	1984	*Green Politics*
Rudolph Bahro	1984	*From Red to Green*
Jonathan Porritt	1984	*Seeing Green: The Politics of Ecology Explained*

(more...)

BOX IIC-1. Fifty Years of Green Sustainability: A history in texts (cont'd.)

Die Gruenen	1983	*Program of the German Green Party*
Fritjof Capra	1982	*The Turning Point*
Murray Bookchin	1982	*The Ecology of Freedom*
Lester Brown	1981	*Building a Sustainable Society*
Duane Elgin	1981	*Voluntary Simplicity*
Andre Gorz	1980	*Ecology as Politics*
Kirkpatrick Sale	1980	*Human Scale*
Carolyn Merchant	1980	*The Death of Nature*
Theodore Rozak	1979	*Person/Planet*
Warren Johnson	1979	*Muddling Toward Frugality*
Farallones Institute	1979	*The Integral Urban House*
James Lovelock	1979	*GAIA: A New Look At Life On Earth*
Peter Berg, ed.	1978	*Reinhabiting a Separate Country*
William Ophuls	1977	*Ecology and the Politics of Scarcity*
Amory Lovins	1976	*Energy Strategy: The Road Not Taken*
Ernest Callenbach	1975	*Ecotopia*
Annie Dillard	1974	*Pilgrim at Tinker Creek*
Robert Heilbroner	1974	*An Inquiry into the Human Prospect*
E.F. Schumacher	1973	*Small is Beautiful*
Herman Daly	1973	*Toward a Steady-State Economy*
Edward Goldsmith et al.	1972	*Blueprint for Survival*
Donella Meadows et al.	1972	*The Limits to Growth*
Francis Moore Lappé	1971	*Diet for a Small Planet*
Nicolas Georgescu-Rogen	1971	*The Entropy Law and the Economic Process*
Barry Commoner	1971	*The Closing Circle: Nature, Man, and Technology*
Charles Reich	1970	*The Greening of America*
Theodore Rozak	1970	*The Making of a Counter-Culture*
Steward Brand, et al.	1968	*The Whole Earth Catalogue*
Garret Hardin	1968	*The Tragedy of the Commons*
Paul Ehrlich	1968	*The Population Bomb*
Barbara Ward	1966	*Spaceship Earth*
Stuart Udall	1963	*The Quiet Crisis*
Rachel Carson	1962	*Silent Spring*
Harrison Brown	1954	*The Challenge of Man's Future*
Aldo Leopold	1949	*A Sand County Almanac*

BOX IIC-2. THE "TEN KEY VALUES" OF THE GREENS

source: O'aht-Ka Green Party Genesse Valley Region, New York State
http://vader.boutell.com/seagreens/TextOnly/Values/index.html

Ecological Wisdom: The Greens recognize that the Earth sustains all life processes. Green ecology moves beyond environmentalism by understanding the common roots of the exploitation of nature and the exploitation of people.

Social Justice: Greens oppose the worldwide system of poverty and injustice, and are working to end oppression based on class, sex, race, citizenship, age, or sexual orientation.

Grassroots Democracy: Greens believe that the power concentrated in big business and big government must be returned to the people. We believe in direct participation by all people in the environmental, political and economic decisions that affect their lives.

Non-Violence: Greens reject violence as a way of settling disputes--it's shortsighted, morally wrong, and ultimately self-defeating. We are working to create a society where war is obsolete.

Decentralization: Power and responsibility must be restored to local communities, within an overall framework of ecologically sound, socially just values and ways of living.

Community-Based Economics: Greens seek a new economics based upon the natural limits of the Earth, which meets the basic needs of everyone on the planet, and is under democratic, decentralized community control.

Feminism: The Green movement is profoundly inspired by feminism. The ethics of cooperation and understanding must replace the values of domination and control.

Respect For Diversity: We honor the biological diversity of the Earth, and the cultural, sexual, and spiritual diversity of Earth's people. We aim to reclaim this country's finest ideals: popular democracy, the dignity of the individual, and liberty and justice for all.

Personal And Global Responsibility: Greens are committed to global sustainability through both political solidarity and of living based on ecological principals that respect our bioregion.

Future Focus: Like the Iroquois Indians, Greens seek a society where the interests of the seventh generation are considered equal to the interests of the present. We must reclaim the future for ourselves and our children.

BOX IIC-3. Criteria for "Being Green"

These are the criteria that Jonathon Porrit, Chair of the UK's Green Party, lists as his personal assessment of "the minimum" for "being green. [source: *Seeing Green: the politics of ecology explained* (1984)]

1) A reverence for the earth and all its creatures

2) A willingness to share the world's wealth among all its peoples; prosperity to be achieved through sustainable alternatives to the rat race of economic growth

3) Lasting security to be achieved through non-nuclear defense strategies and considerably reduced arms spending

4) A rejection of materialism and the destructive values of industrialism

5) Recognition of the rights of future generations in our use of all resources

6) An emphasis on socially useful, personally rewarding work, enhanced by human-scale technology

7) Protection of the environment and a precondition of a healthy society

8) An emphasis on personal growth and spiritual development

9) Respect for the gentler side of human nature

10) Open, participatory democracy at every level of society

11) Recognition of the crucial importance of significant reduction in population levels

12) Harmony between people of every race, color and creed

13) A non-nuclear, low-energy strategy, based on conservation, greater efficiency and renewable sources

14) An emphasis on self-reliance and de-centralized communities

As considered here, the scenario of Green Sustainability is strongly shaped by its belief that objective limits-to-growth will necessitate a transition to a steady-state economy, and that the sooner this process can begin, the less disruptive this transition will be. **IIC-4** documents this element of the Green sustainability scenario.

Is Green sustainability a credible, compelling scenario for the future? In order to assess this it's important to be honest about its full implications. **IIC-5** lists features that William Ophuls proposes would characterize a steady-state society. The authoritarian, hierarchical elements of this steady-state society are strongly at odds with the democratic and decentralist elements that figure prominently in the vision of Green sustainability expressed in Boxes IIC-2 and IIC-3.[80]

This conflict gets to the heart of the major reason why it may be difficult for Green sustainability to serve as the core advocated scenario for the global future. A steady-state world is one in which essentially all people consume not more than some agreed upon or allotted sustainable level of resources and/or output. Such an outcome can be achieved either voluntarily or authoritatively. For it to happen voluntarily would require that all people come to know, adopt and strongly internalize those values, beliefs and behaviors necessary to support the steady-state regime. A world in which 90% of the population live in accord with steady-state norms, but 10% do not, may be a slow growth world, but it is not a steady-state world, and it is a world in which the power and influence of the non-cooperators will grow. A truly steady-state economy requires cooperation from very nearly 100% of consumers and producers.

How might this be expected to come about? Most of the literature on Green sustainability seems to imply that it will happen as people are educated about the issues and come to appreciate the stakes--in other words, through a process of rational choice. Other texts suggest that a mass societal conversion, at least on a par with mass religious conversions, would be needed to replace the symbolic structures, societal narratives and institutional arrangements of a

[80] Authority and hierarchy are even more dramatically at odds with the Green political *practice*, as anyone who has been involved in those efforts can attest.

BOX IIC-4. STEADY-STATE ECONOMICS AS NECESSITY

These excerpts document the central role played by the construction of biogeophysical limits to economic growth as a motivating element in the scenario of Green sustainability.

Ted Trainer (1996):

> "[W]hether we like it our not we cannot define a sustainable society other than (as) a society based on simpler lifestyles, a high level of self-sufficiency, cooperation, and a zero growth economy...Whether or not it is unrealistic to ask people in general at this point in time to endorse such a society is not the focal issue. The crucial point is that *we have no choice* about these matters.... " (p 163)

Warren Johnson (1979):

> "[A]s a society, we might prefer to keep things the way they are now, but as time passes, this will not be an alternative.... We will have less and less choice but to turn toward frugality...The only real question, as far as I am able to discern, is whether we will move to it...efficiently and peacefully." (p 230-231)

William Ophuls (1977):

> "If we will not freely and joyfully place 'moral chains' on our will and appetite, then we shall abdicate to the brute forces of nature or to a political Leviathan what should be our own moral duty...Only a life of self-restraint and simple sufficiency in natural harmony with the earth will allow us to continue to enjoy life, liberty and estate." (p 244)

BOX IIC-5. SOCIAL CHARACTERISTICS OF A STEADY-STATE WORLD
[sources: Ophuls, 1977,1992]

Modesty: "Once the getting and spending of material wealth have ceased to be the prime determinant of status and self-esteem, the search for social satisfaction and personal fulfillment can turn towards the artistic, cultural, spiritual intellectual and scientific spheres."

Politics: "... the market orientation typical of most modern societies will have to be strictly governed."

Stewardship: "...we shall move away from the values of growth, profligacy and exploitation... towards sufficiency, frugality and stewardship. Stewardship...will become the cardinal virtue of ecological economics...The steady-state need not involve joyless self-abnegation, for they would be participating in a deeply satisfying civilization task. Learning to live with scarcity does not mean learning to live without... Yet it must be acknowledged that many people living today might not share this sanguine assessment..."

Diversity: "The pressures of ecological scarcity urge upon us technological pluralism... limitations of energy and material use seem likely to lessen substantially the current high degree of homogenization, centralization and interdependence."

Holism: "There will be a decisive move away from scientific reductionism... toward holism, the assumption that nature is best understood by focusing on the interrelationships..."

Communalism: "...the traditional primacy of the community over the individual that has characterized virtually every other period of history will be restored... Rigid caste systems and inflexible feudal hierarchies are unlikely to be necessary, but the degree of individual subordination that will be required would probably seem insupportable to many living today."

Authority: "...we shall necessarily move from liberty toward authority, for the community will have to be able to enforce its demands on individuals..."

Government: [There will be] "... a movement away from egalitarian democracy towards political competence and status. ...to the extent that a class of Jeffersonian natural aristocrats is still needed to make the system work, it could be subject to constitutional restraints..."

Morality: "It seems extremely unlikely that a real commitment to stewardship could arise out of enlightened self-interest; it will require a change of heart... the steady-state society, like virtually all other human civilizations except modern industrialism, will almost certainly have a religious basis..."

growth-oriented industrial society with new ones appropriate for a no-growth, sustainable society.[81]

If neither of these means are able to assure universal adoption of behaviors compatible with a steady-state world, then overtly authoritative structures would be necessary. Of course, the vision of a sustainable society that Ophuls, Daly and Cobb, and others propose is hardly that of an eco-fascist police state. They appear to envision a benign, in some respects perhaps quasi-feudal, society characterized by a level of individual, social and spiritual maturity, and ecological understanding, that precludes the need for most gross authoritative constraints. However, this society would also have to be able to act effectively in those circumstances when the survival of humankind might be threatened by individuals or groups that fail to cooperate.

Given the apparent necessity of either mass religio-spiritual conversion, or authoritarianism, it's perhaps no surprise that Green sustainability does not have a larger following. Any truly mass appeal that Green sustainability might have would appear to rest heavily on the plausibility of the limits-to-growth critique. If that critique is felt to be strong, then authoritarianism and hierarchy can be accepted as necessary evils. If that critique is felt to be flawed, then a major portion of the rationale for the scenario of Green sustainability is weakened. And as we saw in Section II.A, it is difficult to make a convincing case that limits-to-growth need necessarily impair moderate levels of economic growth for at least the next 150 years, and perhaps longer.

Is it possible that people might be attracted to the scenario of Green sustainability even in the absence of necessity imposed by limits-to-growth? Certainly, many people are attracted by a vision that calls for less material striving, more cooperative human relations, more spiritual depth, and greater appreciation of nature. The important questions are: how many people? Coming from what economic circumstances? If large numbers are attracted to such a vision on its own

terms, then the argument from necessity is unneeded. But so long as a minority of persons do *not* agree to live lives of frugality, cooperation, spiritual growth, etc., then the scenario itself is not realizable, as noted above. At the present time the number of people who hold to the values of Green sustainability, and express these values in their life decisions, and for whom the prospects of limits-to-growth are *not* an important consideration, is probably very small. By itself that doesn't disqualify Green sustainability as a practicable global scenario--the real world expression of any alternative scenario will initially be small. The important question is: at what rate can we credibly expect that people in different countries and from all walks of life will come to adopt the values that support a global regime of Green sustainability, in the absence of expected objective constraints?

In order to help evaluate prospective levels of support for the critically challenging elements of the Green scenario, the following two sections review the results of public opinion surveys.

In section C.2 we review surveys concerning environmental protection, with particular attention to how strongly people feel about the environment in comparison with other issues, and how they weigh possible tradeoffs between environmental and economic concerns.

In section C.3 we report the results of a survey of participants at a major conference on voluntary simplicity, held in Los Angeles in September of 1998. The tenets of the voluntary simplicity movement overlap strongly with those ascribed in these notes to Green sustainability. Further, the voluntary simplicity movement has as its focus encouraging and supporting people in actually living their lives in ways that are consistent with professed values of sustainability. The survey was intended to find out what voluntary simplicity meant to the conference participants, what demographic and other factors characterized the participants, and how participants felt about tradeoffs between consumption, economic growth, and equity.

---

[81] See Ophuls' final point in IIC-5, and the quote from Daly and Cobb in Section II.B.3.d concerning their religious commitment.

In the final section, C.4, we consider the results from the three previous sections, and conclude with an assessment of the credibility of Green sustainability as an advocated scenario.

II.C.2. PUBLIC OPINION ABOUT THE ENVIRONMENT, CONSUMPTION AND ECONOMIC GROWTH

II.C.2.a. General Support for Environmental Protection

Box IIC-6 shows trends in the United States over the past 23 year of support for spending money to protect the environment. After a high point in the early 1970's support moderated for most of that decade, then increased steadily through the 1980's as evidence of threats to the environment mounted. After a second high point in the late 1980's and early 1990's, culminating in the 1991 Earth Summit in Rio de Janeiro, support dropped once more. But despite the ups and downs the level of stated support for environmental protection is consistently high.

Further evidence of strong support for environmental protection is seen in **IIC-7** and **IIC-8.** In 1989 the issues listed in IIC-7 were sources of "worry" for an average of 80% of Americans. By 1997 this proportion had dropped a bit, to 75%, but this still indicates a very high level of concern. In 1994 upwards of 75% of Americans considered pesticides, nuclear power and global warming either extremely or somewhat "dangerous," as shown in Table 1 of IIC-8. And throughout the 1990's, a period of great ferment against governmental regulation, over 80% of Americans consistently supported *stricter* regulations to protect the environment, as shown in Table 2.

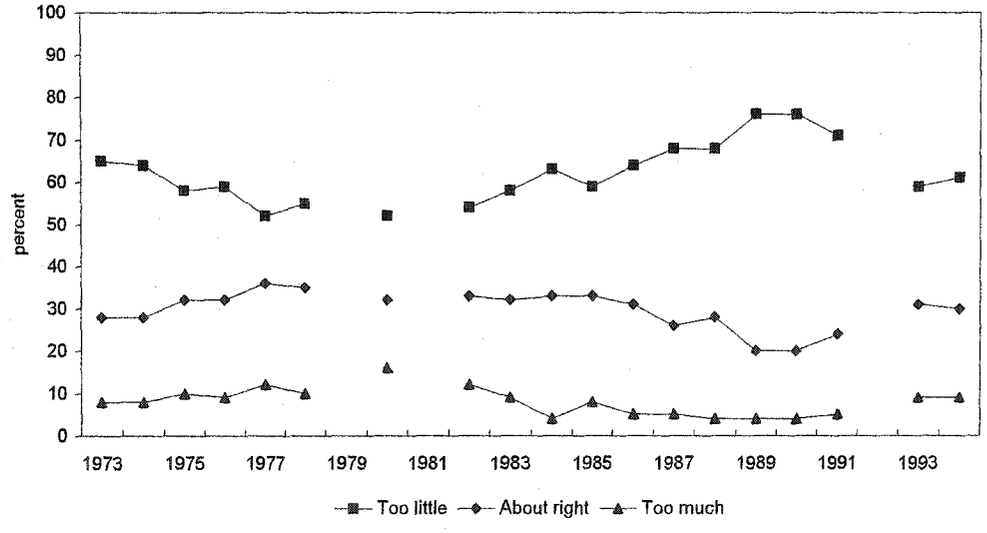
However, despite this very broad concern, environmental issues do not appear to stand out as a particularly *deep* concern. **IIC-9** and **IIC-10** show the results of a 1996 Pew Research Center survey in which respondents were asked to state the main wishes, hopes, fears and worries they had, both for themselves and for the country as a whole. The issues that people mentioned most frequently concerned money, jobs, health, their families, international conflict, crime,

BOX IIC-6. Support for environmental protection
[percents]

Table 1. Are we spending too much money, too little money, or about the right amount on improving and protecting the environment?

	too little	about right	too much
1973	65	28	8
1974	64	28	8
1975	58	32	10
1976	59	32	9
1977	52	36	12
1978	55	35	10
1979			
1980	52	32	16
1981			
1982	54	33	12
1983	58	32	9
1984	63	33	4
1985	59	33	8
1986	64	31	5
1987	68	26	5
1988	68	28	4
1989	76	20	4
1990	76	20	4
1991	71	24	5
1992			
1993	59	31	9
1994	61	30	9

Figure 1. Support for spending to protect the environment



source: National Opinion Research Center General Social Survey, codebook variable NATENVIR

BOX IIC-7. Public concern about environmental problems (1)

[percents]

I'm going to read you a list of environmental problems. As I read each one, please tell me if you personally worry about this problem a great deal, a fair amount, only a little, or not at all. How much do you personally worry about...

		Great Deal	Fair Amount	Only A Little	Not At All
a. The "greenhouse effect" or global warming					
	Nov 97	24	30	26	15
	May 89	35	28	18	12
b. Damage to the earth's ozone layer					
	Nov 97	40	28	21	9
	May 89	51	26	13	8
c. Contamination of soil and water by toxic waste					
	Nov 97	59	24	13	4
	May 89	69	21	7	3
d. Air Pollution					
	Nov 97	47	34	14	4
	May 89	63	25	8	4
e. Pollution of rivers, lakes & reservoirs					
	Nov 97	61	27	9	3
	May 89	72	19	5	3
f. The loss of tropical rain forests					
	Nov 97	44	26	19	10
	May 89	42	25	18	12
g. The loss of natural habitat					
	Nov 97	46	32	16	5
	May 89	58	27	9	5

source: Pew Research Center for People and the Press, News Interest Index Poll, 11/12-16, 1997; Question 22.

BOX IIC-8. Public Concern About Environmental Problems (2)
[percents]

Table 1

In general, do you think the items listed are...	pesticides and chemicals used in farming	nuclear power stations	global warming
extremely/very dangerous for you and your family	37	40	41
somewhat dangerous for you and your family	51	36	39
not very/not dangerous for you and your family	12	24	20

sources: National Opinion Research Center General Social Survey, 1994; codebook variables CHEMFAM, NUKEFAM and TEMPFAM.

Table 2

There needs to be stricter laws and regulations to protect the environment.

	Completely Agree	Mostly Agree	Mostly Disagree
Nov 97	41	40	13
July 94	46	36	13
June 92	55	35	7

source: Pew Research Center for People and the Press, News Interest Index Poll, Nov. 1997.

BOX IIC-9. PERSONAL HOPES AND FEARS

[percents; up to three responses accepted]

1. What are your main wishes and hopes for yourself and your family... the things you most hope for to be happy in your life?

42 **Financial**
more opportunities/get a better job (11); financial security (10); stability of social security (7); make more money/better wages (6); more successful professionally (5); sound economy (4); other (3)

21 **Health**
good health/long life (18)

18 **Family/Children**
happiness for family/children (7); education/job opportunities for kids (6); starting a family/having children (4); other (2)

10 **Peace/Stability**
no wars/People not killing each other (7); other (3)

6 **Quality of life**

6 **Less crime**

4 **Less government**

4 **Return to morality**

4 **Education**
get an education/finish school (3); other (1)

3 **Material possessions**
buy a House (2); other (1)

10 **Other**

12 **Don't know**

2. What are your main fears and worries about your future?

38 **Financial**
job security/find a job (10); personal finances/not enough money (10); stability of social security system (6); the economy (6); retirement plans/money for retirement (4); other (5)

14 **Health**
being sick/poor health (8); inadequate health care/insurance (5); other (2)

10 **Crime**

6 **Worries about children's future**

5 **The political system**

4 **War/international instability**

3 **Things getting worse/going downhill**

3 **Moral decline**

24 **None/no worries**

2 **Don't know**

source: Princeton Survey Research Associates/Pew Research Center for the People & the Press; State of the Union Poll, 11/22-12/1 1996; Questions 3 and 4.

BOX IIC-10. HOPES AND FEARS FOR THE COUNTRY
[percents; up to three responses accepted]

1. WHAT ARE YOUR MAIN WISHES AND HOPES FOR THE COUNTRY'S FUTURE?

26	**Economic**
	more jobs (9); a good/better economy (7); balance budget/less gov debt (6); other (7)
19	**World Peace/National Security**
	world peace/no more war (16); stronger military/security (2); other (2)
12	**Crime**
	less crime/violence (11); eliminate drug problems (1); other (1)
10	**Religion and Morality**
	more moral society (5); more emphasis on religion (3); other
9	**Government/political Leadership**
	better leadership (3); other (6)
8	**Cooperation/unity**
	more unity (4); other (4)
6	**More money for education**
4	**Race relations (4)**
	racial equality (2) other (1)
4	**Improved health care**
3	**Taking care of our own citizens**
3	**Help to the Homeless**
2	**Change Welfare**
9	**Other**
8	**Don't know**

2. WHAT ARE YOUR MAIN FEARS AND WORRIES ABOUT THE COUNTRY'S FUTURE?

18	**Economic**
	the economy (4); unemployment, job loss (4); budget imbalance/debt (3); other (8)
12	**War/National Security**
	war/fighting between nations (10); other (2)
10	**Crime/violence**
8	**Government/Political leadership**
	effectiveness of government/political leadership (4); other
6	**Religion and Morality**
	low morals (4); other (3)
6	**Things are getting worse/going downhill**
3	**Racial tension**
15	**Other**
28	**None/no worries**
1	**Don't know**

source: Princeton Survey Research Associates/Pew Research Center for the People & the Press; State of the Union Poll, 11/22-12/1 1966; Questions 5 and 6.

morality, and the quality of political leadership. Environmental concerns were not mentioned by enough people to appear in the final tally. [82]

The impression that public concern about environmental issues is broad but perhaps less than critical is supported by the survey results shown in **IIC-11.** Eleven news stories that received important coverage in late 1997 are ranked by how closely they were followed by the general public. Coverage of the debate over US global warming policy was ranked second to last.[83]

It is possible that public concern about the environment is not so much less deeply held in a fundamental sense than are concerns about other issues, but that environmental issues appear to be more tractable, and thus perhaps less worrisome overall. This possibility is supported by the results of the survey described in **IIC-12,** which asked about the extent of progress people believed was being made on 17 social problems. Respondents believed that more progress was being made on addressing "environmental pollution" than on any of the other issues mentioned. Those issues on which they felt that *little* progress was being made were largely those that appeared as *high* sources of concern in the surveys described in IIC-9 and IIC-10. As might be expected, environmental protection ranked low--15 out of 20--when respondents were asked to name the single issue that they would like to see more done about. Crime, education, health care, finances, drugs and poverty/homeless issues headed the list.

II.C.2.b. Willingness to Pay for Environmental Protection

How willing are Americans to pay for environmental protection? The survey results displayed in **IIC-13** show very mixed responses. Tables 1, 2 and 3 all indicate that willingness to pay more for environmental protection is split roughly evenly between those who suggest they are

---

[82] Concerns mentioned by less than 2% of respondents were listed as "other."

[83] If the survey had been conducted at the end of December, after the Kyoto negotiations, rather than during the period preceding them, attention paid to coverage of global warming concerns might have registered higher.

BOX IIC-11. NEWS STORIES FOLLOWED BY THE PUBLIC
[percents]

Now I will read a list of some stories covered by news organizations this past month. As I read each item, tell me if you happened to follow this news story very closely, fairly closely, not too closely, or not at all closely.

	Very Closely	Fairly closely	Not too Closely	Not at all Closely
1. Iraq's refusal to let Americans participate in weapons inspections	44	32	10	13
2. The trial of the British au pair accused of murdering an 8-month old child	29	36	20	14
3. Preparations for storm and flooding expected from El Nino	25	37	20	16
4. Recent ups & downs in the stock market	25	36	18	20
5. proposal in Congress to reform the IRS	25	34	18	22
6. The discovery of videotapes of President Clinton's White House coffees with campaign contributors	18	28	28	25
7. Congressional hearings on improper campaign contributions	16	33	27	23
8. The debate in Congress over "fast track" trade legislation	11	23	29	35
9. Chinese President Jiang Zemin's visit to the US	10	29	28	32
10. the debate over US policy concerning global warming	**9**	**24**	**33**	**33**
11. Elections in Virginia, New Jersey, New York City and other localities	7	14	22	55

note: the news stories are shown ranked beginning with the "most closely" followed. In the survey the order of the stories was rotated among respondents.

Source: Pew Research Center for the People and the Press, News Interest Index Poll, Nov. 1997.

BOX IIC-12 . MAKING PROGRESS; MORE TO BE DONE

[percents]

A. Now I'd like to ask you some questions about some of the problems we face in this today... Do you think the problem of (insert) is About the Same as it has been, that we are Making Progress towards solving the problem, or that on this problem the country is Losing Ground?

	Making Progress	About the same	Losing Ground
soc. security/Medicare	10	21	65
high taxes	11	31	55
political corruption	12	36	49
low morals& ethics	12	24	62
drugs	13	21	64
job security	14	25	58
poverty/homeless	14	30	54
illegal immigration	15	32	47
crime	15	23	61
good-paying jobs	19	26	51
health care system	20	25	52
federal budget deficit	23	24	48
public education	24	22	52
race conflict	27	31	39
welfare system	31	21	45
discrimination	33	36	28
* environmental pollution	42	26	30

B. Of the issues listed, which ONE would you most like to see more done about?	
crime	12
public education	12
health care system	8
federal budget deficit	7
soc. security/Medicare	7
drugs	7
poverty/homeless	7
high taxes	7
welfare system	6
low morals & ethics	4
job security	4
political corruption	4
good paying jobs	3
* environmental pollution	3
race conflict	2
discrimination	1
illegal immigration	1
none	1
don't know	4

The responses to question A have been sorted in increasing order of "Making Progress."
The responses to question B have been sorted in decreasing order of "urgency."

source: Pew Center for the People and the Press, State of the Union Poll, 11/22-12/1/96.

BOX IIC-13. Willingness to Pay to Protect the Environment

[percents]

Table 1

We worry too much about the future of the environment, and not enough about prices and jobs today.

	1994
strongly agree/agree	42
neither agree nor disagree	14
disagree/strongly disagree	44

source: National Opinion Research Center General Social Survey, codebook variable GRNECON.

Table 2

People should be willing to pay higher prices in order to protect the environment.

	Complete Agree	Mostly Agree	Mostly Disagree	Completely Disagree
Nov. 97	17	38	29	16
July 94	17	40	28	15
June 92	26	41	22	11

source: Pew Center for the People & the Press, Values Update Survey, Nov. 1997

Table 3

How willing would you be to pay much higher prices in order to protect the environment?

	1994
Willing	50
Neither willing nor unwilling	24
Unwilling	26

source: National Opinion Research Center General Social Survey, codebook variable GRNPRICE.

Table 4

How willing would you be to pay much higher taxes in order to protect the environment?

	1994
Willing	35
Neither willing nor unwilling	22
Unwilling	43

source: National Opinion Research Center General Social Survey, codebook variable GRNTAXES

Table 5

"People should pay the environmental costs of the things they buy. Products should be taxed depending on their effect on the environment."

	Earth Firs	Sierra Clu	public	dry cleane	sawmill wkrs
Agree:	97	85	70	77	48

source: Kempton et al., (1995:257)

Table 6

"I would be willing to pay as much as 10% more a week for grocery items if I could be sure they would not harm the environment."

	Yes	No
1990	64	31
1971	47	43

source: Yankelovitch (1990); cited in Kempton et al., (1995:5).

Table 7

How much more per month would you personally be willing to pay for all the goods and services you use as a consumer, if you know that as a result... business and industry would... not harm the environment?

1990	36.99	[median value]
1984	10.23	[median value, 1990 dollars]

source: Cambridge Reports (1990); citied in Kempton et al., (1995:5)

and those who suggest they are not. Table 3 and Table 4 distinguish between willingness to pay in the form of *prices* and *taxes*, and show a markedly greater unwillingness to pay in the form of taxes. Table 5 is from Kempton et al.'s intensive survey of groups chosen to represent the spectrum of tendencies with respect to environmental values, ranging from Earth First! and the Sierra Club on one end, through a general public sample in the middle, to dry cleaners subject to toxic regulations and finally to saw mill workers who were laid off as a result of legislated reductions in logging on the other. Kempton's results show far higher willingness pay by the environmentalists, as would be expected, but show very high willingness among the general public and the dry cleaners as well. The results in Tables 4 and 5, if valid, might be interpreted to imply that while 70% of the public believes that people *should* pay environmental taxes, only 35% would be willing to actually pay them. Alternatively, there may have been important differences in the context and presentation of the survey that produced such apparently disparate results. [84]

Tables 6 and 7 in IIC-13 go beyond general sentiment and attempt to measure willingness-to-pay in dollar terms. Whether these results indicate high or low willingness is a matter of interpretation. The average household spends about $2803 annually for groceries; thus the 10% premium that 2/3 of Americans are willing to pay for environmentally safe grocery items represents an added dollar cost of $280/year. Meanwhile, as noted below in Table 4, most Americans appear willing to pay an extra 25 cents per gallon of gasoline to reduce global warming; for the average household this represents an added annual cost of $239. The sum of these two premiums alone comes to $519 a year. But Table 7 suggests that for a majority of Americans the amount they would be willing to pay to address environmental harms associated with "all goods and services" they consume would be in the neighborhood of $444 per year.

---

[84] Kempton et al.'s results consistently show far higher levels of support for environmental protection than do the results of most other surveys.

Returning to the important topic of global warming, the public appears split down the middle on their general willingness to support higher prices and taxes, but more clearly opposed to taking action if such steps would cause unemployment to go up a great deal, as shown in **IIC-14**. When specific prices are mentioned, the level of support or opposition become clearer. Nearly three-fourths would support a nickel per gallon gasoline tax, and, as noted above, 60% would support a 25-cent levy. This tax is about the level required by the goals tentatively agreed to in the Kyoto accords, which would bring US CO2 emissions to 7% below 1990 levels by 2010. However, it is not enough to stabilize emissions at a level that would stabilize global warming below 2.5 degrees Centigrade; for this, carbon taxes at a level equivalent to as much $2.00 per gallon are probably required. Still, these higher levels of price disincentives can be phased in over a period of several decades. On balance, the apparent willingness of Americans to support a 25 cent gas tax to address global warming is an encouraging sign. But the question of how much Americans may be willing to pay to address the entire range of environmental concerns remains unresolved.

II.C.2.c. Growth and the Environment

The debate over "growth and the environment" takes place in at least two domains. One is a micro-domain of arguably calculable marginal costs and benefits, and focuses on the sorts of concerns we noted in the immediately preceding section. The other is a macro-domain of less easily articulated but perhaps deeper concerns about the nature of the relation between growth and the environment, and what it means for the well-being of oneself, ones family and others. For most Americans the terms "growth" and "environment" both carry strongly positive connotations; thus the possibility of a conflict between them is unsettling. Survey results reflect this, as shown in **IIC-15**. If forced to choose, most Americans will typically express a commitment to assuring the integrity of the environment, as shown in Tables 1 and 2. At the same time, they seek to affirm statements which suggest that perhaps environmental protection

BOX IIC-14. WILLINGNESS TO PAY TO AVOID GLOBAL WARMING
[percents]

Table 1.

Would you, personally, be willing or not willing to have the United States take steps to reduce global warming if costs for gasoline or electricity went up a great deal?

	1997
Yes, willing	44
Not willing	48
depends (volunteered)	4
no opinion	4

source: The Gallup Organization, www.gallup.com/poll/news971202.html

Table 2

Would you, personally, be willing or not willing to have the United States take steps to reduce global warming if unemployment went up a great deal?

	1997
Yes, willing	34
Not willing	54
depends (volunteered)	5
no opinion	7

source: The Gallup Organization, www.gallup.com/poll/news971202.html

Table 3

Would you be willing to pay 5 cents more per gallon if it would significantly reduce global warming, or wouldn't you?

	1997
Yes, willing	73
Not willing	24
don't know/refused	3

source: Pew Research Center for the People & the Press, 11/97 News Interest Index Poll.

Table 4

Would you be willing to pay 25 cents more per gallon if it would significantly reduce global warming, or wouldn't you?

	1997
Yes, willing	60
Not willing	37
don't know/refused	3

source: Pew Research Center for the People & the Press, 11/97 News Interest Index Poll.

BOX IIC-15. ECONOMIC GROWTH AND THE ENVIRONMENT
[percents]

Table 1

Which of these statements comes closest to your own point of view: Protection of the environment should be given top priority, even at the risk of curbing economic growth, or, Economic growth should be given top priority, even if the environment suffers to some extent?

	protect environment	economic growth	no opinion
1995	62	31	7
1991	70	20	10
1990	70	19	11
1984	61	27	12

source: The Gallup Organization, survey, May 11-14, 1995.

Table 2

Economic growth always harms the environment.

	1994
Agree	21
Neither agree nor disagree	26
Disagree	53

source: National Opinion Research Center General Social Survey, codebook variable GRWTHARM

Table 3

In order to protect the environment, American needs economic growth.

	1994
Agree	48
Neither agree nor disagree	24
Disagree	28

source: National Opinion Research Center General Social Survey, codebook variable GRWTHELP

Table 4

"The American people would be better off if the nation's economy stopped growing so fast."

	Earth First!	Sierra Club	public	dry cleaners	sawmill workers
agree:	97	85	70	77	48

source: Kempton et al. (1995:270)

and economic growth need not, after all, be in conflict, as shown in Table 3 (and in Table 1 of Box IIC-17 as well). Clearly, the terms "economic growth" and "environment" are too abstract to allow a useful unqualified judgment about their relative value. But in the United States the terms are commonly used as metaphors for particular constellations of social values and commitments. These are indeed often in conflict, as suggested by the large minority positions shown in the survey results displayed in IIC-15, and especially in the widely diverging responses shown in Table 4.

II.C.2.d. Consumption and the Environment

Additional ambivalence concerning economic values and environmental values can be seen in the results reported in **IIC-16**. By overwhelming majorities, the respondents express support for a whole range of statements that appear to reflect a dissatisfaction with consumerism and materialism, and a sense that the high-consumption path we are on is in some manner ecologically unsustainable, as seen in Table 1 and Table 2. However, when it comes to making the sorts of changes in personal behavior that these sentiments seem to call for, the respondents agree to all of them, *except* for the one that would eliminate an individual's continuing *option* of pursuing a high-consumption path, as shown in Table 3.

Signs of ambivalence are further compounded by the results shown in **IIC-17.** The statements shown in Table 1 and Table 2 were deliberately crafted by their authors to ferret out inconsistent beliefs. They note that only the Earth First!ers respond in clearly consistent proportions to the two statements (Kempton:130). The responses of the other groups can be reconciled only if we assume they are suggesting that a "drastic" reduction in one's "level of consumption" need not reduce one's "standard of living." I use quotes around the key terms because their precise definition determines whether that suggestion may be reasonable or not.

The results in Table 4 and Table 5 similarly appear to be inconsistent. In Table 4 fully 97% of the public appear willing to decrease their "standard of living today" if this is necessary in

BOX IIC-16. CONSUMPTION AND THE ENVIRONMENT
[percents]

Table 1

	Agree	Disagree	don't know
An underlying cause of environmental problems is that:			
(i) We focus too much on getting what we want now and not enough on future generations.	91	8	1
(ii) buying and consuming is the American Way.	89	11	1
I believe that protecting the environment will require most of us to make major changes in the way we live	88	12	1

Table 2

I'm going to mention some actions that we as Americans could take to help the environment. For each possible action, please tell me whether you believe it would make a Big difference in helping the environment, make Some difference, make No difference at all, or whether it would actually hurt the environment.

	Big/Some	None	Hurt	don't know
i) if we all reduced the amount of stuff we consume.	89	8	1	2
ii) if we taught our children to be less materialistic.	89	9	1	1

Table 3

Some people say that Americans should take action to reduce the amount we consume and the level of materialism in our society. Others say such actions are unnecessary. I'm going to read a list of actions that have been suggested. For each action, please tell me which of these statements best describes your view:

A. That's a good idea; we should move ahead with it.
B. That's a good idea, but I'm not ready to do that.
C. That's not a good idea.

	A	B	C	don't know
i) Use our possessions longer instead of buying new things	81	13	6	1
ii) Spend less money so we can save more.	71	19	9	1
iii) Spending more time working with our neighbors on community service projects and less time shopping	76	15	7	1
iv) Spend less time working and make less money than we do now	18	21	56	4

Source for all tables: Merck Family Fund (1995)

BOX IIC-17. Personal consumption, standards of living, and the environment
[percents]

Table 1

We don't have to reduce our standard of living to solve global climate change or other environmental problems.

	Earth First!	Sierra Club	Public	Dry Cleaners	Sawmill Wrkrs
agree:	23	59	60	63	67

Table 2

Americans are going to have to drastically reduce their level of consumption over the next few years.

	Earth First!	Sierra Club	Public	Dry Cleaners	Sawmill Wrkrs
agree:	90	74	87	69	67

Table 3

You shouldn't force people to change their lifestyles for the sake of the environment.

	Earth First!	Sierra Club	Public	Dry Cleaners	Sawmill Wrkrs
agree:	0	0	27	13	41

Table 4

We have to protect the environment for our children, and for our grandchildren, even if it means decreasing our standard of living today.

	Earth First!	Sierra Club	Public	Dry Cleaners	Sawmill Wrkrs
agree:	100	100	97	87	74

Source: Tables 1 through 4 are from Kempton et al (1995:257,258,270).

Table 5

How willing would you be to accept cuts in your standard of living in order to protect the environment?

	1994
Willing	33
Neither willing nor unwilling	24
Unwilling	43

Source: National Opinion Research Center General Social Survey, codebook variable GRNSOL.

order to "protect the environment for our children..." But in Table 5 only 33% are clearly willing to accept cuts in their "standard of living in order to protect the environment," and fully 43% are explicitly unwilling. The important difference, of course, is that the first question includes "for our children" as the stated rationale for protecting the environment, whereas the second question leaves the rationale unstated. If the reported results are valid, this means that 93% of the 43% of respondents who said they were unwilling to accept cuts in their standard of living in order to protect the environment in and of itself, so to speak, would be willing to do so if they believed the well-being of their children was at stake. This finding might be felt to have important implications for the debate over growth and the environment. On the other hand, the result shown in Table 4 may be less a measure of an intrinsic willingness to support the environment than it is of the willingness of parents to make sacrifices for their children.

II.C.2.e. International Comparisons

Many surveys of environmental opinions in countries other than the United States have been conducted. We highlight a very few of these here to introduce the topic.

A. World Values Survey (1990-1993)

Inglehart (1995) supervised a wide-ranging survey of values held by people in 43 countries, covering 70% of the world's population. Environmental values were directly addressed through several questions. When asked if they approved or disapproved of the environmental movements in their countries, 96 % of the persons surveyed said they approved. When asked if they agreed or disagreed with the statement, "I would be willing to pay more taxes if I were certain that the money would be used to prevent environmental pollution," 65% said they agreed. The results by country are shown in Table 1 of **IIC-18**. People were also asked whether they agreed or disagreed with the statement, "The government has to reduce environmental pollution, but it should not cost me any money." This is the same question as the preceding one, but structured such that a response of *agreement* indicates an *un*willingness to pay

BOX IIC-18. SUPPORT FOR ENVIRONMENTAL PROTECTION AMONG COUNTRIES
[percents]

Table 1
Willingness to Sacrifice for Environmental Protection

"I would agree to an increase in taxes if the extra money is used to prevent environmental pollution."

	country	percent "agree" or "strongly agree"
1	China	78
2	Sweden	77
3	South Korea	76
4	Chile	76
5	Norway	73
6	Turkey	71
7	Brazil	71
8	Denmark	70
9	Britain	70
10	Bulgaria	70
11	Lithuania	70
12	Slovenia	70
13	Netherlands	69
14	Moscow	69
15	Mexico	67
16	Belarus	67
17	Czechoslovakia	67
18	Russia	67
19	N. Ireland	65
20	Portugal	65
21	United States	64
22	Canada	64
23	Latvia	64
24	Iceland	60
25	Estonia	59
26	Spain	57
27	Italy	57
28	Finland	56
29	Nigeria	56
30	India	55
31	E. Germany	55
32	France	54
33	Austria	52
34	Ireland	51
35	Japan	51
36	Argentina	50
37	W. Germany	49
38	Belgium	41
39	Hungary	35

Table 2
Public Support for Environmental Protection

Percent scoring "high" on Environmental Protection Index*

	country	percent
1	Sweden	69
2	Denmark	65
3	Netherlands	64
4	Norway	59
5	South Korea	58
6	Iceland	54
7	Russia	53
8	Turkey	53
9	Czechoslovakia	52
10	China	52
11	Mexico	50
12	Finland	48
13	Brazil	48
14	Japan	47
15	East Germany	47
16	Moscow	46
17	Chile	46
18	Slovenia	46
19	India	45
20	Bulgaria	44
21	Latvia	44
22	Lithuania	43
23	Britain	42
24	Canada	42
25	West Germany	41
26	United States	40
27	Belarus	40
28	Austria	39
29	Estonia	38
30	No. Ireland	36
31	Portugal	34
32	Ireland	36
33	Belgium	33
34	Italy	31
35	Spain	30
36	France	30
37	Argentina	30
38	Nigeria	27
39	Hungary	24

* Respondents are classified as "high" on support for environmental protection if they "agree" or "strongly agree" that:
(1) "I would be willing to give part of my income if I were sure that the money would be used to prevent environmental pollution."
(2) "I would agree to an increase in taxes if the extra money is used to prevent environmental pollution"
AND who "disagree" or "strongly disagree" with the statements:
(3) "The government would reduce environmental pollution, but it should not cost me any money."
(4) "Protecting the environment and fighting pollution is less urgent than often suggested."

Source: Inglehart (1995), "Public Support for Environmental Protection: Objective problems and subjective values in 43 countries."

taxes to reduce environmental pollution. In response to this question only 45% expressed a willingness to pay. Inglehart notes that none of these responses reveal the "true" level of support for environmental protection; rather, they measure different things. Thus, for further analysis, Inglehart constructed an Environmental Protection Index based on the four questions shown at the bottom of IIC-18. The country by country ranking of support for environmental protection, as measured by the Environmental Protection Index, is shown in Table 2.

Inglehart notes that countries that score higher on the Environmental Protection Index tend to do so for several reasons. Some score high for *objective* reasons, i.e., because the level of pollution in their countries is so great that the disutility is widely acknowledged. These include both developing countries like China, Mexico and Brazil, which have only recently begun to industrialize, and more fully industrialized countries such as South Korea, Russia and Czechoslovakia. Other countries score high because of *subjective* or *cultural* reasons. These include the Nordic countries and the Netherlands, who have some of the lowest pollution levels of any countries of the world, yet score the *highest* on the Environmental Protection Index.

Inglehart interprets the pattern of support for environmental protection among countries through his theory of *postmaterialism:*

> "...as a result of the rapid economic development and the expansion of the welfare state following World War II, the formative experience of the younger birth cohorts differed from that of older cohorts in ways that were leading them to develop fundamentally different value priorities. Throughout most of history, the threat of severe starvation had been a crucial concern for most people. But the unprecedented degree of economic security experienced by the postwar generation in most industrial societies was leading to a gradual shift from "materialist" values towards "postmaterialist" values." (p 62)

As used by Inglehart, "materialist" values emphasize economic and physical security, while "postmaterialist" values emphasize freedom, self-expression and the quality of life.

In 1970 Inglehart devised a four-item survey module that, he believed, could distinguish persons and groups holding higher and lower levels of materialist and postmaterialist values. Since that time Inglehart and his colleagues have been conducting surveys that they believe demonstrate empirically the shift from materialist to postmaterialist values in industrial societies.

The four-item survey module asks respondents to consider four goals for their nation and identify the two that they believe should be the top goals. The four goals are:

1. maintaining order in the nation
2. giving the people more say in important governmental decisions
3. fighting rising prices
4. protecting freedom of speech

Persons choosing goals 1 and 3 are identified as "materialist." Persons choosing 2 and 4 are "postmaterialist." Persons choosing any of the other four combinations are identified as having "mixed" values.[85]

Box IIC-19 shows the distribution of materialist, postmaterialist and mixed values among the citizens of six Western European nations over the period 1971 to 1993.[86] **IIC-20** shows the same information for the United States.

Inglehart claims that environmentalist values are clearly postmaterialist values, and associates the rise of the environmental movement in the West with the maturing of the first postwar birth cohorts. **IIC-21** demonstrates a high positive correlation between the importance a person gives to postmaterialist values and the likelihood that they will vote for the Greens in upcoming elections in Europe.

Inglehart's "cohort" theory of societal value shift is a predictive theory. **IIC-22** shows Inglehart's calculations, using demographic and survey data, of the continuing growth of postmaterialist values through 2020 in the six European nations that he has surveyed most thoroughly. Although postmaterialist values continue to spread, they do so at a slower rate than in past decades, largely due to the steady decline in population growth in these countries.

---

[85] Inglehart has also developed 8- and 12-item modules that allow finer identification of materialist and postmaterialist value orientations. The 8-item module include these four additional goals: a) maintaining a high rate of economic growth, b) making sure the country has a strong defense force, c) seeing that people have more say in how things are decided at work and in their communities, and d) trying to make our cities and countryside more beautiful. The 12-item module adds e) maintaining a stable economy, f) progress toward a less impersonal, more humane society, g) the fight against crime, and h) progress toward a society where ideas are more important than money.

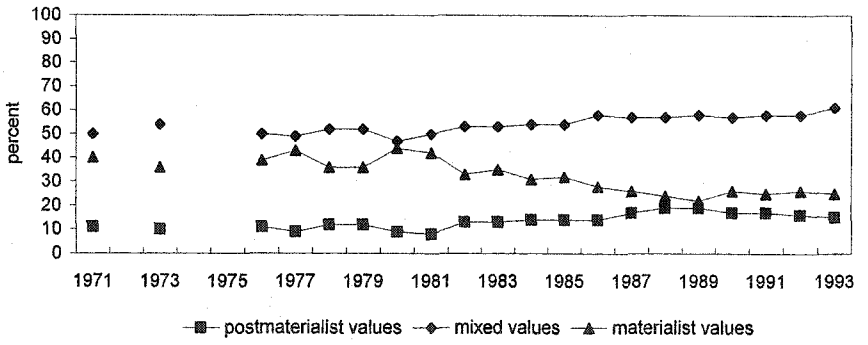
[86] The nations are West Germany, UK, The Netherlands, France, Belgium and Italy.

BOX IIC-19. Materialist/Postmaterialist values in Six Western European Publics
[percents]

Table 1.

	postmaterialist	mixed	materialist
1971	11	50	40
1972			
1973	10	54	36
1974			
1975			
1976	11	50	39
1977	9	49	43
1978	12	52	36
1979	12	52	36
1980	9	47	44
1981	8	50	42
1982	13	53	33
1983	13	53	35
1984	14	54	31
1985	14	54	32
1986	14	58	28
1987	17	57	26
1988	19	57	24
1989	19	58	22
1990	17	57	26
1991	17	58	25
1992	16	58	26
1993	15	61	25

Figure 1. Distribution of Materialist/Postmaterialist Values Western Europe



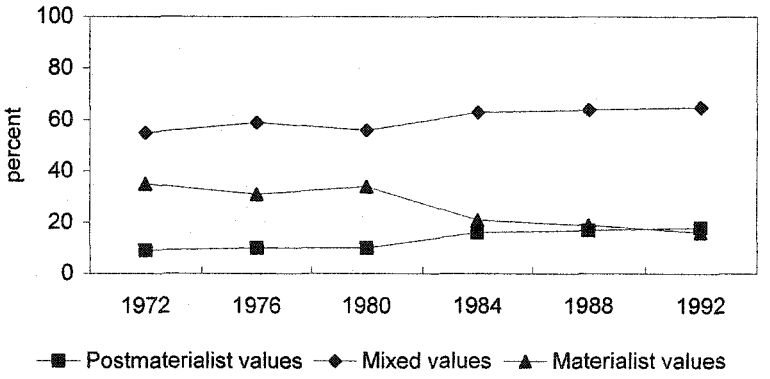
Source: Abramson and Inglehart (1995), Value Change in Global Perspective.

BOX IIC-20. Distribution of Materialist/Postmaterialist values in the US
[percents]

Table 1.

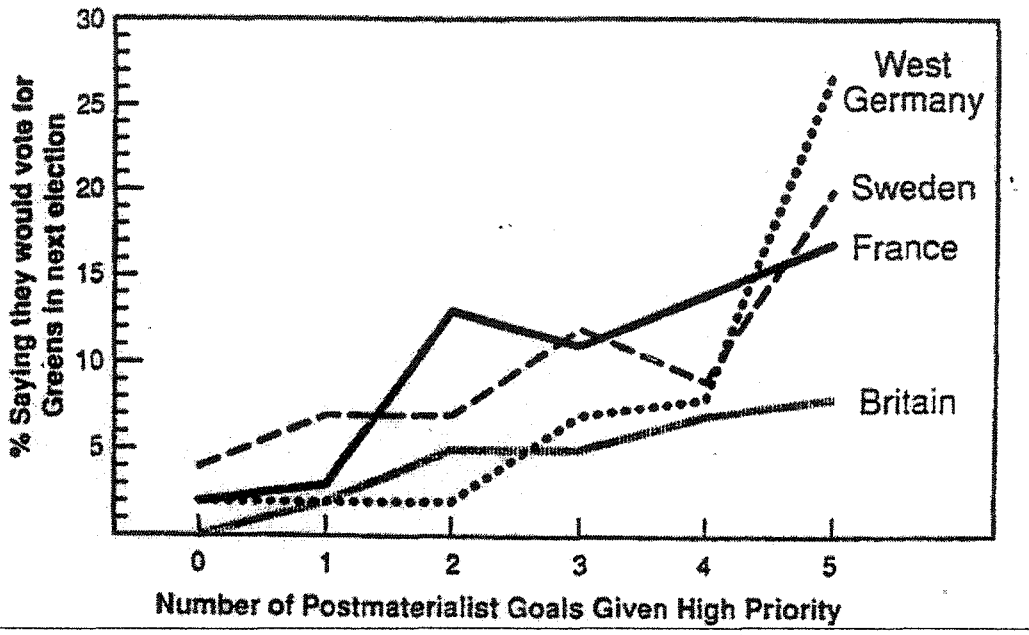
	postmaterialist	mixed	materialist
1972	9	55	35
1976	10	59	31
1980	10	56	34
1984	16	63	21
1988	17	64	19
1992	18	65	16

Figure 1. Distribution of materialist/postmaterialist values in the US



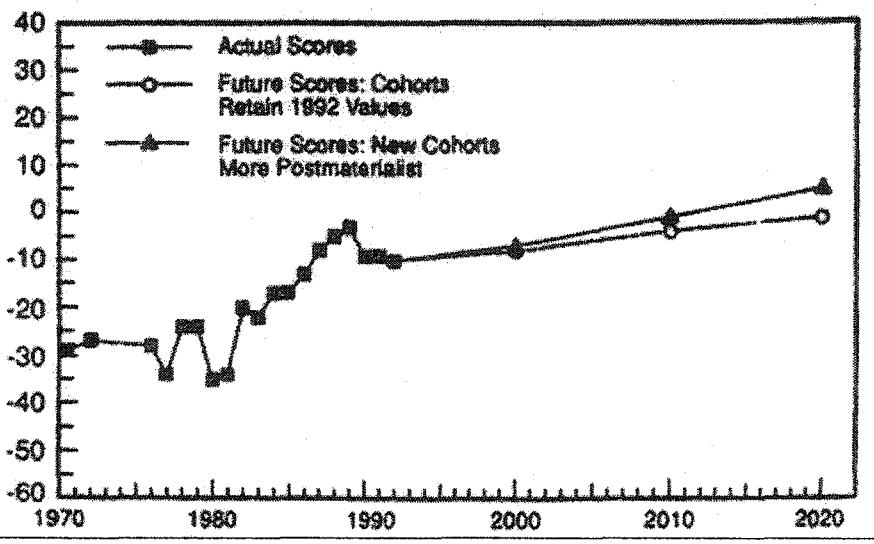
Source: Abramson and Inglehart (1995:19)

BOX IIC-21. Intent to Vote For Environmentalist Political Parties, by Materialist/Postmaterialist Values in Four Countries
[Reprinted from Inglehart, 1995]



BOX IIC-22. Past and Projected Growth of Postmodern Values
[Reprinted from Abramson and Inglehart, 1995]

The vertical axis shows the postmodernist/modernist difference index (PDI), the percentage of a surveyed population identified as postmodernists minus the percentage identified as modernists. The actual scores are based on surveys done in West Germany, Britain, the Netherlands, France, Belgium, and Italy.



Inglehart's theory has been criticized on both conceptual and methodological grounds by many authors. One frequent criticism is that his use of the terms "materialist" and "postmaterialist" is not in accord with the most common understandings of these terms. Under Inglehart's definition, Bill Gates and Ted Turner, for example, might be characterized as holding "postmaterialist" values, if we suppose that they are motivated less by concerns about "economic and physical security" than they are by concerns about "freedom, self-expression and quality of life."

Terminology can be changed. If we believe that the substance of the theory might have some value, how might this inform our judgment about the credibility of the scenarios constructed in Part I of this dissertation?

The most important thing to note is that the values that Inglehart believes accompany the spread of industrial development need not be consonant with one another. On the one hand, more attention may be given to public goods values such as concern for the environment, whether in its utilitarian, aesthetic or intrinsic forms. On the other hand, Inglehart's postmaterialism emphasize individualistic, rather than communitarian or solidaristic, sensibilities, which works against the realization of public goods values.

B. Gallup Health of the Planet Survey (1992)

The Gallup organization conducted a major survey of environmental opinions in 22 countries in preparation for the 1992 Earth Summit. **IIC-23** shows responses to a question in that survey that sought to determine the relative priorities given to environmental protection and economic growth. We see that in 20 of the 22 countries respondents give greater priority to environmental protection, "even at the risk of slowing down economic growth." The results appears to be at odds with many widely held assumptions and much current political controversy. For example, they suggest that Brazil and Mexico may be far more willing to sacrifice economic

BOX IIC-23. Gallup Health of the Planet Survey
[percents]

With which one of these statement about the environment and the economy do you most agree?

* Protecting the environment should be given priority, even at the risk of allowing down economic growth.
* Economic growth should be given priority, even if the environment suffers to some extent.

Countries ranked by percent giving priority to PROTECT THE ENVIRONMENT

70% +		60% - 69%		50% - 59%		< 50%	
Denmark	77	Canada	68	Philippines	59	Turkey	43
Germany (W)	73	Ireland	65	United States	59	India	43
Mexico	72	Uruguay	64	Japan	58		
Norway	72	Rep. Korea	63	Netherlands	58		
Finland	72	Chile	63	Poland	58		
Brazil	71	Switzerland	62	Great Britain	56		
				Russia	56		
				Hungary	53		

Source: Gallup International Institute, Health of the Planet Survey, March 1992. IIPO 1992-93:639.
Sample sizes: Brazil (N=1414); Canada (N=1011); Chile (N=1000); Denmark (N=1019); Finland (N=770); W. Germany (N=1048); Great Britain (N=1015); Hungary (N=1000); India (urban; N=4984); Ireland (N=928); Japan (N=1434); Rep. Korea (N=1500); Mexico (N=1502); Netherlands (N=1011); Norway (N=991); Philippines (N=1000); Poland (N=989); Russia (N=964); Switzerland (N=1011); Turkey (N=1000); United States (N=1032); Uruguay (N=800).

growth in order to protect the environment than is the United States.[87] In some cases the responses to the Gallup survey and to the Inglehart survey seem consistent with one another (e.g., Russians and Turks respond in nearly the same proportions on both surveys) but in others they seem inconsistent (65% of Irish respondents support the environment over growth in the Gallup survey but only 35% score "high" on Inglehart's enviro-index shown in Table 2 of IIC-18.) A regression of the Gallup results against the Inglehart results gives an R^2 of only .20. Many questions about the wording, format, and administration of these surveys, and about cultural factors that might influence responses, would need to be answered before a confident interpretation of their results could be made.

C. Latinobarometer (1995)

Table 1 in **Box IIC-24** shows responses given by people in 8 Latin American countries when asked to name the single most important problem facing their country today. The pattern is similar to that shown in Boxes 4 and 5 when Americans are asked the same question: economic issues—unemployment, low salaries, inflation and poverty--receive the great bulk of mentions; environmental concerns barely show up on the list. Despite this, when the same sample group (in the same survey!) is explicitly asked to choose between the economy and the environment, they respond strongly *in favor* of the environment, as shown in Table 2. These results appear to constitute a logical contradiction: when asked to judge the priority of two issues, one of which is felt to be far more important than the other, respondents give priority to the less important issue. Once more, a confident interpretation of these results is difficult without more information.

D. International Environmental Monitor (1998)

Box IIC-25 shows responses to another question that asks respondents to choose between environmental and economic values, this time in the context of the debate over global warming. Once again, a strong majority of people in a strong majority of countries expresses preferences

[87] In 1994 India and Brazil had per capita incomes of $1,891 and $1,993, respectively; in that year US per capita income was $20,500.

BOX IIC-24 LATINOBAROMETER
[percents]

Table 1

What do you consider the most important problem facing our country today?

	Argentina	Brazil	Chile	Mexico	Paraguay	Peru	Uruguay	Venezuela	unweighted average
unemployment	45	12	14	28	13	31	29	6	22.3
low salaries	13	11	18	12	5	13	20	6	12.3
inflation	3	3	9	27	9	3	10	31	11.9
poverty	6	12	13	8	16	13	6	5	9.9
health	7	19	11	3	9	5	9	8	8.9
education	8	10	6	5	9	10	5	13	8.3
corruption	9	4	2	4	24	3	3	13	7.8
delinquency/crime	2	6	7	3	6	2	8	9	5.4
drugs	1	11	10	1	2	8	2	2	4.6
youth opportunity	2	4	4	3	1	6	2	1	2.9
housing	1	3	3	1	1	1	2	3	1.9
political violence	-	3	2	3	-	3	1	2	1.8
no answer	1	1	-	1	3	1	3	1	1.4
other	1	-	-	1	2	-	1	-	0.6
environment	1	1	1	-	-	-	1	-	0.5

Table 2

Which of the following do you agree with more:

* One should give priority to the protection of the environment even if it might significantly hurt our economy
* One should give priority to a healthy economy even if it might significantly damage the environment

	Argentina	Brazil	Chile	Mexico	Paraguay	Peru	Uruguay	Venezuela	unweighted average
priority to environment	61	57	66	51	57	51	62	58	57.9
priority to economy	28	33	30	38	25	40	28	31	31.6
no answer	11	10	4	11	18	9	10	11	10.5

source: Latinobarometer 1995; IIPO 1995-96:621. Sample sizes: Argentina-1200; Brazil-1200; Chile-1240; Mexico-1204; Paraguay-587 Peru-1226; Uruguay-1212; Venezuela-1200

BOX IIC-25. GLOBAL WARMING SURVEY
[percents]

Which statement do you agree with more:

1. Given scientific uncertainty over climate change, we should not take major action until we know more because of the great economic costs involved.

2. We should assume the worst and take major action now to reduce human impacts on climate, even if there are major costs

country	1998	change from 1997
Greece	85	
France	82	+8
Italy	82	+12
Korea (Rep)	77	+24
Germany	74	+3
Russia	73	+46
Kazakhstan	73	
Indonesia	71	
Australia	70	+3
Japan	68	-1
Canada	67	+6
Finland	65	+11
Great Britain	64	+12
New Zealand	63	-2
Chile	63	+2
Mexico	62	+12
India	61	-2
Argentina	60	
Colombia	58	
China	56	+24
Uruguay	54	
USA	51	+5
Hungary	50	+15
Brazil	"near majority"	
Venezuela	"near majority"	
Poland	"near majority"	
Turkey	"near majority"	

Source: Market & Opinion Research International Ltd. [MORI]. International Environmental Monitor 1995. www.mori.com/polls/iem.
N(Great Britain)=934. Sample sizes for other countries approximated 1000 each.

for acting to protect the environment, "even if there are major costs." Support for action to address climate change increased dramatically from 1997 to 1998, presumably at least partially in response to attention given the issue as the Kyoto Accords were being negotiated, in December of 1997. But again, caution is necessary before interpreting these results in a facile way. The countries surveyed differ greatly in level of economic development, cultural values, amount of schooling, and other factors. The questions as worded in IIC-25 require multiple judgments of facts and preferences, either explicate or implicitly, before an answer can be given. It's not obvious what is being communicated when we say, for example, that 71% of the population of Indonesia, or 51% of the population of the United States, agrees more with the second statement than with the first.

II.C.2.f. Summary

Support for environmental protection among Americans is very broad but may not be especially deep. When asked unprompted to name issues of concern, environmental issues receive far fewer mentions than do such issues as money, jobs, health, family and children. Americans express a high willingness-to-pay for environmental protection in the abstract, but when specific dollar commitments are solicited this support weakens. When forced to choose between "growth" and "environment," large majorities of Americans choose "environment," although their first preference is to affirm statements that deny that a choice needs to be made. Americans show strong support for modifying particular consumption practices to avoid harming the environment, but reject suggestions that their aggregate levels of consumption should be reduced. Surveys of public opinion in other countries show consistently high support for environmental protection, although some of the same qualifications just noted apply.

II.C.3. A SURVEY OF PARTICIPANTS IN THE VOLUNTARY SIMPLICITY MOVEMENT

II.C.3.a. Introduction

The voluntary simplicity movement arose in close association with the counterculture and environmental movements of the late 1960's and early 1970's. It valued moderation over excess, spiritual development over material consumption, cooperation over competition, and nature over technology. In the United States the movement peaked in the mid-1970's, declined, and was quiescent through the 1980's. In the early 1990's voluntary simplicity became a focus of renewed interest. Some observers linked this straightforwardly to the resurgence of environmental activism that began in 1988. Others believed it was a pragmatic response to the recession and economic restructuring of the early 1990's. For still others it was a response to psychic stress associated with rapid technological change, social fragmentation, and the relentless expansion of consumerist values into all domains of human life. Today the prospects for the voluntary simplicity movement are uncertain. With strong and steady economic growth, a shortage of ecological disasters, and growing acceptance of high-tech social norms, the movement might fade once more. If any of these conditions should become problematic, interest in voluntary simplicity could grow.[88] [89]

---

[88] There is a long literature on voluntary simplicity. A good history is David Shi's *The Simple Life* (1985). Thoreau's *Walden* (1854) and Richard Gregg's *The Value of Voluntary Simplicity* (1936) are foundational. Duane Elgin's *Voluntary Simplicity* (1981) set the tone for the current movement. Many of the environmentalist and Green texts listed in Box IIC-1 advocate one aspect or another of voluntary simplicity. With revived interest in the early 1990's came many new books, including Amy Saltzman's *Downshifting: Reinventing Success on a Slower Track* (1991), Amy Dacyczyn's *Tightwad Gazette* (1993), Cecile Andrews' *The Circle of Simplicity* (1997), and Jerome M. Segal's *Graceful Simplicity: Towards a Philosophy and Politics of Simple Living* (1999). Periodicals include *The Simple Living Journal, In Context,* and *Yes! A Journal of Positive Futures.*

[89] There are many varieties of voluntary simplicity. Amitai Etzioni (1998) distinguished three: "downshifters", who maintain high income and consumption patterns, even if they scale back a bit or adopt a simplicity of style; "strong simplifiers," who give up high income careers and live at markedly reduced levels of consumption, but who do not necessarily see themselves as part of a social movement, and who may hold any number of social and political views; and "simple living movement activists" who likewise live on low incomes, but who see voluntary simplicity as part of a wider vision of planetary sustainability.

In September 1998 a major conference on voluntary simplicity was held in Los Angeles, California. More than 750 attendees heard numerous speakers address many aspects of voluntary simplicity. Nearly half the attendees signed up to participate in voluntary simplicity discussion and support groups in their local areas. The conference agenda is shown in **IIC-26.**

II.C.3.b. The Survey

I conducted a survey of attendees at this conference. I had three purposes in mind. First, I wanted to find out what the notion of voluntary simplicity meant to people involved in that movement. Second, I wanted to find out what sorts of people were attracted to the idea of voluntary simplicity. Third, I wanted to find out how participants in the voluntary simplicity movement reconciled competing values concerning consumption, equity, ecological sustainability and economic growth.

This paper reports results of the survey. It focuses especially on the third purpose just noted. We saw in Section II.C.2 that while most people are supportive of environmental protection, they are reluctant to pay very much for it, and even more reluctant to consider reducing income or consumption in the aggregate as a way of helping lessen the impact of economic activity on the environment. I figured that participants at the Voluntary Simplicity conference would be much more receptive to the idea of cutting back consumption. I figured further that participants at this conference were likely to have given more thought to the many ways in which values and behaviors concerning consumption, the environment, equity and growth inter-relate with one another. Thus, I thought, any opinions concerning these issues held by attendees at this conference might represent the edge of the envelope of social and political practicability. That is to say, I thought it unlikely that some other sample of Americans would call for *lower* levels of future economic growth, or *lower* preferred levels of household consumption, than would participants at a conference such as this one. The values endorsed by

BOX IIC-26. THE VOLUNTARY SIMPLICITY CONFERENCE

Here is the program for the conference *"No Purchase Necessary: Building the Voluntary Simplicity Movement,"* held on September 19, 1998 at the University of Southern California. It was organized by Seeds of Simplicity, a non-profit education organization. *

Conference Program

9:00 Welcome/Introduction by Carol Benson Holst, Seeds of Simplicity
9:05 Event Parameters by Michael Beck, Seeds of Simplicity
9:10 Welcome by Tom Shelley, Tom Shelley Enterprises
9:15 Cecile Andrews, Duane Elgin and Ellen Funari -
A Visioning Conversation: Why Are We Here?
9:40 Ed Begley, Jr. - How Much is Enough?
10:00 Audience Forum — Janet Luhrs Booksigning
10:30 BREAK
10:4 Panel: "The Best Things in Life Aren't Things"
Duane Elgin - Voluntary Simplicity: Indicator of Global Change
Mary Kalifon - Children, Families, and Simplicity
Rev. Peter Moore-Kochlacs - Faith and Simplicity Connections
Julie Ozanne - A Consuming Passion
Susan Salterberg - Simplifying for Wellness
12:00 Audience Forum — Cecile Andrews Booksigning
12:30 LUNCH — PBS Special, *Escape from Affluenza*
1:30 Remarks by John de Graaf, Co-Producer of the Affluenza series
1:40 Kalle Lasn - Action Goals: Buy Nothing Day
2:00 Panel: "Taking Action on Simplicity in Your Life."
Cecile Andrews - Advancing Simplicity Circles
Michael Fogler - Un-Jobbing
Janet Luhrs - The Simple Living Guide
Carol Pimentel - Your Money or Your Life
Dave Wampler - Voluntary Simplicity in Cyberspace
3:15 Audience Forum — Duane Elgin Booksigning
3:45 BREAK
4:00 Panel: "Taking Action on Simplicity in Your Group"
Lois Arkin - LA Eco-Village
Kevin Finney - Environmentalists Seize the Day
Julie Russell - Eco-Home Network
May Webber - Ithaca Eco-Village
Rod Gorney - Simplicity and the Human Community
5:15 Audience Forum — Michael Fogler Booksigning
5:30 Wrap Up by Ellen Funari

---

* P.O. Box 9955, Glendale, CA 91226; 818-247-4332; www.slnet.com/cip/seeds

attendees at this conference might thus serve as a set of constraints on the long-range, global scenarios developed in the dissertation, especially those that envision lower rates of economic growth.

The survey form I developed is shown in **IIC-27**. It was distributed along with the conference program. Of the 750 or so participants, 255 (34%) returned completed forms. Although the response was high there is no guarantee that it represented a random sample. Thus the results given in the sections that follow apply to the 255 *respondents*, and not necessarily to the 750 *participants.*[90]

II.C.3.c. Survey Results

1. What does voluntary simplicity mean to the respondents?

Box IIC-28 displays a sample of responses to the first question in the survey, *"In just a few words, what does 'voluntary simplicity' mean to you?"* A great many of the responses touch on one or more of these three themes:

1) reducing consumption, reducing spending, living within means
2) having a rich inner life and peace of mind; spirituality; consciousness
3) living in harmony with the earth

Two additional themes appear repeatedly but not as frequently as the first three:

4) resisting materialist/consumerist/competitive values imposed by society; asserting personal autonomy
5) spending more time with family and friends, building community

The first theme is instrumental/pragmatic in nature. The second theme is psychological/spiritual. The third theme contains both instrumental/pragmatic and

[90] To the extent that we want to learn anything about people who are *attracted* to the notion of voluntary simplicity, i.e., the population of conference attendees, the non-randomness of the survey responses is a disadvantage. For some of the other things we want to learn, however, the non-randomness might actually be an advantage. We might suppose that the 255 survey respondents represent a particularly committed, articulate sub-group of the 750 participants, whose responses to the survey questions might reflect greater engagement with the issues at hand. However, this is speculation.

BOX IIC-27. SIMPLICITY SURVEY QUESTIONAIRE

UNIVERSITY OF CALIFORNIA at Berkeley

VOLUNTARY SIMPLICITY SURVEY
distributed at the Seeds of Simplicity Conference, 9/19/98

This survey is part of a doctoral research project concerning Voluntary Simplicity. The investigator is Rich Hayes, a student in the U.C. Berkeley Energy and Resources Program. The results of this survey will also be used by Seeds of Simplicity. Participation in this survey is voluntary. No personal identifying information is requested, and we ask that you do ***not*** write your name, address, or other identifying information anywhere on this sheet. University regulations only allow persons 18 years of age or older to participate in this survey. We'd like you to answer all questions, but this is not a requirement. Drop the completed sheets in one of the two **BIG BOXES** labeled "**SURVEY!**" by the **Exit Doors.** If you would like copies of the survey results, or other information about the survey, contact Rich Hayes by phone (415-566-0849) or email (rhayes@socrates.berkeley.edu). Thank you so much!

I. Voluntary Simplicity

1. In just a few words, what does "voluntary simplicity" mean to you?

2. What do you think are the one or two most important things you could do to significantly make your life more simple than it is right now?

II. You and Your Household

1. Are you married or not married? Married ____ Not Married ____
2. Do you own your own home? Yes ____ No ____
3. How many people are in your household? (Include yourself as 1) _____
4. How many people in your household are children 17 years old or younger? _____
5. What is the total number of cars owned by people in your household? _____
6. Roughly, how many hours a week do you, personally, spend watching television? _____

III. General

1. City & State of residence _____ Age _____ Sex _____
2. Occupation _____
3. Highest level of schooling: some high school ____ high school diploma ____ some college ____
   four-year college degree ____ professional/post-graduate degree ____
4. Political Party Registration: Republican ____ Democrat ____ Green ____ Libertarian ____
   Peace & Freedom ____ other _____ unaffiliated ____ not registered ____

IV. Money

1. In the part of the state in which you live, what would you say is the minimum annual household income, before taxes, currently necessary to support a household of four people, including two children of high-school age, at each of these levels:
   a. "Just enough to get by": $ _____
   b. "Enough to live in reasonable comfort and security": $ _____
   c. "Much more than enough", i.e., the income level that might be considered "too much": $ _____

2. Roughly, what was your before-tax annual household income last year, from all sources? $ _____
3. Roughly, how much did you put into savings last year, or otherwise not spend? $ _____
4. Roughly, what level of annual household income do you expect to be living at, during the period of your life when you and the members of your household are earning their highest total income? (Assume, for this question, that price levels remain roughly as they are today.) $ _____
5. If you had to live on an annual household income 20% below the level you lived on last year, what steps would you take to do this?

over, please →

BOX IIC-27 (cont'd.)

- - - - - - - - - - - -

simplicity survey (cont.)

6. After you (and your spouse or partner, if any) have both retired, how much annual household income would you like to be able to live on? (If you're already retired you can skip this question.) $_____

V. The Level and Distribution of Income

In 1996 the before-tax annual incomes of American families with heads in the 45-54 age-range were as follows:

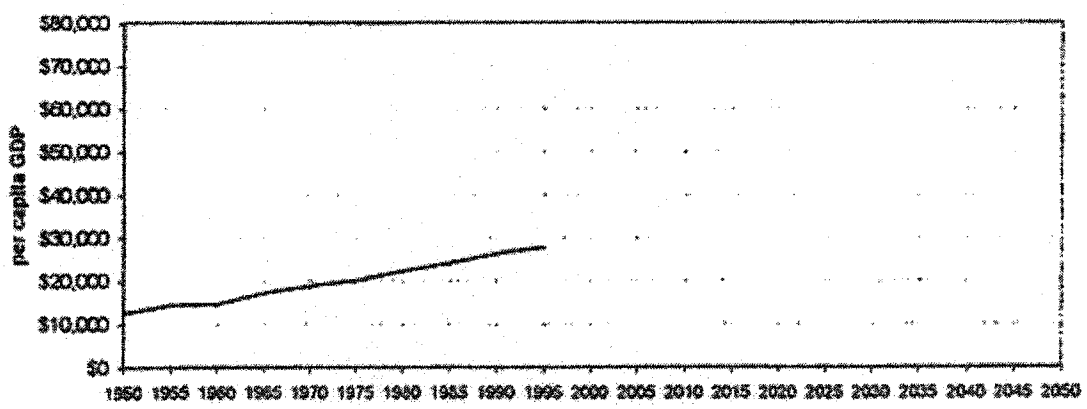
The bottom 20% of these families had an average annual income of about $18,100.
The middle 20% of these families had an average annual income of about $58,600.
The top 20% of these families had an average annual income of about $147,000.

What levels of income for families with heads in the 45-55 age-range do you believe would be consistent with sustainability and fairness, and might be aspired to, over the coming century, as goals for our country? (Assume that price levels remain roughly as they are today.) Just put a dollar value in the spaces below:

The bottom 20% of these families would have an average annual income of about $ _____.
The middle 20% of these families would have an average annual income of about $ _____.
The top 20% of these families would have an average annual income of about $_____.

VI. Economic Growth

The chart below shows the path along which per capita GDP (Gross Domestic Product) has changed in the United States over the 45 years between 1950 and 1995. The dollar values are adjusted for inflation, so they show real purchasing power. With your pen or pencil, sketch the path of *future* per capita GDP change, between 1995 and 2050, that you believe is desirable and achievable. Just sketch a straight or curved or wavy line.



VII. Conference Evaluation: To help Seeds of Simplicity evaluate this conference, please answer this question: "Keeping in mind that volunteers paid for this event, and that no break-out space was possible, what did you find valuable about this conference, what could have been done better, and what else might be done to support people interested in voluntary simplicity?"

That's it! When finished, please drop this sheet in one of the two **BIG BOXES** marked **SURVEY!** at the **Exit Doors.** Thank you very much!

BOX IIC-28. THE MEANING OF "VOLUNTARY SIMPLICITY"

The first question on the Simple Living Survey was:

In just a few words, what does "voluntary simplicity" mean to you?

Here are the verbatim responses taken from the first and every fifth survey form (52 responses = 20.4% of responses). The original numbering of the survey forms was random.

1. spending wisely; creating with raw materials; respecting the earth; developing a rich inner life
5. "smell the roses"
10. reduce stress—let serenity take precedence
15. reducing consumption; getting rid of unnecessary activities-daily life; allowing time for intimacy, spirituality, relaxation; questioning corporate dominance of world economy & politics.
20. ...that one is choosing sanity.
25. enjoying your life, not too concerned about other things and just being plain happy and contented.
30. my choice of life style using less.
35. living in ways to have as little impact on the Earth as practicable. Living in community.
40. consciousness of what's really important.
45. being at peace with what I do and what I have.
50. not consuming, living simply, not buying processed goods, not shopping, riding my bike.
55. having the time to enjoy life, friends/family and the things you have.
60. living consciously, sustainably—both for the earth, future generations and myself.
65. choosing to have less stuff.
70. not being a slave to your possessions.
75. living within my means while maintaining a high quality of life.
80. it means being comfortable with who you are and having peace of mind.
85. living with less stuff and less money.
90. everything in Janet Luhr's books! Less "stuff" & not worrying about having too little $$.
95. purposeful living simply with few resources and control over my life as much as possible; "downsizing."
100. consciously exercising better stewardship of resources.
105. choosing to reduce consumption of material things and peripheral unwanted complications in life to enjoy it more and help heal the planet. Sustainability.
110. choosing to live a conservation lifestyle.
115. simplifying one's life through reducing consumption, waste & stress. Increasing the healthy aspects such and diet & fun.
120. hey check it out. You never know how you might change.
125. living in a way that has little impact on the planet and great (positive)impact on my community; taking the needs of humanity into consideration as I make choices for my family, especially with regard to consumerism.
130. choosing quality of life over quality of possessions.
135. learning to live consciously, deliberately, richly, by reducing the habits, patterns or things that distract us from what is most meaningful to us.
140. scaling back

[More =>]

BOX IIC-28 (cont..)

145. deep abiding warm nurturing respect for people, nature and things around me. It is attention.
150. spending less money. Acquiring less "stuff"
155. dropping out of the "keeping u p with" syndrome/competition and happily doing with less.
160. living below one's means, with purpose or on purpose.
165. enjoying life does not involve buying and spending.
170. living in harmony with earth and all living things.
175. always to have a soulful (?) life and life from the inside out.
180. living with materialism within your needs rather than wants.
185. slowing down, reducing consuming
190. simplify life as much as possible; give extra cash to charity.
195. making choices to unclutter my life in mental and physical ways.
200. having what I need and sharing what I have.
205. a desire to de-complicate many of today's self-imposed regimens and not follow fashion.
210. looking at what is most important to me in my life and trying to center my lifestyle around it. also living in harmony with the earth as much as I can.
215. (not answered)
220. focus on meaningful activities in life; reduce consumer consumption.
225. peaceful living, living with integrity, purpose, intent joy and living lightly.
230. consuming less; being environmentally conscious, recycling everything!
235. enjoying what is most important to me—eliminating what is not essential—becoming comfortable with choices.
240. downsizing consumption; preserving the environment; regaining or sustaining spirituality & promoting gender equity.
245. creating a community of conscious care for people, the earth and spirit.
250. being conscious in my life of how my actions affect the earth, others, & my children. Also, paring down in order to have more of what matters.
255. choosing to "not buy into" values dictated by others. Rather, living by my own values.

psychological/spiritual elements. The fourth and fifth themes are social, or social-psychological, in nature.[91]

Box IIC-29 displays a sample of answers to the second question, "*What are the one or two most important things you could do to significantly make your life more simple than it is right now?*" The answers given suggest four repeated themes:

1) get rid of things, sell things, reduce clutter
2) work less, consume less, travel less, commute less
3) increase attention to family, friends, community
4) increase attention to art, spirituality, nature

The first and second themes are of a pragmatic/instrumental nature and emphasize stock reduction and flow reduction, respectively. The third and forth themes concern social, psychological, and spiritual activities.

2. Who is attracted to the notion of voluntary simplicity?

Boxes IIC-30 and **IIC-31** show aggregate results for selected items included in the survey, and compares them with comparable values for the general populations of Los Angeles Country, California and the United States.

Broadly, the survey respondents were middle-aged, middle-class and highly educated.[92] Over two-thirds were women. Fifty-eight percent of the respondents were in their 40's or 50's; for Los Angeles Country as a whole these age groups comprise only 28% of the population age 20 and over. Only 8% of the respondents were in their '20's; for LA County the figure is 27 %.

---

[91] I tried to estimate quantitatively the frequency with which these themes were mentioned by respondents. However, many items mentioned could be categorized in more than one way. Further, the themes themselves are subjective constructs, and a more careful content analysis might reveal different conceptual clusters. To report my results as part of the main text would be premature. That said, my estimate of the frequency with which each of the themes were mentioned, or implied, by the 52 respondents listed in Box 3 is as follows: Reducing consumption, etc: 54%; Having a rich inner life and peace of mind, etc: 33%; Living in harmony with the earth: 27%; Resisting consumerist values, etc: 23%; Spending time with family, friends, in community, etc: 12%.

[92] Based on past experience I expected conference attendees to be predominantly non-Latino Caucasian, and did not ask that race or ethnicity be identified on the survey form. At the conference I estimated that perhaps 5-10% of attendees were non-Caucasian or Latino.

BOX IIC-29. MAKING YOUR LIFE MORE SIMPLE

Here is a random sample of 36 responses (14 % of all responses) to Survey Question #2: *What do you think are the one or two most important things you could do to significantly make your life more simple than it is right now?*

5. work less (commute less) & more concentration on my art work.
10. go back to my parent's roots—Ireland--and take those of my eight (8) children who are interested with me. And interface with those who never left.
15. cut activities by 2/3
25. a stable job with a good salary, so that I can help my family and my friends/relatives/also people in need. Be a big help in saving the environment (and also protecting it.)
30. stay at home more.
35. sell business stuff (trucks & equipment); dispose of a bunch of personal "stuff".
40. my life is pretty simple right now.
45. get rid of the things in the "get rid of" storage.
55. live in a city that is planned for people (not cars) & has great public transportation; work less hours.
60. plan time to include doing fun or just nothing; grade fewer papers.
65. buy less stuff; clear out clutter
75. make my email work.
80. stop buying fast food. Bring healthy lunches to work. I would save $$$!!
85. have fewer and less expensive hobbies; have a smaller house; work instead of being unemployed.
90. don't worry too much.
100. sell the R.V.
105. understand what I enjoy and what I do for the wrong reasons; scrutinize my spending habits.
110. move closer to work; to work on simplifying my own life; to help others to do the same.
115. stop eating at restaurants & drive less & grow my own food.
120. simple or simpleton. Know the difference.
125. recycle more; pay off debt; stop "charging."
140. travel less
145. stay out of malls; limit TV watching; manipulate homemaking resources appropriately so that I don't have to spend hours cleaning on the weekend; fix meals and eat at home 5 nights (at least) a week.
150. get rid of credit cards (and debts)
160. reduce clutter, junk in my home; scrutinize my spending.
165. get rid of excessive stuff; enjoy life with my kids
175. spend more time in nature and less in front of computer; volunteer more.
180. live within my means; work closer to home
185. leave work at 4:00; say no more or less
190. bike more- drive less
195. get rid of things that create clutter and aggravation for me, things that require taking care of.
200. learn to sew. Stop owning a car.
205. it's pretty simple now - but I'm willing to listen.
216. get rid of computer and television
220. prioritize my time
225. declutter, reduce.
230. stop spending money on "stuff"; reducing what I put out as waste.
240. reduce hours @ work; spending more time w/ spiritual pursuits.
245. quit my current job; use my bicycle for transportation and work at home
250. share, borrow, cut back intentionally, on stuff & search for my purpose
255. eliminate consumer debt; reduce commute time (get a job closer to home).

BOX IIC-30. Summary statistics from Voluntary Simplicity survey, with comparisons

[See notes and sources in Box IIC-31]

survey item	Respondents	LA County	California	USA
sex: % women	68	50	50	51
% men	32	50	50	49
% married	44	52		61
% homeowners	61			
age: mean years	46			
age: median (years)	45			
age by decade (percent):				
less than 20	1	-	-	-
20-29	8	27	25	20
30-39	21	26	25	24
40-49	31	17	18	20
50-59	27	11	12	13
60-69	10	10	10	11
70-79	2	6	7	8
80 or over	0	3	3	4
mean # people/household	2.2	3	2.9	2.7
# children <18 in household:				
0	74	65		65
1	12			
2	12			
3 or more	2			
mean hrs TV/week/respondent	6.9			31
mean # cars/household	1.8	1.7	1.3	1.4
household income				
median	$50,000	$37,507	$39,072	$37,005
mean	$61,410			$49,692
household savings				
median	$5,000			
mean	$10,490			~ $ 2,500
education (%'s)				
no high school diploma	0.4	30	23.8	19.1
high shool diploma	1.6	20.7	22.2	34.4
some college	21.7	27	30.5	24.4
BA degree	31.9	14.5	15.3	14.7
graduate/professional degree	44.4	7.8	8.1	7.5
voter registration status:				
Democrat	55.7	46.2	37.8	
Republican	12.1	26.0	29.2	
Green	8.9	0.3	0.5	
Libertarian	1.2	0.3	0.4	
Peace & Freedom	0.8	0.5	0.4	
other	2.0	2.8	2.8	
decline-to-affiliate	-	9.3	9.1	
unaffiliated	14.1	-	-	-
not registered to vote	5.2	14.6	19.8	

BOX IIC-31. SUMMARY STATISTICS: NOTES AND SOURCES

All values listed in the "Respondents" column in Box IIC-31 were obtained from the survey response forms. Values shown in other three columns—Los Angeles County (LA), California (CA), and USA (USA) are as described below. Values are shown for 1997 unless noted otherwise.

sex: LA: 1990 US Census, data base C90STF3A. venus.census.gov/cdrom/lookup.
CA: 1990 US Census; venus.census.gov/cdrom/ lookup./ 909174476.
USA:Statistical Abstract of the United States, 1996, table #12, p. 14. Figures for 1995.

% married: LA: 1990 US Census Data, Database C90STF3A, venus.census.gov/cdrom/lookup/909171896.

age: The mean age of heads of households in the US in 1997 was 48.6 [U.S. Census Bureau, The Official Statistics, 9/2/98, table 2 p. 5.] The median age for the whole US population in 1995 was 34 [Statistical Abstract of the US, 1995, table 13, p. 14.]

age by decade: LA: 1990 US Census, Database C90STF3A venus.census.gov/cdrom/lookup/909163337. CA: venus.census.gov/cdrom/lookup./909174476. USA:Statistical Abstract of the United States, 1996, table #16, p. 16. Figures for 1995. The breakdown of age by decade gives percents for all persons 20 or older, for LA, CA and USA. The percents shown for Respondents are for all respondents; only 1% were less than age 20, so the other values don't change when they are adjusted to show percents of all respondents 20 or older.

mean # people/household: LA: State & Metro Area Data Book, 1997-98, pp. 75, 130.
CA, USA: California Statistical Abstract 1997, p 182. Figures for 1996.

 # children < 18 in household: LA: US Census Database: venus.census.gov/cdrom/lookup/909170682.
US: Statistical Abstract of the US, 1995. Table 66, p. 58. Figures for 1994.

mean hrs TV/week/respondent: USA: Statistical Abstract of the US, 1997, table 887, p. 565.

mean # cars/household: LA, USA: 1997 California Statistical Abstract, p. 182, 187.

household income: USA: US Census Bureau, The Official Statistics, Sep. 2, 1998. Table 2, p. 5. (median and mean). CA & LA: US Bureau of the Census, Current Population Reports, P60-197, Table C, p. xiii. Money income in the US. For CA, 1995-1996 moving average = $38,457. To adjust 95-96 figures to be comparable to the respondent's 1997 figures I multiplied each value by an estimated consumer price idex of 1.5. by an estimated cpi of 1.016, to get $39,034. For LA, 1995-96 moving average = $36,917, x 1.015 = $37,470. The respondents' figures are directly comparable with those for LA County, but comparison of these figures with those of the US, and to a lesser extent of CA, requires cost-of-living adjustments. The American Chamber of Commerce Research Associates (ACCRA) COL for the metropolitan LA region for 1996 was 1.197. This means that the US figures, for example, should be increased by 19.6% to be comparable with the LA and respondents' figures: $37,005 x 1.197 = $44,294. However, the ACCRA index is based on consumption patterns of fifth quintile, "middle management" households, so it may be a bit high.

HH savings: USA: figures for 1996: savings/HH = $246.6 bill (Statistical Abstract of the US, 1997, table 704, p. 455) / 98.751 HH in US (California Statistical Abstract 1997, section P p. 182) ~ $2500.

education: LA: venus.census.gov/cdrom/lookup/909162909.
CA: venus.census.gov/cdrom/lookup/909174476. USA: Statistical Abstract of the USA, 1995. p. 158, table 240.

party affiliation: LA and CA: California Statistical Abstract, Nov. 1997, Section O. Percents shown are for the total population eligible to vote. On the survey form I used the term "unaffiliated" rather than the correct term "decline-to-affiliate." This may have been misleading, and compromises the value of these figures.

Fully 44% of respondents had graduate or professional degrees, compared with 8% for the general population.

Seventy-four percent of respondents had no children under age 18 as part of their household. Either they have not been parents, or their children are living elsewhere. The comparable figure for LA county is 65%. The average household size--2.2 persons per household--is also notably smaller than elsewhere.

About 56 % of respondents were Democrats, compared with 46% for LA County. About 9% of respondents were members of the Green Party, well in excess of their representation among voters in general but still limited. Only about 12% of respondents were Republicans, less than half their LA County proportion.

Respondents spend only 7 hrs/week watching TV, far less that the mean of 31 hrs/week for all Americans. On the other hand, the number of cars per household owned by respondents is slightly *higher* than the American average.[93]

Median household income of the respondents in 1997 was $50,000. This is higher than that of the general population, which in LA County was about $37,000. Is this result consistent with participation in a movement that stresses lower consumption, simpler life styles, and more attention to spiritual than material pursuits? It depends. **IIC-32** shows a breakdown of income by education and age, for the respondents and for the United States as a whole. We see in Table 1 that the mean and median household incomes of the respondents are quite a bit *lower* than the household incomes of other Americans of equivalent education. Thus one interpretation might be that the respondents have chosen to live at levels of income lower than those they would otherwise be able to command, albeit at levels still higher than average. Of course, it is possible that the lower levels of income reflect real differences in abilities, or at least marketable skills, despite the formal equivalence of educational background.

[93] All but a very few respondents live in Los Angeles County, where automobiles are a practical necessity.

BOX IIC-32. HOUSEHOLD INCOME BY EDUCATION AND AGE

Table 1. Income by education (dollars)

	Respondents		United States - 1997	
	median	mean	median	mean
BA	43,000	54,112	59,048	71,521
MA		69,000	68,115	82,955
Prof. degree			92,228	126,778

Table 2. Income by age (dollars)

	Respondents		United States - 1997	
Age	median	mean	median	mean
15-24	12,000	14,000	22,583	29,026
25-34	35,000	42,900	38,174	45,099
35-44	60,000	64,400	46,359	57,036
45-54	50,000	61,900	51,875	65,286
55-64	55,000	59,000	41,356	57,396

[Figures for the United States: U.S. Census Bureau, The Official Statistics, 9/2/98, table 2, p. 5.]

Note: The figures shown are not adjusted to account for cost-of-living differences between the LA metropolitan region and the average for the US. As noted in Box IIC-31, the ACCRA cost-of-living index for LA is 1.197. Adjusting figures for the US upward by this amount (19.7%) to allow for comparability would reinforce the pattern described in the text in which respondents have lower household incomes than do persons of comparable educational level. However, the caveats noted in Box IIC-31 remain.

Table 2 in Box IIC-32 shows that some of the difference in incomes between respondents and Americans at large could be due to the fact that the mean age of the respondents is higher than the mean for the country as a whole. For both groups persons under 35 have lower incomes than those over 35.

The results in Table 1 show that respondents appear to be putting a larger share of their earnings into savings than are Americans overall. However, this result could also be an artifact of differences in the age distribution of the two groups.

Box IIC-33 displays the occupations given by a random sample of 102 (40%) of the 255 respondents. Note the high proportion of respondents involved in education (~27% of the sample) and medical services (~13%), and services in general. Few respondents hold high-tech jobs and almost none hold blue-collar jobs.

Box IIC-34 suggests that the financial aspirations of respondents might be characterized as moderate to moderately high in comparison with typical American household incomes. At the peak of their earning powers the respondents aspire to mean household incomes of somewhat more than $70,000/year. In 1997 about 30% of all U.S. households with heads of age 45-54 had incomes of $75,000 or more. It appears that a majority of survey respondents aspire to place within the top 30% of households of their own age cohort, at least for some period.[94]

As for retirement, respondents hope to be able to have secured enough savings, or be the beneficiary of sufficient other incomes, to have household incomes of about $40,000/year. Given that their current median incomes are about $50,000 a year, their retirement goals might be thought of as roughly equivalent to their current level of consumption, minus expenditures on kids, commuting, and mortgages. A retirement income of $40,000 per year is equivalent to ownership or entitlement assets of about $600,000, assuming a 6.5% return on investment.

---

[94] Are these figures consistent with an ethic of voluntary simplicity? It's difficult to say without data on life-cycle income patterns. It's possible that some respondents, now in their late fifties, are aspiring towards household incomes of $70,000 for only the final few years of a worklife that otherwise generated far lower

BOX IIC-33. RESPONDENT OCCUPATIONS

Shown are 101 verbatim responses (40% of all responses), selected at random.

1. library assistant
3. student
5. accountant-artist
7. clinical social worker
10. RN-retired
12. scholar assistant
15. college teacher
17. registered nurse
20. special education assistant
22. teacher
25. full-time college student
27. organizer
30. retired teacher
32. public relations
35. self-employed: cleaning business
37. trainer
40. paralegal/songwriter
42. college student
45. health educator
47 systems analyst
50. high school teacher
52. journalist
55. computer programmer
57. retired aerospace engineer
60. high school teacher
62. physician
65. teacher
67. urban planner
70. chemist
72. register nurse - mental health
75. planner for LA county
77. medical assistant
80. quality assurance coordinator
82. marketing communications manager
85. film editor
87. retired - toxins at work (defense)
90. homemaker
92. manager
95. retired teacher
97. actuary
100. retired professor of plastic surgery
102. finance computer systems analyst
105. writer
107. speaker/entertainer
110. operations manager
112. housewife
115. social work: mentoring juvenile offenders
117. college geography teacher
120. mail carrier
122. mother
125. writer
127. environmental nonprofit administrator
130. elementary school teacher
131. teacher
135. former health program administrator
137. elementary school teacher
140. agent
142. engineer
145. office worker
147. psychotherapist
150. grad student: art history
152. body/mind therapist
155. at home mom
157. administrative assistant
160. high school science teacher
162. home school teacher
165. retired homemaker
167. retired elementary school teacher
173. R.N.
172. senior financial manager
175. writer/entrepreneur
177. coach
180. teacher
182. environmental activist
185. school counselor
187. administrative assistant
190. investor
192. actor, writer
195. asst. food service director: school district
197. designer/teacher/artist
200. unemployed; trying to become a teacher
202. student
205. retired engineer
207. high school student
210. mother at home; social worker
212. social worker
216. teacher (substitute)
217. environmental planning & design assistant
220. paralegal
222. paralegal
225. stay home mom/childbirth educator
227. bank teller
230. Americorp-mentor to teens
232. counselor/teacher
235. writer
237. real estate entrepreneur
240. sociologist
242. retired
245. research audiologist
247. counselor for disabled
250. stay at home mom
252. occupational therapist
255. computer security

BOX IIC-34. Survey Responses Concerning Income and Savings
[dollars; see Box IIC-27 for the wording of the questions]

	median	adjusted mean	mean
Table 1.			
household income, 1997	50,000	54,520	61,410
household savings, 1997	5,000	6,036	10,490
max. household income anticipated	70,000	72,840	89,210
anticipated retirement income	40,000	37,630	56,490
Table 2. How much to			
just get by	33,500	33,330	37,190
live in reasonable comfort	50,000	54,990	60,470
too much	100,000	119,200	169,800
Table 3. How much for			
bottom 20%	30,000	29,120	30,560
middle 20%	55,000	51,350	54,190
top 20%	90,000	91,340	98,620
percentage difference:	-10.4%	-12.6%	-17.8%
(Table 3 - Table 2) / Table 2	10.0%	-6.6%	-10.4%
	-10.0%	-23.4%	-41.9%

The adjusted mean is determined by computing the interquartile range, multiplying this value by 1.5, adding this product to the upper quartile to get an upper boundary and subtracting it from the lower quartile to get a lower boundary, and deleting as outliers all sample values that lie above or below these new boundaries.

The current and anticipated incomes of the respondents show wide variances, as displayed **in IIC-35**. Although median household income is $50,000, fully 25% of respondents have incomes above $78,000.

3. Opinions about income, consumption, growth and equity

a. How much is enough?

The question "how much is enough?" is perhaps the central question of the entire debate over economic growth, ecological integrity and social equity. Question IV-I follows Roper-Starch (1995) and divides the question into three parts, as shown on the survey form in Box IIC-27.[95] The responses, shown in Box IIC-35, table 2, suggest that a majority of respondents believe that $33,500 is enough, or more than enough, for a family of four to "just get by" on; that $50,000 is enough, or more than enough, for them to "live in reasonable comfort and security;" and that $100,000 or more is "much more than enough," or "too much."

The distribution of responses is shown in **IIC-36**. We see that variance is least for "get by," more for "comfort" and greatest for "too much".[96]

A quarter of respondents said that $40,000 or more is necessary to "just get by," that $70,000 or more is needed to live in "reasonable comfort and security," and that household income would have to reach $170,000 before qualifying as "much more than enough".

The median level of $50,000 felt to be needed for "reasonable comfort and security" is precisely the median level of the respondents' own current household incomes, as shown in Box IIC-30. Fourteen percent of respondents currently have incomes of $100,000 or more, the median

---

incomes. Further, cost-of-living adjustments using the ACCRA index of 1.196 would reduce the share of respondents aspiring to place within the top 30% from a majority to about 36%.

[95] *Roper Reports,* 1995. The data displayed was taken from Andrew Hacker, 1995, *Money: Who has how much and why*, pp 39-40

[96] The standard deviations for the three categories "get by," "comfort" and "too much" are $14K, $27K and $110K, respectively. The interquartile ranges for these categories are $15K, 30K and $96K. These values exclude outliers of $100K or more for "get by," $200K or more for "comfort" and $1 million or more for "too much".

BOX IIC-35. Current income, maximum anticipated income, and anticipated retirement income

The three charts below show responses to questions IV.2, IV.4 and IV.6 of the survey, as displayed in Box IIC-27. Values on the horizontal axes are in thousands of dollars. The vertical axes show the percent of respondents who gave answers in the ranges shown on the horizontal axes.

Figure 1. Income of respondents, 1997

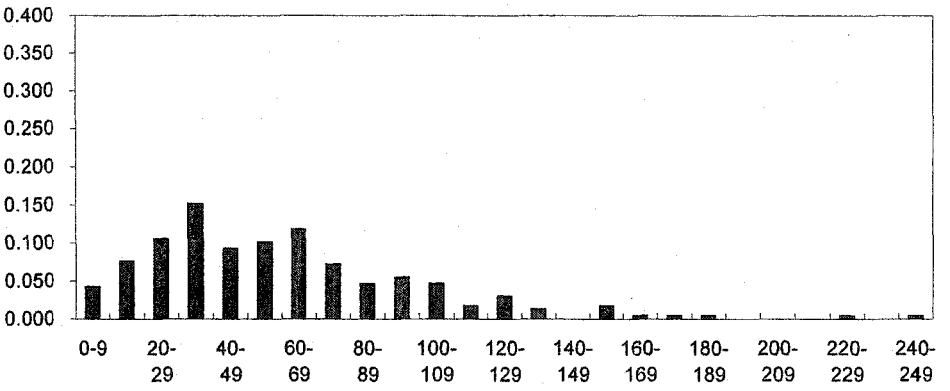


Figure 2. Maximum household income anticipated

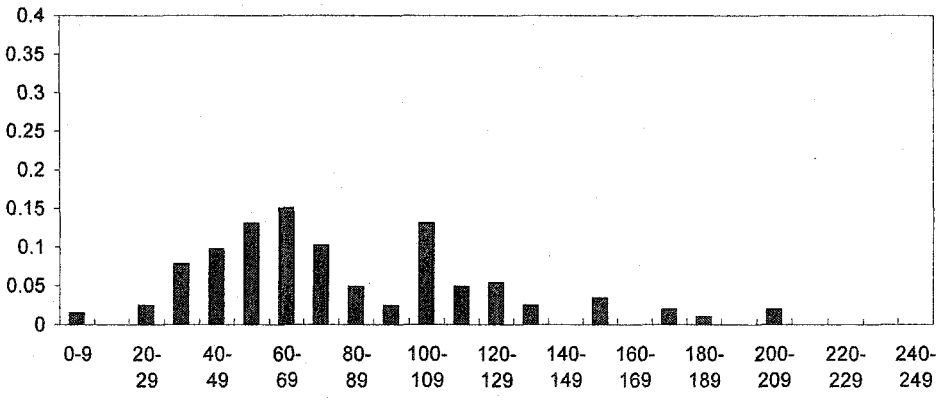
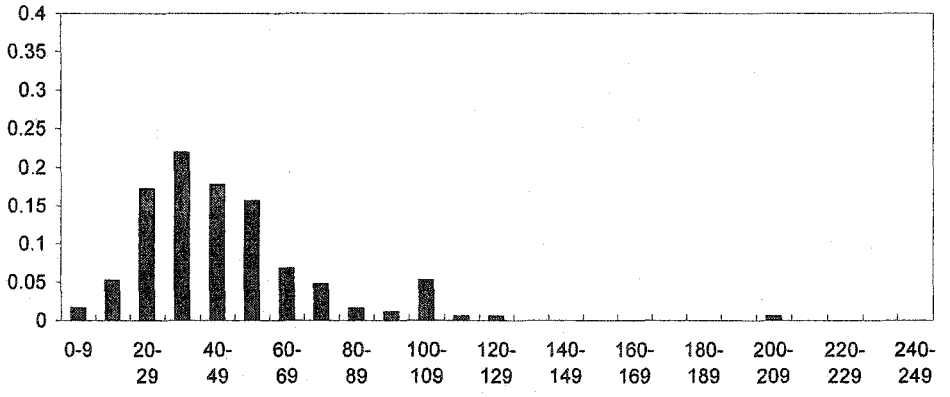


Figure 3. Anticipated retirement income



BOX IIC-36. INCOMES NEEDED TO SUPPORT DIFFERENT LIFE-STYLES

The three charts below show responses to Question IV.1 of the survey, as displayed in Box IIC-27. Values on the horizontal axes are in thousands of dollars. The vertical axes show the percent of respondents who gave answers in the ranges shown on the horizontal axes.

Figure 1. "JUST ENOUGH TO GET BY"

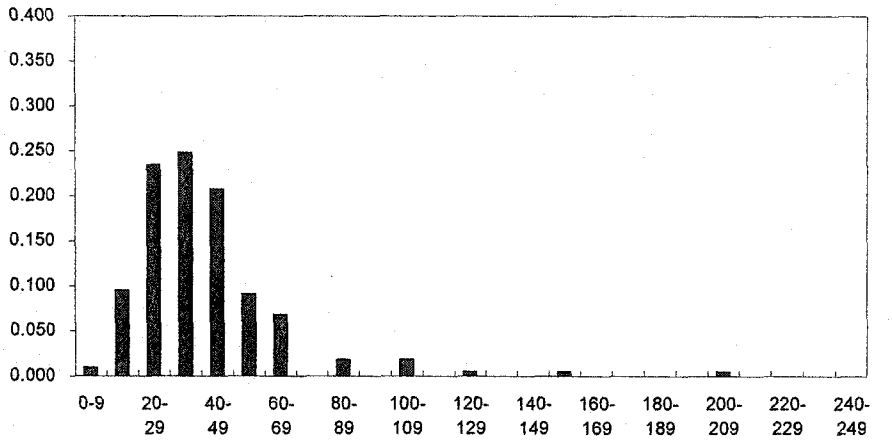


Figure 2. "ENOUGH TO LIVE IN REASONABLE COMFORT AND SECURITY"

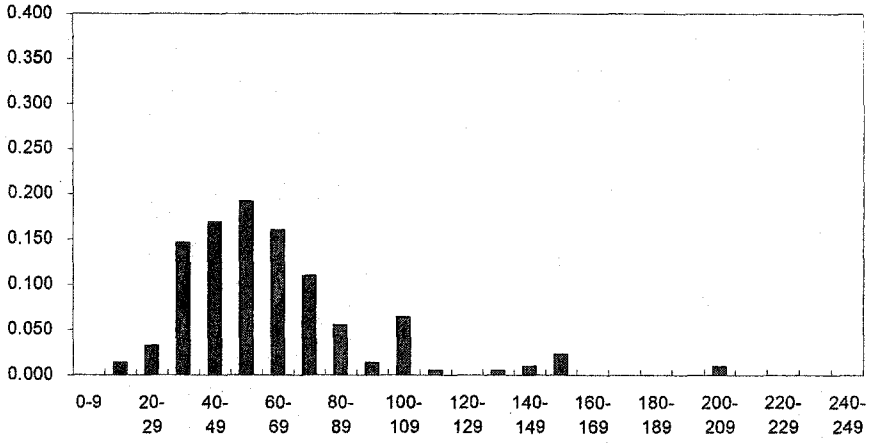
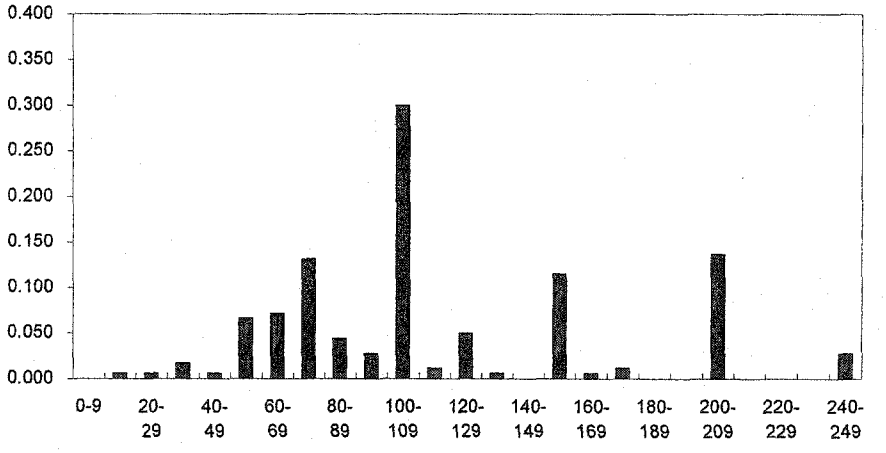


Figure 3. "MUCH MORE THAN ENOUGH"



level judged to be "too much." Fully 33% of respondents aspire to have incomes of $100,000 or more at some time in the future.[97]

It might be expected that attendees at a major conference on "Building the Voluntary Simplicity Movement" would differ from the general public in that the levels of income they believe are "enough" would be lower, perhaps significantly lower, than the levels that the general public believes are enough. **IIC-37** compares the Survey results with results from a 1995 Roper Starch poll of the general public. We see that the Survey respondents and the general public do not appear to differ much in their assessment of the incomes needed to "just get by," and to "live in reasonable comfort and security."[98] However, the Survey question asked for the income needed to support "a family of four, including two children of high school age," while the Roper Starch poll asked about "you and your family." Since a majority of American households include fewer than four people, it is reasonable to suspect that had the question as worded in the Simplicity Survey been asked of the Roper sample, the responses regarding needed levels of income might have been higher.

In its third question the Roper Starch poll asked for the level of income needed "to fulfill all your Dreams" whereas the Simplicity Survey asked for the level of income that respondents considered to be "much more than enough" or "too much." Median responses were both just about $100,000. With the adjustments noted in IIC-37, and the caveat about household size noted above, it's clear that the median response given by the Survey respondents is lower than that given by the Roper Starch sample, although perhaps not greatly so. In comparison with responses

---

[97] The distribution of maximum anticipated incomes shown in Box IIC-35 is bimodal. One mode centers on incomes of about $60,000 and the other—actually more of a spike—is found at $100,000. This pattern might reflect the hold that the cultural image of the "$100,000 life" has on many Americans, apparently including a large minority of participants at the Voluntary Simplicity conference. Alternatively, it might be an artifact of habitation patterns: persons who expect to be living alone might aspire to incomes near $60,000, while those who expect to be living as a couple could aspire to twice that amount, with little significant difference in personal earning status.

[98] If the ACCRA index overstates the cost-of-living then it could be that Survey respondents actually believe that *higher* incomes are necessary to "just get by" and to "live in comfort," than do Americans in general.

BOX IIC-37. LIFE-STYLE INCOME COMPARISONS

	Roper Starch, 1995	Survey Respondents, 1998
How much would you and your family need to...		
Just Get By	percents:	
<=$20,000	26	19
$20,001 - $35,000	45	33
$35,001-$50,000	15	36
over $50,000	14	12
Get-by median:	$25,500	$33,500
Live in Reasonable Comfort?		
<=$35,000	37	12
$35,001-$50,000	21	41
$50,001-$70,000	25	22
over $70,000	17	25
Comfort median:	$41,100	$50,000
Fulfill all your Dreams? / Much more than enough?		
under $50,000	12	8.5
$50,001-$100,000	28	60
$100,001-$200,000	28	19
$200,001-$1 million	14	12
over $1 million	18	0.5
Dreams median	$102,000	$100,000

Adjusted comparison:*	
Roper	Respondents
$31,600	$33,500
$51,000	$50,000
$126,500	$100,000

Sources: Data from the Roper Starch poll are taken from Hacker (1997).
See Box 2 for the wording of the questions used in the Simplicity survey.

*I adjusted the 1995 Roper figures upwards to make them more comparable with the respondents' 1998 figures, by two values. One was a consumer price index of (1.012)^3 = 1.036. The other was the ACCRA cost-of-living index of 1.197 noted in Box IIC-31. Together these gave an index of 1.036 x 1.197 = 1.240. However, the ACCRA index may overstate the differential, especially for the middle and lower quintiles. On the other hand, the different wording ("you and your family" vs. "household of four...") could have elicited higher income responses from the Survey participants, as noted in the text.

to the Survey, which were strongly centered near the modal value of $100,000, responses to the Roper poll were skewed to the upper end. Thus in the Roper poll 32% of the general public said that incomes of $200,000 or more would be necessary to fulfill all their dreams, whereas only 12% of respondents to the Survey said that an income in excess of $200,000 was *not* "too much."

The question "how much is enough?" was addressed a second time, with heavier contextual loading, in Question V of the Simplicity Survey. This question first provided current income figures for bottom, middle and top quintile United States households, and then asked for the income levels that respondents believed were "consistent with sustainability and fairness, and might be aspired to, over the coming century, as goals for our country." Median and mean responses are shown in IIC-34 and the distributions of responses are displayed in **IIC-38**.[99]

The responses are close to the income thresholds that persons offered in response to Question IV.1. The median level believed to be fair, sustainable and practicable for the "bottom 20%" of households ($30,000) is 10% less than the level given in Question IV needed to "just get by" ($33,500). The median level given for the "middle 20%" of households ($55,000) is 10% greater than the level given for "reasonable comfort and security" ($50,000). And the level given for the "top 20%" ($90,000) is 10% less than the level that is considered "more than enough" ($100,000).

While the median household income levels among parallel income categories given in response to Questions V.1 and V are similar, an important difference shows when we consider *mean* levels. In Table 3 of IIC-34, we see that the mean level given as fair, sustainable and practicable for the "top 20%" of households ($98,600) is 42% less than the mean of the incomes considered to be "too much" ($169,800). However, the differences between the means for the "bottom 20%" and the level needed to "just get by," and between the means for the "middle 20%"

---

[99] The current distributions of income by age of householder were calculated using tables F1, F2 and F3, "Money income received by families", in *Money Income in the United States,* U.S. Bureau of the Census, for 1996. See web site http://ferret.bis.census.gov.cgi-bin/ferret.[c]

BOX IIC-38. Sustainable and Fair Annual Average Incomes

The three charts below show responses to Question V of the Survey, as displayed in Box IIC-27. Values on the horizontal axes are in thousands of dollars. The vertical axes show the percent of respondents who gave answers in the ranges shown on the horizontal axes.

Figure 1. Bottom 20% of Households

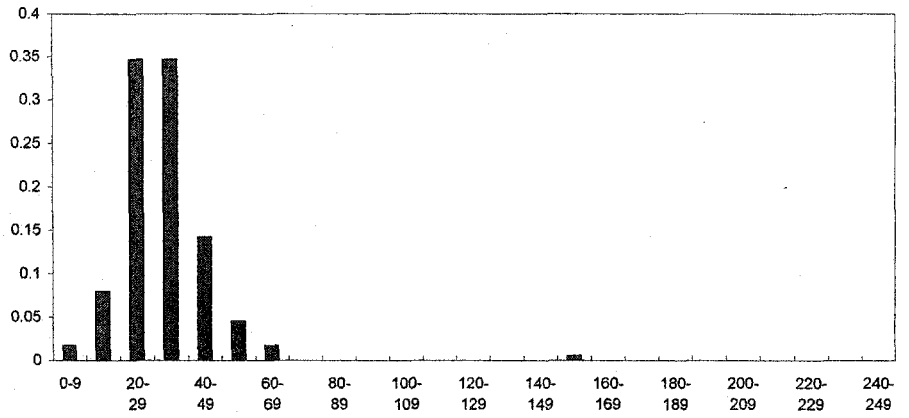


Figure 2. Middle 20% of households

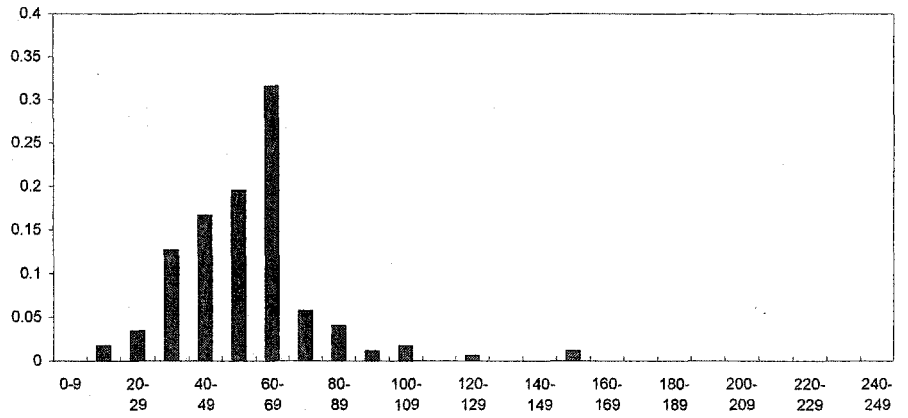
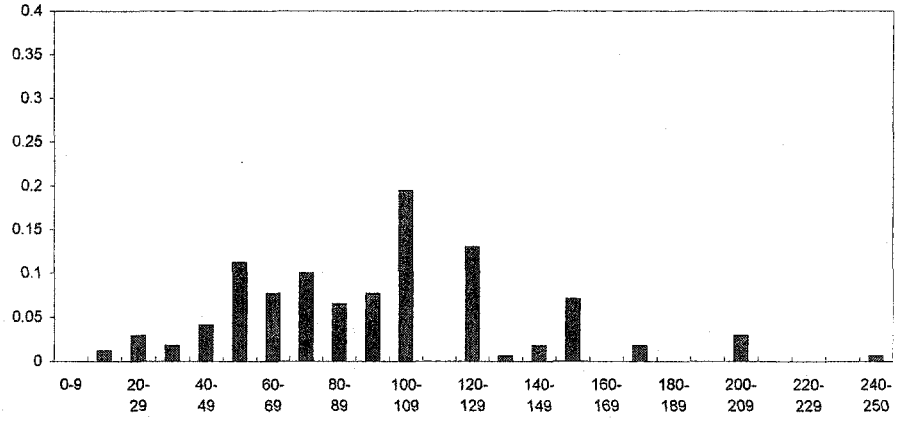


Figure 3. Top 20% of Households



and the level needed for "comfort and security," are proportionately much less. These results suggest that when constraints of equity, sustainability and practicability are taken into account, respondents will adjust their earlier, unconstrained answers by reducing the highest incomes received by the households in the highest income sector.

In order to achieve the levels that respondents believe are fair, sustainable and practicable, the average incomes of the lowest 20% of families would need to increase by 66% ($18,100 to $30,000), while those of the highest 20% of families would decrease by 39% ($147,000 to $90,000). Average incomes of the middle 20% would stabilize at somewhat less than their present levels ($58,000 to $50,000).

The ratio between the highest and lowest quintiles, the "80/20" ratio, is a standard measure of income inequality. Survey respondents believe that an 80/20 ratio of $90,000/$30,000, or 3, is fair, sustainable and practicable for the United States. A comparison with the values shown in Box IIB-1 of these notes shows that at the present time an 80/20 near 3 exists in only one country in the world, the Slovak Republic (80/20 = 2.9), and that only three countries in the world (out of 108 for which statistics exist) have 80/20 ratios below 4 [100]. The mean 80/20 ratio for the industrial democracies is today about 6.5. The United States has an 80/20 ratio of **8**, the highest of the industrial democracies. **IIC-39** shows the range of 80/20 ratios imputed by survey respondents. We see that the survey responses of fully 95% of respondents generate 80/20 ratios of less than 6.5.

b. Economic growth

Question VI of the Survey attempted to assess attitudes about long term economic growth. The question displayed a diagram showing per capita GDP growth in the United States for the 45-year period 1950-1995, and asked respondents to sketch the growth trajectory they

---

[100] These are Ukraine (3.7), Latvia (3.8), and Hungary (3.9)

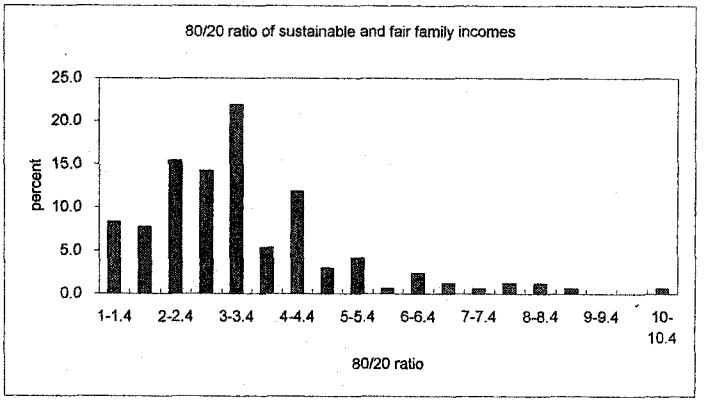
BOX IIC-39. 80/20 RATIOS

The table and chart show the ratios of the values given by respondents for the fifth quintile (top 20%) of families and the first quintile (bottom 20%) in response to Question V of the survey. That question asked respondents to give the level of income that they believed would be "consistent with sustainability and fairness, and might be aspired to, over the coming century, as goals for our country."

Table 1

80/20 ratio	count	percent
1-1.4	14	8.3
1.5-1.9	13	7.7
2-2.4	26	15.4
2.5-2.9	24	14.2
3-3.4	37	21.9
3.5-3.9	9	5.3
4-4.4	20	11.8
4.5-5-4.9	5	3.0
5-5.4	7	4.1
5.5-5.9	1	0.6
6-6.4	4	2.4
6.5-6.9	2	1.2
7-7.4	1	0.6
7.5-7.9	2	1.2
8-8.4	2	1.2
8.5-8.9	1	0.6
9-9.4	0	0.0
9.5-9.9	0	0.0
10-10.4	1	0.6
total	169	100.0

Figure 1



believe is "desirable and sustainable" for the coming 55-year period, 1995-2050. The results are shown in **IIC-40**. Forty-six percent of respondents sketched a trajectory of positive growth, with a mean growth rate of .8%. Twenty-four percent drew a flat line from 1995 to 2050. Twenty-nine percent showed declining per capita GDP, with a mean growth rate of -1.0%.

These average values don't capture some of the variations in the growth trajectories sketched by respondents, in particular those that combine periods of initial growth or decline with subsequent stability. A sample of growth trajectories is shown in **IIC-41.** In Table 3 of IIC-40 we see that 63% of respondents believe that it is desirable to attain zero economic growth by 2050. Of these, 35% would do so after an initial period of positive growth, 27% would do so after an initial period of negative growth, and 38% would move to zero growth more or less immediately.

It is difficult to know how the respondents interpreted their own responses. A recession is two successive quarters of negative economic growth, and a depression is a prolonged recession. Thus one interpretation of the survey results shown in Table 1 of IIC-40 would be that nearly 30% of respondents believe that a 55-year national depression, over which time personal incomes shrink by an average of 42%, is desirable, presumably because at the end of that period economic output will have at last attained a sustainable level.

The 24% of respondents who advocated zero economic growth from 1995 on have the experience of the period 1984-1996, during which most household incomes did not grow, as a reference case for short-term practicability. Of course, zero economic growth as a permanent condition, beginning soon, would present far greater challenges, particularly regarding distributional equity.

The trajectory of slow positive growth advocated by 47% of respondents appears less socially and politically challenging. However, the mean growth rate of .8% would still be considered unacceptably low by most Americans at the present time.[101]

[101] The Clinton administration set a goal for average annual per capita GDP growth of 2.2%.

BOX IIC-40. Opinions about future economic growth

The values shown were given in response to Question VI of the survey, shown in Box IIC-27.

Table 1.

	number	percent	mean per capita GDP in 2050	mean annual growth rate, '95 to '50 (%)
participants who sketched:				
positive growth	62	46	$46,000	0.77
no growth	33	25	$28,000	0
negative growth	39	29	$16,000	-1.01

Table 2.

	number	percent	example in Box IIC-41 [form #]
participants who sketched:			
constantly positive growth	29	26	137
initially positive growth, slowing to zero growth by 2050	25	22	201
constantly zero growth	27	24	29
initially negative growth, "slowing" to zero growth by 2050	19	17	169
constantly negative growth	12	11	82

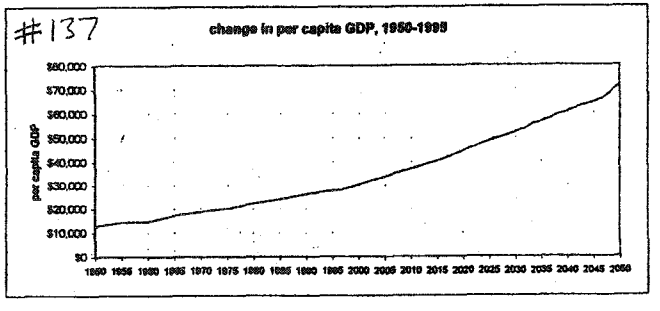
Table 3.

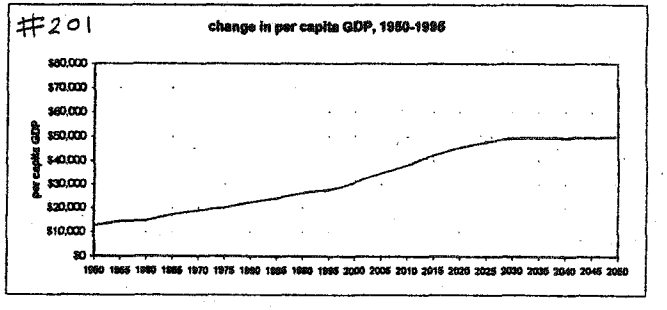
	number	percent
participants who sketched zero growth by 2050 [= the sum of the middle three categories shown in 14b.]	71	63

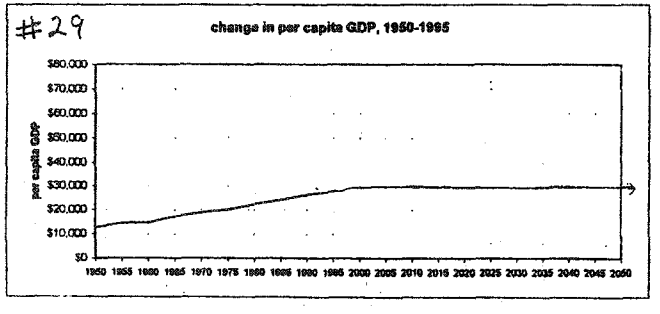
[note: some trajectories which showed net positive or negative growth over the 55-year period of interest are not described even by the finer categories used in Table 2, and so are not included here. This accounts for the discrepancies between Table 1 and Table 2.]

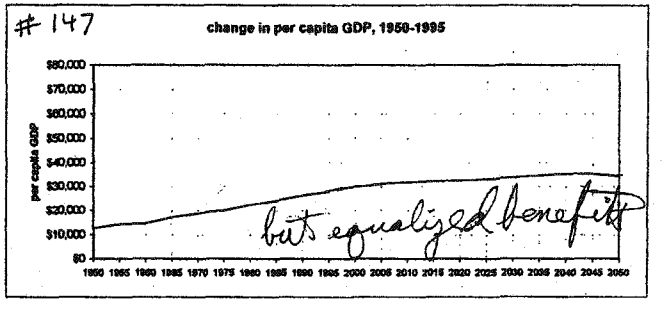
BOX IIC-41. GROWTH TRAJECTORIES, 1950-2050.

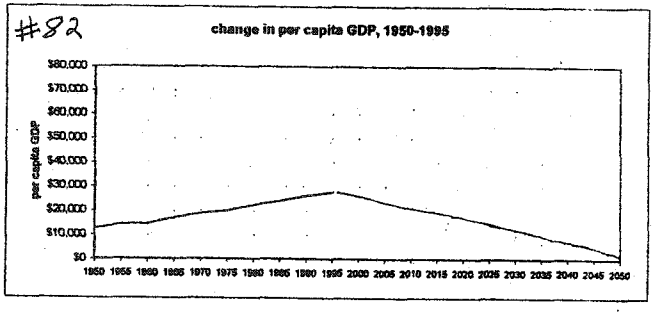
These are examples of responses to Question VI. It asked participants to sketch their vision of "desirable and achieveable" economic growth

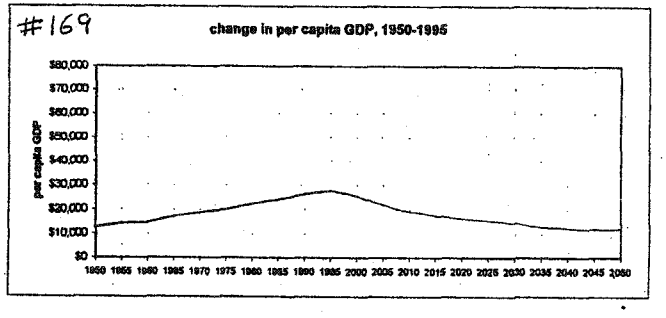












The growth trajectory that is quantitatively most consistent with the "fair, sustainable and practicable" levels of household income specified in response to Question V, and displayed in IIC-34, table a, is one of zero, or perhaps slightly negative, economic growth. If we use the three quintile values given in Question V and its responses to estimate plausible values for the 2nd and 4th quintiles, we can estimate relative total GDP under present and proposed conditions. We can then calculate the rate of growth that would be necessary to arrive at the proposed total GDP level over the 55-year period shown in Question VI. This rate of growth is about -.0032/year, which is one-third of the way between the growth rate of zero given by 25% of respondents and the mean negative growth rate of -.01/yr given by 29% of respondents.[102] If we use the 100-year time frame suggested in Question V, the preferred rate of economic growth is essentially zero.

II.C.3.d. Multivariate Analysis of Survey Results

1. DESIGN OF THE ANALYSIS

The results reported above take the 255 respondents as a single sample. However, significant differences of opinion might exist among respondents according to their age, sex, level of education and other demographic factors, and according to other values, attitudes and opinions they hold concerning the topics at hand.

I conducted a series of multiple regression analyses in order to explore possible influences of such factors on the answers given to questions asked in the survey. Multiple regression is necessary because it enables the influence of one factor to be measured while controlling for the influence of other factors.

The key survey results that I wanted to analyze further, here called the outcome variables, are:

[102] Using values given for the 1st, 3rd and 5th quintile given in the prefatory statement in Question V, we estimate plausible current household income levels for each quintile (in thousands of dollars) of 18, 24, 50, 89 and 147. Using similar proportions applied to the responses to Question V, we estimate plausible desired levels of 30, 40, 50, 70 and 90. These values give relative total GDP values of 345 (present) and

1. The levels of income that respondents felt were currently needed to support the three life-style categories: "just get by," "reasonable comfort and security" and "too much."
2. The levels of income that would be appropriate for the bottom, middle and top household income quintiles in a world where fairness and sustainability were taken into account.
3. The rate of economic growth over the period 1995-2050 that respondents thought was desirable and achievable.

To shed further light on attitudes towards income and consumption I also analyzed:

4. The maximum annual household income that respondents expect to receive, at any time.
5. The level of income that respondents expect to be living on after they retire.

To explore further the correlates of attitudes concerning economic inequality, I analyzed two constructed outcome variables:

6. The ratio of the income levels given as "too much" and as "just enough to get by."
7. The ratio of the incomes given for the top 20% and bottom 20% of households, in a world in which fairness and sustainability were taken into account.

Finally, I wanted to explore the way real-life behavior concerning income and consumption might correlate with attitudes about these, and about economic inequality. For this analysis the outcome variables were:

8. Current household income.
9. Amount saved last year.

For the nine outcome variables just listed I tested the influence exerted by nine explanatory variables. Five of these were demographic variables:

1. Age of respondent.
2. Sex of respondent.
3. Level of formal education of the respondent.
4. Current household income of the respondent.
5. Political party affiliation of the respondent.

Four explanatory variables were attitudinal variables:

6. The levels of income that respondents felt were needed to support the three

---

280 (desired). Using 280 = 345 (1+r)^55, we calculate r = -.0032.

life-style categories: "just get by," "reasonable comfort and security" and "too much".

7. The ratio of the income levels given as "toomuch" and as "just enough to get by."
8. The ratio of the incomes given for the top 20% and bottom 20% of households, in a world in which fairness and sustainability were taken into account.
9. The rate of economic growth over the next 55 years that respondents thought was desirable and achievable.

In total the exercise consisted of 36 regression equations using 9 outcome variables and 9 explanatory variables. Details of the construction and coding of the outcome and explanatory variables are described in **IIC-42**. The regression equations are shown in **IIC-43.** Six complete sets of regression results are shown in **IIC-44**, as examples.

The exercise generated 428 correlation coefficients. Of these, 151 were judged to be invalid or otherwise unuseful.[103] Of the remaining 277, 37 were found to be statistically significant at the 95% confidence level. These are listed in **IIC-45.**

2. RESULTS

The most striking finding of the multiple regression analysis was the paucity of significant results. Of those results that were significant, few appear to be of much consequence.

In this section we review the significant results, such as there were. These are shown in IIC-45 and displayed schematically in **IIC-46** and **IIC-47.**

i. Levels of income needed to support the three life-style categories

The level of income that respondents felt was necessary for a family of four to "just get by" correlated negatively with the age of the respondent. The needed level of income declined by about $350 for every year older the respondent was. For example, if the mean value given by 25

[103] Most of these discarded coefficients were those associated with the political party variables. As noted, the wording of the survey questions concerning political parties was confusing; further, the sample size of parties other than Democrats and Republicans was small, and respondents identifying with the small parties accounted for a large number of outlier values. For these reasons I don't consider the regression results for the parties in these notes.

BOX IIC-42. Names, definitions, units and codes of variables used in the regression analysis

variable	name	definition	units / codes	survey question #
1	Married	the respondent is married	[married = 1; not = 0]	II-1
2	Homeowner	the respondent is a homeowner	[owner = 1; not = 0]	II-2
3	People	# of people in HH	number	II-3
4	Children	# of children < 18 in HH	number	II-4
5	Cars	# of cars in HH	number	II-5
6	TV	# of hours of TV watched	number	II-6
7	Age	age of respondent	years	III-1
8	Sex	sex of respondent	[male = 1, female = 0]	III-1
9	HS2	highest level = HS diploma	[HS2 = 1; other = 0]	III-3
10	somecoll	highest level = some college	[somecoll = 1; other = 0]	"
11	BA	highest level = BA degree	[BA = 1; other = 0]	"
12	[Reference variable: highest level = professional degree]			"
13	Rep	Republican	[Rep = 1; other = 0]	III-4
14	Party2	Green + Peace & Freedom	[Party2 = 1; other = 0]	"
15	Libert	Libertarian	[Libert = 1; other = 0]	"
16	Party3	Other + unaffiliated + not reg'd	[Party3 = 1; other = 0]	"
17	[Reference variable: Democrat]			"
18	Getby	HH income need to just get by	thousand dollars	IV-1a
19	Comfort	HH income need to live in reasonable comfort	"	IV-1b
20	Toomuch	HH income that is much more than enough	"	IV-1c
21	Income	annual HH income	"	IV-2
22	Savings	annual HH savings	"	IV-3
23	Max	maximum HH income expected	"	IV-4
24	Retire	expected HH income at retirement	"	IV-5
25	Q1	"fair & sustainable" income for lowest 20%	"	V
26	Q3	"fair & sustainable" income for middle 20%	"	V
27	Q5	"fair & sustainable income for top 20%	"	V
28	2050	per capita US GDP projected by 2050	"	VI
29	inequality	Q5/Q1	ratio	--
30	rich/poor	Toomuch/Getby	ratio	--

BOX IIC-43. REGRESSION EQUATIONS

Here are the outcome and explanatory variables used in the 36 multiple regression equations of this study. The definitions and coding of the variables are shown in IIC-42.

Regression Equation Number	Outcome Variable	Explanatory Variables
1.	Getby	Age, Sex, Education, Income, Party, Rich/Poor
2.	"	" 80/20
3.	Comfort	" Rich/Poor
4.	"	" 80/20
5.	Toomuch	" Rich/Poor
6.	"	" 80/20
7.	"	" 80/20*
8.	Rich/Poor	" comfort
9.	"	" toomuch
10.	Max	" rich/poor
11.	"	" 80/20
12.	"	" comfort
13.	"	" toomuch
14.	Retire	" rich/poor
15	"	" 80/20
16.	"	" comfort
17.	"	" toomuch
18.	Q1	" rich/poor
19.	"	" 80/20
20.	Q3	" rich/poor
21.	"	" 80/20
22.	Q5	" rich/poor
23.	80/20	" comfort
24.	"	" toomuch
25.	2050	" rich/poor
26.	"	" 80/20
27.	"	" comfort
28.	"	" toomuch
29.	savings	" rich/poor
30.	"	" 80/20
31.	"	" comfort
32.	"	" toomuch
33.	income	Age, Sex, Education, [n/a], Party, rich/poor
34.	"	" 80/20
35.	"	" comfort
36.	"	" toomuch

BOX IIC-44. SAMPLE REGRESSION RESULTS

Regression #3. Outcome variable: income needed "to live in reasonable comfort and and security"

Explanatory variables	Coefficients	
	value	Pr(>/t/)
age	-0.5384	0.0136
sex	-9.4037	0.0528
HS2	-26.2518	0.1736
somecol	-3.3322	0.6052
BA	0.0802	0.988
income	0.0247	0.5324
Rep	2.7001	0.7058
Libert	-15.8608	0.4011
Party2	-4.8196	0.4308
Party3	8.3066	0.2902
inequality	0.3916	0.3243

R^2 = .0843; df = 188

Regression #22. Outcome variable: incomes of top 20% of families in a world valuing "fairness and sustainability."

Explanatory variables	Coefficients	
	value	Pr(>/t/)
age	0.4248	0.2159
sex	2.0001	0.7691
HS2	32.3114	0.1989
somecol	-20.1122	0.053
BA	-7.0301	0.3657
income	0.0983	0.1627
Rep	0.9236	0.9348
Libert	26.868	0.2644
Party2	-8.1528	0.3622
Party3	-21.2284	0.0571
rich/poor	1.051	0.0488

R^2 = .1472; df = 138

Regression #4. Outcome variable: income needed "to live in reasonable comfort and and security"

Explanatory variables	Coefficients	
	value	Pr(>/t/)
age	-0.4305	0.8932
sex	-8.3619	0.6026
HS2	-24.9345	0.518
somecol	-7.231	0.7745
BA	2.9543	0.5033
income	0.0688	0.9261
Rep	-8.1212	0.3822
Libert	-14.7051	0.5563
Party2	-11.7	0.5369
Party3	10.0419	0.1993
80/20	1.6913	0.2212

R^2 = .1465; df = 149

Regression #24. Outcome variable: income inequality; top 20% of households/bottom 20% of households

Explanatory variables	Coefficients	
	value	Pr(>/t/)
age	0.0141	0.3264
sex	0.2144	0.4667
HS2	1.5026	0.1668
somecol	-0.9739	0.0286
BA	-0.387	0.2485
income	-0.0012	0.6797
Rep	0.8708	0.0756
Libert	0.9695	0.3497
Party2	0.8381	0.0282
Party3	-0.3646	0.448
toomuch	0.0004	0.3281

R^2 = .1148; df = 141

Regression #6. Outcome variable: income level beyond which is "much more than enough."

Explanatory variables	Coefficients	
	value	Pr(>/t/)
age	-1.8042	0.5299
sex	-95.5335	0.103
HS2	-214.7217	0.3233
somecol	-2.8532	0.9746
BA	78.1549	0.2431
income	0.1574	0.7936
Rep	-24.9611	0.7997
Libert	258.9932	0.2102
Party2	-21.1255	0.7835
Party3	223.6514	0.0187
inequality	16.4439	0.3281

R^2 = .0.08622; df = 141

Regression #27. Outcome variable: Per Capita GDP Growth, 1995-2050.

Explanatory variables	Coefficients	
	value	Pr(>/t/)
age	0.0927	0.577
sex	3.6055	0.3078
HS2	22.4559	0.238
somecol	0.6439	0.893
BA	-1.1775	0.756
income	-0.0132	0.683
Rep	7.6154	0.1765
Libert	18.0643	0.1749
Party2	-3.0321	0.4945
Party3	-5.33	0.3418
comfort	0.074	0.2416

R^2 = 0.09256; df = 108

BOX IIC-45. SIGNIFICANT REGRESSION RESULTS

Regression number	Outcome variable	Explanatory variable	p-value	Beta
1	Get by	age	.0024	-.4066
2	Get by	age	.0332	-.2707
3	Comfort	age	.0136	-.5384
3	"	sex	.0528	-9.4037
4	Comfort	age	.0461	-.4305
8	rich/poor	income	.0452	.0145
9	"	income	.0132	.0131
10	max	income	.0000	0.7892
10	max	rich/poor	.0000	5.8023
11	"	income	.0000	0.7720
12	max	income	.0000	0.6762
12	"	comfort	.0000	1.0308
13	max	toomuch	.0000	0.1974
14	Retire	income	.0006	0.1087
17	Retire	income	.0001	0.1151
18	Qfirst	income	.0150	0.0598
19	Qfirst	income	.0275	0.0494
20	Qthird	income	.0308	0.0685
20	"	rich/poor	.0113	0.6095
21	Qthird	80/20	.0001	2.7181
22	Qfifth	somecol	.0530	-20.1122
22	"	rich/poor	.0488	1.0510
24	80/20	somecol	.0286	-0.9739
29	income	somecol	.0066	-31.8876
29	"	rich/poor	.0393	1.4960
30	income	somecol	.0053	-33.0026
31	income	somecol	.0089	-29.8997
32	income	somecol	.0076	-31.0936
33	savings	sex	.0178	7.0528
33	"	income	.0000	.3405
34	savings	sex	.0122	7.5980
34	"	income	.0000	.4610
35	savings	sex	.0194	6.6946
35	"	income	.0000	.3270
36	savings	sex	.0162	7.1232
36	"	income	.0000	.3340

BOX IC-46. SIGNIFICANT CORRELATIONS (1)

Comments in the boxes show the direction and magnitude of significant correlations between variables. A blank box means that no significant correlations were found.

	Age	Sex	Income	Education	80/20	toomuch/ getby
income measures:						
Getby	negative (moderate)					
Comfort	negative (moderate)	males < females (moderate)				
Toomuch						
Q1			positive (small)			
Q3			positive (small)		positive (small)	positive (v. small)
Q5				somecol < professional (moderate+)		positive (v. small)
equity measures						
Q5/Q1				somecol < professional (large)		
Toomuch/ Getby			positive (small+)			
growth projection **2050**						

BOX IIC-47. SIGNIFICANT CORRELATIONS (2)

These results are mostly of secondary interest to the central questions that this exercise sought to address, but are noted here for completeness.

explanatory variables

outcome variables	**Sex**	**Income**	**"comfort"**	**"toomuch"**	**"toomuch/ getby"**	**education**
current income		n/a			positive (v. small)	somecol < prof. (large)
maximum anticipated income		positive (large)	positive (moderate)	positive (v. small)	positive (small)	
anticipated retirement income		positive (v. small)				
current savings	men > women (large)	positive (moderate)				

Notes:

1. Savings is positively correlated with income. For every $1000 more in income, about $300-400 more was saved last year. This result includes the distorting effect of several large outliers.
2. Savings is positively correlated with male sex. Male respondents saved on the average about $7000 more than did female respondents, all else controlled for.
3. Having "some college" shows a significant influence on income, but other levels of education do not. Household income of a person with only some college is $30,000 less than that of a professional, all else controlled for. Having only a high school diploma did not produce a significant correlation with income, but this may be due to the small sample size. The sign and magnitude of the coefficient (-$44,000) was consistent with the result for "some college."
4. For every increase of 1 point in the "rich/poor" ratio given by a respondent, their household income showed an increase of about $1,500. This value is very small and of little consequence.
5. Retirement income expectations correlated positively with current income. For every $1,000 more in current income, retirement income expectations increased by about $100. This is not large.

6a. For every additional $1,000 in current income, maximum income expectations increased by about $780.

6b. For every point that the rich/poor ratio increased, maximum income expectations increased by $5800. A 2-point difference in two persons' rich/poor ratios (e.g., from 3 to 5, equivalent to, say, 90K/30K to 150K/30K) would generate an $11,600 > in income expectations.

6c. Maximum income expectations increased by about $1,000 for every $1,000 more that a person believed was necessary for a household to lie in "reasonable comfort and security."

year-olds was $55,000, the mean given by 60 year olds would be about $42,750, all other factors controlled for.[104]

Age also correlated negatively with the value given for the amount needed "to live in reasonable comfort and security." The value given declined by about $500 for every year of age.

Age did not correlate significantly with the levels of household income that were believed to be "more than enough."

The only other instance of a significant correlation for any of the outcome variables treated in this section was that between the level of income believed necessary to live in "reasonable comfort and security," and sex.[105] All else controlled for, men gave values that were about $9,400 lower than the values given by women.

In no instances did current or projected household incomes, education or other attitudes and opinions about income, equity, or economic growth correlate significantly with the levels of income that a respondent felt was "just enough to get by," "enough to live in reasonable comfort," or "too much."

ii. Levels of household income consistent with fairness and sustainability

The levels of income consistent with fairness and sustainability that respondents gave for the bottom 20% of households correlated positively with the respondents' current household income. For every $1000 more that a respondent's household received, the amount that respondents believed the bottom 20% of households should receive increased by about $50-$60. This is a very small amount. If the mean value given by persons living in households with annual incomes of $25,000 was, say, $28,000, then the value given by a person living in a household with an annual income of $85,000 would be about $3,300 more, or $31,300.

The values respondents gave for the preferred income of the middle 20% of households also correlated positively with respondents' household incomes, and by the same small amount.

---

[104] 55,000 - (35 x 350) = 42,750.

For every $1,000 increase in a respondents' household income, their opinion concerning the ideal income for the middle 20% of households increased by about $68.

A respondent's household income did not correlate significantly with the values given by respondents for the preferred income of the top 20% of households.

A negative correlation with the borderline p-value of .0530 was found between the income level that respondents give for the top quintile and whether or not they have some college, but not a BA. For example, if a person with a professional degree felt that a mean top quintile household income of $100,000 was consistent with equity and sustainability, a person with only some college, but identical in other regards, would suggest the lower value of $80,000.

Significant correlations were found between the preferred levels of income that respondents gave for the middle quintile and the constructed measure of equity preference, the 80/20 ratio, and for the preferred income levels that respondents gave for the middle and top quintiles and the weaker measure of equity preference, the "toomuch/getby" ratio. The correlations were positive; that is, as one's "preference" or "tolerance" for income disparities increases, so does the level of income that they believe is just and sustainable, or "needed" for the middle and top income groups. In all three instances the change in the outcome variable per unit change in the explanatory variable was small. Given the somewhat abstract nature of the relations between the variables, the possibility of definitional correlation, and the seeming small consequentiality of the findings, further analysis of these results doesn't seem warranted.

iii. Imputed equity measures as outcome variables

iii-1. The 80/20 ratio.

The ratio of the income levels given by respondents for the top and bottom household quintiles in a world of fairness and sustainability is taken in this study as an imputed measure of equity preference. Neither age, sex, or current income, nor the income believed necessary to support a household at levels that are "comfortable" or "more than enough," showed any

---

[105] Actually this correlation is of only borderline significance, with p(.95) = .0528.

correlation with the 80/20 ratio. However, the variable "some college" was significantly correlated. Respondents with some college, but not a BA, believed that in a world of fairness and sustainability the 80/20 ratio should be about 1 point *lower* than people with professional degrees believed. For example, if a person with a professional degree suggested incomes in the ratio of 110K/31K (3.5), a person with only some college might suggest 78K/31K (2.5), all other variables controlled for. [106] The fact that the 80/20 measure correlates with education, but not income, suggests that education might be a more significant determinant of class identity than income per se. But the results of this exercise are too thin to be anything but suggestive.

iii-2. The ratio "toomuch"/ "getby"

This ratio measures the ratio between the level of income that a respondent would consider "much more than enough." and the level the respondent believes is needed to "just get by. It is a weak measure of a respondent's sensitivity to conditions of economic inequality. The only explanatory variable that correlated significantly with this ratio was household income. The correlation was positive but moderate. If a person with a household income of $20,000 gave "toomuch" and "getby" values of, say, $100K/$30K, a matching person with a household income of $80,000 might give values of $126K/$30K.[107]

iv. measures of desirable and achievable rates of economic growth, 1995-2050.

As discussed above, respondents clearly differed about whether the desirable and achievable rate of economic growth for the coming 55 years was positive, negative or zero, although the range encompassed by the means of their responses was rather small (-1% to +0.8% = 1.8% range). I did not find even a single explanatory variable that was significantly correlated with a respondent's opinion in this regard. Neither age, sex, education, current income or

---

[106] A value of 110/44 would also give an 80/20 ratio of 2.5, but we saw in section b-ii above that having some college, but no BA, correlates with suggested lower incomes for households in the fifth quintile.

[107] ($80K - $20K) = $60K x .0145 = .87; thus the ratio $100K/$30K = 3.3 will increase to 3.3 + .87 = 4.2, or $126K/$30K.

attitudes concerning appropriate levels of income appeared to have a discernible influence on the opinions that respondents have about the preferred rates of future economic growth.[108]

v. Current and expected income, and current savings, as outcome variables

I used this final set of regression equations to see if attitudes and opinions about income, consumption, equity and growth appeared to make any difference in respondents' behavior or expectations concerning these important economic aspects of one's life. Three significant sets of correlations of any consequence were found. Men report that they saved about $7,000 more last year than women reported, all else controlled for. Another significant correlation was found between the levels of income that a respondent believed were needed for "comfort," or were "too much," and the respondent's maximum anticipated income. Specifically, the higher the level of income a respondent believed was needed to "live in comfort and security," the higher the maximum income they aspired to. The third was a positive correlation between the rich/poor ratio that a respondent's opinions generated and both the current and maximum anticipated income of that respondent. Other significant results are described in more detail in IIC-47.

3. SUMMARY AND DISCUSSION OF REGRESSION RESULTS

The regression exercise suggests that the following conclusions are statistically valid and may be of at least moderate consequence:

1. Older people state that, in their opinion, less income is needed for a family of four to "just get by" or to "live in reasonable comfort and security," than do younger people.

2. Men state that, in their opinion, less income is needed to "live in reasonable comfort and security, than do women. Men report higher levels of savings than do women.

[108] Fifty percent of the 255 persons who turned in survey response forms did not complete the question concerning long-term growth rates. This lower response rate may have contributed to the low number of significant correlations.

3. Persons with professional degrees believe that in a world of "fairness and sustainability," households in the highest income quintile can have higher average annual incomes, than do people who have not graduated from college.

There is some support, albeit weakly and inconsistently, for the conclusion that as ones' household income increases so to does ones' estimate of the levels of income that are fair and sustainable for bottom and middle sector households. This conclusion is somewhat of the same sort as the third conclusion above.

The first conclusion prompts the question of whether the observed pattern is a cohort effect or a life-cycle effect. A cohort explanation would look for unique experiences in the formative years of different age groups that would explain the pattern seen. A life-cycle explanation would look for common experiences in all persons as they age that would explain the pattern. Respondents in their late 40's through late 50's were in their teens and twenties during the countercultural period of the mid-1960's through early 70's. Respondents in their 20's and 30's spent their formative years during the less idealistic 80's and 90's. So the willingness of older respondents to accept lower levels of household income might be rooted in that cohort difference. I can't think of a life-cycle explanation that is intuitively convincing.[109] In any event the only conclusive way to decide between cohort and life-cycle explanations is to examine time series data, which is difficult to obtain.

The two results that suggest differences between men and women concerning income thresholds for "comfort" and reported savings are intriguing, but the fact that sex does not correlate in a similar way with comparable outcome variables suggests that these results may not be robust. This same weakness applies to the results suggesting that people who earn more, or

[109] We can speculate that perhaps as people get older they become more conscious of the vagaries of life and thus lower the income levels they believe are needed to get by, and to live comfortably. But this is unconvincing; as people age and become aware of life's vagaries they could just as well *raise* their income thresholds. It's probably wrong to simply state that younger people tend to be more "optimistic" about the economic future. In the late 60's and early 70's it was young people who responded most decisively to

have the potential to earn more, will tend to believe that higher levels of income are fair, sustainable and practicable.

The most consistent results of the regression exercise are the lack of significant correlations. As noted, in no instances did current or projected household incomes, education or opinions about equity or economic growth correlate significantly with the levels of income that a respondent felt were "just enough to get by," "enough to live in reasonable comfort," or "too much." In no instances did age, sex, income or opinions about income or economic growth correlate significantly with imputed patterns of income distribution that respondents thought were fair, sustainable and practicable. And in no instances did age, sex, current or projected household income, education, or any opinions about income or equity correlate significantly with a person's beliefs about desirable and achievable patterns of future economic growth.

There are at least two ways that these negative results might be explained. One is that many of the opinions offered in response to the survey were "pseudo-opinions." Pseudo-opinions are replies to survey questions about which respondents have simply not thought about very much before, perhaps ever. Indeed, the questions asked—how much is enough? What is a fair distribution of income? What rate of economic growth is sustainable? -- are actively avoided by most Americans. Thus any opinions given on the survey form may not be related in a functional sense to any characteristics of the respondent that otherwise have a bearing on important life choices. Of course, this survey was conceived partly on the expectation that the questions asked were ones that conference participants *had* thought about. Still, the requests for quantitative responses may have been novel even for these participants.

A second possibility is that the respondents have certainly thought about the questions at hand, even in some depth, and that their opinions reflect this intentional, conscious process. On this account their answers incorporate a multitude of understandings, beliefs, values, hopes and

---

forecasts of coming economic decline.

fears that in effect trump the more conventional characteristics—age, sex, education, etc.—tested for as explanatory variables. This possibility does not necessarily mean that respondents had earlier formulated *explicit* opinions about preferred rates of growth, equity, etc., which they simply reported when queried. It means rather that there existed a developed set of attitudes that, if made explicit, would correlate with the answers provided on the response form, and that these are not correlated with age, sex, education, etc. In short, the observed results of the regression analysis are consistent with the existence of what might be called a "philosophy of voluntary simplicity."

I believe it might be possible to learn more about which of these is more likely by having a random sample of Americans answer the survey questions, and determining if the pattern of responses shown in the current survey formed a statistically significant cluster. If they did, it would support the suggestion that a "philosophy of voluntary simplicity" exists as an independent variable.

II.C.3.e. The Voluntary Simplicity Survey: Discussion and Conclusion

Respondents to the Simplicity survey were largely white, middle-class and middle-aged. They were highly educated but worked in human services occupations rather than in more highly paid professional sectors. Their household incomes appeared to be comparable with those of Americans of similar age, but were lower than those of households headed by persons of similar educational level.

The characterization most frequently mentioned by respondents when asked about the meaning of voluntary simplicity was that it involved reducing consumption, spending or income. Fully 54% believe that the desirable rate of economic growth over the coming 50 years is zero or negative.[110] At the same time a large minority, and perhaps a majority, of respondents aspire to earnings that would place them within the top 30% of American households with heads of

comparable age. Over a third of respondents aspire to household incomes of $100,000 or more. A majority of respondents wish to see a significant increase in the annual incomes of the bottom 20% of households, from about $18,000 to about $30,000.

Are these responses consistent? They appear not to be, but actually the survey questions that were asked were not finely grained enough to allow inconsistency to be firmly established in all particulars. Using the speculative values suggested in Footnote 104, it would appear that the fair and sustainable income quintile levels affirmed by the respondents could be consistent with zero economic growth, although not with more than minimally negative growth. If a top quintile family were to transfer $12,000/year to a bottom quintile family and $16,000/year to a 2nd quintile family, the income levels of the bottom three quintiles would be in rough alignment with the levels that the respondents felt were fair and sustainable, and would leave the top two income quintiles with money left over. The mean income of the top quintile would need to decline by another $29,000/year in order for the entire economy to be operating at the median values given for fair, sustainable levels.

It's notable that in those cases where responses could be used to construct or approximate an 80/20 ratio, the income levels that were suggested as being reasonable, or as consistent with "fairness and sustainability," generated ratios of about 3 to 1. The actual 80/20 ratio in the United States is about 9.8 to 1.

An obvious problem concerns practicability. The Simplicity survey did not ask for opinions concerning the means by which the various outcomes preferred by the respondents might be achieved. It is possible that additional questions focused on the means of achieving desired outcomes could lead to a re-evaluation of the outcome levels themselves.

By emphasizing different aspects of the responses, different interpretations can be had. If we look at the respondents' actual and anticipated levels of income, we see what appears to be a

---

[110] An additional ~22% of respondents believe that economic growth should be positive but decline to zero by 2050. Only ~25% believe that positive economic growth should continue beyond 2050 (see IIC-40).

group of well-educated urban professionals living, and expecting to live, modestly comfortable lives. If we look at the narrative responses concerning the meaning of voluntary simplicity, we see insightful, challenging questions being raised about the entire modern industrial/consumer society. If we look at the quantitative values given for fair and sustainable levels of income and economic growth, we see patterns consistent only with the most radically ecological and egalitarian ideologies.

II.C.4. ASSESSMENT

Is the scenario of Green sustainability, as understood in Section II.C.1, likely to be desirable, credible and compelling enough, to enough people, to enable it to serve as a practicable advocated scenario? The material presented to this point raises doubts. The fact that biogeophysical constraints on continued economic growth do not appear to be strong, at least over the coming century or longer, reduces the credibility of the argument that global economic growth must in short order be brought to zero if a catastrophic overshoot is to be avoided. The number of persons who would welcome a steady-state world in the absence of necessity appears likely to be small. Americans appear willing to pay several percent of annual income to support environment protection, but they don't appear willing to endorse the end of economic growth. Even those sympathetic to a philosophy of voluntary simplicity are of different minds about the desirability of a steady-state world. Fully 48% appear supportive of continued positive economic growth over the coming half century. Although few desire dramatically higher levels of income, neither do they appear eager to reduce their current household incomes, which appear to be slightly higher than comparable mean values for Americans and about 20 times higher than the mean incomes of households in the developing countries. Finally, people seem far more supportive of policies that would keep income inequality from increasing than they are of those that would reduce income inequality by any significant amount.

Of course, all this could change if new information suggests that limits to growth of the sort discussed in Sections II.A and II.B are closer at hand. In addition, economic growth could be curtailed if it becomes impossible to manage a globalized world economy in a way that ensures stability, equity and ecological integrity. Further, we may decide to forgo continued economic growth if it forces us to become dependent on technologies that have unacceptable social consequences. We consider these last two possibilities in the final sections of this dissertation.

For the moment, however, the material we've reviewed suggests that the our ideal scenario, comprised of quantitative Scenario 5 and the narrative scenario of Green sustainability, is unlikely to be desirable, credible and compelling enough, to enough people, to serve as a practicable advocated scenario.

But what is the alternative? Our review suggests that we might consider a scenario in which economic growth in a mature industrial world proceeds slowly, rather than not at all, and in which we commit to preventing inequality from increasing, rather than hoping to reduce it.

As an example, let's revisit quantitative Scenario 3 presented in Section I.A.3 of these notes. A comparison of key features of Scenarios 1, 3 and 5 is shown in **IIC-48**. In Scenario 3 we envision per capita GDP in the high income countries slowing from its 2000 rate of about 1.7% per year to a rate in 2050 of 0.5%, and remaining at that level for the next 100 years, and perhaps indefinitely. The low and middle income countries, and China, grow at much higher rates for most of the next century, but by 2100 they too begin slowing and by 2150 have also stabilized at 0.5% per year. As shown in Box IA-18 in section I.A.3, this trajectory allows per capita income of all countries to attain parity by 2150. Note that even with the high income countries growing at unprecedented low rates, *global* per capita GDP is growing through the coming century at historically very *high* rates, generally well in excess of 2% per year. And the low-income countries are positively booming, sustaining annual growth rates of 4 and 5 percent for many decades.

Scenario 3 calls for a commitment to ensure that inequality in the developing countries, which today have 80/20 ratios averaging about 8 to 1, declines to the level of inequality in today's developed countries, which have 80/20 ratios averaging 6.5 to 1. In Scenario 3 a further commitment is made to prevent inequality in the developed countries from increasing beyond this current level.

Some readers may object, saying that it is unrealistic to expect the industrial countries to deliberately slow their economic growth to 0.5% within the next half century. But if this does not

BOX IIC-48. COMPARISON OF SCENARIOS 1, 3 and 5

See Section I.A.3 for full scenarios. Scenario 1 is the business-as-usual scenario. All values are as of 2150, and given in 1990 US dollars.

feature	Scenario 1	Scenario 3	Scenario 5
population (billion)	11.3	9	9
per capita GDP			
world	31,120	81,991	44,797
low income countries	11,539	82,747	44,513
high income countries	136,217	80,984	44,892
ratio, high/low per capita GDP	11.8	1	1
economic growth rates (%/yr in 2150)			
world	1.1	0.5	0.0
low income	1.3	0.5	0.0
high income	0.8	0.5	0.0
energy use (terawatts)	165	60.9	33.2
watts/$ GDP	.469	.083	.083
income distribution			
w/in low income countries			
bottom 20%	3,906	26,083	27,147
top 20%	25,525	170,822	67,681
ratio	6.5	6.5	2.5
w/in high income countries			
bottom 20%	41,978	25,063	27,987
top 20%	274,058	163,626	69,818
ratio	6.5	6.5	2.5
ratio, top 20% high income/bottom 20% low income	70.0	6.5	2.5

Very roughly:

Scenario 1 is associated with techno-globo neoliberalism.
Scenario 3 is associated with social-democratic internationalism
Scenario 5 is associated with Green sustainability

happen, the gap between the rich countries and poor countries does not close. And so long as that gap is expected to remain, there is no possibility of negotiating a transition to a world in which *aggregate* economic growth can proceed at a pace and in a manner that is ecologically sustainable and avoids dependence on possibly unacceptable technologies, over the very long haul.

Other readers may object for just the opposite reason, saying that global per capita GDP growth rates of 2% and greater throughout most of the 21st century, resulting in a level of per capita economic output in 2150 *seventeen times higher* than the level of 2000, is ecologically unrealizable. If such rates of growth were to continue indefinitely, that would be so. But the whole point of wanting high growth rates in the short term is to reach a condition of economic parity that would allow negotiation of sustainable growth rates for the long term. Our review of biogeophysical and technological limits in Section II.A suggests that such a trajectory of economic growth—the trajectory displayed in Scenario 3--would be ecologically realizable and, with caveats, sustainable.[111]

Scenario 3 presents further challenges, however. A world in which per capita GDP in the great majority of countries not only grows but *accelerates* for the next half century, and does so in a way that maintains global ecological integrity and social equity, is a highly managed, technologically dense world. Success of such a venture would seem to require, at a minimum, the creation and maintenance of global institutions of governance and accountability, and of a supportive global political culture.

In short, I'm suggesting that our ideal scenario, comprised of quantitative Scenario 5 and the narrative scenario of Green sustainability, be put on the shelf, at least for the moment. In its place we consider an alternative comprised of quantitative Scenario 3 and the narrative scenario identified in Section I.B. as "social democratic internationalism".

---

[111] The caveat is that technological innovation allows an ecologically acceptable level of resource flow to generate 0.5% greater output each year. For a period of many decades or a short number of centuries this seems reasonable (e.g., e^.005(200) = 2.7). In Section III we comment on the prospects for continued growth, even at the low rate of 0.5%, annually, over many centuries and millennia.

Is such a scenario likely to be desirable, credible and compelling enough, to enough people, to enable it to serve as a practicable advocated scenario? We begin to address this question in the next section. If it appears unlikely that a globally integrated economy can be governed in a way that ensures stability, ecological integrity, and social equity, then quantitative Scenario 3 will not be achievable. In that case the trajectory of the world system would appear to be one of great precarity, in which event constraints such as those imposed by Scenario 5 and Green sustainability might be welcome rather than resisted.

II.D. GLOBALIZATION AND GOVERNANCE

Summary

In this section we situate our evaluation of scenarios within the real world context of global economic growth and integration---"globalization". After a review of definitions and interpretations we ask if globalization is more likely to support or to undercut our ability to achieve the goals expressed in quantitative Scenario 3. We conclude that there appear to be practicable institutions and policies that could allow a growing, globalizing, market economy to be managed in a way that keeps financial, trade and investment fluctuations within an acceptable range, and that could successfully address environmental concerns. There also appear to be institutions and polices that could enable developing countries whose growth rates are below those of high-income countries to grow faster, although the magnitude of the political and social commitment needed to achieve this needs to be acknowledged. The most problematic suspected cause of increased inequality—skill-biased technological change—may or may not be reinforced by globalization per se. If tendencies that encourage inequality are mild, there appear to be institutions and policies that can constrain these under conditions of globalization. If such tendencies are great they will pose a major challenge to our chances for realizing Scenario 3.

The existence of practicable institutional and policy blueprints is a necessary but not sufficient condition for Scenario 3 to be credible under conditions of globalization. The advocated governance regime—broadly, "social-democratic internationalism"--presumes the existence of nation-states, structures accountable to nation-states, or other structures that ensure popular legitimacy and accountability. It also presumes a majority socio-political ethos that affirms the solidaristic economic, ecological and equity values expressed in Scenario 3. If globalization seriously undermines structures of accountability or individual commitment to a common future, then the practicability of Scenario 3 is further challenged. Authors differ widely in their assessments of the extent to which globalization can be expected to undermine structures

of accountability and commitments to a common future. If Scenario 3 is to be credible it must at a minimum be strongly affirmed by many people sharing a commitment to cooperate towards its realization.

II.D. GLOBALIZATION AND GOVERNANCE

Introduction

In the last section we suggested that it might be difficult to present our ideal quantitative scenario, Scenario 5, as desirable, credible and compelling. The major difficulties concern the degree of social consensus necessary to reduce output growth rates to zero by 2050 in the high-income countries, and in other countries by 2150, and to bring the 80:20 ratios from their current levels to a stable level of 2.5.

As a possible alternative we revisited Scenario 3. Here output growth slows in the high-income countries to the low rate of .5% a year by 2050, and in all countries to the same rate by 2150, but we do not require that it slow to zero. Further, we seek only that the 80:20 ratio in the high-income countries does not increase beyond its current level of 6.5, and that as the developing countries approach the per capita incomes of the high-income countries their 80:20 ratios decline and stabilize at that same level.

Our discussion to this point has taken place at some remove from any real world context, and if Scenario 3, or any scenario, is to be credible and compelling it can only be so within the context of the real world. The world system is currently in the midst of an extended period of global economic growth and integration, with uncertain implications for our economic, political and social future. How does this state of affairs—"globalization"—bear upon prospects for Scenario 3? If we have reason to believe that globalization would support the achievement of Scenario 3, then we should be supportive of globalization, all else being equal. If we have reason to believe that globalization would make Scenario 3 more difficult to achieve, then we are faced with new challenges if we wish to present it as credible and compelling.

This Section begins by clarifying our use of the term "globalization" and assessing the extent to which the changes that it is meant to describe are or are not in fact taking place. We then review possible governing institutions and policies that could allow us to achieve the several elements of Scenario 3. Then we assess the possibility that globalization might affect political,

social, cultural and other structures and values in ways that could affect our ability to develop the institutions and implement the policies that would be needed in order for Scenario 3 to be realized.

II.D.1. DEFINITIONS OF GLOBALIZATION

Box IID-1 lists definitions of globalization. In these notes we use Rodrik's definition: globalization is "the international integration of markets for goods, services, and capital, and the secondary impacts, positive and negative, that this has on economic, political and social life in societies."

Many people use "globalization" to describe a more multifaceted, multicausal process of global transformation, and would consider Rodrik's definition as descriptive of one particular facet of this, i.e., "economic" globalization. Waters distinguishes economic, political and cultural globalization, and describes sixteen aspects of these, as shown in **IID-2.** Holm and Sorenson illustrate "narrow" and "comprehensive" ways in which globalization can be understood, as shown in **IID-3.**

We use Rodrik's definition as a convenient entree into a complex discussion. Clearly, what he calls "secondary impacts" are the cause of much of the controversy over globalization. Further, these secondary impacts may themselves encourage or discourage further economic integration, and have other, independent causes, and may have impacts upon one another as well.

In these notes the terms "globalization," "economic globalization" and "global economic integration" are treated roughly as synonyms, and are variously used for convenience or emphasis.[112]

[112] The term "globalization" is also used colloquially to denote the spread of some thing or condition widely throughout the world, e.g., "the globalization of soccer" or "the globalization of Mormonism."

BOX IID-1. DEFINITIONS OF GLOBALIZATION

1. largely economic and political-economic

Dani Rodrik (1997)
Globalization is "the international integration of markets for goods, services and capital," and the secondary impacts, positive and negative, that this has on economic, political and social life in societies.

James Mittelman (1997)
Globalization is "a multifaceted process of economic integration in which industries produce common cultural goods and technologies for consumers throughout the world. Closely related is a political restructuring away from a Westphalian system driven by superpowers toward a decentered and more pluralistic post-Westphalian framework opening space for diverse regional, national and local formations." (p 1)

Robert O. Keohane (1995)
Globalization is "the intensification of transnational as well as interstate relations." (p 165)

R. J. Barry Jones (1995)
The term *globalization* is closely related to integration, interdependence and convergence but is typically used to convey the sense of a larger set of related phenomena of major import:

* Persons involved in business and commerce commonly use the term to describe "the standardization of production technologies and capabilities, world-wide, and the increasing exposure of all states to a common set of practical problems and competitive economic pressures."

*Persons operating within a political-economy framework use the term to "mark the general progress of the internationalization of finance, production and economic transactions, to a level that now threatens the traditional functioning of the nation-state, the capacities of governments for effective action and, ultimately, the potency of the democratic polity."

* for Marxians "globalization" marks the hegemony of transnational capitalism and the institutional primacy of the transnational corporation.

Philip G. Cerny (1995)
Globalization is the spreading across borders and economic sectors of a set of economic and political structures and processes deriving from the increasing structural differentiation of goods and assets that "1) are frequently (although not always) more transnational and multinational in scale (i.e., are in significant ways more inclusive) than the state; 2) potentially have a greater impact on outcomes in critical issue-areas than does the state...; and 3) may permit actors to be decisionally autonomous of the state." (p 596)

Mihaly Simai (1994)
"Globalization could be defined as the entirety of such universal processes as technological transformation, increasing interdependence caused by mass communications, trade and capital flows; and the homogenization and standardization of production and consumption patterns." (p 371)

(con't.)

Box IID-1 Definitions of Globalization (continued)

2. largely sociological

James N. Rosenau (1997)
Globalizing processes "consist of all those forces that spread readily across national boundaries... (and) impel individuals, groups, societies, governments, institutions and transnational organizations towards engaging in similar forms of behavior or participating in more encompassing and coherent processes, organizations, or systems." The objects and activities that spread across boundaries include goods and services, people, ideas and information, money, normative orientations, and behavioral patterns and practices. These spread through two-way interactions, one-way telecommunications, emulation, and institutional isomorphism. (p 81)

Jan Aart Scholte (1996)
"Globalization refers to the emergence and spread of a supraterritorial dimension of social relations." Examples include the proliferation and growth of transnational corporations (global companies), popular associations (global civil society), and regulatory agencies (global regimes); global climate change, worldwide epidemics and the decline of biodiversity; whole-world production lines and articles of global consumption; the expansion of world-wide standards (from common scales of measurements to universal human rights); non-territorial networks of collective solidarity; and a growing consciousness of the world as a single place. (p 46)

Malcolm Waters (1995)
Globalization is "a social process in which the constraints of geography on social and cultural arrangements recede and in which people become increasingly aware that they are receding."(p 3)

Holm and Sorenson (1995)
Globalization is "the intensification of economic, political, social and cultural relations across borders." (p 6)

Roland Robertson (1992)
"Globalization as a concept refers both to the compression of the world and the intensification of consciousness of the world as a whole..." (p 8)

Anthony Giddens (1990)
"Globalisation can be defined as the intensification of worldwide social relations which link distant locations in such a way that local happenings are shaped by events occurring many miles away and vise-versa." (p 64)

A.G. McGrew (1992)
"The forging of multiplicity of linkages and interconnections between the states and societies which make up the modern world systems. The process by which events, decisions, and activities in one part of the world can come to have significant consequences for individuals and communities in quite distant parts of the globe." (p 262)

BOX IID-2. WATERS' INVENTORY OF GLOBALIZATION TRENDS
[source: Waters 1995]

DIMENSION	IDEAL-TYPE PATTERN OF GLOBALIZATION	CURRENT STATE OF AFFAIRS
A. ECONOMIC GLOBALIZATION		
Trade	Absolute freedom of exchange between localities. Indeterminate flows of services and symbolic commodities.	Minimum tariff barriers. Substantial non-tariff and cultural barriers. Regional neomercantilism.
Production	Balance of production activity in any locality determined only by physical/geographical advantages.	International social division of labor being displaced by a technical division of labor. Substantial decentralization of production. Dematerialization of commodities.
Investment	Minimal FDI. Displaced by trade and production alliances.	TNC's being displaced by alliance arrangements but considerable FDI remains.
Organizational Ideology	Flexible responsiveness to global markets.	Flexibility paradigm has been orthodox but very substantial sectors of Fordist practice remain.
Financial Market	Decentralized, instantaneous and "stateless."	Globalization largely accomplished.
Labor Market	Free movement of labor. No permanent identification with locality.	Increasingly state regulated. Considerable individual pressure for opportunities for "economic" migration.

(cont'd.)

Box IID-2. Waters' Globalization Inventory (cont.)

DIMENSION	IDEAL-TYPE PATTERN OF GLOBALIZATION	CURRENT STATE OF AFFAIRS
B. POLITICAL GLOBALIZATION		
State sovereignty	Absence of sovereign states. Multiple centers of power at global, local and intermediate levels.	Crisis and attenuation of the state. Evidence of aggregation and decentralization of state powers.
Focus of problem-solving activity	Local issues in the context of the global community.	Increasing focus on local-global nexus but societal community probably still paramount.
International organizations	Powerful; predominant over national organizations.	Multiplying rapidly but relatively powerless.
International relations	Fluid and multicentric.	Superpower system attenuating.
Political culture	Common and planetary transcendence of etatocentric	Advance of liberal democracy/postmaterialism. commitments.
C. CULTURAL GLOBALIZATION		
Sacriscape	De-territorialized religious mosaic	Relativization and fundamentalism.
Ethnoscape	De-territorialized cosmopolitanism and diversity	Emergent infranationalism and supranationalism.
Econoscape	Consumption of simulations and representations	Advanced dematerialization of commodities.
Mediascape	Global distribution of images and information	Deregionalizaed distribution of images & information
Leisurescape	Universal tourism and the 'end of tourism'.	Declassification of subjects and objects.

BOX IID-3. DIMENSIONS OF GLOBALIZATION
[source: Holm and Sorenson, 1995]

Holm and Sorenson note that the term "globalization" is commonly used to refer to any of four related but different processes, as displayed and described below. The definitions are either more narrowly concerned with economics or more broadly concerned with general social change, and they suggest either that globalization is mostly an expansion of existing sorts of institutions and relationships or a transformative process creating new sorts of institutions and relationships.

	Range/Scope of Change	
Type/Scope of Process	Quantitative (More of the same)	Qualitative (Epochal shift)
Narrow: Economics	* Intensified interdependence	* Economic globalization
Comprehensive: Social Change	* Increasing interconnectedness	* Globalizing societies

* *Intensified interdependence* describes a process whereby national economies become increasingly integrated, largely via trade and investment.

* *Economic globalization* describes a process whereby increasing integration dissolves national economic institutions, and new global institutions carry out most production, marketing and regulation.

* *Increasing interconnectedness* describes a process whereby not only national economies but national political, social and cultural processes become increasingly interconnected and interdependent, although not necessarily integrated, with one another.

* *Globalizing societies* describes a process whereby increasing interconnectedness dissolves most national-level institutions and in fact nation-states themselves, and social relations become truly integrated across geographical regions.

II.D.2. IS GLOBALIZATION HAPPENING?

Box IID-4 lists significant developments that, taken together, support the case that the world is undergoing a process of systemic economic globalization, and that this is associated, either causally or in parallel, with other impacts on society. Trends over time of important quantitative indices of global economic integration are shown in **IID-5.**

A number of authors argue that the intensity and extent of the trends referred to as globalization are overstated. After a detailed review Wade (1996) concludes that "...using two eyes rather than one we find evidence that the world economy is less internationalized, less integrated than [the globalist] account suggests." **IID-6** lists items Wade and others use to support this conclusion. Hutton (1994) says:

> "Globalization is a term used too loosely, characterizing finance rather than production and trade. There is global management of production by some companies, but what is surprising, given modern technology, is how little production is organized on this basis—and how firmly national most economic variables remain." (p 13)

Globalization enthusiasts respond that even if the skeptics are strictly correct regarding current magnitudes and proportions, they greatly underestimate the pace and depth of the changes underway. On this account, as the synergistic impacts of the recent triumph of market economics and liberal democracy combine with the extraordinary possibilities offered by the new technologies—information, communication, materials, biotech, and more—globalization can only have an increasingly greater impact on our lives.

IID-2 shows Waters' assessment of how far towards "ideal" (i.e., complete) globalization various economic, social and cultural variables have moved. He judges that of his six economic variables, two--financial markets and organizational ideologies--are quite globalized, while labor markets are only minimally globalized.[113] Of the political variables he believes that globalization is most advanced in the areas of international relations and political culture. Finally, he suggests

[113] Here the adjective "globalized" means "having reached the condition described in Column 2 of Box IID-2," and "globalization " refers to the process of reaching that condition.

BOX IID-4. EVIDENCE THAT GLOBALIZATION IS HAPPENING
[main sources: Held (1997), Wade (1996)]

Trade

1. At the turn of the century 12-13% of the GDP of industrial nations was traded. Trade declined during the inter-war period but accelerated afterward, and doubled from 1960 (9.5%) to 1990 (20.5%).
2. Global merchandise trade grew at an average of 1.5 times the rate of world GDP, from 1965 to 1990.
3. Many more types of goods, especially service goods, are now traded, thanks to technological innovation.
4. Many more countries than ever before are engaged in active trade (e.g. India and China).
5. In the US in 1960 the biggest firms faced two to five main competitors. Today a large firm may have 10 or more serious competitors. Half of them may be foreign, playing by different rules.

Finance

1. The proportion of foreign exchange turnover to trade grew from $11/1 to over $55/1 since 1982.
2. Liberalization in the 1980's and early 1990's has created highly integrated global capital markets.
3. The stock of international bank lending rose in just 10 years from 4% of OECD GDP in 1980 to 44 % in 1990. By 1995 world turnover in foreign exchange was *$1.3 trillion a day.*

Foreign Direct Investment

1. A higher proportion of firms now have operations in many more countries than in 1960.
2. A higher percentage of total value added is produced by firms outside their home country.
3. In the 1980's FDI flows grew at over 20%/yr, 3x faster than trade, and 4x faster than output.
4. Countries in both the North and South have greatly liberalized their rules for FDI.

Multinational Corporations

1. Multinational corporations account for a growing share of output. By 1994 MNC's accounted for 30% of gross global output, 70% of world trade, and 80% of international investment. They controlled 1/3 of the world's private sector productive assets.
2. Most large industrial and financial corporations are now multinationals. In the UK in 1963, 20% of the largest MNC's had subsidiaries in more than 20 countries; by 1970 this had grown to 70%.
3. Companies are exploiting their technological innovations internationally. 45% of US patents granted in 1990 came from outside the US.

Cultural and Communications Trends

1. The spread of a single language - English - for global communication among elites.
2. The increase in the volume of electronic and other communications across country boundaries.
3. The increase in tourism, from 70 million in 1960 to 500 million in 1995 (a 5.6 % annual increase).
4. The increase in on-going collaborative work across national boundaries within and among the professions and other specialized sectors, leading to the creation of "epistemic communities".

The Environment

1. As economies expand, the magnitude of transboundary and global common environmental impacts has expanded exponentially. This creates a need for multilateral treaties and institutions.

Security and law enforcement

1. the increased availability and transportability across borders of terrorism, weapons of mass destruction, diseases and drugs.

Governance

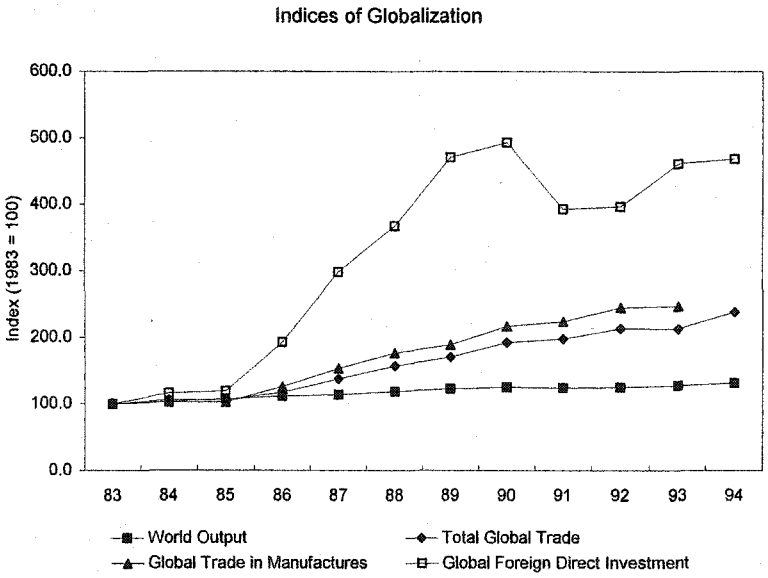
1.The items just listed, and others, have resulted in a major increase in the number and type of intergovernmental and non-governmental organizations and structures. The number of International NGO's increased from 176 in 1909 to 4626 by 1989.

BOX IID-5. INDICES OF GLOBALIZATION

[source: Grundlach and Nunnenkamp (1996)]

Activity (values normalized to 100 in 1983)

year	83	84	85	86	87	88	89	90	91	92	93	94
World Output	100.0	103.8	107.5	111.3	113.8	118.8	122.5	125.0	123.8	125.0	127.5	131.3
Total Global Trade	100.0	105.8	106.2	117.4	137.8	157.0	170.3	192.3	197.5	213.1	212.5	237.7
Global Manufactures Trade	100.0	102.8	102.8	125.7	153.3	176.6	188.5	216.4	223.5	244.4	246.7	
Global FDI	100.0	116.1	119.0	192.5	298.0	367.4	470.6	493.0	392.9	396.9	460.7	468.1



BOX IID-6. EVIDENCE THAT GLOBALIZATION IS NOT HAPPENING
[major sources: Wade (1996), Huntington (1996)]

Trade

1. The value of trade as a fraction of GDP is still quite small in all but the smallest countries: only 12% for the US, Japan and EU, and much less than 10% in most of Asia and Latin America.
2. The ratio of world trade growth to output growth has actually *decreased* over the past twenty years, from 1.65 in 1965-1980 to 1.34 in 1980-1990.
3. Intrafirm trade as a proportion of total trade has been stable since 1977, at about 33%.
4. The North's (i.e., the OECD's) share of world trade *rose* from 81% in 1970 to 84% 1989.
5. The share of northern imports coming from the non-oil exporting South, excluding the four East Asian NICs, *fell* from 7.1% in 1970 to 6.2% in 1990.
6. Trade by the US with low-wage countries (those where wages are less than one-half the US levels) equals only 3% of its GDP, not much higher than the equivalent figure in 1960.
7. Although exports of manufactures from the South to the North have grown very fast over the past two decades (almost 15%/year), this fast growth started from a very low base, so by 1989 it still only accounted for 16% of world manufactured exports. Future growth of manufactured exports from the South is in question because almost half go to just one market, the US.
8. North-South trade is strongly regionalized, not globalized. Latin America trades with North America; Eastern Europe, Africa and the Middle East trade with Western Europe; East and Southeast Asia have the biggest share of their trade with North America, and secondly with Japan.
9. Although OECD tariffs have declined from 25% in 1950 to about 5% in 1990, their place has been taken by quotas, "voluntary" trade restraints, managed trade and other non-tariff barriers.

Foreign Direct Investment

1. To the extent that investment capital has left one northern country it has been reinvested in large part in another northern country and secondarily in a southern economy within the same region.
2. In the 1980's, outgoing FDI in the North was only between 5 and 15 percent of net domestic business investment, and incoming FDI was between less than 1% (Japan) and 14% (US).
3. 75% of inward FDI flows worldwide in the 1980's have been *to* the US and EU.
4. Of the FDI flowing to the South, the great bulk is to only 6 countries--the four East Asian tigers, plus Mexico and Brazil.
5. FDI is regionalized in the same pattern as is trade.

Finance Capital

1. The number of financial products sold in highly integrated world markets is quite limited: currencies, government bonds and commodity, currency and interest futures.
2. Stock markets are far from being fully integrated, because few companies have a sufficiently global reputation for trading in their stock to be active outside the home market.
3. Financial regulations, tax systems, accounting practices, and corporate ownership rules are all mainly national (although efforts to harmonize are underway: within the EU, and globally regarding, e.g. capital adequacy requirements).
4. Domestic savings and investment rates remain highly correlated among the OECD countries. In a fully integrated market the correlation would be zero.
5. Differences in the price of borrowed funds between different national markets remain substantial (although it is true that the cost of capital is far more similar among nations than are other economic variables such as wages and years of schooling.)

[cont.]

BOX IID-6. [cont.]

Multinational Corporations

1. Most MNC's have *not* become stateless, footloose, global entities.
2. Most MNC's hold most of their assets and employees in their home country. For example, General Motors in 1989 had 70% of it's employees and 70% of it's assets in the US.
3. The large majority of shares of stock are held by individuals and legal entities in the home nation.
4. Top management and governance rest in home country hands. In 1991 only 2% of the Board members of big American companies were foreigners.
5. R&D remains a home country operation. In the US, MNC's did 90% of R&D in US in 1980's.
6. Technological innovation can cut two ways. Cheaper and better communications and travel can make operations in foreign countries more practicable and thus encourage globalization of production and marketing. but new design, processing, materials and fabrication technologies can remove the comparative advantages that a foreign operation might have and encourage "re-localization."
7. 497 of the world's 500 largest industrial corporations have their central offices in just five countries: USA, Japan, UK, Germany and France.

Culture and Communications

1. Ethnic groups are using inexpensive, accessible media to maintain their identity within dominant cultures and resist assimilation.
2. The percent of people in the world who speak English, either as a native or second language, *declined* from 9.8% in 1958 to 7.6% in 1992.

that all five of the variables listed as "cultural" are well on their way towards complete globalization.

II.D.3. INTERPRETATIONS OF GLOBALIZATION

Even when they agree on definitions, authors differ concerning the extent to which they believe globalization is actually happening, what impacts it might be having, what sectors or populations are likely to benefit or lose as a result, what might be done to encourage or discourage any of these developments, and how any or all of these developments are normatively interpreted.

Arguing from the techno-libertarian right, Ohmae (1995) says that economic globalization is occurring at a breakneck pace, that it is dissolving the power, autonomy and sovereignty of the nation-state, and that these are good things and should be encouraged, because they will result in more efficient allocations of resources and greater prosperity and personal freedom for all.

Arguing from the movement-activist left, Jerry Mander and David Korten (1996) of the International Forum on Globalization agree that economic globalization is indeed proceeding rapidly and that it is indeed dissolving the power, autonomy and sovereignty of the nation-state, but believes that as a result economic inequality will increase, the environment will be destroyed, and corporations will rule the world. The IFG calls on unionists, environmentalists and others to organize to stop globalization before it's too late.

Arguing from the social-democratic left, Hirst and Thompson (1996) maintain that economic globalization is neither as rapid nor as pervasive a phenomena as popular accounts suggest, that the ability of nation-states to act in support of social and economic justice remains strong (although requiring higher degrees of international cooperation) and that progressives should resist the disempowering narrative of globalization and continue to pressure the nation-state for redress.

Arguing from the neo-liberal center, *The Economist* (1997) suggests that economic globalization is proceeding at just the right pace and can be expected to continue, and that the capabilities and competence of nation-states remains strong. The fact that nation-states have not acted more vigorously to curtail globalization is taken as a sign that it is judged by the peoples of the world to be, on balance, a good thing.

Arguing from the social-democratic center, Reich (1991) says that globalization has already transformed the structure of the world economy such that nation-states can no longer adopt policies that constrain corporations, but that nation-states can and should tax wealthy *individuals* to support programs to arrest the growth of economic inequality caused by globalization. If this is not done growing social tensions will lead to an anti-globalization backlash, which would be a bad thing because globalization supports the economic growth that is necessary if poverty is to be overcome.

Arguing from the nationalist right, Buchanan (1997) charges that globalization is the work of a cosmopolitan elite that "wants to move America into a New World Order where the World Court decides quarrels between nations, the WTO writes rules for trade...the IMF and World Bank order wealth transfers from continent to continent... the Law of the Sea Treaty tells us what we may or may not do on the high seas... and the United Nations decides where U.S. military forces may or may not intervene."

Arguing from the post-modern left, Rosenau (1997) says that economic, social and cultural globalization is indeed rapidly underway, is rendering the nation-state increasingly powerless, and that this is a good thing because it helps subvert the dominant racist and sexist order and opens new loci of contestation and social construction.

Box IID-7 shows a typology of normative socio-political stances with respect to globalization. **IID-8** and **IID-9** list reasons people give for supporting and opposing globalization. **IID-10** summarizes Rodrik's recent critique of globalization.

BOX IID-7. NORMATIVE STANCES TOWARDS GLOBALIZATION

Many people who believe that globalization is happening, and that it has the potential to impact the existing role of the nation-state, and who articulate normative judgments about these matters, fall into one of the five categories below:

I. ***Globo-enthusiasts***

a. ***Globo-libertarians*** believe that globalization is a strong net positive, and that attempts to constrain the growth of global market can only lead to inefficiency and lost benefits.

b. ***Globo-communitarians*** believe that globalization is, on balance, a net benefit, but argue that global markets need to be regulated to prevent instability or gross inequity from derailing the process.

II. ***Globo-skeptics***

a. Internationalist social democrats share many views with globo-communitarians, but while the latter presume the desirability of globalization and seek to smooth over some rough edges, internationalist social democrats presume the priority of social solidarity, and are willing to support globalization so long as it does not endanger this core commitment.

b. ***Anti-globalists*** believe that globalization will be a net loss rather than a net gain, and call for a less economically integrated world:

i) ***left-green anti-globalists*** believe a globalized world will be run by transnational capitalists, and will be inequitable and ecologically unsustainable.

ii) ***nationalist anti-globalists*** believe a globalized world will be run by transnational cosmopolitans who want to impose their statist values on free peoples.

III. ***Globo-realists***

a. ***nationalist globo-realists*** want to secure the benefits that integration and trade can give their people without sacrificing national sovereignty, autonomy and power.

BOX IID-8. REASONS GIVEN FOR SUPPORTING GLOBALIZATION

1. Globalization allows factors to be employed in ways that maximize efficiency and allows consumers to make consumption decisions that maximize satisfaction. Together these generate optimal rates of economic growth.

2. The liberalization and integration of market economies offers the only realistic chance that the poor nations of the earth will ever have to attain the levels of material well-being that have been achieved by the industrial North.

2. Greater integration of market economies builds relations of interdependence that minimize the likelihood of military conflict.

3. The market economies promoted by globalization foster desirable social, cultural and political values, such as liberal democracy, individual initiative, and respect for civil and human rights.

4. Free market globalization is helping support an explosion of technological innovation that will revolutionize and transform the nature of human life on earth.

5. Globalization is a continuation of basic expansionary and accumulative drives that are inherent in human nature and have been underway for millennia. Opposition is misguided; rather we should affirm these drives and shape them towards positive ends.

BOX IID-9. REASONS GIVEN FOR OPPOSING GLOBALIZATION

1. Globalization generates economic inequality within and among nations. Especially vulnerable are the working classes of the developed world and the poorest sectors of the developing world. Meanwhile a techno-capitalist elite accumulates unprecedented wealth.

2. Globalization disempowers the nation-state. In order to remain competitive, countries are forced to discontinue long-standing public sector programs that support the general welfare. Further, globalization prevents countries from adopting policies that might cushion or compensate for the impacts of globalization itself. Finally, globalization channels the minimal remaining resources of the nation-state into providing services that support the interests of global capital.

3. Globalization greatly enhances the political power of multinational corporations, who use this power in ways that advance the interests of their wealthy owners and managers.

4. The world economy is globalizing without creating those institutions of economic governance necessary to ensure its own stability. The risk exists that a small perturbation could trigger a global economic collapse.

5. Globalization undercuts the ability of nations to provide desired levels of domestic environmental protection. Simultaneously it generates new transboundary environmental problems and exacerbates present ones. The multilateral institutions proposed to deal with global environmental concerns are undemocratic and cannot stand up to the interests of global capital.

6. By simultaneously generating greater income inequality and undercutting the ability of nation-states to respond in ways that compensate for this, globalization puts the social cohesion of nations at risk.

7. By encouraging a greater sense of separation, distrust, and resentment, globalization could destroy the normative foundations that support democratic institutions of governance.

8. Globalization propagates a materialist, consumerist and individualist set of values that sustains high levels of personal and societal tension and conflict.

9. Globalization compels developing countries to accept Western capitalist economic, political and social institutions and values.

BOX IID-10. RODRICK'S ANALYSIS

Since the early 1970's the Institute for International Economics has played a major role in arguing for the desirability of increased international trade and economic integration. In 1997 the Institute published *Has Globalization Gone Too Far?* a critique of globalization by the economist Dani Rodrik. Roderik concluded that:

1. Liberalized global trade "accentuates the asymmetry between groups that can cross international borders (either directly or indirectly, say through outsourcing) and those that cannot" (p 4). As a result:
   a) workers pay a larger share of the cost of improvements in work conditions and benefits;
   b) workers incur greater instability in earnings and hours worked; and
   c) the bargaining power of workers erodes.

2. "Globalization engenders conflicts within and between nations over domestic norms and the social institutions that embody them." (p 5) Under traditional multilateral trade policies, differences in national norms, practices and institutions are treated just like differences in factor endowments or other determinants of comparative advantage. Thus, increased trade can create conflicts regarding workplace practices, legal rules, social safety nets, labor standards, environmental policy, competition policy, corruption, and other areas.

3. Because globalization also makes it difficult for nation-states to provide traditional forms of social protection, "the cumulative consequence of the tensions mentioned above will be the solidifying of a new set of class divisions—between those who prosper in the globalized economy and those who do not, between those who share its values and those who would rather not, and between those who can diversity away its risks and those who cannot." (p 6)

4. "Hence globalization delivers a double blow to social cohesion—first by exacerbating conflict over fundamental beliefs regarding social organization and second by weakening the forces that would normally militate for the resolution of these conflicts through national debate and deliberation." (p 70)

Rodrik makes clear that he offers these criticisms in order to encourage reforms that will allow globalization, which he otherwise supports, to continue. His suggested package of reforms is discussed in section II.D.3 below.

A full evaluation of the merits of these claims and counter-claims is beyond the scope of this short overview. For the time being we can usefully proceed by posing the following question: if continued economic globalization might in fact generate the sorts of consequences listed in IID-8 and IID-9, in what ways might our ability to achieve Scenario 3 be affected?

II.D.4. INSTITUTIONS AND POLICIES

In this section we review proposals for governing institutions and policies that would allow the elements of Scenario 3 to be achieved under conditions of continued globalization. We address three topics. The first concerns global economic management, that is, our ability to ensure that global economic fluctuations are kept within acceptable levels. The second concerns ecological integrity: what institutions and policies will allow ecological problems to be successfully addressed under conditions of globalization? The third concerns distributive equity: what institutions and policies will ensure that economic inequality stabilizes at a level no greater than it is in the developed world today?[114]

II.D.4.a. Global Economic Management

The destabilizing potential of large, unregulated global currency and financial markets is widely acknowledged. Many authorities recognize the need for collective institutions and policies to ensure adherence to sound standards and practices on the part of firms and countries alike, and to provide assistance in times of emergency.[115] During any given episode of instability national leaders blame greedy speculators, who in turn blame deficit-prone national leaders. But there is a strong mutual self-interest in reaching agreements about policies and institutions that can ensure global financial stability. Some propose a return to fixed or semi-fixed exchange rates, perhaps modeled on the European Monetary System (EMS). Greider (1997) proposes

[114] A forth topic of concern is the governance of technologies of profound consequence. For convenience this is discussed in Section II.E.

[115] See Soros (1998), Kapstein (1996) and Simai (1994).

"tighter terms of credit, tighter requirements for purchasing bonds and other financial instruments on borrowed money, restriction of the use of derivatives to the genuine market hedging needs of multinational commerce, and ceilings on some interest rates to curb reckless borrowing."

An increasingly noted proposal for reducing foreign exchange fluctuations due to speculation is that a tax be levied on short-term currency transactions. Known as the "Tobin tax" (see **IID-11**), this tax would be set at very low levels so that it would be negligible for transactions used to make long-term investments or finance conventional commercial transactions, but its burden would rise steeply as the cycling periods became increasingly smaller.[116] (The Tobin tax is also a potentially major revenue source, as described in IID-11 and in discussed in Section IID.4.a below.)

Beyond currency and financial controls, the long-term stability of a growing, globalizing market economy requires regulation of trade, investment and other macroeconomic flows. The conclusion of the Uruguay Round of GATT and the creation of the WTO demonstrates the practicability of such regimes with respect to trade. In 1998 the OECD attempted to secure approval of the Multilateral Agreement on Investment described in **IID-12**. This effort stalled after protest from NGO's and others, but corporations, governments and multi-lateral institutions remain committed to the goals of the MAI. The WTO, in particular, has begun preparations for negotiations over global standards and policies concerning investment. Hirst and Thompson list a full roster of policies and institutions that they suggest can practicably be employed to ensure global economic stability, as shown in **IID-13**.

I cite the IMF, WTO and MAI as examples of our ability to construct governance regimes of the scope and scale needed to successfully ensure global economic stability, not to suggest that the current programs of these institutions will do so, or to defend their programs in other regards.

---

[116] The Tobin tax is named after Nobel-laureate economist James Tobin, who first proposed it in 1972.

BOX IID-11. THE TOBIN TAX

The Tobin tax is a percentage levy on foreign exchange transactions. If set at low rates it would have a negligible effect on currency transactions used for trade and investment, but could strongly penalize the short term exchanges that characterize speculative strategies, and thus reduce exchange rate volatility. The high volume of foreign exchange transactions means that even low taxes would generate large revenues.

volatility reduction Let the domestic rate of return per year $= i$, the foreign rate $= i^*$, the Tobin tax $= t$, and the duration of the investment, in years or portions of a year, $= y$. Returns on domestic and foreign investments are equalized when:

(1) $(1 + i^*y)(1-t) - t = 1 + iy$, or

(2) $i^* = (i + 2t/y) / (1-t)$

Plugging in, we see that with a domestic rate of return of 10% and a Tobin tax of 0.10% , the return would need to be 10.1% on a foreign investment of 2 years, 11.2% on an investment of 2 months, 15.2% on an investment of 2 weeks, and 46.5% on an investment of 2 days.

By increasing the cost of short round-trip transactions, the Tobin tax reduces the proportion of "speculators", i.e., those who expect exchange rates to diverge from their long-run equilibrium. Frankel (1996:41) shows that if the proportion of speculators declines with respect to the proportion of "investors" --those who expect exchange rates to regress *towards* their long-run equilibrium--then the volatility of exchange rates can be expected to decrease.

bases, rates and revenues Foreign currency exchanges totaled $1.3 trillion per day in 1995. Of this amount 80% involved round-trips of 7 days or less. After accounting for possible changes in the volume of transactions due to the tax, Felix and Sau (1996: 223) give these revenue estimates:

Tobin tax rate	total revenues
0.05%	$ 90 billion
0.10%	$ 148 billion
0.25%	$ 290 billion

tax evasion Traders may seek to evade a Tobin tax by moving their trading sites to countries that have not agreed to abide by the provisions of the tax. The best way to prevent this is to push for as near a universal agreement to participate as possible. If this is not possible participating states can agree to impose a stiff surtax on any trades made in a non-participating jurisdiction.

Traders may also seek to replace currency transactions with near-substitutes, such as currency futures, forwards, swaps and options. Most analysts assume that some of these instruments would need to be taxed but have different opinions about how difficult this would be.

The tax rate chosen has an important bearing on the amount of evasion. Some authors estimate that if the tax is 0.10% or lower, evasion will not be worth the effort.

[more...]

BOX IID-11. The Tobin tax (cont.)

major devaluations The Tobin tax should dampen general volatility but will not be able to stop speculation if traders suspect that a country has so mismanaged its finances that a major devaluation, say of 15% or more, is in store. The Tobin tax dampens a speculative "build up" and gives a country time to adjust its policies to forestall a major devaluation.

administration Banks, which provide most foreign exchange, could either add the amount of the tax to each customer bill or absorb it. Most authors suggest that the tax be collected at the site of the transaction by each national government. The government would keep an agreed upon portion and forward the balance to an international agency for use or redistribution.

After the basics of a Tobin tax have been agreed to by treaty, an international body would be needed to 1) draft a tax code; 2) interpret and amend the code thereafter; and 3) collect and administer revenues earmarked for international purposes. Some authors suggest the IMF but others prefer a new, independent agency. A weighted voting rule would be needed to gain the support of countries with large foreign exchange markets.

distribution of the proceeds Kaul and Lagmore (1996:257) estimate that a 0.10% Tobin tax levied in 1995 would have generated $148 billion in revenues, from the UK (29.5% of total revenues, or $44 billion), USA (15.5%), Japan (10.2%), Singapore (7%), Hong Kong (6%), and some other European countries. Industrial countries would have generated 85% of total revenues and developing countries (including Singapore and Hong Kong), about 14%.

However, we saw that to be effective the Tobin tax would need to be universal. Developing countries would be able to bargain for a larger share of the proceeds in return for their support. Kaul and Lagmore suggest a distribution formula in which:

* low and middle level income developing countries would retain 100% of proceeds
* higher-middle-income developing countries could retain 90% of proceeds
* high-income countries could retain 80% of the proceeds
* remaining proceeds are used for "global commons" purposes

Kaul and Lagmore estimate that under this formula the Tobin tax would have generated $27 billion per year for global commons purposes in 1995.

reservations about the Tobin tax Analysts skeptical about the Tobin say that:

* "Rocket engineers" could devise sophisticated market derivative instruments to evade the Tobin tax, reduce the tax base and decrease its effectiveness.
* The political challenge of getting all nations to agree on a program for levying, collecting and administering such huge amounts of money could be prohibitively difficult.
* Exchange rate volatility would not be a problem if governments simply followed prudent fiscal and monetary policies.
* Global commons needs can be adequately provided for from conventional funding sources.

BOX IID-12. OECD Multilateral Agreement on Investment (MAI)
[source: Preamble Center for Public Policy (1997)]

The purpose of the MAI is to remove obstacles to the further integration of the global economy. The agreement limits the ability of national and subnational governments to restrict foreign investment, and to otherwise regulate both foreign and domestic firms within its boundaries. Key provisions include:

* **National Treatment** Countries cannot take actions that have the effect of putting foreign investments at a disadvantage relative to domestic ones. For example, countries could not require that foreign firms hire a certain percentage of managers locally.

* **Most Favored Nation (MFN)** Countries are required to treat all foreign countries and investors the same with respect to regulatory laws. This provision would prohibit, for example, national boycotts of goods produced by a country charged with human rights violations

* **Performance Requirements** Laws that require investors to meet certain conditions if they want to establish an enterprise in a particular locale or if they want to be eligible for tax incentives or other government aid would be prohibited. This would include, for example, state laws that require local financial firms to invest a percentage of their assets in the community.

* **Compensation for Expropriated Assets** Countries would be required to compensate foreign firms for expropriated assets. This is not controversial. However, the provision may be interpreted to include as "expropriation" any policy that reduces a firm's profits from what they might otherwise have been, e.g., anti-pollution laws.

* **Repatriation of Profits** Countries would not be able to prohibit or restrict an investor from moving profits from the operation or sale of a local enterprise, or any other assets, to the investor's home country.

***Investor-to-state Dispute Resolution** International investors and firms would have the right to sue national governments, and to seek monetary compensation, in the event that they believe a law or policy violates investor rights. They would have the option to have the case heard by an international tribunal rather then in the countries' domestic courts.

* **"Roll-back" and "Standstill" Provisions** Countries would be required to eliminate any federal, state or local laws that might violate MAI provisions, and to refrain from passing such laws in the future. Country-specific exemptions may be provided for in the final MAI treaty.

* The MAI does not currently contain provisions concerning the responsibilities of firms regarding fair compensation, treatment of employees, environmental protection, and other concerns.

BOX IID-13. GLOBAL ECONOMIC GOVERNANCE

Hirst and Thompson (1996) review the prospects for economic governance under conditions of globalization and conclude that "...there are good economic grounds for believing that the international economy is by no means ungovernable..." They offer this menu of practicable governance mechanisms:

1. Governance through agreement between the major advanced states, and particularly the G3 (Europe, Japan and North America), to stabilize exchange rates, to coordinate fiscal and monetary policies, and to cooperate in limiting speculative short-term financial transactions.

2. Governance through a substantial number of states creating international regulatory agencies for some specific dimension of economic activity, such as the WTO to police the GATT settlement, or possible authorities to police foreign direct investment and common environmental standards.

3. Governance of large economic areas by trade and investment blocs such as the EU or NAFTA. Both are large enough to pursue social and environmental objectives in a way that medium-sized nation-states may not be able to do independently, enforcing high standards in labor market policies or forms of social protection. The blocs are big enough markets in themselves to stand against global pressures if they so choose.

4. Governance through national-level policies that balance cooperation and competition between firms and the major social interests, producing quasi-voluntary economic coordination and assistance in providing key inputs such as R&D, the regulation of industrial finance, international marketing, information and export guarantees and training, thereby enhancing national economic performance and promoting industries located in the national territory.

5. Governance through regional-level policies of providing collective services to industrial districts, augmenting their international competitiveness and providing a measure of protection against external shocks.

II.D.4.b. Ecological Integrity

We saw in Section II.A that the rates and patterns of economic growth shown in Scenario 3 can likely be achieved without necessarily triggering global ecological collapse or so degrading the resource base that further growth is impaired.[117] However this achievement would require significant collective action on a global scale over an extended period of time. If there is reason to believe that such collective action would be difficult then our initially optimistic analysis is challenged.

Since 1970 nearly 20 major international treaties have been negotiated addressing such concerns as ocean pollution, endangered species, ozone depletion, transboundary hazardous waste movement, biological diversity, climate change, and other critical issues (see **IID-14**). Several hundred more have been negotiated addressing more narrow issues, many on a regional or bilateral basis. The effectiveness of these treaties has been mixed, but they are evidence that the simple mechanics of constructing policy regimes of global environmental governance is within the capacity of nation-states.[118]

In recent years new concerns have been raised about the compatibility of continued global economic growth and environmental protection. One concern is that increased economic integration and trade puts pressure on developed countries with high environmental standards to reduce them, and on developing countries to maintain low standards. Another is that environmentalists in both developed and developing countries are increasingly denied access to the processes by which policy concerning trade and the environment is decided. A third is that

---

[117] The critical provisos are that either solar hydrogen or nuclear fusion become practicable sources of energy by about 2050, or that some other means of preventing atmospheric warming from exceeding 3.6° C be found.

[118] See IIASA (1995), Haas et al. (1993), and Bernauer (1995) for extended discussions of global environmental governance.

BOX IID-14. MAJOR ENVIRONMENTAL TREATIES AND CONVENTIONS SINCE 1970

Treaty or convention	Date formulated	Number of signatories and ratifiers
Wetlands of International Importance	1971	84
Prohibition of Biological and Toxic Weapons	1972	122
World Cultural and Natural Heritage	1972	120
Prevention of Marine Pollution by Dumping	1972	73
International Trade in Endangered Species	1973	111
Prevention of Pollution from Ships	1978	65
Transboundary Air Pollution (Europe)	1979	47
Conservation of Migratory Species	1979	47
Conservation of Antarctic Marine Life	1980	27
UN Law of the Sea	1982	126
Vienna Convention on the Ozone Layer	1985	103
Early Notification of Nuclear Accident	1986	80
Assistance for a Nuclear Accident	1986	82
Montreal Protocol on the Ozone Layer	1987	96
Transboundary Hazardous Waste Movement	1989	58
Convention on Biological Diversity	1992	140
Convention on Climate Change	1993	143
Kyoto Protocols on Climate Change	1997	

[*source:* World Resources Institute (1992, 1994); compiled by Sandler (1997)]

the accelerated economic growth that greater integration and trade allows threatens to destroy important ecological resources before steps to protect them can be taken.

Berlin and Lang (1996) divide trade and environmental conflicts into five categories and offer solutions that they believe should be able meet the demands of environmentalists while enabling trade and economic growth to continue, as outlined in **IID-15.** They urge that existing and future trade regimes allow a greater responsiveness to the legitimate environmental concerns of the developed nations, and that a major financial commitment be made to assist developing nations in accelerating their acquisition of environmental protection infrastructure. They urge that a new international body be formed to provide the ongoing coordination that these efforts demand. Such a "WTO for the environment" would allow rules to be negotiated, compliance monitored, violations punished, cooperation rewarded, and more.

Like Berlin and Lang and others, Esty (1994) acknowledges that developing nations would find it costly to move rapidly towards stronger environmental protection at the same time that they desire to secure high and stable rates of conventional economic growth. He cites Maurice Strong's estimate that developing countries will need $625 billion per year to devote to environmental protection, restoration, and industrial ecology. Strong suggests that $120 billion of this annual amount should be provided by the developed world.

Esty proposes as a first step that the developed countries set up a fund to enable developing countries to remedy those environmentally harmful practices that have major impacts upon the *developed* countries, either directly or indirectly. Esty suggests an initial goal of $10 to $20 billion annually, provided by a tax or import duty of perhaps 1/100 of 1% on global trade and capital flows.[119] Such a Green Tax, which is an extension of the Tobin tax discussed earlier, would be progressive (because rich countries have higher trade and capital flows), neutral in its

[119] This suggestion is similar to that proposed by European Community GATT Ambassador Tran Van Thinh, who calls for "creation of a Solidarity Fund for the global environment, financed by a 0.25 percent levy on all imports except those of the least-developed countries." (Esty 1994).

BOX IID-15. TRADE AND THE ENVIRONMENT: CONFLICTS AND SOLUTIONS

Berlin and Lang (1996) divide trade and environment conflicts into five categories and suggest ways that critical environmental concerns can be addressed without unduly restricting continued economic growth, as outlined below.

1. Application of product standards to goods sold within a nation's borders

Problem: Traders want to harmonize acceptable standards to facilitate trade. Greens, knowing that traders are less concerned about environmental protection, fear harmonization at lowest common standards.

Proposed Solution: So long as product standards do not discriminate in favor of domestic producers, trade law should recognize the right of nations to impose them on imports as they desire. Berlin and Lang say that Chapter 9 of NAFTA recognizes this right, but that GATT, which requires standards based on "sound science", does not, and will generate continued conflict.

2. The application of import restrictions on industrial goods because production processes in the exporting nation do not met the importing nation's standards

Problem: Historically traders oppose letting one country restrict imports from another that has lower production standards because, they argue, countries at different stages of development put different values on the various trade-offs involved. Greens argue that citizens of developing countries are willing to allow more pollution in their production processes because market and governance failures don't allow the true price of environmental degradation to be internalized.

Proposed Solution: Global agreement on minimum process standards is a reasonable goal, if due allowance is made for phasing-in over time. Further, individual nations should be allowed to restrict imports whose production they feel is harmful to the global commons, so long as the country imposing the condition pays for the action with offsetting trade concessions elsewhere. Finally, nations should be allowed to require that any domestic firms relocating or developing production facilities in another country abide by process standards of the *home* country. Berlin and Lang suggest that negotiations to tighten process standards begin as existing international agreements are periodically revisited. After progress has been made on these, negotiations could begin on a case-by-case basis concerning additional practices of high global concern. Berlin and Lang state: "As this process proceeds, we believe that it will become apparent that there is a need for the creation of a counterpart of the GATT for the environment."

3. The role of government subsidies for pollution control equipment

Problem: Governments have long used subsidies as a way to give their industries a trade advantage without having to impose tariffs, and traders have long sought to prohibit this. But in many developing countries local industries are unable to afford effective pollution-reduction technology, and if any pollution control is to happen at all it requires government

[more...]

BOX IID-15. Trade and the Environment (cont.)

subsidy. Under current GATT rules, if a government wishes to subsidize the installation of pollution-control equipment, other nations can challenge that action as an unfair practice.

Proposed Solution: GATT should be amended to allow subsidies for installation of pollution control and similar facilities, with the allowance graded by level of development. As industries in developing countries improve their ability to finance pollution-reduction facilities, the amount of allowable subsidy should be reduced.

4. The special case of wildlife, forest and other renewable resources

Problem: Many persons, especially though not exclusively in the US and Europe, consider wildlife, forest and other renewable resources to be "part of a common heritage," even when the resource in question might be located wholly within one country, and thus legitimate objects of trade discrimination. Traders tend to treat products based on such resources no differently than they do industrial products.

Proposed Solution: Traders should agree that "wildlife, fish and plants are subject to different standards from those for industrial goods, and that bans on importation of fish and wildlife should be accepted so long as they are applied equally to domestic and foreign products." Berlin and Lang say that article 104 of NAFTA includes such provisions, and that GATT should be amended to do so as well.

5. The impact of trade on patterns of development and thus the environment.

Problem: Even if trade agreements require environmentally sound practices for particular commodities, the impact of increased trade and the resulting economic growth will result in many second- and third-order stresses on the environment, which developing countries in particular are not yet affluent enough to prevent or mitigate.

Proposed Solution: A very small (e.g., ½ of 1%) duty on all imports by all countries should be agreed upon, with the revenues used to help developing countries "leapfrog" to a higher level of environmentally sound infrastructure, even as economic development proceeds at an otherwise conventional pace. If such a duty were levied on the current $5.2 trillion of annual world trade it would generate a fund of $26 billion

distortionary effects among countries, and too small to have any noticeable impact on trade or capital flows themselves.

Esty follows Berlin and Lang and advocates formation of a Global Environmental Organization (GEO). In order to ensure its political legitimacy among global and national publics, the GEO should employ a governance structure similar to that of the WTO, which operates on a consensus basis with an implicit understanding that the positions of the larger countries are given more weight. In addition the GEO might follow the example of the International Labor Organization (ILO) and include structured roles for business, environmental and governmental organizations.

The policy and administrative challenges facing a GEO would be great, but with agreement on substantive goals they would not be insurmountable. The creation of a GEO would indeed represent an incursion on nation-state sovereignty, but not to any extent greater than is currently the case with countries that are members of the IMF, the World Bank, or the WTO.

Some authors are not convinced that the global environmental governance regimes described by Berlin and Lang, and Esty, would be successful. They say that although such proposals are mechanically plausible, the costs that such elaborate processes impose on environmental activists, indigenous peoples, rural communities, and others who are not part of the global professional class, are prohibitive, while the multinational corporations that are primary agents of the problems at hand have effectively immediate access.[120]

Perhaps the most frequently offered response to this concern is to suggest that the growth of the "NGO community" or, more generally, "global civil society" will provide the necessary vehicles of participation. However, understandings of the nature and significance of "civil society" are as diverse as the understandings of "globalization." For some authors civil society stands in opposition to governmental authoritarianism, and in fact includes and embraces the institutions of neoliberal capitalism. For other authors civil society stands as a loyal opposition

that keeps neoliberal capitalism from destroying itself through excess. Still others see civil society as the seed-bed of a new order that might someday succeed neoliberal capitalism.

We discuss global civil society further in Section II.D.5 below. For now we note that it is not difficult to imagine a global regime that could successfully address those environmental issues of most concern to the world's professional classes. How that regime might be made truly accountable to other constituencies is not clear. However, while this inequity may be objectionable from a social justice standpoint, it is not obvious that it would prevent that regime from successfully avoiding ecological catastrophe or growth-impairing resource degradation.

II.D.4.c. Distributional Equity – What the Data Show

After making their case for the practicability of global economic governance under conditions of globalization (see IID-13) Hirst and Thompson go on to say,

> "Such governance cannot alter the extreme inequality between [the advanced developed nations] and the rest, in terms of trade and investment, income and wealth. Unfortunately, that is not really the problem raised by the concept of globalization. The issue is not whether the world's economy is governable towards ambitious goals like promoting social justice, equality between countries and greater democratic control for the bulk of the world's people, but whether it is governable *at all.*" (p 189)

This is an amazing and telling statement. It suggests that the function of governance under globalization is reduced to the single important but limited task of maintaining the rate of growth of per capita GDP at some positive value. One may hope that this growth is equitably distributed and that desires for public goods are minimal; but if not, there is little that can be done.

Taken as it stands, the statement by Hirst and Thompson is incorrect. The issues raised by globalization are precisely those of social justice, equality, and democratic control. If increasing globalization generates social injustice and economic inequality, and undercuts the prospects for democratic governance, it is not sustainable.

---

[120] See Mander and Goldsmith (1996).

Recent Trends and Findings [121]

Economic inequality among countries declines when per capita GDP growth rates of low-income countries exceed those of high-income countries. To the extent that globalization allows developing countries greater opportunities for trade and investment, and for the acquisition of technology and human and social capital, globalization should help reduce income inequality among countries.

The table in **IID-16** shows that 48% of the world's people currently live in developing countries that are growing faster than the high-income countries. If we suppose that over the next several years the countries of the Former Soviet Union and Eastern Europe are able to attain annual rates of growth higher than the 1.9% of the high-income countries, then 70% of the world's people would be living in either high-income countries or countries that are narrowing the income gap. That leaves, however, some 30% of the world's people living in countries whose growth rates are not keeping up with those of the high-income countries. Put differently, of the people living in the developing world, 65% live in countries that are becoming more equal to the industrial North and 35% live in countries that are becoming less equal.

The situation regarding distribution of income within countries is equally mixed. As we saw in Section II.B, there is much uncertainty regarding the causes of changes in economic inequality within countries. Historically the single greatest cause of reductions in economic inequality has been the transition from an agricultural to an industrial economy. If globalization helps developing nations make this transition it should contribute to greater economic equality within countries. However, the 150-year agricultural-industrial transition made by today's developed countries was accompanied by massive expansion of a national public sector that provided health care, education, infrastructure, social insurance and other collective and redistributive goods. It is possible that the circumstances of 20th - 21st century globalization may

[121] This section extends to the international arena the discussion of economic inequality in Section II.B that focused largely on the domestic United States.

BOX IID-16. GROWTH RATES OF COUNTRIES

source: United Nations Development Program, 1997

countries	number of countries	annual per capita GDP growth rate, 1985-95	population (milions)	% of world population
High-income countries	26	1.9	902	15.9
countries w/ less than 1.9% pc GNP growth, 1985-95	54	-1.1	1208	21.3
countries w/ 1.9% pc GNP growth or greater, 1985-95	25	3.7	2754	48.5
Former Soviet Union + Eastern Europe	17	-6.9	351	6.2
figures not available	11	0.8	458	8.1
totals	133	0.8	5673	100.0

make the provision of such services more difficult for today's developing countries. Alternatively, the market efficiencies and availability of advanced technologies that globalization fosters could allow persons in developing countries to acquire the human capital necessary for income growth more rapidly than in previous eras.

The economic position of the working classes of the developed nations appears to be more unambiguously threatened by globalization. However, the magnitude of this challenge is highly uncertain. Perhaps the most comprehensive recent analysis of the impact of increased economic integration on income inequality is that prepared by Cline (1997). The structure and results of his TIDE ("trade and income distribution") model are outlined in **IID-17** through **IID-20.** Cline finds that over the past twenty years increased economic integration has accounted for about 9% of the pressure that has widened the gap between skilled and unskilled wages in the United States[122]. In the future the disequalizing impact of integration is expected to be even less, largely due to rising skill levels in the developing countries that will reduce the comparative advantage that skilled workers in the developed countries currently hold. Further, Cline finds that because trade liberalization has already proceeded quite far, further liberalization will not have as great an impact on inequality as it has had over the past decades.[123] Finally, Cline's analysis reconfirms that while economic integration has worked to the disadvantage of low-skilled workers in the developed countries, it has worked to the advantage of low-skilled workers in the less developed countries.

This comparatively mild assessment of the impact of globalization on income inequality is tempered, however, by the fact that Cline's model is unable to explain nearly 60% of the increased disparity between skilled and unskilled wages in the US over the past 20 years (see IID-

---

[122] Cline considers "economic integration" to include the effects of trade liberalization, lower transportation and communication costs, outsourcing and immigration.

[123] By the same token, of course, further liberalization will not provide the same gains in output growth that it has in the past.

BOX IID-17. The TIDE ["Trade and Income Distribution Equilibrium"] Model [Cline, 1997]

Equations of the model

(1) $Q_{ij} = \tau_{ij} \left[S_{ij}^{\gamma Sj} U_{ij}^{\gamma Uj} K_{ij}^{\gamma Kj} \right]$

(2) $\tau_i = ce^{a_i + b_i t}$

(3) $C_{ij} = Q_{ij} + M_{ij}^{*} - X_{ij}, \quad j = (1,3)$

$= Q_{ij}, \quad j = (4,5)$

(4) $M_{ij}^{*} = \sum_{p=1}^{n} X_{pij} (1 - \lambda_{p_{ij}} - \beta_{pij}), \quad j = (1,3)$

$= 0, \quad j = (4,5)$

(5) $M_{ij} = \sum_{p=1}^{n} X_{pij}$

(6) $Max\, W = \sum_{i=1}^{n} W_i$

(7) $W_i = \prod_{j=1}^{5} C_{ij}^{\phi ij}$

subject to:

(8a) $\sum_{j=1}^{5} S_{ij} \leq S_i$

(8b) $\sum_{j=1}^{5} U_{ij} \leq U_i$

(8c) $\sum_{j=1}^{5} K_{ij} \leq K_i$

(9) $-0.01 Q_i \leq X_i - M_i \leq 0.01 Q_i$

(10a) $X_{ij} < 0.5 Q_{ij}$

(10b) $M_{ij}^{*} < 0.5 C_{ij}$

where:

Q = output (GDP)	X = exports	λ = transportation costs
τ = parameter of technological productivity	M* = effective imports	γ = output elasticity
	B = costs of trade protection	ϕ = welfare elasticity
S = skilled labor	W = well-being	t = year (1973 = 1, 1993 = 21)
U = unskilled labor	i = country (1,13)	
K = capital	j = product sector (1,5)	
C = consumption	p = trading partner country	
M = gross imports	a,b,c = technological productivity parameters	

BOX IID-18. DESCRIPTION OF THE TIDE MODEL

The TIDE model divides the world into 13 "countries" or regions: United States, Canada, European Union, Japan, rest of OECD, Mexico, rest of Latin America, China, G4 (Hong Kong, South Korea, Singapore, and Taiwan) India, rest of Asia, Eastern Europe including Russia, and rest of world.

There are five product sectors: 1. skill-intensive manufactures, 2. unskilled-intensive manufactures, 3. capital-intensive manufactures, 4. skill-intensive nontradables, and 5. unskilled-intensive nontradables.

Equation (1) shows output (GDP) as a function of skilled labor (S), unskilled labor (U), capital (K), and technological productivity (τ).

Equation (2) shows that technological productivity grows at constant rates that can vary for each country i, but which do not vary by type of product j within each country.

Equation (3) shows that consumption (C) of tradable goods is equal to the value of those produced domestically (Q) plus effective imports (M*) less exports (X). Consumption of non-tradable goods is equal to the total produced.

Equation (4) shows that for country i, the value of effective imports of a product j equals the sum of exports of that product from all other countries, less transportation costs (fraction λ) and trade barrier costs (fraction β). Imports of nontradable goods are zero.

Equation (5) shows that for country i, gross imports (i.e., what must be paid to acquire effective imports) of product j are equal to the sum of exports of product j from all other countries.

Equation (6) is the objective equation. In the TIDE model global well-being is maximized if each country maximizes its own well-being.

Equation (7) defines well-being as a decreasing function of consumption in which goods in all five product sectors are substitutable among one another.

Equations 8, 9 and 10 impose boundary conditions on the optimization problem.

TIDE is a static general equilibrium model. When it is run to optimize well-being it generates the optimal pattern of production and trade, i.e., levels of these such that no country could increase its well-being by increasing or decreasing them, given available factors. In addition it shows the marginal products of the factors of production, i.e., their wages and rents, under these circumstances. Cline runs the model using estimated and projected factor endowments (i.e., levels of labor, capital and technological productivity) for 1973, 1984, 1993, 2003 and 2013. He is thus able to calculate relative changes in skilled and unskilled wage levels over this period. By varying the values of the trade parameters λ and β he can estimate the impact of trade policies on the wage ratio of skilled and unskilled workers.

BOX IID-19. Sources of the Increase in Wage Disparity in the United States [percentages][1]

[from Cline 1997; table 5.1]

I. 1973-93			
A. Equalizing forces			
Increase of stock of skilled relative to unskilled labor			- 40
B. Unequalizing forces			97
Trade: Stolper-Samuelson effects[2] [3-10]		6	
lower transportation and communication costs	3		
trade liberalization	3		
Trade: outsourcing, Hicksian convergence[3]		1 ?	
Immigration		2	
Falling minimum wage		5	
Deunionization		3	
Skill-Biased Technological Change[4]		29	
Other unexplained		29	
C. Net Effect			18
II. 1993-2013			
Trade: Stolper-Samuelson effects		4	

--

notes

1) percentages for each potential force must be chained, not simply added, to equal total unequalizing impact. Similarly, "A" and "B" must be chained to calculate "C." [i.e. (1 - .40) * (1 + .97) = (1.18)].

2) These are the "classic" effects of trade whereby producers and consumers adjust their economic behavior based on comparative advantage.

3) Hicksian convergence refers to the theorem suggesting that as lower income countries become more productive the terms of trade will change in ways that decrease wages in high-income countries.

4) Cline's model leaves 58% of the increase in inequality unexplained. He arbitrarily divides this residual equally between "skill-biased technological change" and "other unexplained".

BOX IID-20. SUMMARY OF CLINE'S CONCLUSIONS
[Cline, 1997]

After a survey of the literature on trade and income distribution, and his own analysis using the TIDE model, Cline offers these conclusions:

1. The contribution of trade and immigration to rising US wage inequality has been somewhat larger than previously estimated in most of the literature[1].

2. Nonetheless, the bulk of increased inequality probably arose from skill-based technological change, with additional significant contributions from the falling real minimum wage and the decline in unionization.[2]

3. A doubling in the ratio of US skilled (some college or more) to unskilled (high school or less) labor supply over the past two decades should have caused the skilled wage to fall sharply relative to the unskilled wage, in the absence of other factors.

4. As a result, whereas the impact of trade and immigration may have been as much as about half of the net increase in US unskilled wage inequality, these external-sector influences only contributed about one-tenth of the gross unequalizing forces on US wages[3].

5. Trade liberalization in the past has probably caused little if any reduction in the absolute level of US unskilled wages, although by raising skilled wages it has contributed part of the rise in wage inequality associated with trade.

6. At least an equal part of the impact of trade was attributable to falling transportation and communications costs rather than changes in trade policy.

7. For the future, free trade under Asia-Pacific Economic Council (APEC) and the Free Trade Area of the Americas (FTAA) should not cause much change in wage inequality and is unlikely to cause absolute reduction in unskilled wages.

8. A policy of new, high protection against developing countries would cause serious losses to US skilled labor and either some loss or minimal gain to unskilled labor.

notes:
1) Cline's review of the results of past studies suggests that trade contributed about 20-30% of the recent increase in the skilled/unskilled wage ratio, while the TIDE model suggests it was near 50%. Box IID-19 shows the total of trade and immigration impacts to be (1.06)x(1.01)x(1.02) = 1.09, i.e., 9%, which is 50% of the overall increase of 18% (but see 3 below).

2) IID-19 shows the total impact of these three sources to be (1.29)x(1.29)x(1.05)x(1.03) = 1.799. i.e., 80%.

3) That is, 9% is only about 10% of the 97% total of unequalizing forces shown in IID-19.

19). Economists have taken to attributing this unexplained portion to "skill-biased technological change." However, as Cline notes, the evidence for this and in fact the concept itself are ambiguous. If we were to suppose that an important portion of the growth of "skill-biased technological change" was in some sense caused or encouraged by increased economic integration, or perhaps by "globalization" in its broadest senses, then the relation between globalization and increased economic inequality may be of more significance than Cline's analysis suggests.[124]

In any event, Cline recognizes that even an apparently small increase in economic inequality can have large social and political consequences. He concludes his study by emphasizing that "a commitment to open trade needs to go hand in hand with a commitment to a whole array of domestic polices that help ensure that the society evolves in an equitable rather than an inequitable direction." (p 275)

II.D.4.d. Distributional Equity – What Is To Be Done?

Scenario 3 calls for equality of per capita GDP among countries by 2150. This is achieved through high, steady growth rates in the lower-income countries and slower growth rates in the high-income countries. Scenario 3 also calls for a stable 80:20 ratio no greater than 6.5 within all countries by 2150. What mechanisms and policies are available that would allow these goals to be achieved, under conditions of globalization?

Below we offer some comments on the challenges that these goals present. Then we summarize proposals for addressing one or more of the elements of Scenario 3. We close with comments on the proposals.

---

[124] This is, in fact, the contention of Rodrik (1997), but he offers no further justification for it.

i. Comments on the Equity Goals of Scenario 3

1. Scenario 3 requires that low-income countries grow faster than high-income countries, but 35% of the developing world population lives in countries that are not even matching the high-income growth rates. A high priority needs to be given to policies and assistance that will enable these countries to achieve strong, steady economic growth.

2. In order for economic inequality between the high- and low-income countries to be eliminated within the next 150 years, Scenario 3 requires that per capita GDP annual growth rates in the high-income countries decline to and stabilize at 0.5% by 2050. Many people believe that it is unrealistic to expect this to happen. We discussed this concern in Section II.C.4 and will discuss it further in Section III, but in order to make headway with the other elements of Scenario 3 we won't address it in this section.

3. The policies needed to maintain an 80:20 ratio of 6.5 to 1 are particularly uncertain because, as noted, we are not sure what the forces of disequalization truly are and how strong they might be. Cline's analysis indicates that the disequalizing effects of trade liberalization can be expected to decrease with time, and we can see that the impact of several other sources of inequality—the lagging minimum wage and de-unionization in particular—can be significantly reduced by policy. Rough calculations using Cline's figures suggest that conventional policy tools, along with the major "natural" equalizing impact of rising skill levels in developing nations (which decreases the comparative advantage, and thus the premium, of skilled workers in developed countries) might be able to reduce the percentage increase of skilled over unskilled workers over the coming two decades to 7%, which is a marked improvement over the 18% increase of 1973-1993.[125] But confidence in this exercise is unwarranted because of the large uncertainty concerning the future of "skill-biased technological change" and other unknowns.

[125] If we assume that the minimum wage is regularly adjusted for inflation, and that stronger labor legislation and organizing halts the disequalizing impact of deunionization, and that Stolper-Samuelson effects decline from 6% to 4%, but that all other forces remain as shown in Box IID-19, then the net unequalizing effect over the period 1993-2013 is (1-.40)x(1.04)x(1.01)x(1.02)x(1.29)x(1.29) = 1.069 = 7%.

Cline's figures suggest that small changes in these factors could lead to either much greater disequalizing pressures or much greater equalizing pressures.[126]

In order to make at least some progress towards addressing our topic question, we posit this minimal condition, namely, that nation-states, or some other collective structures, must be able to provide public goods capable of having a distributive impact comparable to that provided by the public goods of today's social democracies: education, health care, progressive taxation, social security, collective bargaining, a minimum wage, and the like. We don't have to specify, at this point, the types or levels of such goods that might be required over any period of future decades. But we need be know that public goods with an equivalent distributive impact could be provided if needed--either autonomously by national governments, by national governments as part of multilateral agreements, by supranational institutions, or by other means. If it turns out that the impacts of globalization on economic inequality are mild then we won't need to use these capabilities to a great extent. But we need to know that they would in fact be available if we are to proceed confidently to support continued globalization while holding to the goals of Scenario 3.

ii. Summaries of Proposals

1. In preparation for the 1995 World Summit on Social Development, **the United Nations Development Program (UNDP)** offered an ambitious program to enhance the human and social capital of the world's poorest populations, so as to enable them to participate thereafter in the benefits of the expanding global economy. This program is outlined in **IID-21**. Such a program, if successful, would go a long way towards allowing the among-countries equity goal of Scenario 3 to be achieved. The UNDP program increases the flow of development aid, trade, and

---

[126] If we make the same assumptions as in the immediately preceding exercise, but assume also that "skill-biased technological change" and "other unexplained" are each 22% more unequalizing (i.e., their impact increases from 29% to 35%), then the net unequalizing effect for 1993-2013 returns to its 1973-1993 value of 18%. If the two uncertain factors each *decrease* by 22%, (from 29% to 22.6%) then the equalizing and unequalizing forces balance and the skilled/unskilled wage ratio is unchanged from 1993 to 2013.

BOX IID-21. UNDP PROPOSAL FOR GLOBAL SOCIAL DEVELOPMENT

[source: UNDP 1994 Human Development Report]

1. A **new world social charter,** prepared by the United Nations, in which "We the people of the world solemnly pledge.. .(to) take all necessary actions, nationally and globally, to reverse the present tend of widening disparities with and between nations...(and to) overcome the worst aspects of poverty in our lifetime through collective effort." The charter would include priorities, time tables and enforcement provisions.

2. A **human development social compact,** in which all countries pledge to ensure the minimal human development requirements for their own people, and to assist the very poorest nations that are not able to do so on their own. Targets for 2005 are:

* universal primary education, for both girls and boys
* cut adult illiteracy rates in half
* primary health care for all, with focus on immunization of children
* eliminate severe malnutrition, and halve moderate malnutrition
* universally available family planning
* safe drinking water and sanitation for all.
* credit for all, to ensure self-employment opportunities

UNDP estimated that the cost of accomplishing these goals before 2005 would be about $100/billion per year, an increase of $40 billion over current spending of $60 billion. $32 billion would be come from developing countries (by increasing the share of current GDP going to these programs from 13% to 20%) and $8 billion from donor countries (by increasing the proportion of all aid they give for the above human priority concerns from 7% to 20%).

3. **Mobilization of the peace dividend.** Although military spending in the industrial countries has declined by 3.6% since 1987, it has remained constant or increased in poor countries. Resolving local conflict should be made a global priority so that financial, human and social capital and resources can be freed up for peaceful development.

4. A **global human security fund.** Economic growth, globalization and uneven development have resulted in a number of major problems that impose costs on all nations, particularly on poor nations, and that can only be addressed on a global level. Treaties need to be negotiated to address:

* nuclear proliferation
* ethnic conflicts
* natural disasters
* refugee flows
* transmittable diseases
* natural resource depletion
* environmental pollution

Implementation of such treaties would require financial support, especially to ensure compliance by developing nations not yet able to contribute their share. UNDP estimated global human security funding needs of $250 billion annually. They suggested three revenue sources:

[more...]

BOX IID-21 UNEP Proposal (cont.)

1. *Peace Dividend:* The 3% annual decline in military spending in the rich countries since 1987 has generated a peace dividend of $385 billion. If the developing countries could begin a similar 3% decline they could realize a dividend of $75 billion by 2005. If the rich countries contributed 20% of their dividend to the global human security fund, and the developing countries contributed 10%, an average of **$14 billion/year** would be available.

2. *Fees on globally important transactions or polluting emissions:*
   a) a Tobin tax of .05% could raise **$150 billion/year** [see IID-11].
   b) a global energy tax of $1/barrel of oil or coal equivalent could raise **$66 billion/year.**

3. *Official Development Assistance:* Donor countries currently contribute about 0.35% of their GDP to ODA, one-half of their .7% pledged amount. If they "restructured existing ODA and committed some new funds", they could provide around **$20 billion/year** to the global fund.

6. A **UN economic security council** would be created to oversee these efforts. It would have 11 permanent members from the industrial countries and 11 rotating members. All decisions would require majorities of both the industrial and the developing country members.

7. A **World Central Bank** would be created to help stabilize global economic activity, act as lender of last resort to financial institutions, calm financial markets, regulate financial institutions, and create and regulate new international liquidity. UNDP says the IMF was supposed to play this role but the industrial countries have not cooperated, and are not likely to "until a crisis forces the issue". In the meantime UNDP believes the IMF should:

* be allowed to issue special drawing rights, in the range of $30-50 billion, to "help fuel world recovery at a time when... most of the world is in the grip of deflationary policies";
* be given more power to impose conditionality , but re-focused on promoting economic growth, employment and human development, rather than on short-run demand management;
* acquire regulatory control over international banking activities.

9. The **World Trade Organization** rules should be modified to address environmental concerns and to liberalize exchange of labor services. Eventually the WTO should become the World Trade and Production Organization, with power to negotiate and enforce rules concerning production and technology as well.

10. A **World Anti-Monopoly Authority** should be created to ensure that TNC's, which control 70% of world trade and dominate production, do not resort to monopolistic and restrictive practices, but rather use their considerable power for human social and economic development.

foreign direct investment going to developing countries, refocuses these flows in ways that benefit the poorest within these countries, and calls for the strengthening of the international regimes that would guide this effort. If successful, the UNEP program would reduce world poverty by 50% within a decade of its inception.

2. **Ian Robinson** (1995) acknowledges the benefits of increased trade, investment, and communications but wants to ensure their distributive equity. He notes that a "social democratic globalization" would have to:

1) neutralize social dumping pressures associated with the high levels of capital mobility that will exist in any global market economy; and

2) create new mechanisms for redistributing a substantial portion of the economic grains from globalization to those individuals and nations most in need. These would require: 1) a *social and environmental charter*, which "would set out basic worker rights and labor and environmental standards that all members of GATT, the IMF, and other international organizations would have to meet;"and 2) *structural funds*, which "would help pay for the upgrading of standards and infrastructure, and the promotion of economic development in depressed regions."

Robinson suggests that a minimal social charter would protect just four basic worker rights:

1) the right to organize unions that members control democratically;
2) the right to engage in collective bargaining and to strike;
3) freedom from forced labor for prisoners and children; and
4) freedom from discrimination in hiring, promotion or remuneration.

To provide structural funds Robinson proposes a Tobin tax of 0.5 percent, which would yield about $1.5 trillion in annual revenues.[127] For a decade or so these funds would be used to eliminate developing country debt. After that time funds would be disbursed on a per capita basis

---

[127] Note that this rate and yield is very much higher than the levels considered practical by the authors cited in Box IID-11.

to all qualifying countries for restricted uses, such as universal public education and health care. To quality for their share of structural funds governments would have to:

1) respect and protect the four basic labor rights of social charter; and
2) be democracies.

Robinson sees little support at this time among national governments for his package of social democratic reforms, although he notes some interest from France and the EU. Therefore, he believes, the task at hand is less to advance this package programmatically than it is to:

> "[D]emonstrate to democratic publics that the neoliberal form of globalization is not natural, inevitable, or desirable. Success in this regard will undercut the hegemony that neoliberal economic ideas currently enjoy. Putting a simple yet radical alternative form of globalization on the political agenda weakens their standard argument: 'There is no alternative'." (p 379)

3. **Hirst and Thompson** (1996) consider the mechanisms necessary to address distributional equity concerns both among and within countries. Regarding the former they focus on the small levels of foreign direct investment that finds its way to the poorest countries. They note that much of the Uruguay Round of the GATT dealt less with trade per se than it did with FDI, including TRIMS (trade-related investment measures) and TRIPS (trade-related aspects of intellectual property rights), thus confirming the legitimacy of investment regulations as a multilateral concern. They propose a general agreement on international investment (GAII) which would:

1) define, codify and guarantee property rights of multinational corporations regarding FDI;
2) protect the rights of labor and conditions of work;
3) recognize the rights of governments to defend certain of their legitimate national economic functions, including support for R&D, defense considerations, and balance of payments issues;
4) establish binding protocols on taxation of multinational corporations;
5) establish a disputes mechanism that would be written into international law;
6) strengthen existing protocols on the environment.

They see little active support for such a comprehensive agreement at this time, and suggest two more modest initiatives as interim efforts:

1) The Triad (US, EU and Japan), which accounts for 75% of FDI, could agree on the treatment of FDI within their own borders, and of FDI in developing countries by companies over which they have influence.

2) Separate agreements on key topics, such as taxation and transnational corporation property rights, could be negotiated among a larger number of countries.

In order for nation-states to address equity concerns within their own borders, Hirst and Thompson identify three requirements:

> 1) the state must construct a *distributional coalition* that agrees upon a sustainable program of national income and expenditure, the major provisions of which would specify:
>
> i) the division of national income between consumption and investment;
> ii) the level of taxation necessary to sustain state investment in infrastructure;
> iii) training and other collective services for industry;
> iv) a framework for controlling wage settlements, the growth of credit, and levels of dividends such that inflation is kept within internationally tolerable limits;
>
> 2) the state must support a *political culture* that balances collaboration and competition and in which the major interests are accustomed to bargaining over national economic goals; and
>
> 3) the state must negotiate a workable *distribution of fiscal resources and regulatory authority* among its national, regional and municipal levels of government.

4. **Luard** (1990) states that "politics is basically about disparities of income, wealth, influence and power" and thus "the inequality of nations drives global politics." However, he's skeptical of the practicability of the more ambitious proposals to address distributional equity. He offers a set of more moderate trade policy reforms that, he believes, "could simultaneously work to increase growth in low-income countries, and work to benefit lower income sectors in those countries" (pp 133-135). He proposes that:

a. Changes be made in the GATT to reduce protection of agricultural products. These provisions hurt rural populations in developing countries, whereas the current emphasis on

reducing protection of manufactured goods benefits mostly the better-off urban populations in those countries.

b. Declines in commodity prices be compensated for at higher levels than are currently provided by the IMF and EEC. Luard says that this is far more efficient than assistance to producers through "commodity schemes."

c. When quantitative trade restrictions are imposed, larger quotas be allowed to the 40 or so poorest developing nations.

d. More attention be given to activities of those development agencies, such as Tradecraft and OXFAM, that specialize in buying handicrafts and other products from the rural poor in developing countries.

e. The IMF, and creditor countries in general, extend conditionality to include a "...commitment to policies aiming at a better distribution of income." This reassurance to the poorest, including the urban poor, would help gain acceptance of other, necessary but painful, conditionality requirements.

f. UNESCO programs be reformed to benefit the poorest in the poor countries. For example, "assistance for irrigation works can be of a kind which brings benefits to poor peasants rather than wealthy landlords."

g. Technical assistance focus on raising the skills of rural agricultural workers rather than of urban industrial workers.

h. Medical assistance focus on basic care in rural areas rather than expensive hospitals in the capital city.

i. Priority should be given to assisting landless peasants to organize to protect their interests, rather than, say, to assisting urban workers in the formation of western-style trade unions.

Luard sees little active support for most of these reforms at this time. He suggests that in future years the most disadvantaged in the poorest countries will constitute a large percentage of

migrating populations. This will motivate concern within the developed nations, and will establish transnational capabilities that poor countries will be able to use to exert pressure for reforms.

5. Earlier we noted the critique of globalization offered by **Rodrik** (1997). What does he suggest be done to avoid the "solidifying of a new set of class divisions"? His proposals fall into two categories. The first are income generation and distribution measures. These include recommendations that a global tax on "foot-loose factors" (i.e., portfolio and investment capital) be considered, with the proceeds shared among countries; that national governments explore ways to enhance social insurance within existing levels of spending, so as to avoid budget deficits; [128] and that an international convention to restrict the ability of firms to avoid taxes through foreign investment be negotiated.

Rodrik's second set of proposals are trade and "social tension" measures. On the one hand, he says, "we need international institutions that must encourage greater convergence of policy and standards ('deep integration') among willing countries, in order to help reduce tensions arising from differences in national practices." On the other, he says room must be made "for selective disengagement from multilateral disciplines, under well-specified contingencies, for countries that need breathing room to satisfy domestic requirements that are in conflict with liberalizing trends."

6. **Greider** (1997) argues for a global commitment to "shift returns from capital to labor, reversing the maldistribution of incomes generated by the marketplace under the *rentier* system." He says the key features of such a new world order would include:

1. ***taxation of capital*** *rather* than labor;
2. ***reforming the terms of trade*** to ensure more balanced flows of commerce, compelling exporting nations to become larger consumers of global production. Nations that run large trade surpluses would be punished with temporary trade barriers.

[128] He suggests shifting the composition of income transfers from "old-age insurance" and other entitlements to labor-market risk insurance (i.e., unemployment compensation, trade adjustment assistance, and training).

3. ***raising wages*** on the low end as rapidly as possible, by requiring trading nations to honor labor rights.

4. a general ***write-off of the bad debts*** *of* the poor nations.

5. reforming the objectives of ***the central banks*** to support a pro-growth regime that will allow a reinflation of wage incomes. "Central banks must learn to take some risks on the upside, instead of worrying about inflation."

6. refocusing national economic ***policy on raising wages:*** raising minimum wages, strengthening labor laws, reducing tax breaks and subsidies for corporations, and underwriting high-speed rail systems, urban housing rehabilitation and childcare.

7. **Bello** (1998), arguing from the perspective of the Global South offers a critique of the "failed Asian model" and calls for a new developmental agenda characterized by "negotiated and selective integration" with the global economy. Its themes include:

1. A ***Tobin tax*** to control disruptive speculative capital flows;

2. ***Progressive income taxes*** to support national investment, and democratic management of this investment to avoid speculative gambles by corrupt, nepotistic politicians and financial elites;

3. Completion of "the unfinished social justice agenda of the progressive movement in Asia," notably ***land and asset reform,*** to bring the still very large marginalized populations of the region into the market, with the wherewithal to compete successfully;

4. A fundamental economic mechanism that is "more rational than the invisible hand of the market", yet avoids the failings of both "the heavy hand of socialism" and "the interventionalist hand of the Asian model". Bello believes the new mechanism "must be ***democratic decision-making*** by communities, civic organizations and people's movements. The challenge is how to operationalize such institutions of economic democracy."

5. A commitment to ***ecological sustainability.*** Bello says, "Instead of 8 to 10 percent [growth] rates, many environmentalists speak of rates of 3 to 4 percent." He says that slower growth rates would simultaneously lessen ecological damage and force attention to the imbalances of wealth and power in Asian society. Higher growth rates, Bello says, allow the elites to take the greatest share while permitting the incomes of the masses to grow just enough to avoid political unrest.

Bello concludes, "These ideas and others remain to be welded into a coherent strategy, and that strategy in turn awaits a mass movement to carry it."(pp 16-21)

8. Analysts who are skeptical of the desirability or political practicality of the sorts of structural reforms or redistributive measures outlined above have only a few credible options available with which to address problems of distributional equity under globalization. The most

widely embraced of these is education and training. **Mandle** (1997), arguing from the social-democratic left, says that for all their obvious flaws, globalization and technology, if guided properly and made inclusive, have the potential to make dramatic inroads against poverty, malnutrition, illness and ignorance. He says that the "anti-trade left" is "silent on the question of how, in the absence of trade, wages in poor countries could be increased over the long-run." Mandle acknowledges that some US workers will be disadvantaged by more open trade and globalization, but replies that the answer is not to stop trade but to shift those workers to industries where the US has the comparative advantage. He is forthright in acknowledging that this will require more and better education, training, retraining, and other support. He goes on to say that,

> "The real danger lurking in the liberal anti-trade position is that it concedes precisely what we have to fight for: a supportive government committed to advancing the productive skills of the labor force and offering an adequate safety net for those who confront difficulty in the highly competitive world economy. Aside from the impossibly high price tag associated with such a strategy, this strategy turns its back on the legitimate interests of the poor in other, less-developed nations. ... Rather than pitting the poor of the developed world against the poor of the third world, as protectionism does, we should be prepared to continue to fight for economic justice everywhere." (p 12)

Mandle supports limits on trade in goods produced with child labor, goods produced under demonstrably unsafe working conditions, and goods produced in violation of internationally negotiated environmental protections. But he believes that the only ultimately effective path is to "...make certain our workers can compete at the highest levels of productivity."

9. In a similar vein **Reich** (1991) presents a set of policies designed to bolster the earnings power of workers in the developed countries without resorting to across-the-board trade barriers. He stresses the important point that it is in the long run interest of workers in the developed countries to help enhance, not retard, the economic development of poor countries. His program of "positive economic nationalism" calls for developed countries to:

> 1) ***eschew governmental barriers to trade,*** money, and ideas, but allow focused governmental intervention designed to ***enhance training, skills, and education.***

2) consider ***public subsidies to firms that undertake high-valued production*** within the nation's borders. To prevent unproductive competition among nations in this regard, a "GATT for investment" would need to be negotiated. Its provisions would include appropriate levels and targets for focused subsidies, rules defining fair tactics, and a prohibition on threats to close domestic markets, unless compensating investments are made. Reich suggests that "the amount of a permissible subsidy might be directly proportional to the size of a nation's work force but inversely proportional to its average skills. Nations with large and relatively unskilled work forces would be allowed greater leeway in bidding for global investment than nations with smaller and more highly skilled work forces." (p. 313)

4) support the ***pooling and allocation of subsidies to sectors where they could do the most good,*** as the European Community has begun to do regionally for major R&D efforts.

5) ***ease the transition of workers out of old industries*** and technologies, using "severance payments, relocation assistance, extra training grants, extra unemployment insurance, regional economic aid, and funds for retooling or upgrading machinery. Since every nation benefits when overcapacity anywhere is reduced, these subsidies might come from a common fund established jointly by all nations."

6) seek to ***develop the capacities of the work forces of the Third World,*** "as a means of promoting indigenous development and thereby enhancing global wealth. To this end, the shift of high-volume, standardized production to Third World nations would be welcomed, and markets in advanced nations would be open to them."

iii. Comments on the Proposals

1. The UNDP proposal is the most ambitious of the proposals surveyed. If implemented it would mean a 67% increase in annual bilateral aid (from $60 billion to $100 billion) and a nearly 5000% increase in the funds administered by the development agencies of the UN (from $5 billion to $250 billion.) The numbers invite skepticism, and indeed, the 1995 UN World Summit on Social Development, for which the UNDP proposals were prepared, passed with little notice. But it is difficult to deny that the conditions described in the human development social compact (item #2 in IID-21) will in fact need to be achieved if the poorest 30% of the world's people are to become part of the global economy. Further, these conditions –better education, health care and sanitation--are precisely the sort that have been addressed by the public sector, rather than the market, in the history of economic development in the West. The burden appears to rest on skeptics to show how the needed results can be achieved in ways that don't require focused collective attention and support.

Skeptics might dismiss the $250 billion "human security fund" proposed by UNDP (item #4 in IID-21) as a thinly-veiled subsidy program for inefficient developing country bureaucracies. But careful consideration of the major problems listed in item #4 suggests that at least the premises of UNDP's proposal are sound. The problems listed appear in the most immediate instance to be caused by underdevelopment and poverty, yet they impose hardships on both the developed and the developing world. The poorest nations, especially, simply do not have the resources needed to address these problems. Thus if the North wants to see real results, it is going to have to make more of a commitment to assisting the developing countries.

The stated intent of the UNDP proposal is to encourage the vitality of market economies in the developing world and their integration into the larger global market economy. This stands in contrast to similar ambitious UN proposals of two decades ago, notably those intended to establish the New International Economic Order (NIEO), which were intended as challenges to market capitalism.

2. Ian Robinson highlights the two measures most often called for in the proposals reviewed. One is the inclusion of labor rights and standards in international economic agreements. The other is a source of funds to provide assistance that markets cannot be expected to provide.

The real impact of labor rights and standards on incomes, growth and equity depends on many more factors than we can review in these notes. For now I'm going to assume that there exists a regime of such rights and standards that will be acceptable to labor and capital in both the developed and the developing world, and that will not significantly impede continued economic growth and integration. The existence of such rights and standards can have an important impact on particular sectors of the labor force, but, as our review in Part II-E suggested, does not have a large direct impact on aggregate levels of inequality. However, rights and standards can be of indirect benefit by helping empower a labor constituency that can influence other policies that might reduce inequality.

The real impact of the Tobin tax is likewise difficult to assess. If we take the high-middle estimate of $150 billion in annual revenues suggested by Felix and Sau, and re-distribute it on a per capita basis as suggested by Robinson, we find that the Tobin tax generates revenues of about $25/year per person. For the 75% of the world's population who live in the 49 poorest of the world's countries, and whose mean per capita income is $430, this amount would represent an annual income increase just under a 6% (i.e., $430 to $455). On the other hand, Tobin tax revenues would represent a very large supplement to the national budgets of most developing countries. For example, Kenya and Nicaragua would receive per capita Tobin revenues totaling $640 million and $94 million, respectively, which in both cases is nearly 25% of their current national budgets. Alternatively, if the Tobin tax were used to support global commons initiatives, its real impact on poverty, growth, and equity would depend on many complex factors.

3. Rodrik warns that globalization may cause "the solidifying of a new set of class divisions, but his proposals to prevent this seem inadequate. Regarding trade he recommends only that greater efforts be made to achieve convergence of standards, and that more allowance be made for "selective disengagement" where national differences appear particularly acute. These policies would allow the advocates of global economic integration to placate the minimum number of aggrieved constituencies necessary in order to prevent the formation of a broad-based anti-trade coalition. The two tax measures Rodrik recommends are worthy but he does not provide details on rates and estimated potential yields.

4. Greider's package of reforms largely derive from two, somewhat contradictory, understandings of the nature of the global economic problem. On the one hand Greider asserts that economic growth is too slow. This is because bankers have a self-interest in ensuring that high demand does not generate inflationary pressures that decrease the value of their outstanding loans. Thus they unduly restrict credit that could otherwise support growth, new jobs and higher wages. On the other hand Greider asserts that economic growth is, in a sense, too fast. This is because technology and liberalized trade are allowing more and more goods to be produced by

lower and lower paid workers. This will generate a glut, which will lead to a global depression. In order to address the first problem Greider calls for inflationary monetary policies (item #5). In order to address the second problem he calls for constraints on trade, and on other measures that raise the wages of lower income workers.

Both Rodrik (1997) and Krugman (1997) have criticized Greider's analysis. Bankers are as pro-growth as any capitalists; inflation feeds on itself and high inflation is no friend of the working classes. The "global glut" argument is valid only if the real marginal propensity to consume declines as income increases, but despite the intuitive reasonableness of this assumption the evidence for it is thin.

Greider's six proposed measures, if implemented very cautiously, could—separately and together—move the levels and distributions of income in a more equitable direction, but not by great magnitudes. On the other hand if they were implemented aggressively enough to have a more appreciable equity impact, they would likely be seriously destabilizing.

5. Bello's call for progressive taxes and land and asset reform is central to any program of growth and equity in developing countries, and of proven efficacy. But Bello is also looking for something more, for a "fourth way" beyond neoliberal capitalism, state capitalism and state socialism. He calls for the development of economic democracy rooted in local communities, and for slower, more ecologically sensitive economic growth in the South. Skeptics can dismiss this orientation as pastoralist or escapist, and as we saw in Section II.C.1, often with good reason. But the growth and equity goals of Scenario 3 can in fact be achieved with per capita GDP growth rates in the developing countries of as "low" as 4%-5%, provided these are maintained over several decades.

6. Mandle and Reich distinguish themselves from the other authors reviewed in arguing that greater trade liberalization and economic integration can work to the benefit of workers in the developed world, if accompanied by a commitment to training and education. This stance is attractive because it holds out the prospect that the interests of workers in the developed and the

developing world need not, in fact, be at odds. We saw in Section II.B.3 that Reich's proposals for training and education did not hold great promise of significantly reducing aggregate economic inequality in the United States. However, Scenario 3 only seeks to guarantee that inequality *becomes no worse*, in which case training and education may be able to play a more critical role. The remaining uncertainty, of course, concerns the extent to which skill-biased technological change is encouraged by the process of globalization.

II.D.4.e. Assessment and Next Steps

In this section we reviewed proposals for governing institutions and policies that might allow us to achieve the goals of Scenario 3, under conditions of globalization. Proposals exist for practicable institutions and policies that could allow a growing, globalizing, market economy to be managed in a way that keeps financial, trade and investment fluctuations within some safe range. Proposals also exist for institutions and policies that could address environmental concerns in a way that allows economic output to grow at the rates and to the levels desired in Scenario 3.

There also appear to be institutions and policies that could enable those developing countries whose growth rates are below those of the high-income countries to grow faster. But the magnitude of this challenge needs to be acknowledged.

Our assessment concerning institutions and policies by which we might keep economic inequality from increasing is more ambiguous.[129] On the positive side we note that the direct contribution that economic integration makes to inequality appears to be moderate, and is expected to decrease. On the negative side we note that the single largest suspected cause of increased economic inequality--"skill-biased technological change"--is in fact not well understood, and it is not impossible that some aspects of globalization may contribute to it. Our review identified many governing institutions and policies that are mechanically practicable and

[129] These comments draw on material covered in Sections II.B and II.C as well as in this section.

could be expected to encourage greater economic equality. If the disequalizing forces of globalization turn out to be mild, we might be cautiously optimistic about the ability of the programs described above to offset these. If disequalizing forces turn out to be strong they will pose a major challenge to continued economic globalization, and to our chances for realizing Scenario 3.

Next steps

The existence of reasonable institutional and policy blueprints is a necessary but not a sufficient condition for Scenario 3 to be credible. The financial, environmental and distributive policies just reviewed presume the existence of healthy nation-states, or other structures of governance in some manner accountable to nation-states, that are able to successfully craft and administer complex global public good regimes. They also presume the existence and continuity over time of a majority socio-political ethos that affirms the humanitarian and solidaristic values of Scenario 3.

What impact might globalization have on the viability of the nation-state? Does globalization encourage or discourage solidaristic social norms and values? These critical questions are addressed in the next section.

II.D.5. GLOBALIZATION, THE NATION-STATE AND SOCIAL NORMS AND VALUES

II.D.5.a. Review of Authors

In this section we review and evaluate the work of authors who have addressed the two questions just posed. The first four authors - Ohmae, Rosenau, Mathews and Cerny - argue that the conventional nation-state cannot expect to remain the central structure of governance in a globalizing world. The next five authors - Reich, Hirst and Thompson, Slaughter, and Keohane - have greater hopes for a continued central role, albeit modified, for the nation-state. Lastly we consider Brown's skepticism regarding "global community," and Huntington's vision of a regionalized world based on civilizational heritage.

1. **Kenichi Ohmae** has gained recognition as one of the strongest proponents of the inevitability and desirability of end of the nation-state. He says that investment, industry, technology and individuals are now more globally mobile than ever, and that their unconstrained free-market dynamism will go further towards meeting human needs than could any form of national regulation. He believes that "region-states," governance structures suited to a cosmopolitan world sustained largely by technology and information, will supplant the nation-state system that arose in a world of ethnic populations sustained by agriculture.[130] Thin, inter-regional structures will maintain currency and infrastructure standards, and be available for police functions. Ecological integrity will be ensured because prosperous individuals desire it. Ohmae implies that a fair distribution of income is one generated by a fair free market.

For these notes the important part of Ohmae's account concerns the ways in which increasingly intense levels of economic integration, communications and technology—

[130] Ohmae's list of nascent region-states includes Rhone-Alps/Lyon, Northern Italy, Languedoc-Roussillon/Toulouse/Catalonia, Baden-Wurtemberg/upper Rhine, Wales, San Diego/Tijuana, Silicon Valley/Bay Area, Research Triangle, Guangdong/Hong Kong/south China, Pusan/Fukuoka/Kitakyushu, Tokyo region, Osaka/Kansai region, Penang Island, and Singapore/Johore/Riau Islands.

globalization—are transforming social and cultural values, and are making the nation-state obsolete. In *The End of the Nation-State* (1995), Ohmae writes that today

> "Using a telephone, fax machine, or personal computer linked to the Internet, a Japanese consumer in Sapporo can place an order for clothing with Lands' End in Wisconsin or L.L. Bean in Maine, have the merchandise delivered by UPS or Yamato, and charge the purchase to American Express, Visa, or Master Card. That same consumer can also access software support or remote computer repair services provided, say, by a company based in Singapore or Kuala Lumpur but relying on Indian engineers based in Bombay and on database maintenance carried out in China. That same consumer can call or fax First Direct in Great Britain or any number of financial institution in the United States 24 hours a day, transfer money from anywhere to anywhere... For Nintendo kids, this will be a normal part of everyday life... they will save money, boost flexibility, and increase their range of choice. But they will also make an ever-larger share of their economic transactions effectively invisible to government. Where—in any of these business systems—can customs officers charge duties, local governments claim value-added taxes, or bureaucrats compile accurate trade statistics? Thus...power over economic activity will inevitably migrate from the central governments of nation-states to the borderless network of countless individual, market-based decisions." (p 39)

Ohmae celebrates the end of traditional cultures and modes of cultural transmission:

> "The social glue of intimate familiarity and shared experience once came only from participation in and with a family. Now it comes from watching how a kid from another culture whom you've never seen before reveals character and mind-set through programming style... Today, millions of Nintendo kids have ready access to multiple avenues of external communication. This is even truer for their younger siblings and will be truer still for their children. The link among generations has been broken; a new link with those sharing similar experience has been forged."

Ohmae answers those critics who complain that his vision promotes a superficial gadget-and-video consumerism at the expense of centuries of human tradition and culture:

> "The emotional nexus of culture... is not the only web of shared interest able to [sustain a society]...Information-driven participation in the global economy can do so too, ahead of the fervid but empty posturing of both cheap nationalism and cultural messianism. The well-informed citizens of a global marketplace will not wait passively until nation-states or cultural prophets deliver tangible improvement in lifestyle. They no longer trust them to do so. Instead, they want to build their own future, now, for themselves and by themselves." (p 16)

2. James Rosenau is a scholar of international affairs whose post-modernist sensibilities perceive a world of "turbulence" that is undergoing profound change along many dimensions. To understand governance in this era is to "...look for authorities that are obscure, boundaries that

are in flux, and systems of rule that are emergent... The task is not so much impossible as it is a challenge to one's appreciation of nuance and one's toleration of ambiguity."

In *Along the Domestic-Foreign Frontier: Exploring Governance in a Turbulent World* (1997), Rosenau calls for abandoning the "state-centric worldview" and adopting a new one, which

> "...should recast the relevance of territoriality, highlight the porosity of boundaries, treat the temporal dimensions of governance as no less significant than the spatial dimensions, recognize that networking organizations have become as important as hierarchical ones, and posit shifts of authority to subnational, transnational, and nongovernmental levels as normal." (p 29)

The key transforming elements of this turbulent world include:

> "...a skills revolution at the micro level of individuals, a spread of authority crises at the intermediate level..., and a bifurcation of the collectivities at the macro level in which a multi-centric world of diverse Spheres of Authority (SOA's) is hypothesized as having emerged to compete, cooperate or otherwise interact with the state-centric world of national governments. These transformations are conceived to be driven by the technological innovations of the microelectronic revolution and other powerful sources of globalization as well as by heightened sensitivities to ethnic identity and other powerful sources of localization." (p 43)

IID-22 shows Rosenau's contrast of the conventional state-centric world and the emerging multi-centric world.

Rosenau perceives the weakening power of hierarchy or "command" mechanisms being superseded by "steering" or "control" (i.e., cybernetic) mechanisms:

> "[S]ome actors, the controllers, seek to modify the behavior and/or orientations of other actors, the controllees, and the resulting patterns of interaction... can properly be viewed as a system of rule sustained by one or another form of control... it does not matter whether the controllees resist or comply with the efforts of controllers; in either event attempts at control have been made. (When) the attempts become increasingly successful and compliance with them increasingly patterned... a system of rule founded on mechanisms of control can be said to have evolved.... It follows that systems of rule can be maintained and their controls successfully and consistently exerted even in the absence of established legal or political authority. The evolution of intersubjective consensus's based on shared fates and common histories, the possession of information and knowledge, the pressure of active or mobilizable publics, and/or the use of careful planning, good timing, clever manipulation, and hard bargaining can—either separately or in combination—foster control mechanisms that sustain governance without government." (p 147)

BOX IID-22. "STRUCTURE AND PROCESS IN THE TWO WORLDS OF WORLD POLITICS"

[from Rosenau (1997), *Along the Domestic-Foreign Frontier: Exploring Governance in a Turbulent World]*

	State-centric World	Multi-centric World
Number of essential actors	less than 200	hundreds of thousands
Prime dilemma of actors	Security	Autonomy
Principal goals of actors	Preservation of territorial integrity, physical security	Increase in world market shares; maintenance of system integration
Ultimate resort for realizing goals	Armed forces	Withholding of cooperation & compliance
Normative priorities	Processes, esp. those that preserve sovereignty & the rule of law	Outcomes, esp. those that expand human rights, justice and wealth
Modes of collaboration	Formal alliances whenever possible	Temporary coalitions
Scope of agenda	Limited	Unlimited
Rules governing interactions among actors	Diplomatic practices	Ad hoc, situational
Distribution of power among actors	Hierarchical by amount of power	Relative equality, for initiating action
Interaction patterns among actors	Symmetrical	Asymmetrical
Locus of leadership	Great powers	Innovative actors; extensive resources
Institutionalization	Well-established	Emergent
Susceptibility to Change	Relatively low	Relatively high
Control over outcomes	Concentrated	Diffused
Bases of decisional structures	Formal authority; law	Various types of authority & leadership

The institutions that populate these new spheres of authority come in many forms and go by different names:

> "NGO's, nonstate actors, sovereignty-free actors, issue networks, policy networks, social movements, global civil society, transnational coalitions, transnational lobbies, and epistemic communities. " ..." (p 40)

Would it be possible to achieve the levels of economic stability, ecological integrity, and distributional equity identified in Scenario 3 in such a multi-centric world?

Rosenau faces the ecological question forthrightly. He asks, "Is it plausible to anticipate a system of rule comprised of UN agencies, international regimes, NGO's and other relevant actors that achieves effective control over such truly global situations as ozone depletion, ocean pollution, loss of biodiversity, and potentially devastating climate changes?" After recounting the magnitude of these concerns he suggests that there are at least four reasons for "avoiding a premature pessimism". The first is the continually increasing salience of environmental issues. The second involves the decreasing inclination of nation-states to assert their sovereignty on environmental matters, even when they would otherwise be able to do so. The third is the skills revolution, reflected in the growth of NGO's and the widespread awareness of environmental issues. The forth is that as people experience local environment degradation, and work to contain and reverse it, they will more readily appreciate the need for cooperation on a global level.

Rosenau's discussion of distributional equity, and of political economy in general, is less than thin. Amazingly, in a work on global governance with an index of over 1400 topics addressed in nearly 500 pages, there is not a single indexed reference to *equality, inequality, income, wealth, class,* or *status.* There is a single reference to *poverty* (page 111) and one to *capitalism* (page 444) but none at all to either *socialism* or *neoliberalism.*

Rosenau recognizes that his multi-centric, de-centered vision may be unsettling, and wants to find a way to interpret it affirmatively. He notes that the pending turbulence may in fact represent a transition to a new, more stable, globalized world community. Evidence for this includes:

"...the evolution of widely shared norms of human rights and environmental concern, the erosion of sovereignty, the diminution of the competencies of states, the advent of the Internet and other means of communicating around and across national borders – that suggest that long-standing processes of identity and legitimacy formation may no longer operate and are being replaced by the emergence of a capacity for multiple loyalties. The dynamics of change may well lead people to look beyond concrete territorially based units and, instead, view themselves as participants in the concrete issue-based processes that criss-cross [the globe]... the long term may witness a shift in which people slowly expand their state-oriented definitions of self interest to include the notion that their interests are also well served through adherence to procedures and standards that are transnational, even global, in shape." (p 446)

3. **Jessica Tuchman Mathews** (1997) forecasts the decline of the nation-state and the rise of nonstate actors:

"National governments are not simply losing autonomy in a globalizing economy. They are sharing powers... with businesses, with international organizations, and with a multitude of citizens groups, known as nongovernmental organizations (NGOs)... Increasingly, resources and threats that matter, including money, information, pollution, and popular culture, circulate and shape lives and economies with little regard for political boundaries.... Even the most powerful states find the marketplace and international public opinion compelling them often to follow a particular course. (p 50)

She says that the primary "engines of change" have been the revolutions in computers and telecommunications:

"(These have)...broken governments' monopoly on the collection and management of large amounts of information and deprived governments of the deference they enjoyed because of it... By drastically reducing the importance of proximity, the new technologies change people's perceptions of community. Fax machines, satellite hookups and the Internet connect people across borders with exponentially growing ease while separating them from natural and historical associations within nations." (pp 51-52)

Mathews gives special attention to the positive role that she believes NGO's will be able to play in filing important gaps left by the demise of the nation-state. She cites:

* *their range of roles:* "They breed new ideas; advocate, protest, and mobilize public support; do legal, scientific, technical and policy analysis; provide services; shape, implement, monitor and enforce national and international commitments; and change institutions and norms."

* *their diversity and explosive growth:* "It is impossible to measure a swiftly growing universe that includes neighborhood, professional, service, and advocacy groups, both secular and church-based, promoting every conceivable cause and funded by donations, fees, foundations,

governments… or the sale of products and services. The true number is certainly in the millions…"

* *their large budgets and expertise:* "(These) approximate and sometimes exceed those of smaller governments and of international organizations…. Today NGO's deliver more official development assistance that the entire UN system (excluding the World Bank and the IMF)."

* their interpenetrating into *hybrid international authorities* that include state and nonstate bodies, such as the International Telecommunications Union, the International Union for the Conservation of Nature, and bodies that monitor national elections. In some cases nonstate organizations such as the International Standards Organization and the International Security Markets Association function in a quasi-public capacity.

* *service delivery*: "In many countries [NGO's] are delivering services—in urban and rural community development, education and health care – that faltering governments can no longer manage."

Mathews presents two case studies of the new power of NGO's:

* *their role in opening up trade negotiations:* "Increasingly, NGO's are able to push around even the largest governments. When the US and Mexico set out to reach a trade agreement, the two governments planned on the usual narrowly defined negotiations behind closed doors. But NGO's had a very different vision…"

* *their key role at 1992 Earth Summit in Rio de Janeiro.* "With the broader independent base of public support that environmental groups command, NGO's set the original goal of negotiating an agreement to control greenhouse gases long before governments were ready to do so, proposed most of its structure and content, and lobbied and mobilized public pressure to force through a pact that virtually no one else thought possible when the talks began."

Although her tone is strongly affirming of the future potential of the NGO's in global governance, she offers important qualifications:

"For all their strengths, NGO's are special interests, albeit not motivated by personal profit. (They)... often suffer from tunnel vision, judging every public act by how it affects their particular interest. Generally, they have limited capacity for large-scale endeavors, and as they grow, the need to sustain growing budgets can compromise the independence of mind and approach that is their greatest asset." (p 64)

Mathews notes other problematic aspects of a world of diminished nation-states and stronger non-state actors: increased social fragmentation, less willingness to invest in public goods, sheer unmanageability, an increased democratic deficit, and the solidification of technological haves- and have- nots. In addition, she says, there may be some jobs only states can do:

"Providing a modicum of job security, avoiding higher unemployment, preserving a livable environment and a stable climate, and protecting consumer health and safety are but a few of the tasks that could be left dangling in a world of expanding markets and retreating states."

Despite these dangers she believes that "the clash between the fixed geography of states and the nonterritorial nature of today's problems and solutions, which is only likely to escalate, strongly suggests that the relative power of states [vis-à-vis nonstate actors] will continue to decline." And in that case:

> "Whether the rise of nonstate actors ultimately turns out to be good news or bad will depend on whether humanity can launch itself on a course of rapid social innovation...Needed adaptations include a business sector that can shoulder a broader policy role, NGO's that are less parochial and better able to operate on a large scale, international institutions that can efficiently serve the dual masters of states and citizenry, and, above all, new institutions and political entities that match the transnational scope of today's challenges while meeting citizens' demands for accountable democratic governance." (p 66)

4. **Philip Cerny** (1995) recognizes many of the same forces at work in the world described by Ohmae, Rosenau and Mathews, but interprets them more skeptically. Regarding the impact of globalization on governance, Cerny says

> "...[G]lobalization leads to a growing disjunction between the democratic, constitutional and social aspirations of people – which continue to be shaped by and understood through

> the framework of the territorial state—and the increasingly problematic potential for collective action through state political processes. Certain possibilities for collective action through multilateral regimes may increase, but these operate at least one remove from democratic accountability. Indeed, the study of international regimes is expanding beyond intergovernmental institutions or public entities per se toward "private regimes" as critical regulatory mechanisms. New nodes of private and quasi-public economic power are crystallizing that, in their own partial domains, are in effect more sovereign than the state." (p 618)

Cerny describes what he believes is the last remaining useful role for the nation-state under conditions of globalization:

> "The outer limits of effective action by the state..(will) comprise its capacity to promote a relatively favorable investment climate for transnational capital—i.e., by providing an increasingly circumscribed range of goods that retain a national-scale (or subnational-scale) public character ... Such potentially manipulable factors include: human capital (the skills, experience, education and training of the work force); infrastructure (from public transportation to high-technology information highways); support for a critical mass of research and development activities; basic public services necessary for a good quality of life for those working in middle- to high-level positions in otherwise footloose (transnationally mobile) firms and sectors; and maintenance of a public policy environment favorable to investment (and profit making) by such companies, whether domestic or foreign owned." (p 611)

But even this narrowed vision of the role of the nation-state may be too much to expect. If the demand for goods and assets best provided by trans- and supra-national structures is more powerful than that for goods and assets of a national or sub-national scale, then the nation-state

> "... [C]ould increasingly be characterized by a general loss of legitimacy. Under these conditions, government per se will essentially become privatized, losing much of its public character. The world will be a neofeudal one, in which overlapping and democratically unaccountable private regimes, regional arrangements, transnational market structures, 'global cities', nongovernmental organizations (NGOs), quasi-autonomous NGO's and international quasi-autonomous NGO's, with rump governments... attempting to ride free on global/local trends for short-term competitive interests. Collective action will take many forms, and the state will be perceived as relatively powerless with regard to the pursuit of a wide range of collective goals." (pp 624-625)

Cerny notes that although we can't say which scenario will prevail, the momentum appears to be with the latter. In that event, he says, "The main question that remains to be asked is whether such a system will tend toward chaos or toward a certain stability of a plurilateral kind."

5. In his book *The Work of Nations* (1991) **Robert Reich** appears allied with the authors just reviewed in making a case for the diminished role of the nation-state, but he differs importantly from them in arguing that one of the few things the state can still do is implement policies that will make incomes more distributionally equitable. His account usefully goes beyond analysis and presents an engaged narrative and vision.

Reich argues that global economic integration is widening the gaps between skilled and less skilled workers in the developed world. He believes the main redress still available to nation-states is intensive education and training, together with social safety nets for the very disadvantaged.[131] Globalization has ruled out corporate taxation and deficit financing as revenue sources for such programs, but the personal income tax remains practicable. Reich estimates that the funds needed for an education-training-safety net agenda can be raised without pegging income taxes so high that they motivate emigration.

However, Reich continues, support for even such a moderate agenda is becoming increasingly difficult because 1) organized labor, historically the main political driver of progressive economic policies, has been weakened, in part by globalization; and 2) the educated, professional, upper-fifth of Americans are "seceding" from the rest of the nation, moving to privileged, gated communities in the US while building bonds of enterprise and identity with their counterparts in Europe, Asia and elsewhere. Reich says,

> "To improve the economic position of the bottom four-fifths will require that the fortunate fifth share its wealth and invest in the wealth-creating capacities of other Americans. Yet as the top becomes ever more tightly linked to the global economy, it has less of a stake in the performance and potential of its less fortunate compatriots." (p 301)

[131] Reich's program for addressing economic inequality in the United States is discussed fully in Section II.B.3.b of these notes.

Reich says that if current trends continue, by 2020 the affluent one-fifth of Americans will enjoy incomes nearly 30 times higher than the bottom fifth, and feel few social or political ties to the stagnating four-fifths.[132] However, Reich sees two events that will

> "...likely intervene to deflect this trajectory. Not the least is the inability of symbolic analysts to protect themselves, their families and their property from the depredations of a larger and ever more desperate population outside.[133] The peace of mind potentially offered by platoons of security guards, state of the art alarm systems, and a multitude of prisons is limited." (p 303)

However,

> "There is also the possibility that symbolic analysts will decide that they have a responsibility to improve the well-being of their compatriots, regardless of any personal gain. A new patriotism would thus be born, founded less upon economic self-interest than upon loyalty to the nation." (p 303)

Reich reflects upon the ideal of "loyalty to the nation:"

> "What do we owe one another as members of the same society who no longer inhabit the same economy? The answer will depend on how strongly we feel that we are, in fact, members of the same society... The question is whether the habits of citizenship are sufficiently strong to withstand the centrifugal forces of the new global economy. Is there enough of simple loyalty to place—of civic obligation, even when unadorned by enlightened self-interest—to elicit sacrifice nonetheless?"... "The question is relevant to all nations subject to global economic forces... In some societies, the pull of the global economy notwithstanding, national allegiances are sufficiently potent to motivate the winners to continue helping the losers.... The Japanese, Swedes, Austrians, Swiss, and Germans, for example, view themselves as cultures whose strength and survival depend, to some extent, on sacrifices by the more fortunate among them. It is a matter of national duty and pride. Partly as a result, the distribution of income within these nations has been among the most equal of any countries." (p 305)

However, Reich speaks against the nurturing of a similar nationalism in America. He says it requires an enemy, can sow conflict and dissension at home, endangers global economic prosperity, and ignores the fact that if we are to have a peaceful world we need to solve global inequality as well, and to cooperate with the rest of the world on many issues, including the environment, disease, and crime.

Reich contrasts nationalism with cosmopolitanism:

---

[132] My calculations suggest a lower but still unprecedentedly high 80:20 ratio of about 15:1 by 2020. See Box IIB-17.

[133] "Symbolic analysts" is Reich's term for the educated, professional upper and upper-middle classes.

> "The cosmopolitan man or woman with a sense of global citizenship is...able to maintain appropriate perspectives on the world's problems and possibilities. Devoid of strong patriotic impulses, the global symbolic analyst is likely to resist zero-sum solutions and thus behave more responsibly (in this sense) than citizens whose frame of reference is narrower." (p 309)

But there is a dark side to cosmopolitanism, as well. Reich asks:

> "...will the cosmopolitan with a global perspective choose to act fairly and compassionately? Will our current and future symbolic analysts—lacking any special sense of responsibility toward a particular nation and its citizens—share their wealth with the less fortunate of the world and devote their resources and energies to improving the chances that others may contribute to the world's wealth?"

> He continues, "[W]ithout strong attachments and loyalties extending beyond family and friends, symbolic analysts may never develop the habits and attitudes of social responsibility. They will be world citizens, but without accepting or even acknowledging any of the obligations that citizenship in a polity normally implies. They will resist zero-sum solutions, but they may also resist all other solutions that require sacrifice and commitment. Without a real political community in which to learn, refine, and practice the ideals of justice and fairness, they may find these ideas to be meaningless abstractions." (p 309)

An additional problem with pure cosmopolitanism is that it can engender a sense of resignation. Reich says that even sensitive and sympathetic persons may feel overwhelmed, if their ties to one another are only abstract, intellectual, and mediated.

Reich concludes, "In short, while a cosmopolitan view provides a useful and appropriate perspective on many of the world's problems and avoids the pitfalls of zero-sum thinking, it may discourage the very steps necessary to remedy the problems it illuminates."

He then asks if these options--zero-sum nationalism and impassive cosmopolitanism—are the only ones available. He answers, no, and calls for a *positive economic nationalism*, in which each nation's citizens take primary responsibility for enhancing the capacities of their countrymen for full and productive lives, but who also work with other nations to ensure that these improvements do not come at others' expense."

Positive economic nationalism rests on a "sense of national purpose—of principled historical and cultural connection to a common political endeavor." Included in this endeavor would be commitments to encourage new learning within the nation, smooth workforce

transition, educate and train nation's workers, improve the nation's infrastructure and create international rules of fair play.

The overarching intent of such an endeavor would be to enhance global welfare rather than to advance ones' nation's well-being at the expense of anothers'. Reich says, "We meet on an infinitely expanding terrain of human skills and knowledge. Human capital, unlike physical capital, has no inherent bounds. "

A critical element of Reich's account, for our purposes, is his concluding focus on human agency. He notes that if they were motivated by nothing other than a short-term economic calculus, none of the important constituencies would perceive a self interest in cooperating. Educated and affluent professionals would benefit most from laissez-faire cosmopolitanism, and workers would benefit from protectionism. Only an act of mutual, conscious, affirmative choice can motivate a better outcome. Reich concludes, "We can, if we choose, assert that our mutual obligations as citizens extend beyond our economic usefulness to one another, and act accordingly." (p 315)

6. As we saw earlier, **Hirst and Thompson** (1996) make a strong case that the extent, depth and pace of global economic integration, and in turn the presumed structural obsolescence of the nation-state, are overstated by both supporters and opponents of globalization. Hirst and Thompson also reject the argument that the social and cultural cohesion of the nation-state has been weakened as people reject the nationalisms sustained by the cold war and adopt cosmopolitan identities based on a globalized consumer culture. They say that the vast majority of people are not mobile across national boundaries, and that the nation-state still constitutes a primary shared community of fate.

Hirst and Thompson also challenge the idea that the growing importance of transnational corporations has the effect of weakening national identities and cultural commitments among its managers, employees, stockholders and others who come within its ambit. They say that most

multi-nationals have no need or desire to become "footloose transnationals." These corporations want the benefits that a home country base can provide, including a national business culture, a civil and social milieu, a well-functioning material and legal infrastructure, and the like.

Hirst and Thompson acknowledge that the increased necessity of multilateral and supranational relations under conditions of globalization has an impact on the autonomy and role of the nation-state. But they say that nation-states remain central: "Regulatory regimes, international agencies, common policies sanctioned by treaty, all come into existence because major nation-states have agreed to create them and to confer legitimacy on them by pooling sovereignty." In addition,

> "[N]ation-states are crucial agencies of representation...[They] ensure that, in a very mediated degree, international bodies are answerable to the world's key publics, and that decisions backed by the major states can be enforced by international agencies because they will be reinforced by domestic laws and local state power." (p 191)

However, Hirst and Thompson then admit,

> "Such representation is very indirect, but it is the closest to democracy and accountability that international governance is likely to get. The key publics in advanced democracies have some influence on their states and those states can affect international policies. Such influence is the more likely if the populations of several major states are informed and roused on an issue by the world 'civil society' of transnational non-governmental organizations (NGO's). Such NGO's, like Greenpeace and the Red Cross, are more credible candidates to be genuine transnational actors than are companies. It is easier to create a cosmopolitan agency for common world causes like the environment or human rights than it is to build a rootless business whose staff are asked to identify with its mundane activities above all else in the world." (p 191)

7. **Ann Marie Slaughter** (1997) considers two common accounts of the future of governance in a globalizing world, finds them wanting, and offers a third. According to Slaughter,

> "Globalization implies the erosion of national boundaries. Consequently, regulators' power to implement national regulations within those boundaries decline, both because people can easily flee their jurisdictions and because the flows of capital, pollution, pathogens and weapons are too great and sudden for any one regulator to control... The liberal internationalist response to these assaults on state regulatory power is to build a larger international apparatus. Globalization thus leads to internationalization, or the transfer of regulatory authority from the national level to an international institution." (p 192)

But Slaughter says that liberal internationalism

> "...is infeasible at best and dangerous at worse. It requires a centralized rule-making authority, a hierarchy of institutions, and universal membership. Equally to the point, efforts to create such an order have failed." (p 183)

On the other hand, she says, the "new medievalists" that celebrate the erosion of state control and the growth of a complex web of private spheres of authority miss the key point that

> "...[P]rivate power is still no substitute for state power. Consumer boycotts of transnational corporations destroying rain forests or exploiting child labor may have an impact on the margin, but most environmentalists or labor activists would prefer national legislation mandating control of foreign subsidiaries." (p 184)

Slaughter calls her alternative "transgovernmentalism:"

> "The state is not disappearing, it is disaggregating into its separate, functionally distinct parts. These parts—courts, regulation agencies, executives, and even legislatures—are networking with their counterparts abroad, creating a dense web of relations that constitutes a new, transgovernmental order. Today's international problems—terrorism, organized crime, environmental degradation, money laundering, bank failure, and securities fraud—created and sustain these relations." (p 184)

As examples of transgovernmentalism in action she cites:

* The Basle Committee on Banking Supervision, organized in 1988 by the governors of the central banks of the 12 major industrial countries to develop and informally enforce capital adequacy requirements among the banks under their supervision. This occurred independently of the apparatus of the World Bank, the IMF, or the G7.

* The fact that jurists from many nations, including Supreme Court justices, are citing each others' decisions as precedents for their own decisions, despite the fact that decisions rendered by outside courts can have no authoritative force. Thus a global common law is slowly emerging, with no need of a Supreme World Court or international treaties.

In response to the charge that transgovernmentalism is a technocracy of the policy elite, she says,

> "The strength of transgovernmental networks as a world order ideal will ultimately depend on their accountability to the world's peoples... Critics contend that government institutions engaged in policy coordination with their foreign counterparts will be barely visible, much less accountable to voters still largely tied to national territory... Citizens

> of liberal democracies will not accept any form of international regulation they cannot control. But checking unelected officials is a familiar problem in domestic politics. As national legislators become increasingly aware of transgovernmental networks, they will expand their oversight capacities and develop networks of their own." (p 197)

8. Like Hirst and Thompson, and Slaughter, **Robert Keohane** (1995) argues for the continued vitality of the nation-state under conditions of globalization:

"Only the state can solve the collective action problem for millions of individuals. A non-state global market world would be a painful world for many, if not most. People will demand a state that can protect them. They will create it. They will not let it fade."

He is optimistic about the future role of multilateral and supranational institutions. He offers a "rationalist-institutionalist" interpretation of changes in sovereignty under conditions of complex interdependence.

> "Sovereignty will no longer allow states to have supremacy over what occurs within their territories. What sovereignty does confer on states ... is legal authority that can either be exercised to the detriment of other states' interests or be bargained away in return for influence over others' policies. ... Sovereignty is less a territorially defined barrier than a bargaining resource for a politics characterized by complex transnational networks." (p 177)

As an example of states' bargaining away a portion of their sovereignty Keohane cites the negotiations leading to the 1989 Montreal Protocol on Protection of the Ozone Layer. In that case developing countries withheld their consent until the North had agree to provide funds to facilitate their transition from production and use of chlorofluorocarbons (CFC's) to less harmful substitutes.

Keohane says that the process of creating the new supranational institutions and regimes necessary under conditions of globalization will be contentious and lengthy, but on balance beneficial, because these institutions are necessary if economic growth is to continue. But, he says,

> "Adjustment costs will be high, hence there will be losers in the short run. There may also be long-run losers, since globalization will continue to put downward pressure on wages for those workers in developed countries who can be replaced by workers in poorer parts of the world or who compete in national labor markets with such workers.

> Hence domestic institutions that provide retraining, that spread the costs of adjustment, and perhaps that redistribute income on a continuing basis to globally disadvantaged groups will be essential corollaries to maintaining and strengthening international institutions in an age of globalization." (pp 183-184)

Keohane then offers an important caveat. Much of the world is far from the condition of complex interdependence that characterizes relations among the developed nations. In the many "zones of conflict", enmeshed in both civil and international strife,

> "...the traditional functions of sovereignty—to clarify boundaries, institutionalize practices of reciprocity, and limit intervention—will probably be more salient than its use as a resource in bargaining over issues involving transnational networks. [Here,] the danger that sovereignty was invented to deal with—chronic, ideologically justified intervention—will remain prominent... Nation-building was a bloody 300-year process in the West and is likely to continue to be conflict-laden in the future." (p 184-185)

In other words, sovereignty needs to be made secure before it can be bargained away. If Keohane is right, the world faces a unique challenge: at the same time that continued economic growth requires the developed nations to forego some sovereignty in order to construct new supranational regimes, the task of enhancing the sovereignty of developing nations needs to continue, and in fact to accelerate. If this is not done, the developing countries could face an uneven, distorted form of development, and become subject to newly intense forms of exploitation.

9. **Christopher Brown** (1995) acknowledges the likely benefits of globalization but recognizes the dangers of growing economic inequality. He notes that proposed mechanisms and policies to contain economic inequality will lie stillborn if the values and intent of society as a whole are not strongly supportive. He asks, much as Reich did, "What are the necessary social requirements that would allow a global politics of redistribution?"

Brown notes the many philosophies and ideologies that have pinned their hopes for a just, sustainable world on a universal system of values, including those identified with Christianity, Islam, the Enlightenment, Marxism and Western progressive thinking in general. Some authors, he says, look to the new social movements, notably environmentalism, as possible sources of a new common set of global values. Others try to find ways that seemingly particularistic identities

such as race, ethnicity and nationalism might, if differently understood, provide a common normative anchor for global society.[134]

Brown surveys these attempts and concludes, for all the obvious reasons, that "it is difficult, if not impossible, to see which way the wind is blowing when it comes to assessing the prospective growth of common interests and identities in the world today." However, he notes that this pervasive uncertainty might itself suggest a set of common norms. He offers as a candidate "communitarian relativism," which affirms the importance of communitarian structures as the basis for social cohesion, yet refrains from claiming the fundamental superiority of any one structure over another. Brown argues that particular *practices* of communitarian structures (e.g., genocide or ritual clitorectomy) can be criticized while the legitimacy and co-equality of the structure itself is affirmed. He acknowledges the objection that communitarian structures *require* a sense of the superiority, even if only subtly stated, in order to sustain allegiance. He answers that while this has indeed been the case historically we are now entering a new stage of history, one in which old, seemingly inherent patterns of human life are understood to be social constructs and subject to human agency.

Brown continues by suggesting that a deeply held set of universal values, sustaining a "global community," is not necessary in order to achieve a just and sustainable world order. He says,

> "...many of the positive features that a putative world community might provide could be found within the scope of an association of communities founded on the rule of law but not united in any global project—international society as a practical association...Such an association could be based on the recognition of a general duty to relieve suffering by mutual aid and assistance, and, thus, would mandate substantial redistributions of income and wealth, but the basic premise would be that the pursuit of social justice and a deeper sense of community is something that makes more sense locally than on a global scale—that the most important 'spheres of justice' are those which are internal to particular societies rather than cross-cultural in aspiration...The goal would be an association of socially just communities which was, itself, constructed on socially just lines...The idea of a plurality of morally autonomous, just communities relating to one another in a

[134] Reich's "positive economic nationalism" might be taken as an example of this.

framework of peace and law seems rather more appropriate to today's world than does its alternative." (pp 105-6)

10. In *The Clash of Civilizations* (1996), **Samuel Huntington** takes issue with many of the current accounts of globalization. He contends that:

* Although modernization is allowing many nations to industrialize and integrate economically with the rest of the world, modernization is distinct from Westernization, and is producing neither a universal civilization in any meaningful sense nor the Westernization of non-Western societies.

* A *civilization-based* world order is emerging: "Peoples and countries with similar cultures are coming together. Peoples and countries with different cultures are coming apart.[135] Everywhere, people are asking, 'who are we?' And the answers come down to 'blood and belief, family and faith.'"

* The West is declining in relative influence; Asian civilizations are expanding their economic, military and political strength; Islam is exploding demographically; and non-Western civilizations in general are reaffirming the value of their own cultures.

* The West's universalistic pretensions increasingly bring it into conflict with other civilizations, most seriously with Islam and China. Avoidance of a global war of civilizations depends on world leaders accepting and cooperating to maintain the multicivilizational character of global politics.

Huntington characterizes a "civilization" as the broadest possible cultural entity, generally though not always encompassing a dominant language type, ethnicity and religious tradition, and generally very long-lived, although not immortal and certainly mutable. He notes

[135] He says, "People separated by ideology but united by culture come together, as the two Germany's did and as the two Koreas and the several Chinas are beginning to. Societies united by ideology or historical circumstances but divided by civilization either come apart, as did the Soviet Union, Yugoslavia, and Bosnia, or are subjected to intense strain, as is the case with Ukraine, Nigeria, Sudan, India, Sri Lanka, and many others." (p 28)

that there is wide agreement among scholars on the identification of about 5 to 10 major existing civilizations. For *The Clash* he specifies eight: Sinic, Japanese, Hindu, Islamic, Western, Orthodox, Latin American and (possibly) African.[136] **IID-23** describes and compares these civilizations.

Huntington notes and rejects the globalist argument that greater economic integration, communication and modernization will lead to the adoption of common core values. He argues that the identifiable characteristics of Western civilization—which include "the Greco-Roman legacy, Catholicism and Protestantism, separation of spiritual and temporal authority, rule of law, social pluralism, representative bodies of governance, and individualism"--preceded industrialization and modernization by several centuries. Modernization, by contrast, involves "industrialization, urbanization, increasing levels of literacy, education, wealth and social mobilization, and more complex and diversified occupational structures." Some of the items in the first list certainly appear conducive to some in the second, but the generality or strength of this relation is not obvious. Huntington's argument implies that it is plausible to imagine, say, Sinic or Islamic civilizations, some fifty years hence, with all "modern" qualities listed above, but with social structures and cultural values very different from, or even antithetical to, those of the West.

Huntington doesn't deny that global integration of market economies is a powerful force for change. Indeed, he argues that it is precisely the tensions caused by this integration that are motivating countries to seek allies beyond the level of the nation-state. But he suggests that when countries consider whether to throw their lot in with an atomized world consumer culture overlain by a thin set of coordinating institutions, or to build common cause with their co-civilizationists, the latter option wins easily.

---

[136] Huntington also identifies a number of minor existing civilizations, including Anglophone Caribbean, Ethiopian, Haitian, and perhaps Jewish and Buddhist.

BOX IID-23. HUNTINGTON'S CIVILIZATIONS

In *The Clash of Civilizations* Huntington (1996) identifies eight major existing civilizations, as described and compared below.

Sinic. the common culture of China and the Chinese communities of Southeast Asia and elsewhere outside of China as well as the related cultures of Vietnam and Korea. Chinese civilization has existed since perhaps 2500 BCE.

Islamic. Includes all the followers of Islam. There are many distinct cultures or sub-civilizations within Islam, including Arab, Turkic, Persian, and Malay. Islam arose in 7th century Arabia.

Hindu. Includes India and some surrounding territories. Hindu civilization has existed since at least 1500 BCE.

Western. Europe, North America, plus other European settler countries such as Australia and New Zealand. Most of the distinct features of Western Civilization were evident by 700 CE.

Latin America. Mexico, Central and South America, and many Caribbean countries. Huntington acknowledges that many would consider Latin American civilization a part of Western Civilization.

African. All of Africa other than the Islamic north and east coast. Ethiopia may be a separate civilization or sub-civilization.

Orthodox. The Christian lands that broke from Rome in the 10th century. The border between Orthodox and Western civilization stretches from the North Sea to the Mediterranean, with the Baltic countries in the West and most of Ukraine and the Balkans in the East.

Japanese. Evolved from Chinese civilization but is now separate. Emerged between 100-400 CE.

Statistical Comparisons of Civilizations

	territory under political control, 1993, thous mi2; (%)		populations, 1993, thous.	percent of world population 2010	2025	share of world GDP, 1992
Sinic	3,923	7.5	1,340,900	22.3	21.0	10.0
Islamic	11,054	21.1	927,600	17.9	19.2	11.0
Hindu	1,279	2.4	915,800	17.1	16.9	3.5
Western	12,711	24.2	805,400	11.5	10.1	48.9
Latin American	7,819	14.7	507,500	10.3	9.2	8.3
African	5,682	10.8	392,100	11.7	14.4	2.1
Orthodox	7,169	13.7	261,300	5.4	4.9	6.2
Japanese	145	0.3	124,700	1.8	1.5	8.0

Huntington acknowledges the existence of a global, largely westernized, capitalist and professional elite, but doubts that the values celebrated by this sector are widely shared:

> "Each year about a thousand businessmen, bankers, government officials, intellectuals and journalists from scores of countries meet in the World Economic Forum in Davos, Switzerland. Almost all these people hold university degrees in the physical sciences, social sciences, business, or law, work with words and/or numbers, are reasonably fluent in English, are employed by governments, corporations and academic institutions with extensive international involvement's, and travel frequently outside their own country. They generally share beliefs in individualism, market economies, and political democracy, which are also common among people in Western civilization. Davos people control virtually all international institutions, many of the world's governments, and the bulk of the world's economic and military capabilities. The Davos Culture hence is tremendously important. Worldwide, however, how many people share this culture? Outside the West, it is probably shared by less than 50 million people or 1 percent of the world's population and perhaps by as few as one-tenth of 1 percent of the world's population." (p 57)

Huntington's argument suggests that in the developing countries modernization will proceed more rapidly and successfully than will the spread of Western social norms. After a certain point the Western-oriented elites in these countries may perceive that their interests could be better served by re-identifying with their civilizational roots.[137]

Huntington uses his analysis to motivate a *realpolitik* for the 21st century. He offers a long list of reasons why we can expect international conflict to increasingly take the form of conflict between nations of different civilizations. Among these is that

> "It is human to hate. For self-definition and motivation people need enemies: competitors in business, rivals in achievement, opponents in politics. They naturally distrust and see as threats those who are different and have the capability to harm them. The resolution of one conflict and the disappearance of one enemy generate personal, social and political forces that give rise to new ones... In the contemporary world [the new enemy] is more and more likely to be people from a different civilization." (p 131)

In order to prevent inevitable conflicts between nations of different civilizations ("fault line wars") from escalating into conflicts between civilizations themselves, Huntington suggests that two rules be followed:

---

[137] Huntington concedes that the West will remain the most economically powerful civilization well into the 21st century, but affirms that its relative power will inevitably decline. At some point Sinic civilization will regain its former rank, and "The two-hundred-year Western 'blip' on the world economy will be over." (p 88)

1) *the abstention rule:* The core state of a civilization abstains from intervening in conflicts within other civilizations[138]; and

2) *the joint mediation rule:* Core states negotiate with each other to contain or halt fault line wars between states or groups of states from their civilizations.

Beyond this, Huntington stresses how important it is that the West negotiate its coming period of relative decline in a way that does not jeopardize its own integrity or encourage major world conflict. On the one hand the West needs to disabuse itself of the illusion that Western liberal democracy and culture is the inevitable, or the most desirable, way of life for all humankind: "In the emerging world of ethnic conflict and civilizational clash, Western belief in the universality of Western culture suffers three problems: it is false; it is immoral; and it is dangerous."

At the same time, Huntington says, the West, and especially hegemonic America, should strongly reject calls to transform into a multicultural civilization. He says that in a world where identity, loyalty and cooperation are based on culture, a truly multicultural civilization becomes dysfunctional. Rather, the West needs to "...reaffirm its Western identity and unite to renew and preserve itself against challenges from non-Western societies."

At the very end of his account Huntington concedes the possibility of a stage of human development beyond that of "civilizations." He says that for all their important differences, there is at least a "thin" morality common to the world's major religions and the civilizations they support. "If humans are ever to develop a universal civilization, it will emerge gradually through the exploration and expansion of these commonalities." In order to encourage this Huntington adds

3) *the commonality rule:* "...peoples in all civilizations should search for and attempt to

---

[138] Huntington shows that all current civilizations, with the possible exception of the Middle East, have a single dominant or potentially dominant state that could serve as a hegemon to maintain peace among the states of that civilization and lead negotiations with other civilizations.

expand the values, institutions, and practices they have in common with peoples of other civilizations."

II.D.5.b. Analysis: What does it mean for Scenario 3?

1. It is difficult to see how Scenario 3 could be achieved if continued growth and globalization have the impacts on the nation-state, and on social commitment and values, foreseen by Ohmae. Of course, if people come to share the techno-libertarian values that Ohmae celebrates then Scenario 3 would not be desired in any event. We might assume that thin structures of inter-regional coordination could ensure stability of investment flows and thus economic growth. We might also assume that if major ecological threats emerged sufficient social and technological resources could be mobilized to counter them. But in Ohmae's anarcho-capitalist world the political structures necessary to ensure distributive equity would not exist. As noted, Ohmae views this as a positive feature, not a negative one.

2. Although Rosenau's account of the end of the nation-state is nuanced and wistful, while Ohmae's account is brash and confident, it is equally discouraging so far as the prospects for Scenario 3 are concerned. Scenario 3, after all, is precisely the sort of grand metanarrative that post-modernists such as Rosenau believe are no longer tenable. While environmental concerns figure prominently in Rosenau's vision, the political structures needed to address these become, in Rosenau's account, "obscure," "in flux," "temporary," "ad hoc" and "diffused." Governance regimes of this sort would be even less able to address the distributional goals of Scenario 3.

3. Mathews forecasts the decline of the nation-state in a manner similar to that of Ohmae and Rosenau, but differs from Ohmae in acknowledging the high social costs this might entail, and from Rosenau in calling for an ambitious collective commitment to overcome these. The

institutions that embody this commitment are not nation-states but rather NGO's, a socially-conscious business sector and unspecified "new political entities."

Can such a governance regime support the achievement of Scenario 3? Under Mathews' pessimistic scenario, clearly not. But her optimistic scenario summons up images of a confident, engaged, policy-savvy world community enthusiastically networking to take on the big challenges of the 21st century. It is not difficult to imagine that a global elite of this caliber could negotiate agreements that would promote stable economic growth, high growth rates in developing countries, and environmental integrity. It would clearly be in the self-interest of the leadership and stakeholders of globalized NGO's, transnational corporations and global administrative committees to have this happen. But interests regarding distributional equity are less clear. Even in her most optimistic scenario, Mathews implies that the most that could be done to address this concern is "providing a modicum of job security (and) avoiding higher unemployment."

4. Cerny offers an account of the decline of the nation-state not dissimilar to that of the three authors just reviewed, but stripped of their attempts to cast it in an appealing light. His "positive" scenario forecasts a minimalist state serving the interests of global capital. His "negative" scenario forecasts a neofeudalism which may or may not "tend towards chaos." In neither instance is Scenario 3 a credible option.

5. Reich goes further than any of the authors reviewed except Huntington in teasing out the strands of a full ideational narrative that could possibly motivate the reforms he wants to see in order to realize the values he deeply holds. He says that if the professional classes of the world shun nationalism and cosmopolitanism, and embrace positive economic nationalism, they will be motivated to allow themselves to be taxed at levels sufficient to provide workers and the poor with training and other services sufficient to keep inequality from increasing so high that it endangers social cohesion and continued economic growth.

In Section II.B.3 we saw that education and training of the sort emphasized by Reich cannot be counted on to greatly reduce aggregate economic inequality in mature industrial countries. Scenario 3, however, only looks to hold the line on inequality. If disequalizing forces are mild, Reich's training and education package might play an important role in offsetting these.

Reich suggests that the professional classes might be motivated to embrace positive economic nationalism out of fear of the consequences if they do not, but recognizes that this motivation is not a sturdy one and won't truly supply the commitment and creativity needed for the long haul. The deeper motivation he appeals to is a sort of inclusive self-interest informed by a rational, secular humanism. He says, in essence, "imagine how wonderful the world could be if we all cooperated."

The important question then becomes, is this motivation powerful enough to resist the divisive forces that Reich himself attributes to globalization? Ohmae and Huntington, at least, would say no. At the bottom of these differences lie different beliefs about the nature of human nature.

6. Accounts like Hirst and Thompson's, Keohane's, and Slaughter's, all of which affirm a continuing, albeit modified, role for the nation-state, are encouraging insofar as the prospects for Scenario 3 are concerned. The elements of Scenario 3 clearly require major collective initiatives, and nation-states are today the premier collective institutions.

Some of the arguments of these authors raise questions. Hirst and Thompson's seeming confidence in the ability of NGO's to serve as a countervailing force against global capital may be misplaced. Slaughter is perceptive in pointing out that NGO's are more effective as strong pressure groups acting on strong governments than they are as substitutes for weak governments. Keohane's easy assurance in proclaiming that under globalization "institutions that...redistribute income on a continuing basis to globally disadvantaged groups will be essential..." appears to greatly underestimate the massive challenges of that task. Slaughter's account of

"transgovernmentalism" suggests a useful component of a more complex multilateral response to globalization rather than a full alternative in itself.

7. C. Brown's vision of "communitarian relativism" suggests an intriguing middle position for those who can't stomach the post-modernism of Rosenau but feel that the liberalism of Reich and Keohane somehow misses the profound challenge that globalization poses for cultural norms and political practice. Further, while Reich struggles to devise a project that might be compelling for all the peoples of the world, Brown settles for a far more modest, and thus perhaps more realistic, set of mutual agreements among otherwise normatively diverse polities. But is communitarian relativism up to the task of guiding a globalizing world through the transitions called for in Scenario 3? I sense it might be better suited as the political philosophy of a mature world, say, the world of 2150 after the Scenario 3 transitions have been achieved.

8. Huntington's account seems like a throwback to classic realism, replete with hegemons, coalitions and billiard balls, except that autonomous civilizations now replace autonomous nation-states. If this is the shape of the world to come, how might that affect the prospects for Scenario 3?

The goals of economic stability and maintenance of ecological integrity are largely global commons concerns, and should be easier to achieve in a regionalized world of 7 or 10 civilizations than in today's world of 133 states, assuming that the former have the capacity to negotiate and hold their internal constituencies, and one another, accountable.

The equity goals set out in Scenario 3 are appropriate for a complex, interdependent world. Under that circumstance economic inequalities between and within countries generate discontent and conflict. But Huntington's civilizations (Japan excepted) are large enough geographically, and rich enough in natural resources and people, to set their sights almost independently of one another, should they so choose. We might imagine a civilization choosing a development path that took into account important cultural values, even at some loss in economic growth. A nation that attempted to do that today would quickly be marginalized, materially

deprived, and subject to military aggression. But the continent--sized civilizations that Huntington projects would be more secure--materially, militarily, and culturally. Further, if strong inter-civilizational norms of non-interference became deeply established, as Huntington recommends, the range of developmental options that each civilization might pursue is greatly broadened.

Similarly, some civilizations might choose an internal distribution of income more egalitarian than the 80:20 ratio of 6.5 to 1 specified in Scenario 3, while other civilizations might be comfortable with a less equal distribution, especially, perhaps, if it were tempered by strong communal norms of obligation and reciprocity. The point is that the cultural distance between civilizations that Huntington foresees lessens the experience of inequity that persons in different civilizations might have when otherwise comparing their lots. Thus the combination of large physical scale and internal cultural homogeneity that characterize Huntington's civilizations appears to make the achievement of Scenario 3 simultaneously both easier and in some respects less critical.[139]

II.D.6. ASSESSMENT

The vertical axis of **IID-24** shows the six aspects of Scenario 3 that we've focused on in these notes. All of them involve collective action on a global scale. I've ranked them according to my judgment, based on this review, of how difficult it would be to successfully implement the policies that would achieve these goals, assuming we desired to have that happen, given the current distribution of individualist/competitive and communitarian/cooperative values.

The horizontal axis displays the impact that globalization could have on the degree to which these individualist/competitive and communitarian/cooperative values predominate among and within people and societies.

---

[139] However, inter-civilizational agreement would still need to be reached concerning global environmental goals and global economic growth rates.

BOX IID-24. SCENARIO 3, COLLECTIVE ACTION, AND GLOBALIZATION

"difficult" global collective goals

* *slower growth in high-income countries* **control of destabilizing technological change*	3	6	9
* *stable 80:20 ratio* * *ecological integrity* * *higher growth rates in low-income countries*	2	4	6
**stable economic growth*	1	2	3

"easier" global collective goals

stronger communalist/cooperative values

stronger individualist/competitive values

The numbers in each cell represent an ordinal ranking of the difficulty of successfully implementing the italicized policies, with 1 = least difficult and 9 = most difficult.

The goal of control of destabilizing technological change is discussed in detail in Section II.E, following.

Globalization might make collective action more difficult either through *structural impacts,* as might occur, say, if global financial integration makes it impossible for nations to provide social welfare safety nets, or through *cultural impacts,* as might occur, for example, if people come to experience markedly greater satisfaction participating in globalized commercial entertainment regimes than they do participating in non-market recreations with family members.

On the other hand, globalization could make collective action easier, say by reducing global transactions costs (a *structural* impact) or by fostering a convergence of social and political values around the world (a *cultural* impact.)

Clearly, to the extent that globalization makes collective action more difficult, Scenario 3 becomes more difficult to achieve.

As we've seen, authors differ widely in their assessment of the impacts of globalization. These differences reflect different understandings of objective conditions and processes, different beliefs about the nature of human nature, different personal values held by the authors, and different intentions that the authors had in preparing and sharing their assessments.

If globalization has the impacts that authors such as Ohmae, Rosenau and Cerny foresee, Scenario 3 would be unachievable. If globalization has the impacts that Mathews foresees, the implications for Scenario 3 are unclear but not encouraging. If globalization has impacts of the sort that Hirst and Thompson, Reich, Keohane and Huntington foresee, Scenario 3 gets a reprieve and is at least worth further consideration.

The weakening of the nation-state weakens the prospects for Scenario 3, but this can be compensated for if new supranational structures capable of delivering public goods are formed, either on a global scale or on Huntington's civilizational scale.

A major challenge facing any politics of global distributional equity is how to structure the organizations and coalitions of mass power necessary to articulate a program and carry it to fulfillment. In the industrial North, efforts in support of distributional equity on the national level have historically been pushed by parties grounded in organized labor and its allies. If we cannot

imagine an analogous process taking place on an international or otherwise global scale, it will be difficult to make a credible case that the equity elements of Scenario 3 can be achieved.

In Section I.B.4 we constructed four candidate advocated political economy scenarios: techno-globo-neoliberalism, social-democratic internationalism, Green sustainability, and civilization-of-civilizations.[140] Clearly, the political economy scenario that appears to be most compatible with—in fact, essential for—quantitative Scenario 3 is that of social-democratic internationalism.[141]

The human future is constrained but not determined. Within any set of constraints many futures are possible, and which ones are realized importantly depends upon human agency. If Scenario 3 and social-democratic internationalism are to be credible they must at a minimum be strongly desired by many people sharing a collective commitment to making them happen.

Next steps

Our analysis of the practicability of Scenario 3 under conditions of globalization has been moderately encouraging, but with many important provisos as just noted. However, there is an additional topic that needs to be considered: the prospect of profound technological change. Scenario 3 relies upon technological change to generate the efficiencies and new services that will allow output to grow, and to do so without endangering the environment. But technologies have impacts that go far beyond their first-order intended impacts. As we'll see in the next section, the suite of new technologies currently under development promise to be of enormous social, political, and cultural consequence. If these consequences are thought to be incompatible with the realization of Scenario 3, then means need to be devised to proscribe these technologies or otherwise bring them within the ambit of societal governance. If such control is judged to be

[140] See Boxes IB-15 and IB-16 of that section.

[141] As noted in Section II.C, a fair number of reformist elements of the scenario of Green sustainability can be integrated into the scenario of social-democratic internationalism.

prohibitively difficult, then alternatives to Scenario 3 and social-democratic internationalism need to be considered.

II.E TECHNOLOGICAL CHANGE

Summary

Scenario 3 depends on continued technological innovation to ensure continued economic growth. We need to ask if there are features of such ongoing technological change which might be objectionable, or which might even erode the conditions necessary for the achievement of Scenario 3.

Section II.E.1.a reviews forecasts of technological change for the period 1966-2000. These forecasts were wrong in many details but accurately predicted broad trajectories. Section II.E.1.b reviews forecasts for 2000-2025. We conclude that these forecasts are reasonable ones. Section II.E.1.c reviews projections of technologies beyond 2025. These are necessarily more speculative, but are consistent with past and current trends and appear reasonable in broad outline.

The technologies forecast in the studies reviewed promise to increase the ability of humankind to manipulate the natural world by many orders of magnitude. Their widespread application has the potential to profoundly change the nature of life on earth, including human life. Importantly, these technologies are celebrated by a great many of their developers as driven by imperatives resistant to social control. Techno-global neoliberalism fosters the development of these technologies in ways that reinforce its present commanding position. If Scenario 3 is to be seen as a credible alternative, its supporters will need to understand the profound implications of the current technological trajectory, and establish the popular support and the institutions necessary to allow effective social oversight and regulation.

II.E.2 reviews the powerful new human genetic and reproductive technologies. These technologies have the potential to be uniquely destabilizing. If the goals of Scenario 3 and social-

democratic internationalism are to be realized many of the new human genetic technologies will need to be constrained and some will need to be proscribed.

Section II.E.3 documents the vision of the genetically-enhanced human future that has, with little public attention, become almost a consensus view among prominent scientists in genetics, biotechnology and related fields.

Section II.E.4 surveys policies that have been proposed and enacted to bring the new human genetic technologies under responsible societal control. We see that the needed policies have in fact already been enacted, piecemeal, in one country or another. The challenge before us now is to have these policies adopted universally.

Section II.E.5 assesses the state of pubic opinion concerning biotechnology issues in general and human genetic technologies in particular. We see that opinion on these topics is at the moment still unformed, and survey responses vary widely depending on the wording of the questions asked. However, careful comparison of survey questions suggests that large numbers of people are able to make thoughtful distinctions between those technologies they would like to see allowed and those they would like to see proscribed.

Section II.E.6 concludes by assessing the implications of our review of the challenges of technological change for the credibility of Scenario 3.

II.E. TECHNOLOGICAL CHANGE

Scenario 3 depends upon ongoing technological innovation to ensure continued, and ecologically benign, economic growth. However, we need to ask if there are features of such ongoing technological change that might be objectionable, or that perhaps might even erode the conditions necessary for the achievement of Scenario 3. If so, we need to ask how we might constrain or forego these technologies, and at what cost. If the means by which these technologies are to be constrained are themselves objectionable or costly, then Scenario 3 might not be desirable, credible and compelling after all, and other scenarios would need to be reconsidered.

In this section we review and evaluate past and current projections of technological change. Then we assess the bearing that currently projected technological changes may have on the prospects for our quantitative and narrative scenarios of global development, and for Scenario 3 in particular.

II.E.1. REVIEW OF PROJECTED TECHNOLOGICAL TRAJECTORIES

We begin by reviewing Kahn and Wiener's 1965 forecast of technological innovations likely to be realized by 2000. This allows a first, very rough assessment of the utility of such projections. Then we review the 1997 forecasts made by Coates et al. of technologies likely to be realized by 2025. Finally we review forecasts offered by a variety of authors of the nature of technologies that might be realized later in this century, and beyond.

II.E.1.a. The Year 2000: Herman Kahn and Anthony Wiener (1967)

Kahn and Wiener assumed that human civilization would develop along a set of trends that they suggested had been underway in the West for at least the last two centuries, and which, they believed, were about to spread to the rest of the world. These trends are shown in **IIE-1**.

BOX IIE-1. Kahn and Wiener's List of Long-Term Trends
[Kahn and Wiener (1967)]

1. increasingly empirical, this-worldly, secular, humanistic, pragmatic, utilitarian, contractual, epicurean or hedonistic cultures
2 bourgeois, bureaucratic, meritocratic, democratic (and nationalist?) elites
3. accumulation of scientific and technological knowledge
4. institutionalization of research, development, innovation and diffusion
5 worldwide industrialization and modernization
6. increasing affluence and (recently) leisure
7. population growth
8. urbanization and (soon) the growth of megalopolises
9. decreasing importance of primary and (recently) secondary occupations
10. increased literacy and education
11. increasing capacity for mass destruction
12. increasing tempo of change
13. increasing universality of these trends

The growth of technological knowledge is identified explicitly as one of these trends. Nearly half of the trends shown in IIE-1 are bound up in one way or another with the development and spread of technology. Kahn and Wiener recognized the critical importance of technology and devoted a full chapter of their book to a review of technological innovations we could expect by 2000. Their forecast is shown in **IIE-2.**

An assessment of this forecast is shown in **IIE-3.** Perhaps 40-50% of the items listed might be considered to have come to pass. This figure rises to 50-60% if we include those items that are today technologically feasible but which have not been developed largely because the need or desire for them has not been strong. If we include the close calls--those innovations that we might reasonably expect will be realized within the next 10 to 15 years --the percentage rises to 60-70%.

The items on Kahn and Wieners' list can be classified according to more general purposes, functions or applications. One classification is shown in **IIE-4.**

II.E.1.b. 2025: Scenarios of US and Global Society Reshaped by Technology: Joseph Coates, John Mahaffie and Andy Hines (1997)

Coates et al. present a carefully considered forecast of technological innovations that they expect should be realized during the first quarter of the 21st century. Some of the major innovations they forecast are shown in **IIE-5.**

Coates et al. assume a "no surprises" scenario of social, political and economic development that provides the context and motivation for the scientific and technological developments analyzed and forecast. For the most part these projections represent a continuation through 2025 of the civilizational trends identified by Kahn and Wiener in 1965.

Four "enabling technologies" are identified as "primary drivers of change" over the coming quarter century: information technologies, materials technologies, genetic/biological technologies, and energy technologies. At a finer scale of resolution the items in the Coates et al. list fall pretty neatly into the categories derived from Kahn and Wiener's list shown in IIE-4

BOX IIE-2. Kahn and Weiner's List of Likely Technological Innovations by 2000

In their book, *The Year 2000: A Framework for Speculation on the Next Thirty-Three Years*, Kahn and Weiner presented this list of "One Hundred Technological Innovations Very Likely in the Last Third of the Twentieth Century."

1. Multiple applications of lasers and masers for sensing, measuring, communication, cutting, heating, welding, power transmission, illumination, destructive (defensive), and other purposes
2. Extreme high-strength and/or high-temperature structural materials.
3. New or improved superperformance fabrics (papers, fibers, and plastics).
4. New or improved materials for equipment and appliances (plastics, glasses, alloys, ceramics... , and cements).
5. new airborne vehicles (ground-effect machines, VTOL/STOL, super-helicopters, giant and/or supersonic jets.
6. Extensive commercial application of shaped-charge explosives.
7. More reliable and longer-range weather forecasting.
8. Intensive and/or extensive expansion of tropical agriculture and forestry.
9. New sources of power for fixed installations (e.g., magnetohydrodynamic, thermionic..., and radioactivity).
10. new sources for power for ground transportation (storage battery fuel cell, propulsion [or support] by electro-magnetic fields, jet engine, turbine, and the like).
11. Extensive and intensive worldwide use of high altitude cameras for mapping prospecting, census, land use, etc.
12. New methods of water transportation (such as large submarines, flexible and special purpose "container ships")
13. Major reduction in hereditary and congenital defects
14. Extensive use of cyborg techniques (mechanical aids/ substitutes for human organs, senses, limbs, etc.)
15. new techniques for preserving or improving the environment
16. Relatively effective appetite and weight control
17. New techniques and institutions for adult education
18. New and useful plant and animal species
19. Human "hibernation" for short periods (hours or days) for medical purposes.
20. Inexpensive design and procurement of unique items through computerized analysis & automated production
21. Controlled and/or supereffective relaxation and sleep
22. More sophisticated architectural engineering (e.g. geodesic domes, "fancy" stressed shells, pressurized skins,)
23. New or improved uses of the oceans (mining, extraction of minerals, controlled "farming" source of energy)
24. Three-dimensional photography, illustrations, movies, and television
25. Automated or more mechanized housekeeping and home maintenance
26. Widespread use of nuclear reactors for power
27. use of nuclear explosives for excavation and mining, generation of power, creation of high temperature-high-pressure environments, and/or as a source of neutrons or other radiation
28. General use of automation and cybernation in management and production
29. Extensive and intensive centralization (or automatic interconnection) of current and past personal and business information in high-speed data processors
30. Other new techniques for surveillance, monitoring, and control of individuals and organizations
31. Some control of weather and/or climate.
32. Other experiments with the overall environment (e.g., permanent increase in C-14 and temporary creation of other radioactivity by nuclear explosions, and the deliberate increasing generation of CO2 in the atmosphere.)
33. New and more reliable "education" & propaganda techniques for affecting public and private human behavior.
34. Practical use of direct electronic communication with and stimulation of the brain
35. Human hibernation for relatively extensive periods (months to years)
36. Cheap and widely available central war weapons and weapon systems
37. New and relatively effective counterinsurgency techniques (and perhaps also insurgency techniques)
38. New techniques for very cheap, convenient, and reliable birth control
39. New, more varied and more reliable drugs for control of fatigue, relaxation, alertness, mood, personality, etc.
40. Capability to choose the sex of unborn children.
41. Improved capability to "change" sex of children or adults
42. Other genetic control and/or influence over the "basic constitution" of an individual.
43. New techniques and institutions for education of children
44. General and substantial increase in life expectancy, postponement of aging, and limited rejuvenation
45. Generally acceptable and competitive synthetic foods and beverages (e.g., carbohydrates, fats, proteins, enzymes, vitamins, coffee, tea, cocoa, and alcoholic liquor)
46. "High quality" medical care for undeveloped areas (medical aides, referral hospitals, artificial blood plasma)
47. Design and extensive use of responsive and supercontrolled environments for private and public use

(more...)

BOX IIE-2. (cont'd)

48. Physically nonharmful methods of overindulging
49. Simple techniques for extensive and "permanent" cosmetological changes (perhaps complexion and skin color)
50. More extensive use of transplantation of human organs
51. Permanent manned satellite and lunar installations-interplanetary travel
52. Application of space life systems or similar techniques to terrestrial installations
53. Permanent inhabited undersea installations and perhaps even colonies
54. Automated grocery and department stores
55. Extensive use of robots and machines "slaved" to humans
56. New uses of underground "tunnels" for private and public transportation and other purposes
57. Automated universal (real time) credit, audit and banking systems
58. Chemical methods for improving memory and learning
59. Greater use of underground buildings
60. New and improved materials and equipment for buildings and interiors (e.g., variable transmission glass, heating and cooling by thermoelectric effect, and electroluminescent and phosphorescent lighting).
61. Widespread use of cryogenics
62. Improved chemical control of some mental illnesses and some aspects of senility.
63. Mechanical and chemical methods for improving human analytical ability more or less directly
64. Inexpensive and rapid techniques for making tunnels and underground cavities in earth or/or rock
65. Major improvements in earth moving and construction equipment generally
66. New techniques for keeping physically fit and/or acquiring physical skills
67. Commercial extraction of oil form shale
68. Recoverable boosters for economic space launching
69. individual flying platforms
70. Simple inexpensive home video recording and playing
71. Inexpensive high-capacity, worldwide, regional and local communication (perhaps using satellites & lasers)
72. Practical home and business use of "wired" video communication for both libraries or other sources) and rapid transmission and reception of facsimiles (possibly including news, library materials, commercial announcements, instantaneous mail delivery, other printouts, and so on)
73. Practical large-scale desalination
74. Pervasive business use of computers for the storage, processing and retrieval of information
75. Shared time (public and interconnected?) computers generally available to home & business on a metered basis.
76. Other widespread use of computers for intellectual and professional assistance (translation, teaching, literature search, medial diagnosis, traffic control, crime detection, computation, design, analysis, etc.
77. General availability of inexpensive transuranic and other esoteric elements
78. Space defense systems
79. Inexpensive and reasonably effective ground-based BMD
80. Very low-cost buildings for home and business use
81. Personal "pagers" (perhaps even two-way pocket phones) and other personal electronic equipment, for communication, computing and data processing program
82. Direct broadcasts from satellites to home receivers
83. Inexpensive (less than $20), long lasting, very small battery operated TV receivers
84. Home computers to "run" household and communicate with outside world
85. Maintenance-free, long life electronic and other equipment
86. Home education via video and computerized and programmed learning
87. Stimulated and planned and perhaps programmed dreams
88. Inexpensive (less than one cent a page),rapid high-quality black and white reproduction; followed by color and high-detailed photography reproduction-perhaps for home as well as office use
89. Widespread use of improved fluid amplifiers
90. Conference TV (both closed circuit and public communication system)
91. Flexible penology without necessarily using prisons (by use of modern surveillance, monitoring, and control)
92. Common use of (long lived?) individual power source for lights, appliances, and machines
93. Inexpensive worldwide transportation of humans and cargo
94. Inexpensive road-free (and facility-free) transportation
95. New methods for rapid language teaching
96. Extensive genetic control for plants and animals
97. New biological/chemical methods to identify, trace, incapacitate, or annoy people for police and military uses
98. New and possibly very simple methods for lethal biological and chemical warfare
99. Artificial moons and other methods for lighting large areas at night
100. Extensive use of "biological processes" in the extraction and processing of minerals

BOX IIE-3. Assessment of Kahn and Wiener's 1967 Forecasts

I assessed each of the100 items shown in Box IIE-2 according to how closely they fit the descriptions listed below. "Sympathetic" assessments resolved ambiguities in ways that gave a higher percentage of good predictions. "Unsympathetic" assessments gave a lower percentage of good predictions.

description	sympathetic assessment	unsympathetic assessment
The innovation has occurred, precisely as or very nearly as he described it	41	26
The innovation has occurred, at least roughly or in the spirit of his description	10	15
The innovation has not occurred but is clearly feasible and is reasonably likely over the next 10-20 years	10	10
The innovation is clearly feasible, but the need or desire for it has not developed	13	9
The feasibility of the innovation is still uncertain; at best its realization is many decades away	13	23
The innovation is very likely infeasible, and the authors should have known better than to include it in this list	4	9
The authors' description is too general or ambiguous to allow an assessment to be made	9	8

BOX IIE-4. A Classification of Kahn and Weiner's 100 Technological Innovations

Kahn and Wiener's predictions, shown in Box IIE-2, can for the most part be assigned to one or another of the general categories of purpose, function or application shown below:

*Manufacture and build things to higher performance standards, faster and cheaper.
*Transport matter, energy and information, in more flexible forms, faster and cheaper.
*Manipulate the biogeophysical processes of the earth.
*Manipulate the bodies and behaviors of plants and animals.
*Enhance the physical and mental condition and abilities of children and adults.
*Expand options concerning health and reproduction.
*Extend human lifetimes
*Reduce the time and effort spent on household and personal maintenance activities.
*Extend human activities to the rest of the solar system and beyond.

BOX IIE-5. TECHNOLOGIES OF 2025 [Coates et al., 1997]

The items listed below were selected and summarized from different sections of Coates et al.'s book.

Theme: Advances in science and technology are extending humanity's ability to take an active role in "influencing, guiding, supervising and governing the natural and built environments of our planet."

1. The genetic components of 4,400 human diseases and disorders are identified and major progress has been made towards therapies. 2000 single gene disorders, such as Huntington's Cholera, polycystic fibrosis and kidney disease, have been eliminated. Physical and mental abilities are being enhanced through genetic technologies.

2. *In utero* alteration of traits is practiced with respect to such conditions as schizophrenia, diabetes, sexual predisposition, simple brain capabilities, and baldness.

3. Cloned human organs are allowed to be used as replacements for diseased organs. Cloning techniques also allow growth of organoids to produce needed hormones, enzymes and other substances that a person may be lacking.

4. Synthetic body parts are common, aided by targeted drug treatments. Persons who are blind, deaf or otherwise impaired have their abilities extended via advanced bio, neuro-bio, and information technologies.

5. Substantial progress has been made in mapping the cognitive modules of the brain.

6. Progress has been made towards brain-mind manipulation, largely via pharmaceuticals, to influence emotions, learning, sensory acuity, memory and other psychological states.

7. Foolproof DNA identification of individuals for forensic and legal purposes has been developed.

8. Geneticists administer gene therapies prenatally and in young children to manage the genes that promote and inhibit the aging process. Life expectancy of a person born in 2025 is 85. High levels of functioning throughout old age are normal.

9. The genome of prototypical plants, animals, and micro-organisms is fully understood, leading to more refined management, control and manipulation of their health, propagation or elimination. Up to 60% of crop losses in the US due to pests have been eliminated, along with Lyme disease and elephantiasis.

10. Food is synthetically and genetically manipulated to suit an individual's taste, nutritional needs and medical status. High-protein vegetables have been engineered to support vegetarian practices.

11. A new Green Revolution involves genetic engineering for greater photosynthetic efficiency, salt and drought tolerance, pest-resistance and self-propagation, along with extensive farmer management training and hi-tech irrigation systems.

12. Half-size genetically engineered diary cattle produce high volumes of milk but consume only 2/5 the forage of full size cattle. Dairy milk has been fine-tuned to human needs, with variations for children, adults, and those intolerant of milk components. Farm animal diseases have been largely eliminated by cloning.

13. Closed-loop materials use, product lifetimes 5 times longer than in 1995, and extensive use of the 3R's (recycling, reclamation, remanufacturing) are standard.

14. Mining, logging and drilling are targeted, minimalist, and clean. Trees used for paper pulp are genetically engineered to allow nonchemical pulping.

15. Animals are used as bioreactor "gene-pharms" to produce pharmaceuticals, enzymes, hormones and other products.

16. Water and power is supplied to the US, Mexico and Canada through an integrated continental grid. The Great Lakes and James Bay in Canada, serve as major water storage and distribution reservoirs. Losses due to drought have been reduced by 75%. Bio-membrane technologies make large-scale water salinization practical.

17. There is a worldwide, broadband, fiber optic network of networks giving universal "fiber to the home". Face-to-face, voice-to-voice, person-to-data and data to data communications is available to and from any place and any time. Terminals and displays are ubiquitous. Three dimensional, very high definition, full VR interface is standard. Computers are 5,000 to 10,000 times faster than in 1990.

18. Language translation is effective in printed telecommunications for restricted but practically significant vocabularies.

[more...]

Box IIE-5 Technologies of 2025 (cont.)

19. Micro-machines, smart surfaces and dynamic structures are ubiquitous and unobtrusive. Infrastructure is self-monitoring and to a limited degree self-repairing.

20. Manipulation at molecular or atomic levels allow manufacturers to customize materials for highly specific functions.

21. Standardization, modular design, passive safety systems, automation and computer monitoring have increased the safety and efficiency of light water reactors. Radioactive wastes are being stored using glass ceramics and subduction zone injections.

22. Most cars are gasoline hybrids: gasoline-electric, ethanol methanol-electric, reformulated gasoline-electic, compressed natural gas-gasoline, hydrogen-gasoline, and hydrogen-electric.

23. Advances in information, materials and bio technologies have contributed to significant energy efficiencies and have reduced the rate of growth of energy use dramatically.

24. "Smart homes" and commercial facilities with computer controlled EMS's (energy management systems) are standard.

25. Materials and manufacturing processes mimic biological ones: honey combs and cellular structures, wood-plastic forms using ligino-cellulose as a feedstock, and bio-compatible polymers, ceramics and glasses.

26. Construction costs have been dramatically reduced and made more sensitive to environmental constraints through virtual reality modeling and design, automatic component production, modular units, and automatic site preparation.

27. "Restyling" is common: outer features of cars, furniture, houses, etc. are easily and cheaply replaced and modified, while inner structural features are built for very long life.

28. "Taggants" allow rapid, automated identification of the chemical and compositional structure of materials, thus facilitating recycling, reproducing and remanufacturing.

29. Combinatorics, genetic algorithms, and evolutionary approaches are applied to chemical engineering, pharmaceuticals, product design and other technologies, and to problem-solving in general.

30. 40,000 types of plastics are in use in 2025, up from 15,000 in 1990, used mostly in small-volume, special applications. By contrast high-volume plastics, metals and glasses for containers, food wrappers and packaging are limited to a very few species to make recycling economical.

31. Macroengineering projects to tap resources, reverse environmental degradation, provide living space, and construct intercontinental and global scale transportation and information linkages are underway.

32. Higher volumes of travel are supported through a fully integrated system of intelligent vehicle highway systems, (IVHS), mag-lev and other fast-rail systems, fixed and rotary winged aircraft, hovercraft, ships, personal rapid transit, subways and more. Information technology coordinates and monitors transit of people and goods; collects fees, tolls, fares and tariffs; enforces regulations; governs autopilot systems and automatic cargo handling; and weights trucks. The costs of sea cargo transport are markedly reduced by the use of factory ships, magnetohydrodynamic drives, and biotech tools for cleaning barnacles off keels.

33. Info-tech allows 40% of the workforce to work in distributed networks. Workers increasingly use high-tech mobile offices to spend more time at customer and vendor sites, while keeping in easy touch with the home offices via voice, video and print.

34. Family cars are commonly small vans fully equipped as mobile video/info centers.

35. Robots have solved the "bin-picking problem" and do multiple tasks by voice command without reprogramming. "Dark factories" are in increasing use.

36. Extensive global sensing networks of satellites, remote observation devices, and ground-based sensors help monitor pollution, allow pricing approaches to global environmental regulation, and assure compliance with global environmental treaties.

37. Vigorous commercial exploitation of space focuses on satellite communications, earth observation, launch and transport services, space robotics, materials processing, and the processing, interpreting and selling of space data.

38. The International Space Station was fully operational by 2015. Human landing on Mars is set for 2030. Preparations are underway for human exploration of the outer solar system.

The Coates et al. study differs notably from Kahn and Wiener's in its reduced concern with military technologies and its heightened concern with technologies that address environmental problems. These differences reflect two of the few ways in which the world of 1997 is truly different from the world of 1965: the end of the Cold War and the rise of the environmental movement. Coates singles out "environmentalism" as a fifth "primary driver of change" over the coming decades.

If we straightforwardly adopt the results of our assessment of Kahn and Wiener's 1967 forecast as a guide, we might expect that upwards of 50% of the innovations listed in IIE-5 should come to pass by 2025.

However, this is may be a conservative estimate. Kahn and Wiener's list contains a number of idiosyncratic items (e.g., human "hibernation"), and the Coates et al. list might be overly cautious. Many of Coates' forecasts represent the diffusion and conventional modification-through-use of technologies that are already at or very near operational and commercial status. It might not be unreasonable to expect that 60-70% of the innovations forecast by Coates are likely to be realized.

Is a world that is sustained and shaped by the technologies described in IIE-5 a desirable world? Persons and societies that hold different values would answer this question in different ways. However, a close inspection of the items on the Coates et al. list suggests that most, although not all, appear to have to larger constituencies that would be inclined to support them, than they do constituencies that would be inclined to oppose them, giving current social, economic and political values.

Two technologies included in the Coates et al. list might not command general support. Although current opinion surveys suggest acceptance of the application of genetic technologies to plants and animals, and to humans for the prevention and treatment of disease and disability, they show more ambivalence about proposals to genetically enhance human traits such as life span,

physical appearance and mental abilities.[142] Also, very large-scale macroengineering projects often have sufficiently negative impacts on enough constituencies to motivate a successful opposition. However, even if these two red-flag items were prevented from becoming important features of our technological environment, the development of the remainder of the items on Coates' list would ensure that the overall content, look and feel of Coates' vision would largely still be realized.

Of course, even if each item on Coates' list, considered separately, was felt by most people to confer a net benefit, the complete package, taken as a whole, might not be. And even if the complete package was felt to be desirable on its own terms, it might still be challenged if people felt that its realization would commit us to a trajectory of technological development whose consequences at a later date would be undesirable.

This second possibility is particularly relevant to our concern with global development over long periods of time. In the next section we review several studies that speculate on the nature of technological innovation over the full course of the 21st century, and beyond.

II.E.1.c. Beyond 2025: Long-Range Visions of Technological Change

Noted authors and texts that consider long-range technological prospects are listed in **IIE-6**. Topics that appear often in these texts are shown in **IIE-7**. Longer-range projections developed by Michio Kaku are shown in **IIE-8**.

These authors claim that science and technology have brought humankind to the verge of a profound transformation. They believe that over the coming century we will develop unprecedented powers to manipulate all aspects of the natural world, including our own bodies and minds. The first applications of these new powers will in turn give rise to even greater transformative possibilities, the likes of which are quite literally beyond our imagination today.

---

[142] See the full discussion of public opinion about technology and genetic engineering in Section II.E.2.c below.

BOX IIE-6. Texts that Speculate on the Long-Range Technological Future

Eric Drexler, *Engines of Creation.* (1986)
Eric Drexler, *Nanosystems: Molecular Machinery, Manufacturing and Computing* (1992)
Freeman Dyson, *Infinite in All Directions* (1988)
Freeman Dyson, *Imagined Worlds* (1997)
Robert Ettinger, *The Prospect of Immortality* (1964)
Richard Feynman, "Plenty of Room at the Bottom" in:*Engineering and Science* 23 (Feb 1960)
Ben Finney and Eric Jones, *Interstellar Migration and the Human Experience* (1985)
Neil Gershenfeld, *When Things Start to Think* (1999)
Michio Kaku, Visions: *How Science will Revolutionize the 21st Century* (1997)
Kevin Kelly, *Out of Control. The Rise of Neo-Biological Civilization* (1994)
Ray Kurzweil, *The Age of Spiritual Machines: When Computers Exceed Human Intelligence* (1999)
Steven Levy, *Artificial Life: The Quest for A New Creation.* (1992)
Ralph Merkle, "Molecular Repair of the Brain" in: *Cryonics* 10 (Oct. 1989)
Marvin Minsky, *The Society of Mind* (1986)
Hans Moravec, *Mind Children: The Future of Robot and Human Intelligence* (1988).
Hans Moravec, "Pigs in Cyberspace" in: *Extropy* (Winter 1993)
William O'Neill, *The High Frontier: Human Colonies in Space* (1977)
Heinz Pagels, *The Dreams of Reason* (1988)
Gregory Paul and Earl Cox, *Beyond Humanity: Cyberevolution and Future Minds* (1996)
Lee Silver, *Remaking Eden: How Cloning and Beyond Will Change the Human Family* (1998)
Gregory Stock, *Metaman: The Merging of Humans and Machines into a Global Superorganism* (1993)
Frank Tipler, *The Physics of Immortality* (199)

Numerous articles on aspects of the Extraordinary Future have been published in journals such as *Whole Earth Review, WIRED,* and *EXTROPY: the Journal of Transhumanist Thought.* Many Web sites are devoted to these topics as well.

BOX IIE-7. Topics Common to Discussions of the Long-Range Technological Future

This is a list of topics that appear repeatedly in works concerning the development of technology over the next century. These topics include foundational technologies, applications, scientific and technological disciplines and theories, and topics of general interest.

* nanotechnology, picotechnology and femtotechnology
* robots, androids, and cyborgs
* cellular automata, artificial life, artificial consciousness and artificial intelligence
* virtual reality, genetic algorithms, fuzzy logic, and neural networks
* expert programs, knowbots and distributed intelligence
* complexity theory, chaos theory, and theories of spontaneous order
* genetic engineering, germline manipulation, cloning, and body/mind enhancement
* human evolutionary biology and evolutionary psychology
* new growth theory, biomics, agorics, and facultative anagorobes
* cyberlife, cyberbeings, avatars, and cybersex
* life extension, cryonics, and immortalism
* transhumanism and posthumanism
* morphological freedom, transbiomorphosis and ectogenesis
* smart drugs, smart machines, and smart surfaces
* grey goo, red goo, green goo, blue goo, khaki goo and ubergoo
* galactic & extra-galactic colonization, terraforming, star-lifting, stellar husbandry
* Dyson Spheres, O'Neill colonies, Kardaschev types, and Loftstrom loops
* the "Singularity:" its nature, developmental path, and expected date of arrival

BOX IIE-8. PROJECTIONS FOR 2020-2050 AND 2050-2100

In *Visions: How Science Will Revolutionize the 21st Century,* physicist Michio Kaku assesses the state and future of science and technology. He suggests developments that can be expected over three periods: 2000-2020, 2020-2050, and 2050-2100. His projections for 2000-2020 are similar to those of Coates et al. for 2000-2025. His projections for the later two periods include the items below. His projections are in general more conservative than those of most authors writing on this topic.

2020-2050

* By 2020 the limits of silicon chip technology will have been reached; further increases in computational power will require optical, DNA, quantum or other technologies.
* True robot automatons that have common sense, can understand human language, can recognize and manipulate objects in their environment, and can learn from their mistakes.
* Genuine artificial intelligence and effective expert systems permeates the Internet; the entire stock of human knowledge is available on the internet
* Genomes for all significant life forms mapped and sequenced. Major focus is functional analysis.
* Many complex polygenic traits will be fully understood, eg. arthritis, autoimmune diseases, schizophrenia, the aging process, facial features.
* Germline gene therapy, and human cloning, will be practical, if not banned.
* Growing and implanting new organs, including complex ones such as the heart and the hand, will be as common as kidney transplants today, especially as we extend the life span.
* Tissue engineering will have advanced.
* Mapping and understanding complex neural/brain behavior will have advanced.
* Deep bionics will have advanced, e.g., neural-chip connections for simple muscular functions.
* First commercial nuclear fusion plant will be operative.
* Room temperature superconductors w/ commercial applications spawn a 2nd industrial revolution.
* First practical nanotechnology applications will be realized.
* Solar electric-ionic rocket engines: solar cells ionize xenon gas and electric plates accelerate the ions to create low, continuous thrust; interplanetary travel inexpensive and commonplace.
* Long-haul interplanetary missions traverse deep space. We have a robot base on the moon, a manned Mars science colony, and manned probes of the asteroid belt and comets.

2050-2100

* Quantum computers will be operational.
* Manipulation of age genes, tissue engineering and other biotechnologies will extend the typical human lifetime to 150 years.
* Nuclear fusion will be globally widespread.
* All organs except the brain will be growable and replantable.
* Robots that are self-aware will serve as "secretaries butlers, assistants and aides."
* The "deep structure" of human genetic processes will be understood.
* Novel human organs will be engineered.
* New life forms will be constructed.
* Some forms of integrated human/computer functioning will be practicable.
* The neural processes of the brain will be completely mapped; behavior will be deeply understood.
* Research on rockets that can reach nearby stars, perhaps using interstellar hydrogen ramjet fusion engines, will be advanced. Unpiloted, decades-long flights will be planned. Plans will have begun for the first space colonies.

Over the past fifteen years this claim has acquired new momentum in the wake of real breakthroughs in information technology, genetic engineering and neurobiology, the spread of personal computers and the Internet, the pending completion of the Human Genome project, and other developments.

The vision of a human future radically transformed by deep technology gained coherence as a world view in the late 1980's with the publication of *Engines of Creation* by Eric Drexler. This book popularized *nanotechnology* as the foundational technology of the human future.

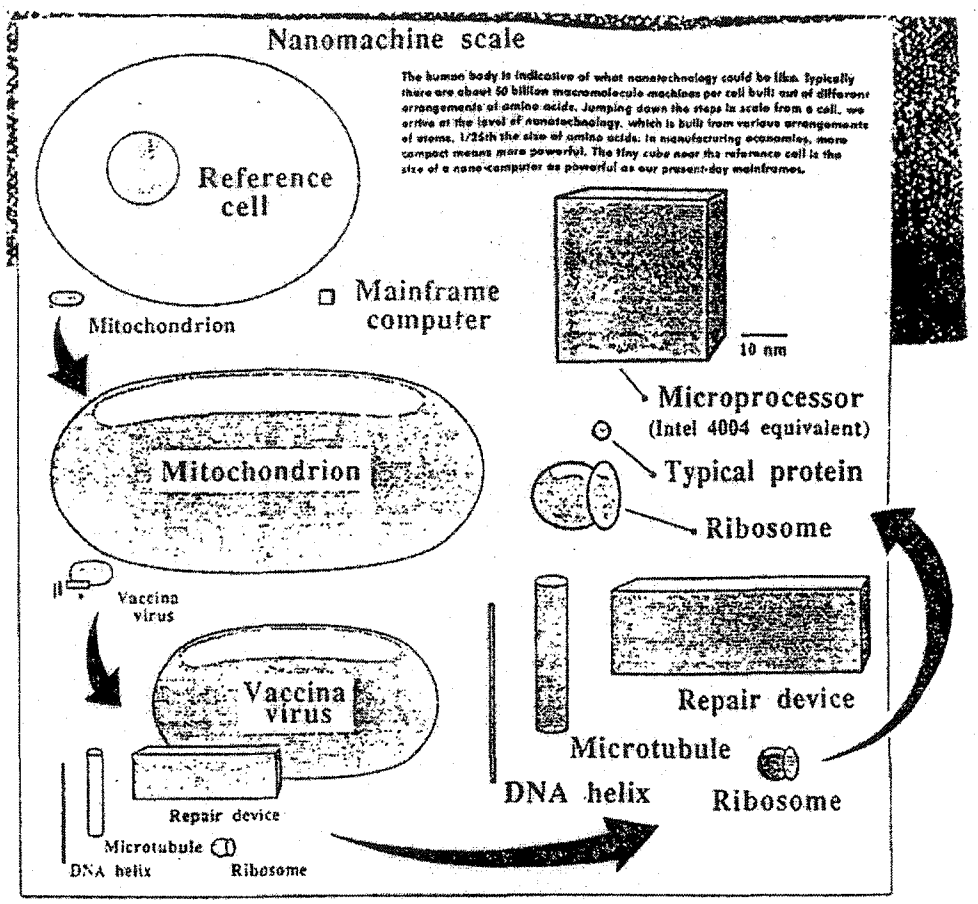
The term "nanotechnology" refers to the precise manipulation of matter and energy at the level of individual atoms and molecules. Drexler suggested that it should be possible to build a computer with the power of an IBM mainframe no bigger than a single-celled bacterium (see **IIE-9**). Components would be constructed of molecular-scale rods, gears, wheels, etc. Such a computer could guide equally small mechanical devices, called *assemblers,* that could manipulate atoms and molecules one at a time and thus construct literally anything, including reproductions of themselves. This prospect of nano-scale computers and assemblers gave new impetus to speculation on all sorts of technological capabilities that up until that point had seemed constrained by the limits of macro-scale engineering.

Kevin Kelly, editor of *WIRED* and former editor of the *Whole Earth Review,* draws on possibilities opened by nanotechnology in offering his vision of the coming "neo-biological civilization." He envisions

> "...mutating buildings, living silicon polymers, software programs evolving off-line, adaptable cars, rooms stuffed with coevolutionary furniture, gnatbots for cleaning, manufactured biological viruses that cure your illnesses, neural jacks, cyborgian body parts, designer food crops, simulated personalities, and a vast ecology of computing devices in constant flux." (1994 p 472)

Kelly's account is only slightly more dramatic than Coates', which itself draws heavily on the spirit of nanotechnology. The possibilities become more challenging when we look to the decades beyond the Coates et al. reference date of 2025.

BOX IIE-9 Nanotechnology
[Reprinted from Drexler (1987)]



Among the dominant themes in the literature that considers this period are those concerning the enhancement of cognitive abilities, whether human or mechanical. Hans Moravec, Director of the Mobile Robot Lab at Carnegie-Mellon University, has considered the possibility that human minds and consciousness could be transferred from brains to machines, as described in **IIE-10.**

A repeated theme in the literature of the Extraordinary Future [143] concerns the prospects for human endeavors beyond the earth, typically of gargantuan scale. An example is David Criswell's detailed scenario of space colonization described in **IIE-11** and **IIE-12.**

Many authors join notions of the machine embodiment of consciousness with the desire to expand consciousness beyond the confines of the earth. Moravec (1992) says,

> "There are about 10^56 atoms in the solar system. I estimate that a human brain-equivalent can be encoded in less than 10^15 bits. If a body and surrounding environment take a thousand times more storage in addition, a human with immediate environment might consume 10^18 bits. An equivalent Artificial Intelligence should probably get by with less, since it does without the body-simulation 'life support'... So a city of a million human-scale inhabitants might be efficiently stored in 10^24 bits. If the atoms of the solar system were cleverly rearranged so that every 100 could represent a bit, then a single solar system could hold 10^30 cities—except by the time intelligence has expanded that far, more efficient ways of using space-time would surely have been discovered, increasing the number much further." (p 5)

A particularly encompassing development of these themes is that of Tulane University astrophysicist Frank Tippler. He asks, "Can we imagine a way in which human society might live, and grow, forever?" His affirmative answer involves colonization of the galaxies by conscious machines and the manipulation of gravitational collapse, as described in **IIE-13.**

Speculation about the Extraordinary Future been influenced in recent years by the notion of the "Singularity," defined by Vernor Vinge (1981) as "the postulated point or short period in our future when our self-guided evolutionary development accelerates enormously (powered by nanotechnology, neuroscience, artificial intelligence or perhaps uploading) so that nothing

---

[143] I adopt here the term used by Paul and Cox (1997) to refer to a future profoundly transformed over the coming decades by technologies of the sort listed in Box IIE-7.

BOX IIE-10. UPLOADING MINDS

[from: Hans Moravec, *Mind Children* (1988)]

"You've just been wheeled into the operating room. A robot brain surgeon is in attendance...You are fully conscious. The robot surgeon opens your braincase and places a hand on the brain's surface. This unusual hand bristles with microscopic machinery, and a cable connects it to the mobile computer at your side. Instruments in the hand scan the first few millimeters of brain surface... These measurements allow the surgeon to write a program that models the behavior of the uppermost layer of the scanned brain tissue. This program is installed in a small portion of the waiting computer and activated... You are given a push-button that allows you to momentarily 'test drive' the simulation, to compare it with the functioning of the original tissue. When you press it, arrays of electrodes in the surgeon's hand are activated... They are programmed to inject the output of the simulation into those places where the simulated tissue signals other sites... You press the button, release it, and press it again. You should experience no difference. As soon as you are satisfied, the simulation connection is established permanently. The brain tissue is now impotent... Microscopic manipulators on the hand's surface excise the cells in this superfluous tissue and pass them to an aspirator, where they are drawn away.... The surgeon's hand sinks a fraction of a millimeter deeper into your brain....the process is repeated for the next layer, and soon a second simulation resides in the computer... Layer after layer of the brain is simulated, then excavated. Eventually your skull is empty, and the surgeon's hand rests deep in your brainstem. Though you have not lost consciousness, or even your train of thought, your mind has been removed from the brain and transferred to a machine. In a final, disorienting step the surgeon lifts out his hand. Your suddenly abandoned body goes into spasms and dies. For a moment you experience only quiet and dark. Then, once again, you can open your eyes. Your perspective has shifted. The computer simulation has been disconnected from the cable leading to the surgeon's hand and reconnected to a shiny new body of the style, color and material of your choice. Your metamorphosis is complete." (p 109)

Box IIE-11. INTERPLANETARY AND INTERSTELLER HABITATION
[source: David Criswell , *Solar System Industrialization: Implications for Interstellar Migrations* (1985)]

Criswell presents detailed proposals for the expansion of human habitation throughout the solar system and beyond, as illustrated in IIE-12. The expansion takes place in several stages:

I. Habitation of the Lagrange Wells (L4 and L5)

Criswell estimates that it would be more economical to build independent orbiting space habitats, called *space homes,* than it would be to colonize the moon or Mars. The space homes would be constructed in the gravitational wells L4 and L5 located in front of and behind the moon in its orbit around the Earth. Each space home would support 1 million people. Criswell projects that raw materials from the moon and available asteroids would allow construction of 240,000 space homes by 2200, allowing a total human population of 240 billion.

II. Planet Lifting

If we wanted to continue to expand beyond 2200 we could begin to disassemble the planet Jupiter and convert it into space homes. Jupiter could provide raw materials for about 400 years of continued growth.

III. Sun Lifting

If we wished to expand much further we would have to disassemble the sun. Interestingly, this action could *extend* the lifetime of the sun beyond its current estimated span of 5 billion years. "If Sol could be gently unwrapped of its outer layers and converted into white dwarf form, then the new dwarf could live 1,150 times the currently estimated age of the Universe (20 billion years)." Criswell details several approaches to sun-lifting. In one, a ring of very large solar-powered particle accelerators orbits the sun. Directed particle beams create a dynamic magnetic field close to the sun that propels matter from the solar atmosphere out through "holes" located over the north and south poles. As the matter cools complex elements are formed and are later mined. Sun-lifting would take about 300 million years. Over that time human civilization would have been able to grow to a population of 2x10^21, occupying 2x10^12 earth-equivalent space home habitats.

IV. Inter-Stellar Migration

Criswell suggests that the technology of stellar-lifting would allow us to forego concern over the presence or condition of planetary systems, which in any event represent minuscule resources, and simply colonize the galaxy star-by-star.

BOX IIE-12. Interplanetary and Interstellar Habitation (figures)
[Reprinted from Finney & Jones, 1985]

Figures 1 and 2 might be compared with the scenarios originally considered in Box IA-1.

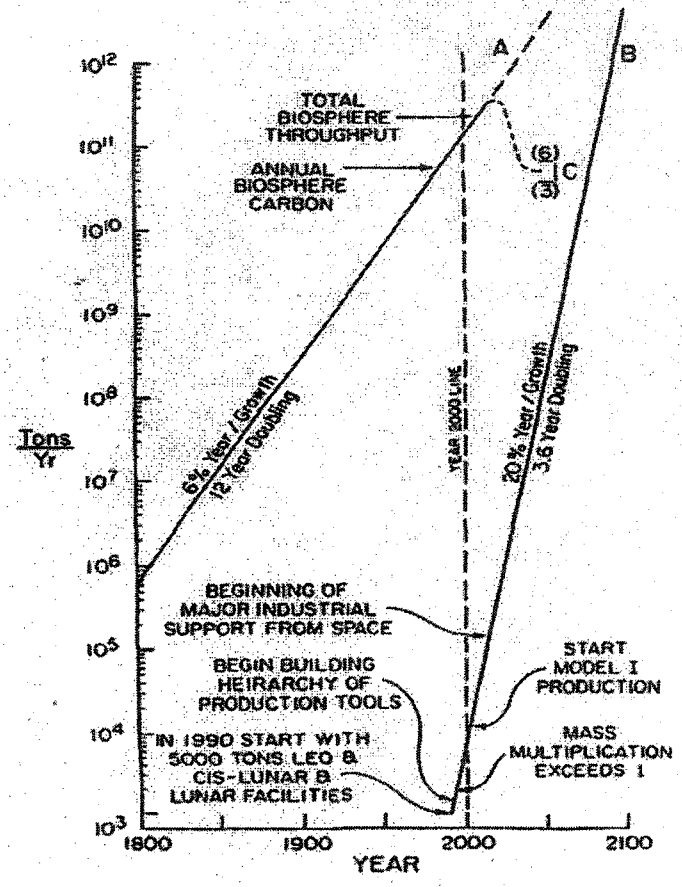


Figure 1. Annual Projected Production of "Demandite."

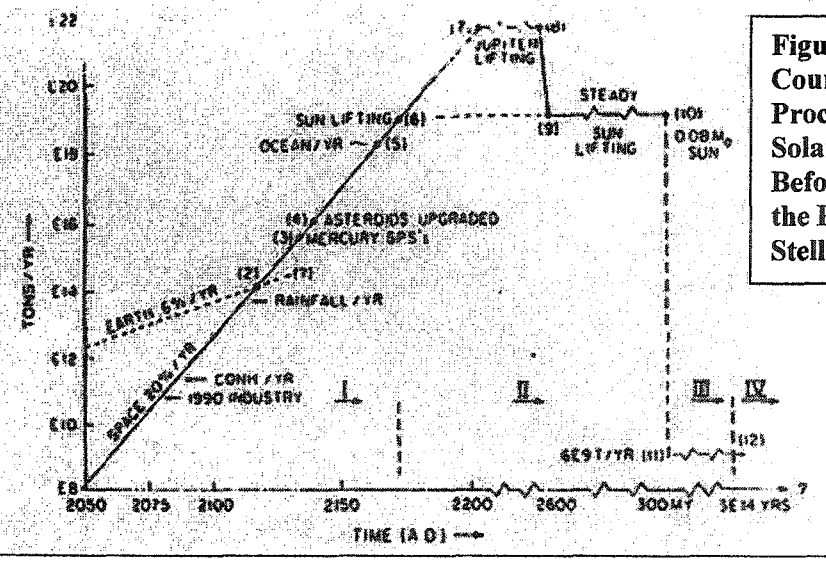


Figure 2. The Course of Mass Processing in the Solar System Before and After the Period of Stellar Husbandry.

BOX IIE-13. ETERNAL LIFE

[source: Frank Tipler, *The Physics of Immortality* (1994)]

Tipler argues that natural resource constraints and the eventual death of the sun require that "Life, if it is to continue, must leave the Earth and colonize space."

Colonization would employ self-reproducing universal constructors with human-level intelligence, each weighing no more than 100 grams. These would be accelerated to 90% of light speed and reach Proxima Centauri in 10 years. Colonies would require 100-300 years to grow from 100 grams to full civilization status, after which they would launch new constructors towards the next star.

At these rates this schedule is feasible:

colonization of the Milky Way galaxy	600,000 years
colonization of the Andromeda galaxy	3 million years
colonization of the Virgo Cluster	70 million years

After 10^18 years life will have engulfed the Universe. However, the energy to power this universal civilization undergoes continual entropic degradation and will eventually approach zero. Tipler asks if there is a way that this "heat death" might be avoided. He notes that by the time we engulf it the Universe is expected to have reached its maximum expansion and to have begun its collapse. He says that if our descendants act in concert "life in the far future can easily force the Universe to collapse very rapidly in two directions while remaining the same size in the third direction*...This means that the directions of contraction will be hot spots and the other direction will be a cold spot. This temperature difference will power life in the far future."

As the Universe continues to collapse it approaches its "Omega Point" of zero volume, infinite density and infinite temperature. What happens to life then? Tipler says that although the Universe "exists for only a finite proper time, it nevertheless could exist for an infinite subjective time." It can do this because the conditions of increasingly higher density and temperature can, if appropriately manipulated, provide an infinite supply of energy for an infinite amount of information processing between any given point in time and the final Omega Point. And life, according to Tipler, is "information processing subject to selection."

Tipler notes that "since a human being has about 110,000 active genes, the human genome can code about 10^10^6 possible genetically distinct humans. Furthermore, the human brain can store between 10^10 and 10^17 bits... which implies that there are between 2^10^10 and 2^10^17 possible human memories. On this basis there are (10^10^6)x(10^10^17), or about 10^10^17, possible human states." While this is a large number it is still finite. Tipler expects that as the Universe approaches the Omega Point of infinite information processing ability it will be able to "emulate" all persons who have ever lived, or might have lived, and that they will live and be aware for an indefinite period of subjective time.

---

* The technical term is a "Taub Universe", after U.C. Berkeley mathematician Abraham Taub.

beyond that time can be reliably conceived" [144] Authors and researchers for whom the notion of a technological Singularity is credible allow themselves to speculate only on the topic of how the Singularity might most rapidly be realized (**IIE-14**) [145]

Many authors believe that life extension should be among the earliest achievements of the Extraordinary Future, and that immortality, either as biological or mechanical beings, should not be far behind. Several of these authors have made plans to have their bodies cryonically suspended if they die before technologies of immortality have been developed.

The Extraordinary Future represents a fairly straightforward extension of those technologies forecast by Coates et al. in 1997 for 2025 and by Kahn and Wiener in 1967 for 2000. This can be seen by comparing the technologies listed in Box IIE-7 with the categories derived from Kahn and Wiener's 1967 list shown in Box IIE-4.

Authors writing about the Extraordinary Future typically claim that it is inevitable (see **IIE-15**).[146] They offer several arguments. The argument from evolutionary psychology is that human beings have dispositions to behave, and to get pleasure from behaving, in ways that increase our abilities to understand and control our environment, accumulate resources, protect ourselves from harm, and to both compete and cooperate in ways that enhance these ends. On this view the desire to develop and use technologies of the sort that will give us the Extraordinary Future is a natural expression of the same human nature that motivated the development and use of pottery, stone arrowheads, and the alphabet. If the Extraordinary Future is possible, it is inevitable, because we find it desirable.

---

[144] Vinge is a mathematician at California State University at San Diego. In mathematics a singularity exists at the point where a function approaches infinity, as the function $y = 1/x$ does as x approaches zero.

[145] Many enthusiasts of the Extraordinary Future believe that the Singularity will occur within 20-30 years, if not sooner. Other authors caution that it may not arrive for as long as 50-60 years.

[146] Compare these statements of inevitability with those in Box IIC-4 concerning the inevitability of a steady-state economy. Compare them also with statements about the inevitability of human genetic manipulation in Section II.E.2.b.

BOX IIE-14. PATHS TO THE SINGULARITY

1. In a paper delivered at a NASA symposium Vinge (1993) saw four paths that could independently lead to the Singularity:
    1) powerful computers wake up
    2) large computer networks wake up
    3) computer/human interfaces become so intimate that users may reasonably be considered superhumanly intelligent
    4) Biological science may provide the means to improve native human intellect.

2. Yudkowsky (1996) believes "the Singularity will occur through enhanced humans, not necessarily through computer technology." His projected path is:
    1.0) first-stage enhanced humans
    1.5) improved human-computer interface
    2.0) nanotechnology
    3.0) high-speed neurons
    3.5) additional neurons
    4.0) computer-class "Powers"

3. Porter (1997) takes the opposite view and suggests that there will be "de-novo" human-equivalent computer minds before major human brain manipulation or uploading is practical. The stages are:
    1) wiring diagrams for human brain
    2) abundant parallel computation
    3) virtual worlds with thousands of organisms with neural architectures inspired by 1
    4) selection of promising organisms/societies/neural architectures/etc. (using genetic algorithms and other tools employing natural section principles)
    5) return to 3; repeat until Singularity.

William Calvin (1993) cautions that if the Singularity is to be achieved quickly, say within 30-50 years, we will face at least three important challenges:

1. Ecology: Calvin cites Aldo Leopold on the dangers of unanticipated consequences that often follow the introduction of new species, in this case superhumans, into an ecosystem.
2. Values: Calvin says that "agreeing on values and implementing them *in silico*" is a bargaining process between humans and the superhumans, and that we might prefer to wait as much as several decades before allowing them to go free.
3. Reaction: "Human reactions to silicon superhumans could create enormous strains in our present civilization."

However, Calvin concludes that "I don't see realistic ways of 'buying time' to make this superhuman transition at a more deliberate pace. And so the problems of superintelligent machines will simply need to be faced head-on in the next several decades, not somehow postponed by slowing technological progress itself."

BOX IIE-15. THE INEVITABILITY OF THE EXTRAORDINARY FUTURE

Vernor Vigne (1993): "I have argued that we cannot prevent the Singularity, that its coming is an inevitable consequence of the humans' natural competitiveness and the possibilities inherent in technology...Even if all the governments of the world were to understand the 'threat' and be in deadly fear of it, progress toward the goal would continue... The competitive advantage—economic, military, even artistic—of every advance in automation is so compelling that passing laws, or having customs, that forbid such things merely assure that someone else will get them first." (p 4)

Gregory Paul and Earl Cox (1996): "In the end, it will not be possible to stop or dramatically slow down CyberEvolution at the local, state, province or national level. There will never be a consensus to stop CyberEvolution. Humans are inherently variable and divergent in their desires, and in a world of billions, there will always be great numbers who like and want what new technologies have to offer them. For the neo-Luddite movement to have any chance to succeed would require the imposition of a world government with extreme powers over all society, all industry, and all technology. It would have to be a global police state." (p 433)

San Francisco Examiner (2/27/95): "Technology leaders and government officials from the Group of Seven nations...gathered in Brussels...(to discuss) the broad implications of an economic and social restructuring born of the information revolution... (one) poised to bring about the most massive societal shifts worldwide since industrialization.". According to Martin Bangemann, vice president of the European Commission, "As I always tell people who have anxieties [about these massive shifts] you do not have a choice." (p A15)

A second argument acknowledges that many people may not in fact regard the Extraordinary Future as desirable, but goes on to say that so long as *some* people desire these technologies they will be realized. The reason is that people who possess these technologies will obtain abilities to prevail over those who do not, and thus over time the former will come to replace the later.

A third argument goes further and suggests that even if *nobody* regards the Extraordinary Future as desirable, it will *still* come to pass. Suppose everyone in the world vowed not to develop the technologies of the Extraordinary Future. Unfortunately, in a world of 6 billion people none of us can be sure than someone isn't lying, or deluding themselves about their own probable behavior. Because these technologies truly give their possessors great powers of life and death, none of us can afford to be at the mercy of those who might posses them. Thus, despite our preferences otherwise, we will all seek to develop the technologies of the Extraordinary Future.[147]

The Extraordinary Future envisions the end of human life as we know it. Princeton biologist Lee Silver anticipates that the spread of genetic engineering will lead to the eventual speciation of human beings.[148] Authors who believe that the uploading of human minds into machines is possible hold out the prospect of improved "post-biological" human lives. Others simply believe that artificial minds will be able to out-perform human minds, and that human beings will, either gracefully or otherwise, be replaced. Few authors find this undesirable; most celebrate it. Tipler says,

> "The death of *Homo sapiens* is an evil only for a racist value system. Our species is an intermediate step in the infinitely long temporal Chain of Being... It is a logically necessary consequence of eternal progress that our species become extinct!" (quoted in Regis, 1990 p.147).

---

[147] This argument has the structure of the game theoretic Prisoners' Dilemma.

[148] Section II.E.2 discusses human genetic and reproductive technologies in detail.

II.E.1.d. Evaluation and Discussion

The vision of the Extraordinary Future is indeed extraordinary. How might we evaluate it?

It is possible that the authors noted above don't really believe what they are saying, but this is not likely. Tipler tells of the time his young daughter asked him if she would, in fact, find eternal life as the Universe approached its Omega Point: "I realized I had to tell her what I really believed. I told her, 'yes'." [149]

It might be that the Extraordinary Future is the province of second-rate minds, and can be taken less seriously for that reason. This is not likely, either. While the topic has attracted its share of *poseurs,* its leading authors include some of the most respected scientists of our time. Here is noted neurophysiologist William Calvin (1993):

> "Even the first 'work-alike" computer will be recognizably 'conscious'...And I don't mean trivial aspects of consciousness such as aware, awake, sensitive, and arousable. It will likely include focusing attention, mental rehearsal, abstraction, imagery, subconscious processing, 'what-if' planning, decision-making, and the narratives we humans tell ourselves when awake or dreaming. To the extent that such functions can operate far faster than they do in our one millisecond-scale brains, we'll see an aspect of 'superhuman' emerging from the 'work-alike'" (p 2).

Freeman Dyson is widely respected for his contributions to astrophysics, his work on behalf of nuclear weapons control, and his broader interest in the human prospect. He offers this vision of the human future:

> "The next hundred years will be a transition between the metal-and-silicon technology of today and the enzyme-and-nerve technology of tomorrow..., the result of combining the tools of genetic engineering and artificial intelligence. [This will be followed by] the permanent and irrevocable expansion of life's habitat from Earth into the cosmos...To this process of growth and diversification I see no end." (1988 pp 286; 298)

Finally, Stephen Hawking, whom many regard as the most important physicist since Albert Einstein, believes that in the future, "Humans will change their genetic make-up to give them more intelligence and better memory." According to an interviewer,

---

[149] Tipler shared this story during a symposium at U.C. Berkeley in April 1995.

> "Hawking believes some life form could be designed to withstand the hundreds of thousands of years it would take to travel around the galaxy. He even talks about a new kind of life – machines that could replicate themselves and populate far-off planets." (Einstein, 1996)

There are other explanations to account for what might appear to many to be a series of bizarre, even perverse, notions. One is that these authors, despite their intellectual gifts, may in some sense be suffering from social or personality deficits. For example, similar fantasies of omniscience, omnipotence and omnicompetence are frequently found among persons with narcissistic personalities and similar disorders.

Another possible explanation is that the Extraordinary Future is a narrative of denial that allows privileged persons a way to avoid confronting inequity, and social and political conflict in general, in the world. Distributional conflict can be mitigated so long as economic output continues to grow, but continued output growth depends upon continued technological innovation. If we can believe in a future of unending technological innovation we can more easily avoid having to worry about distributional concerns.[150]

Still another possibility is that the authors noted above may be right. Their analytic gifts may have enabled them to understand human nature, and the human predicament, more deeply than others have, and to envision a means by which we might transcend our plight and realize a more desirable future for all.

It is difficult to assess degrees of subjective development, denial or understanding, but perhaps we can assess objective credibility. Do the claims of the Extraordinary Future hold up to scientific scrutiny?

Skeptical assessments of the vision of the Extraordinary Future are noted in **IIE-16**, along with responses. A very tentative conclusion is that many of the more dramatic claims are indeed

---

[150] The narrative of the Singularity might be thought of as a hypertrophied version of this dodge. If we believe that the confluence of near-future technological breakthroughs renders speculation beyond the next thirty to forty years or so irrelevant, then we are relieved of having to concern ourselves with much of anything.

BOX IIE-16. Skepticism Regarding the Extraordinary Future

Are the technologies of the Extraordinary Future credible? Some scientists have doubts.

1. Nanotechnology: The core of the nanotech vision is the "assembler", a machine of nano-scale dimensions that can be programmed to construct artifacts atom-by-atom, and to reproduce itself. Critics have suggested that quantum uncertainties, thermal vibration, and ambient high-energy radiation preclude such devices. Other critics charge that Drexler and others have overlooked crucial design requirements. Jones (in Stix, 1996) asks, "How do the assemblers get their information about which atom is where, in order to recognize and seize it? How do they know where they themselves are, so as to navigate from the supply dump (where raw atomic material is stored) to the correct position in which to place it? How will they get their power for comminution (breaking up material) into single atoms, navigation and, above all, for massive internal computing?...Until these [and other] questions are properly formulated and answered, nanotechnology need not be taken seriously." Other authors accuse nanotechnology of being a "cargo cult science", a disciple which has much of the trappings of real science but is founded on a gross illusion. (Stix, 1996). Proponents of nanotechnology offer detailed rebuttals. They note that quantum uncertainties apply to electrons but not to atoms and molecules. Damage from thermal vibration and ambient radiation could be controlled by the inclusion of mechanisms that detect, repair and replace damaged parts, in the same manner as does DNA. Energy could be supplied to assemblers via sound waves. A debate concerning the technical credibility of nanotechnology ensued in 1996 following a critical article in *Scientific American*. See details at www.foresight.org/SciAmDebate.

2. Intelligent machines: The construction of "intelligent" machines is central to the vision of the Extraordinary Future. The belief that this feasible is generally grounded in an existence proof: *we* are intelligent, and we are, in the final analysis, task-achieving systems constructed of matter and powered by energy, i.e., machines. Surprisingly, scientists and philosophers who are skeptical of the claims of the AI enthusiasts tend not to disagree with the substance of this argument. Rather, they emphasize the practical difficulty of achieving true artificial intelligence. Searle (1992) makes a strong case that digital computers cannot be "intentional," although he allows that intentional machines may be constructed in some other manner. Edleman (1992) doubts that artificial consciousness is likely to happen "for a very long time." He believes that artificial consciousness, like human consciousness, would have to evolve in a social milieu.

3. Immortality: The achievement of radical longevity would need to overcome the two related but different processes of cellular aging and cellular senescence. Aging is the result of wear and tear, largely caused by the progressive destruction of cellular components by free oxygen radicals that are a product of respiration. Cellular senescence is the inability of cells to undergo further division. This happens because the tips of DNA chains, called telomeres, shorten every time a cell divides, and are only long enough to allow 60-100 divisions. A program of radical longevity would require technology that could 1) manipulate DNA to allow telomeres to regenerate themselves and thus avoid senescence, 2) improve the cellular machinery that reduces the production of free radicals and improves repair capability, and 3) modify nerve cells so that they can reproduce and thus prevent the brain from shrinking. In

(more...)

Box IIE-16 (cont'd)

addition, any effective program of radical longevity should provide an improved immune system and high-powered medical care. Paul and Cox (1996) describe such a suite of such technologies and say, "actuarial calculations suggest that the expected life span of a non-aging, disease-free person who does not do anything stupid and who lives in a low crime area will be on the order of 1000 years." (p 295)

Skeptics suggest that the mechanisms of aging and death are evolutionary adaptations that are far more deeply embedded that the above program suggests. They argue that since animals are likely to die from disease, accident or predation after some expected period, animals that reproduced at a greater rate in their early years and then died would leave more offspring than those that might have given birth at a more leisurely pace spread over a longer possible biological lifespan, even if the biologically maximum possible number of offspring was significantly greater in the latter instance. Once the feature of natural death evolved, it would be adaptive for all other systems in a body to forego characteristics that would maintain their viability for longer than the average life-span. Thus any program that sought to extend longevity much beyond 100 years or so would likely require the massive re-engineering of numerous physiological processes. Proponents of life extension argue that these objections do not invalidate the legitimacy of their efforts. (see *The Economist,* 1995).

4. Human travel in space: Some proponents of the Extraordinary Future are also strong skeptics concerning the prospects for extensive human space travel. Paul and Cox (1996) say, "Bluntly put, people in space is a joke. It will never happen... Man in space is the evolutionary equivalent of fish conquering the land by building fish tanks with wheels." They describe the immense logistic, technical and environmental difficulties of planetary settlement and the effective impossibility of human interstellar travel. The Solar System might offer an exciting locale for scientific exploration but little else. Cox and Paul use this argument to support their case for the machine embodiment of consciousness, which could indeed allow interstellar travel. However, it is possible to offer a compromise assessment of the possibilities of humans in space. While interstellar travel is probably impossible, and extensive, permanent interplanetary settlements and Dyson Spheres may be impractical, the large-scale utilization of Solar System resources, using very advanced, highly reliable machines, tended by a limited technical staff, could still become an important human project over the next century.

highly problematic, but that a credible core remains. While ubiquitous Drexlerian nano-scale technologies may be beyond our reach, micro-scale technologies are not. Mental "uploading" may be a crack-pot dream, but the enhancement of mental abilities via genes and machines could become routine. The end of aging may be too much to expect, but healthy lifetimes lasting many more than seven or eight decades could be the norm for the grandchildren of children living today. And while the idea of the Singularity is likely an escapist fantasy, the suggestion that the emerging technologies are likely to enhance, rather than to exhaust, the potential for additional and even more profound technologies, seems very reasonable.

In short, we can't assume that the vision of the Extraordinary Future is simply too outlandish to take seriously. Note also that the comparatively moderate technological project outlined by Coates' et al. for 2025 lays precisely the groundwork needed to realize the technologies of the Extraordinary Future in the second half of the next century.

Discussion

Scenarios of Green sustainability, social-democratic internationalism and civilization-of-civilizations all affirm communal values that both support and constrain individual actions. But the current trajectory of technological change on balance tends to erode communal resources of allegiance, competence, and power, and strengthens those effected through individuals, transient networks of individuals, and the narrowly instrumental institutions of corporate capitalism. These are the primary institutions of agency of techno-globo neoliberalism.

The challenge to our new candidate advocated scenario—quantitative Scenario 3 and the narrative scenario of social democratic internationalism—is particularly acute. It's difficult not to come away from a close reading of Coates' list with the sense that even under a strong social democratic-internationalist regime, the great majority of the technologies listed would, in themselves, be acceptable--in fact, desirable. The core social democratic ethos would mandate that the benefits of such technologies be equitably distributed, but would not, in most instances, demand that they be foregone. With respect to ecological integrity, assessment is more complex.

Coates et al. put a high priority on environmental protection, but it is a very high-tech, deeply managed form of environmental protection that they call for. It would, however, be a viable option under many variants of social democracy. On the other hand, a social-democratic environmentalism informed more heavily by some of the values of Green sustainability would not be as ready as Coates' account suggests, perhaps, to genetically engineer or otherwise technologically manipulate forests, crops, livestock, fisheries and human beings.

But with the exception of genetic engineering, I don't have the sense that the technological "look and feel" of a social-democratic internationalist world would necessarily be *radically* different from what it would be under techno-globo neoliberalism. Arguably it might in many ways be even more technologically dense, simply because on a global scale economic output grows *faster* under the social democratic internationalist Scenario 3 than it does under the business-as-usual/neo-liberal Scenario 1.[151]

It is possible that a markedly less technologically dense 21st century might come about if certain of the voluntary simplicity sensibilities described in Section II.C.3 were to become rooted and widespread within an otherwise social-democratic/Scenario 3 trajectory. We might imagine a world that still grows steadily along the Scenario 3 trajectory, and is affluent and technologically rich, but which has come to use technology in a more subtle, discreet and non-invasive manner than at present.

What might be the motivation for such restraint? For one thing, such a soft-path techno-cultural trajectory would be consistent with the element in Scenario 3 that calls for per capita GDP growth rates to lessen significantly in the developed world by the middle of the next century, and in the rest of the world after another hundred years. Beyond this, however, I believe that the vision of the Extraordinary Future itself, as proclaimed by its enthusiasts, would strike the

[151] Although economic growth is slower in the developed countries under Scenario 3 than under Scenario 1, it is faster in the developing countries. This makes global economic growth on balance, faster. See the scenario displays in Section I.A.3.

great number of people who appreciate its implications as sufficient reason to adopt an attitude of extreme caution regarding the new technologies. After all, it is not a trivial matter when a reputable scientist proclaims that "it is a logically necessary consequence of eternal progress that our species become extinct."[152]

Concern about the impacts of technology is hardly new. What is different now is simply that the stakes are quickly getting much larger than ever before. Profoundly powerful technologies are being developed at the same historical moment that globalization is making their control more difficult. The possibility of a run-away prisoners' dilemma presents itself, in which the judgment by individuals that they will be unable to count on societal control of destabilizing technologies leads them to behave in ways that accelerate the spread of the destabilizing technologies themselves.

The general outlines of what needs to be done should be clear. We need to adopt a strong precautionary attitude about certain categories of new technological innovations; we need to reaffirm the right and responsibility of governments and civil society to constrain technological innovations judged to be undesirable; and we need to establish the national and international institutions and policies needed to accomplish this.

The major technological challenge

Of all the sets of technologies noted in our discussion thus far there is one that stands out as uniquely problematic. These are the new human genetic and reproductive technologies. These technologies figure prominently in popular fears about the human future, and do so in ways that computers and space travel do not. Together with "artificial intelligence" and "artificial life," they are the centerpiece technologies of the techno-utopian world view. [153]

---

[152] Tipler, quoted above.

[153] Our ability to genetically engineer animals is a near existence proof of our ability to genetically engineer human beings, and the creation of metabolizing, reproducing structures – "artificial life" - is actively being pursued. But I follow those authors who believe that "artificial intelligence" will not be possible. For discussion see Searle (1992), Chalmers (1996), McGinn (1991), and Nagle (1974). For a

The new human genetic technologies have a uniquely powerful and transformative potential, one which could set humankind on a trajectory that would make it greatly more difficult, and eventually impossible, to affirm communal goals of a global nature. If widely applied to the modification of existing human attributes in ways that can be passed on to our children, these technologies would erode our experience of being part of a common humanity, both within and across generations. Inheritable genetic modification of human biological and cognitive traits would set into motion a positive feedback loop generating increasingly more profound modifications. Each generation of genetically modified people would be less indisposed towards, and have more capability for, modification of their own children. Indeed, such concepts as "generation" and even "children" would change, as the biological relationships with specific others that have defined those categories become less central to ones' identity. The fund of conceptual categories and processes bequeathed to us by natural selection over millennia would now be instantly mutable. How would a person whose mental processes in part derive from purposeful genetic modification think about what it would be like *not* to have genetically modified mental processes?

It can be argued that in a world of many billions of people many years would pass before even a small percent of humanity is genetically modified. This may be so, but the point offers little comfort. Well before such technologies become widely adopted, the mere *expectation* that they will in due course be widely used will begin to change the way we think of ourselves, our children, and our obligations to others. It would set off a techno-eugenic arms race as individuals and countries compete to develop and apply the latest genetic enhancements.

Such a prospect is deeply antithetical to any vision of a social democratic internationalist / Scenario 3 world. If we are to have any hope of achieving such a world, human genetic

---

detailed review of the "consciousness wars" see *The Nature of Consciousness* (Block et al, 1997). On the other hand, the inheritable modification of cognitive processes through genetic engineering could be practicable within two decades or less.

technologies will need to be strongly controlled, and in importance instances proscribed. In the next section we explore in detail the challenges that the new human genetic technologies present.

II.E.2 THE NEW HUMAN GENETIC TECHNOLOGIES

Introduction

The new human genetic and reproductive technologies represent, arguably, the single most portentous technological development in all of human history. While certain applications are benign and to be welcomed, others would profoundly transform the nature of human life and human society.

These technologies are being developed and actively promoted by an influential network of scientists and others who see themselves ushering in a new techno-eugenic human future. This vision celebrates the mechanization and industrialization of human reproduction and the wholesale design of human lives. It dismisses values of community and compassion as anachronisms ill-suited for the new techno-eugenic era. It celebrates nothing less than the end our common humanity, as we segregate into separate genetic castes and eventually into separate species.

If these technologies cannot be effectively controlled it is difficult to imagine how the vision of the human future embodied in Scenario 3 and social democratic internationalist values could be sustained. By the same token, it is difficult to imagine how these technologies might be controlled *other* than under a social democratic internationalist regime of global governance.

In this Section we explore the challenges presented by the new human genetic technologies. Section II.E.2.a provides an overview of the technologies, focusing on the most consequential technologies of cloning and inheritable genetic modification. Section II.E.2.b documents the larger social and political vision of the human future held by advocates of the new techno-eugenics. Section II.E.2.c analyzes public opinion on these issues. Section II.E.2.d reviews policy options for bringing the new technologies under societal control, and assesses the chances of their success under our several narrative scenarios.

II.E.2.a. Overview of the New Human Genetic and Reproductive Technologies

The new genetic and reproductive technologies can usefully be separated into two groups: those that involve intervention in human reproductive processes but which do not manipulate particular genes, and those that do directly manipulate particular genes. The new techno-eugenics achieves its particular power from combinations of these sets of technologies. **BOX IIE-17** displays technologies within these two groups, which we now review.

NEW REPRODUCTIVE TECHNOLOGIES

This section describes new human reproductive technologies that do not involve direct manipulation of particular genetic sequences. These technologies allow for the selection and manipulation of gametes, embryos and fetuses, and tissues derived from these. **IIE-18** notes recent developments in this rapidly developing field.

a. Expanded pre-natal, pre-implantation, and pre-conception screening and selection

i. pre-natal: At present a fetus can be routinely tested for about 450 genetic conditions; some of the more common of these are listed in **IIE-19.** A dramatic increase in the number of disease and non-disease traits for which genetic components are known is expected within a very few years.

ii. pre-implantation: Parents at risk of transmitting certain defective genes to their children can consider the option of pre-implantation genetic diagnosis (PGD). In this procedure several embryos are created using *in-vitro* fertilization (IVF), and each is checked for the presence or absence of the defective gene. Only the healthy embryos are implanted. Between 1991 and 2000 about 150 babies have been born after PGD. The cost is high--about $10,000-$60,000 per healthy birth--and success rates are low, although these factors could change. As with pre-natal testing, it should eventually be possible to screen for genes that contribute to tens of thousands of human traits. Conditions for which PGD is available are marked with an asterisk in IIE-19.

BOX IIE-17. NEW HUMAN GENETIC AND REPRODUCTIVE TECHNOLOGIES

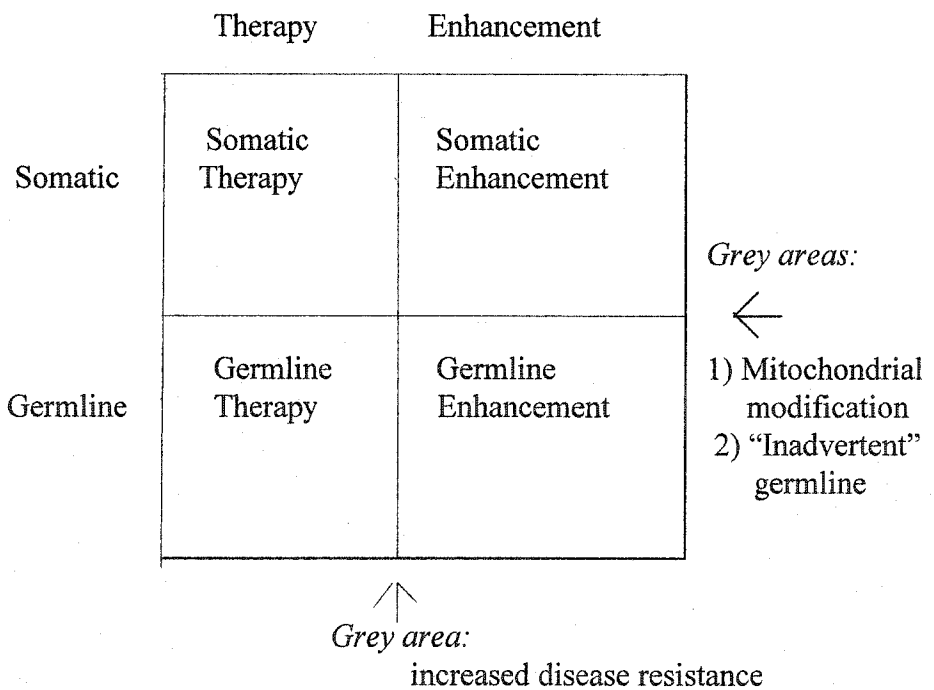
I. New Human Reproductive Technologies

(manipulating gametes and embryos but not individual genes)

Prenatal, Preimplantation and Preconception Genetic Screening
Somatic Cell Nuclear Transfer (human cloning)
In-Vitro Ovum Nuclear Transplant (IVONT); Cytoplasmic Transfer
Embryonic Stem Cell Technologies
Mouse Maturation of Human Sperm
In vitro Egg Maturation
Surrogacy; Egg and Sperm Donation
Human/Animal Hybrids; Human Chimeras

I. New Human Genetic Technologies

(manipulating individual genes)



BOX IIE-18. CURRENT TECHNOLOGIES INVOLVING THE NEW HUMAN GENETIC TECHNOLOGIES

1. Pre-implantation screening: Researchers at Hammersmith Hospital in London recently implanted an in vitro-fertilized embryo that had been screened for a late-onset form of bowel cancer. The pregnancy failed, as do 80% of IVF attempts, but there is no reason to suspect that future efforts should not succeed. This would be the first PGS for a late onset disorder.[1] In 1998 the Affymetrix Corporation in Santa Clara, CA announced that it is marketing a DNA "chip" that can identify hundreds of different genes simultaneously. As such technologies are perfected the number of traits that PGS can screen for can be expected to grow dramatically.[2]

2. Pre-conception screening: In September 1998 the IVF and Genetics Institute of Arlington, VA, announced that they are offering a new and effective technique to determine the sex of sperm prior to fertilization. The procedure adds $2,500 to the $6,000-$10,000 cost of a typical IVF cycle.[3]

3. In-vitro ovum nuclear transplant: Dr. James Grifo, director of the division of reproductive endocrinology at NYU Medical Center, hopes to achieve the live birth of a baby conceived after nuclear transplant before the end of 1999. St Barnabas Hospital in London has attempted the transfer of mitochondria between eggs from different women, and hopes to have a live baby shortly.[4]

4. Human cloning: Dr. Donald Wolf of the Oregon Primate Research Center hopes to produce rhesus monkey clones by Spring of 1999. Texas A&M University is attempting to clone a millionaire donor's pet dog. Dr. Severino Antinori of Chieti University in Rome—a leading Italian embryologist—"is considering leaving Italy, where cloning experiments are banned, to begin work that may allow infertile men to have children." Lee Silver has admitted to knowledge of "quiet" efforts underway at two US IVF clinics to prepare for human cloning. In December 1998 the British Human Genetics Advisory Committee recommended that "therapeutic cloning" be allowed to begin[5]

5. Embryonic stem cells: Scientists at Britain's Roslin Institute, working with others at the University of Wisconsin--Madison, have applied for permission to begin experiments that would combine cloning and embryonic stem cell technologies. They propose that upon birth a child would have one or more therapeutic clones created. From these, embryonic stem cells would be generated and chemically "frozen." If, in later life, the child needed a new organ or tissue implant, the appropriate stem cells would be "unfrozen" and used to generate the needed items. This procedure is roughly equivalent to selecting one of two identical twin embryos at a very early age and channeling it into a sort of arrested, modified state, to serve as a tissue bank for the twin that is allowed to come to term.[6]

6. Human Artificial Chromosomes: Several groups of scientists, including Willard et al at Case Western Reserve, are developing HAC's and hope to have a practicable one within three years.[7]

---

[1] San Francisco Examiner, 11/8/98, A-3.
[2] New York Times, 4/8/97; Affymetrix press release: www.affymetrix.com/press.
[3] Time, 9/21/98. "Boy? Girl? Up to You!" p. 82.
[4] New York Times, 10/10/98, A-28.
[5] Wolf: personal communication; Texas A&M: www.missyplicity.com; Severino: New Scientist,10/31/98; Silver: NY Times, 12/9/98 p. 1; Seed: San Francisco Examiner, 12/2/98 p. A-16; GTAC: news.bbc.co.uk, 12/8
[6] San Francisco Examiner Nov. 8, 1998 p. A-3.
[7] Nature Biotechnology, 16 May 1998, p. 415-416.

BOX IIE-19. Prenatal Testing and Pre-Implantation Genetic Diagnosis

I. Monogenic conditions
[main source: T. Gelehrter, F. Collins, D. Ginsburg, Principles of Medical Genetics, 1998]

Prenatal testing for about 450 chromosomal and monogenic conditions is offered by many clinics. Some of the most commonly tested for are listed below. Conditions with an asterisk are among those for which pre-implantation genetic screening is also offered. Monogenic conditions are often mentioned as candidates for germline genetic therapy; however, in all but a very small number of instances they can be prevented by prenatal and pre-implantation screening.

Chromosomal Aneuploidies: *
Down, Turner, and Kleinfelder syndromes, and other aneuploides
Autosomal dominant conditions:
Myotonic dystrophy — Adult polyscystic kidney disease
Huntington disease * — Neurofibromatosis 1
Familial breast cancer
Autosomal recessive conditions:
sickle cell anemia * — B-thalassemia — a-thalessemia — Cystic fibrosis *
Phenylketonuria — Tay-Sachs disease * — a1-Antitrypsin deficiency
X-linked recessive conditions:
Hemophilia A and B — Duchenne and Becker muscular dystrophy *
Fragile X syndrome * — Ornithine transcarbamylase deficiency

Selected centers also offer testing for:
Rhesus (Rh D) * — Lesch Nyhan Syndrome * — Alport Disease
Retinitis Pigmentosa — Familial Edematous Polyposis Coli *
Marfan syndrome * — Spinal muscular atrophy *

Polygenic conditions
main source: Anders Sandburg, www.aleph.se/Trans/Individual/Body/gene_page.

Predispositions towards these conditions are thought by many scientists to have polygenic components that should be identifiable and thus available for prenatal and pre-implantation screening. These conditions are also mentioned as candidates for germline genetic intervention, but the caveat noted for monogenic conditions applies here as well. It is likely that genetic components of many thousands of conditions can be identified.

alcoholism	alheizmer's	susceptibility to environmental toxins	
schizophrenia	congenital deafness	risk-taking	
cancer	obesity	hypertension	drug abuse
diabetes	male sexual orientation	aggression	shyness
manic-depression	breast cancer		

iii. pre-conception: Some couples who desire PGD are troubled by the prospect of destroying surplus embryos that are not implanted. If the genetic contents of eggs and sperm could be determined prior to fertilization, the number of unwanted surplus embryos could be greatly reduced. Such analysis is presently available only for the single trait of sex, but research on testing for other traits is underway.

b. oocyte cytoplasm transfer (OCT) and *in vitro* ovum nuclear transplant (IVONT)

Changes in the cytoplasm of an egg often make it more difficult for older women to conceive. Fertility clinics have begun transferring cytoplasm from the eggs of younger women into those of older women in an attempt to remedy this situation. Alternatively they have tried to transplant the nucleus of an egg of an older woman into the enucleated egg of a younger woman. The cytoplasmic mitochondria, which help regulate cellular energy production, have a set of genes independent of those in the cell nucleus. As a consequence, an embryo conceived from an egg that has received cytoplasm from another egg has three genetic parents: a nuclear father, a nuclear mother, and a mitochondrial mother.

c. somatic cell nuclear transfer (SCNT) / human cloning

Somatic cell nuclear transfer is the act of taking the diploid nucleus of a somatic cell and transferring it into a female egg from which the haploid nucleus has been removed. Under proper conditions the new construct will begin behaving as a viable zygote and undergo cell division and differentiation. If implanted in a female uterus the expectation is that this clonal zygote would develop and come to term as a clonal infant. The infant would be the genetic twin of the person from whom the somatic cell nucleus was taken. Some researchers propose that SNCT be used not to create a duplicate human being, but to create stem cells that could be used to treat diseases without being rejected by a person's immune system.

d. embryonic stem cells

The very early embryonic cells are totipotent, that is, they can each develop into any cell in the human body. As they divide they become successively more committed to specialized developmental paths. In 1998 scientists were able to isolate and grow embryonic stem cells in vitro. It is anticipated that stem cells could be used to grow tissues and organs suitable for transplantation. Further, they could be genetically modified to produce novel characteristics. Finally, embryonic stem cells could be used to facilitate human germline engineering. A culture of these cells would be dosed with vectors carrying a desired gene, the nuclei of those that successfully incorporated the new gene would be transplanted into eggs, and these clonal eggs would be implanted into a uterus and grown to term. [154]

e. *in vitro* egg maturation and "fetal motherhood" technologies

One drawback of pre-implantation genetic screening as a powerful eugenic technology is that only about 8-15 eggs can typically be obtained from a woman at one time. This limits the range of traits that can be screened for. The following procedure has been suggested as a way to increase the number of screenable zygotes. A woman would conceive a female fetus by pre-conception selection, gestate the fetus until four months, abort it, harvest the 200,000 or so immature eggs that have by then developed within the fetus, cultivate several hundred or thousand of these to maturity in vitro, and fertilize them. The fertilized eggs could then be screened and the most desirable ones implanted and brought to term. The mother would in effect be giving birth to her genetic grandchild; the child's genetic mother would be the aborted fetus. If desired, the eggs could be modified by germline genetic manipulation after fertilization. [155]

---

[154] See Zimmerman (1991) for a full description of the important relation between stem cell technologies and germline modification.

[155] See Cha et al. (1991) and Bonnicksen (1997) for a full description and advocacy of such "fetal motherhood" procedures.

f. mouse maturation of human sperm

Germline manipulation could be facilitated by removing sperm precursor cells from a man, adding new genes by retroviral transfection, implanting the engineered sperm precursors into mouse testes to mature, extracting mature sperm, testing these for the presence of the desired gene, and using for insemination those sperm found to have the desired gene.[156]

g. human/animal chimeras, hybrids, and clones

A chimera is a creature that possesses cells with different genotypes, e.g., those of two different individuals or species. In 1983 Steen Willadsen produced the first sheep-goat chimeras simply by taking cells from very early embryos of each and mixing them together. Sheep and goats are phylogenetically more distant than are humans and chimpanzees, so it appears that human-chimp chimeras would be possible. Alternatively, human/chimp hybrids could be created by implanting human genes into the early embryo of a chimpanzee, or vise-versa. Finally, nuclei from adult human cells have recently been transplanted into enucleated cow eggs cells to create a possibly viable cow-human embryo. The human nucleus would ensure that as the embryo developed it would become increasingly more "human" and less "cow." but all the cells of the resulting creature would contain cow mitochondria. This procedure was developed as a way to obtain an inexpensive source of embryos that could be used to develop stem cell cultures.[157]

DIRECT GENETIC MODIFCATION

The defining technique of the new technologies of human genetic modification is our ability to add, delete or modify specific genes within a cell. For example, a desired gene (the "transgene") can be spliced into a retrovirus or other simple organism (the "vector") capable of

[156] See Weiss (1998)

[157] See Fehilly et al. (1984) and *New York Times* (1998) for details on human chimera technologies.

penetrating a cell membrane and releasing the transgene into the cell cytoplasm. The transgene integrates into a chromosome and begins producing the desired protein.[158]

Figure 1 of IIE-17 displays two important distinctions that help classify the new genetic technologies.

One distinction is between gene modifications intended to treat a medical condition ("therapy"), and those intended to "enhance" some aspect of appearance or performance. The other distinction is between gene modifications that have an impact solely on a single person, and those that have an impact on a person's children and subsequent descendants. This is the distinction between "somatic" and "germline" genetic manipulation. Somatic genetic manipulation seeks to change the genetic makeup of particular body ("somatic") cells that comprise the functioning organs of a person—lungs, brain, bones, etc. Changes in somatic genes are not passed on to the one's children. Germline genetic manipulation changes the sex cells (i.e., the sperm and egg, or "germ," cells) whose sole function is to pass a set of genes to the next generation.

These distinctions define four modes of genetic manipulation. "Somatic therapy" seeks to treat a medical condition without changing a person's germ cells. "Somatic enhancement" seeks to modify the appearance or performance of a healthy person, again without affecting germ cells. "Germ-line therapy" seeks to prevent a medical condition from being passed on to future generations. Finally, "germ-line enhancement" seeks to change the appearance or performance of a child, who is otherwise expected to be healthy, in a way that allows this change to persist over future generations.

Somatic gene therapy trials were begun in 1990. **IIE-20** shows the status of these efforts as of 1998. In general, the results have not been encouraging.

---

[158] There are several variations of this process. See any recent human genetics textbook for a fuller account, e.g., Gelehrter et al. (1998).

BOX IIE-20. SOMATIC GENE THERAPY

I. World Wide

Patients enrolled in somatic gene therapy protocols as of June 1996:

A. By Disease:

Cancer:	848	leukemia/myeloma	89
AIDS	372	arterial diseases	16
cystic fibrosis	152	ADA deficiency	12
		TOTAL	1489 (+ ~ 48 others = 1537)

B. By Country:

USA	1229	Germany	47	Switzerland	19
UK	61	France	44	Egypt	15
Netherlands	55	Canada	22	Italy	14

(+ < 10 each: Spain, Austria, Sweden, China, Finland, Japan)

II. United States

Totals, as of June 1995:

Human gene transfer clinical trials:	107
number of subjects:	597
number of institutions:	37

By disease category:	number of patients
I. Gene Therapy	501
A. Monogenic inherited	64
A1-antitrypsin deficiency	0
Chronic granulomatous disease	0
cystic fibrosis	53
familial hypercholesterolemia	5
Fanconi anemia	0
Gaucher disease	0
Hunter syndrome	0
SCID-ADA deficiency	6
B. Carcinomas, multiple types	214
C. HIV	219
D. other	4
Peripheral artery disease	4
rheumatoid arthritis	0
II. Gene Marking Techniques	96
A. Cancer	81
B. Infectious diseases	15
C. other	0

note: "0" means the protocol has been approved but no patients have yet been given gene transfers.
[Sources: T. Marcel and J. D. Grausz, "The TMC Worldwide Gene Therapy Enrollment Report." *Human Gene Therapy*, 10/20/96, p. 2025. Gail Ross et al., "Gene Therapy in the United States: A Five-Year Status Report" *Human Gene Therapy*, 9/10/96, p. 1781.]

Germline therapy has not been attempted, and is explicitly banned in many countries, but its development and use is being advocated by noted scientists, as we discuss in Section IIE.2.b. The conditions listed in Box IIE-19 are suggested as possible early candidates for the germline therapy. **IIE-21** lists proposals for genetic enhancement that have appeared in the literature. Most of these enhancements could engineered as either germline and somatic modifications.

The distinctions between therapy and enhancement, and between somatic and germline gene modifications, are not always clear. Gene manipulation that cures cystic fibrosis would be considered by most people to be therapeutic. Gene manipulation that enables a child of average height potential to reach an adult height of seven feet would clearly be an enhancement. But what about gene manipulation that confers resistance to lung cancer? Prevention of illness has long been considered a proper medical imperative. Yet the example given is clearly an enhancement of the normal human condition.

The distinction between somatic and germline genetic modification is more easily drawn, because germline genetic changes can be detected empirically. However, at least one ambiguous instance exists. As noted above, the cytoplasmic mitochondria possess a set of genes independent of those in the cell nucleus, and in the process of cytoplasmic transfer as a fertility treatment, some mitochondria get transferred as well. Although particular genes have not been engineered, the total genetic complement of the new zygote has been modified, and these modifications would be passed to successive generations.

A difficulty with many applications of germline genetic engineering is the necessity of inserting the correct new gene in precisely the correct location along a human chromosome, a process known as homologous replacement. An alternative is to develop a human artificial chromosome (HAC) which can carry new genes into a cell nucleus, enable these to function effectively, and be transmitted intact through many generations. A person carrying an extra, artificial chromosome in their germs cells would be able to mate only with a partner who also

BOX IIE-21. Examples of Proposed Genetic Enhancements

A. LeRoy Walters and Julie Gage Palmer (1997)

"Five potential types of enhancements...are particularly compelling examples of the prospects for enhancement genetic engineering:

1. *Size:* "the germline insertion of a growth hormone gene could enhance the stature of a child who is otherwise destined to be short, or even average in size."
2. *Sleep*: "a gene for an agent that could reset the circadian clock or reduce the need for sleep would be transferred to cells that could be implanted in the hypothalamus. There they would cooperate with the brain cells controlling sleep."
3. *Aging*: "genetic manipulation involving the insertion of hyperactive human superoxide dismutase genes into bone marrow stem cells might provide an anti-aging "therapy."
4. *Memory*: "The ability to remember words names, facts and experiences is one thing many people might like to improve for themselves and their offspring. ...The enhancement would be carried out by inserting NMDA (N-methyl-D-aspartate) genes into human cells... to increase the number of NMDA receptors..."
5. *Aggression:* "Aggression is often cited as an example of a prime candidate for genetic manipulation, although it is not clear whether the desired change would be an increase or decrease in aggressive tendencies."

B. Anders Sandberg (1998) [source: www.aleph.se/Trans/Individual/Body/gene_page]

1. Artificial symptoms: Since many potentially life-threatening diseases lack easily noticed symptoms, we could "...add genes coding for enzymes producing a strongly coloured compound, which colors the urine. These genes are normally repressed by a repressor which is inactivated by the presence of certain disease-indicative chemicals" (several repressors could be linked, so that only certain highly selective combinations would cause the color shift.)
2. Sight: humans use four slightly different types of rhodopsin for colour vision. Other varieties are known among animals, and could perhaps conceivably be added to expand human perceptive range ...from the near ultraviolet (based on insect rhopdopsin) to the near infrared.

C. Assorted Others:

1. Genes implanted to generate growth hormone in short, but normal range, youth.
2. Genes implanted to produce natural vaccines against many diseases.
3. Genes implanted that produce appetite-surpressent hormones to control weight gain.
4. Cosmetic applications: baldness, hair color and type, secondary sex characteristics
5. Genes for resistance to industrial toxins for someone who works with hazardous chemicals
6. Therapeutic enhancement: "insertion of an additional LDL receptor gene in 'normal' individuals could significantly decrease the morbidity and mortality caused by atherosclerosis." (Eisenberg 1997, quoting W.F. Anderson.)

D. The Economist; editorial (1992)

"What of genes that might make a good body better, rather than make a bad one good? Should people be able to retrofit themselves with extra neurotransmitters to enhance various mental powers? Or to change the colour of their skin? Or to help them run faster, or lift heavier weights? Yes, they should. Within some limits, people have a right to make what they want of their lives."

carried the additional chromosome. In effect, the two persons would become members of a new species of human being.

DRAWING LINES

The new genetic technologies present humankind with the most important question we have ever had to answer: where do we draw the lines? There are few persons or constituencies that strongly oppose somatic gene therapy on principle, assuming it is shown to be safe and effective. Somatic gene enhancement raises many concerns. Some somatic enhancements may be no more controversial than dying ones' hair, while others may be profoundly dangerous or otherwise unacceptable. But the effects of somatic enhancements are limited to a single person, and thus potential risks are constrained.

The critical dividing line is between somatic and germline applications, whether for therapy or enhancement. Some people are opposed to all germline engineering. Others support germline therapy but oppose enhancement, and believe the distinction can be made and enforced. Others might be similarly inclined to support therapy and oppose enhancement, but doubt that the distinction can be made or enforced. People of this mind need to decide whether they believe that the benefits of germline therapy warrant accepting the spread of germline enhancement, or if the unacceptability of enhancement requires that the benefits of therapy be foregone.

BOXES IIE-22, IIE-23, IIE-24 and IIE-25 show arguments in favor of and opposing germline gene therapy, and rebuttals to these. **IIE-26** addresses the central question of whether in fact germline modification is necessary as a therapeutic technique. We see that other reproductive and genetic techniques, notably PGD, are at least as good, and in fact preferable, to germline modification as a means of allowing parents at risk of passing on disease-causing genes, in all but a very small number of instances. **IIE-27** summarizes the attitudinal and normative differences that typically underlie opinions as to whether or not germline therapy should be allowed.

BOX IIE-22. ARGUMENTS IN FAVOR OF GERMLINE GENE THERAPY

1. Some genetic diseases affect the fetus as it develops. Only early fetal gene therapy can counter these. In the process the germline will be modified, but this is a benefit, not a risk.

2. Parents may wish to spare their children and descendants from having to either:
   a) undergo somatic gene therapy if they are born afflicted with a defect; or
   b) face difficult decisions regarding possibly transmitting a disease-related gene to their own children or descendents.

3. Germline therapy is more efficient than somatic therapy, in that it permanently removes defective genes from the gene pool

4. Physicians have a responsibility to offer their patients the fullest possible range of options for medical treatment.

5. Researchers deserve to have the freedom to explore new modes of treating and preventing disease.

6. Humans evolved to compete for advantage, and germline engineering is motivated, ultimately, by the desire of people to out-compete others. Efforts to stop germline engineering will fail because cunning people will do it anyway. Therefore we should support it, and make sure its development and use proceed in a safe and effective manner.

BOX IIE-23. REBUTTALS TO ARGUMENTS IN FAVOR OF GERMLINE GENE THERAPY

Each numbered statement below is a rebuttal to the argument with the same number in Box IIE-22.

1. Fetal somatic gene therapy can employ techniques that are specific to cells that need to be treated, and thus avoid the threat of germline modification.

2. Prenatal testing with the possibility of abortion, and pre-implantation screening, can allow parents to accomplish these same ends, while avoiding the risks that germline modification entails, for all but a very small number of couples. [See Box IIE-26 for details]

3. Prenatal and preimplantation procedures also permanently remove defective genes, as do other options for parenthood such as adoption and gamete donation.

4, 5. These responsibilities and freedoms are not absolute. Democratic societies have the right and responsibility to proscribe procedures that they believe are unsafe or otherwise undesirable.

6. Humans evolved the ability to work cooperatively in society. If sufficient numbers of people decide that germline engineering is a technology the risks of which outweigh its benefits, or is otherwise undesirable, we can agree to forego its development and use.

BOX IIE-24. ARGUMENTS AGAINST GERMLINE GENE THERAPY

1. Unanticipated negative effects of germline manipulation will be passed on to all future generations.

2. Informed consent of the affected subjects is not possible.

3. The research on embryos necessary to develop germline gene therapy is ethically unacceptable.

4. Germline gene therapy will likely always be an expensive procedure available only to the affluent professional classes, thus exacerbating social and economic inequality.

5. Germline gene therapy will open the door to germline enhancement, which
   a) entails medical risks even greater than those that germline therapy entails;
   b) if "successful", would likely greatly exacerbate social and economic inequality;
   c) could generate cascades of genomic change beyond our ability to understand, assess, or control;
   d) could give malevolent dictators dangerous powers.

6. Human beings have a moral right to receive a genetic patrimony that has not been subjected to artificial tampering.

7. Germline technologies would contribute strongly to the cultural construction of human beings as biologically perfectible artifacts. This would encourage widespread negative feelings of self-worth, change the nature of the parent-child relationship, and likely have other profound and destabilizing socio-cultural impacts. Further, the standards of "perfection" would reflect current social biases, and children engineered to meet these standards might find themselves genetically "out of fashion" in the world in which they live as adults.

BOX IIE-25. REBUTALS TO ARGUMENTS AGAINST GERMLINE GENE THERAPY

Each statement below is a rebuttal to the argument of the same number in Box IIE-24.

1. All innovative efforts at technical progress entail some risk. Society can pledge to compensate anyone who suffers. Also, particular genetic problems created as a result of germline modification could very likely be corrected by using the same techniques that caused them.

2. In most societies parents give informed consent for medical treatment of children of theirs who are unable to. Alternatively, informed consent can be engineered into many germline manipulations by including genetic "on-off" switches that can be activated by patients after they have reached the age of consent.

3. Research on embryos is ethically acceptable if the benefits outweigh the costs, and if the embryos are treated with respect. These conditions can be met in a way that allows germline techniques to be developed.

4. The costs of germline procedures may come down. If they don't come down far enough to be equitable, public sector assistance could be provided. Even if only the more affluent benefit from the new technologies, this is better for society than if the new technologies were not developed at all.

5. In general, most germline genetic enhancements will turn out to be more desirable than not. If necessary, society can pass laws to prevent enhancements it believes are undesirable. The use of genetic technologies by malevolent dictators needs to be constrained by international commitment and cooperation.

6. This "moral right" has not been universally acknowledged. Future generations could also be said have a moral right to a healthy genome.

7. Human nature, not cultural construction, motivates people to want to improve themselves and endow their children with advantages. Feelings of self-worth, and parent-child relationships, will improve, not suffer, when germline engineering becomes an option. Most important standards of improvement are constant across cultures and historical time.

BOX IIE-26. IS GERMLINE GENE THERAPY NECESSARY?

Germline gene therapy is often mentioned as a way of ensuring that a couple can have children free of serious genetic disease. However, there are alternatives to germline engineering that accomplish this: adoption, embryo donation, gamete donation, pre-natal testing with the possibility of pregnancy termination, and pre-implantation screening.

Prenatal and preimplantation procedures enable most couples to have a child that is fully genetically related to them and free of genetic disease. In only two instances is this not possible:

1. Both partners are homozygous for the same genetic disease.

2. A couple, both members of which are heterozygous for a genetic disease, are willing to use pre-implantation genetic screening, but are unwilling to discard defective embryos or donate or discard healthy embryos not implanted.

In both instances the number of couples who fit these descriptions is so small that statistics are not available; cases are cited anecdotally.

Proponents of germline therapy argue that even if there were only a single couple in the world who would not be able to have a healthy child of their own without using germline techniques or violating their conscience, this would be sufficient grounds to justify development of germline technology.

Opponents of germline therapy argue that individuals homologous for a genetic disease can have healthy children of their own by partnering with any one of the 99.96% of people who are *not* similarly homologous, or by adoption or gamete or embryo donation. In any event implications of launching humankind into a new evolutionary epoch are not outweighed by the benefits that might be realized by the number of couples that would fall into the two categories listed above, no matter how individually compelling these might be.

BOX IIE-27. CORE DIFFERENCES BETWEEN PRO- AND ANTI-GERMLINE ADVOCATES

These lists summarize attitudinal and normative differences between pro - and anti- germline advocates based on the sets of arguments and rebuttals shown in Boxes IIE-22 through IIE-25.

FAVOR Germline	OPPOSE Germline
1. More confident that serious harm can be avoided; more willing to accept harm that might happen.	1. Less confident that serious harm can be avoided; less willing to accept harm that might happen.
2. More protective of individual than of societal prerogatives. Libertarian tendencies.	2. Seek to balance individual and societal prerogatives. Social democratic tendencies.
3. Less willing to constrain researchers.	3. More willing to constrain researchers.
4. Less concerned about equity impacts.	4. More concerned about equity impacts.

WHAT IT'S ALL ABOUT

In 1989 biologists David Suzuki and Peter Knudtson issued a warning about the connection between the new genetic and the new reproductive technologies:

> "Newspaper headlines trumpeting medical breakthroughs with test-tube babies, surrogate mothers, sperm banks and frozen embryos remind us that this art of external, or in vitro, fertilization is already a reality. Remarkably, even as society becomes increasingly concerned about the potential social and ethical effects of these and other human reproductive technologies, we hear little public discussion about the role these same techniques may play in future human germ-line therapy procedures. The fact is that almost any scientific advance that grants greater access to human reproductive cells and embryos hastens the day when the genetic manipulation of human germ cells will become medically feasible." (p 204)

A decade later, advocates of the new techno-eugenics were extolling the connection between these sets of technologies. Here is Lee Silver of Princeton, one of the leading techno-eugenic enthusiasts:

> "IVF...will now serve as a stepping stone to many reprogenetic possibilities that go far beyond its original purpose... the development of IVF marks the point in history when human beings gained the power to seize control of their own evolutionary destiny...By bringing the embryo out of the darkness of the womb and into the light of day, IVF provides access to the genetic material within." (1998 p 74-75)

Ian Wilmut (1998) of the Roslin Institute in Scotland, where the first adult mammalian cloning techniques were devised, makes clear how cloning, stem cell technologies and germ-line engineering are envisioned as components of a single, far-reaching techno-eugenic procedure, in just one sentence:

> "If a couple was willing to produce an embryo that could be treated by advanced forms of gene therapy, nuclei from modified embryonic cells could be transferred to eggs to create children who would be entirely free of a given disease." (pp 58-63)

Although the great majority of genetic researchers justify their work as motivated by a compassionate desire to prevent genetic diseases, it is untenable to suppose they are not aware that the techniques they are developing could be used for other purposes. Further, the majority of these researchers tend to oppose, often passionately, societal controls over their research. Meanwhile, as we'll see in the next section, a minority of researchers and others quite willingly acknowledge that their driving vision is one of a world in which affluent, professional couples use

these technologies to produce new and superior genetically-engineered human or post-human beings.

II.E.3. THE NEW TECHNO-EUGENIC VISION OF THE HUMAN FUTURE

A core set of philosophical, normative and political commitments are held by many proponents of the new techno-eugenics. These include commitments to:

* materialism, reductionism and determinism
* science and technology as autonomous endeavors properly exempt from social control
* laissez-faire economics, de-regulation, and the presumed priority of market outcomes
* a libertarian political philosophy grounded in social Darwinist views of human nature and society

Together these core commitments represent a unique ideological stance. It differs from conservative ideologies in its antipathy towards religion and traditional social values, from left-progressive ideologies in its rejection of egalitarian values and social welfare as a public purpose, and from Green ideologies in its celebration of the technological transformation of the natural world – plants, animals, humans and ecosystems. It might be thought of as a sort of utopian libertarian scientism. It is shared by a small but influential number of scientists, persons associated with high-tech private enterprise, and technologically literate academics and journalists.

A further common thread in the statements of many of these scientists and others is the repeated assertion that the advent of the new techno-eugenic human era is "inevitable," and, for good measure, that this is so "whether we like it or not."

This section highlights statements by a variety of scientists and others who espouse one aspect or another of the new techno-eugenics, or of libertarian scientism in general. The authors cited are hardly of one mind on all matters, but they show a strong commonality of perspective and normative commitment. Their statements show a strong commonality as well with those made by supporters of the Extraordinary Future cited in Section II.E.1.

II.E.3.a. Lead Speakers at the March 1998 UCLA Symposium

In March 1998 a major symposium was held at the University of California, Los Angeles, titled "Engineering the Human Germline." Nearly 1000 participants heard a roster of noted scientists speak in favor of the new human genetic engineering technologies. The lead organizer, Gregory Stock, described the symposium as the kick-off of campaign "to make it [germline engineering] acceptable" to the American people.[159] Statements and texts prepared by scientists who spoke at the UCLA Symposium are excerpted below.

1. Gregory Stock

Stock serves as Director of the Science, Medicine and Society Program at UCLA's Center for the Study of Evolution and the Origin on Life. He received a Ph.D. from John Hopkins University and an MBA from Harvard. In his 1993 book, *Metaman: The Merging of Humans and Machines into a Global Superorganism*, Stock offers this vision of the human future:

> "By applying biological techniques to embryos and then to the reproductive process itself, Metaman will take control of human evolution.. Once people begin to reshape themselves through biological manipulation,...the definition of "human" begins to drift. Altering even a small number of the key genes regulating human growth might change human beings into something quite different...Competitive pressures within Metaman will ensure the spread of any useful ways of significantly enhancing human capabilities. Populations that adopt such techniques will generally outdistance those that do not, just as has been the case with other technologies. The computer has become a necessity for modern society, and if a process were developed to triple human intelligence or to enable people to get along with no sleep, these too would soon become 'necessities'. Such changes will not be painless. Like all major developments, they will cause great stresses within society. But asking whether such changes are 'wise' or 'desirable' misses the essential point that they are largely not a matter of choice; they are the unavoidable product of the technological advance intrinsic to Metaman." (pp 168-169)

2. Lee Silver

Silver is a noted scientist at Princeton University, where he conducts research in mammalian genetics, evolution, reproduction and developmental biology. He received his doctorate from Harvard University. In his 1998 book, *Re-Making Eden,* Silver celebrates the

[159] The official Symposium report can be found at www.css.ucla.edu:80/huge/report.html.

coming future of "repro-genetic" human enhancement, in which the health, appearance, personality, cognitive ability, sensory capacity and life-span of our children all become artifacts of genetic manipulation, traits literally selected from a catalog. Silver acknowledges that cost and other factors will limit their full use to only a small portion of Americans, so that over time society will segregate into the "GenRich" and the "Naturals:"

> "The GenRich—who account for 10 percent of the American population—all carry synthetic genes... that were created in the laboratory ...All aspects of the economy, the media, the entertainment industry, and the knowledge industry are controlled by members of the GenRich class...Naturals work as low-paid service providers or as laborers, and their children go to public schools... If the accumulation of genetic knowledge and advances in genetic enhancement technology continue ... the GenRich class and the Natural class will become...entirely separate species with no ability to cross-breed, and with as much romantic interest in each other as a current humans would have for a chimpanzee." (pp 4-7)

Silver continues:

> "Many think that it is inherently unfair for some people to have access to technologies that can provide advantages while others, less well-off, are forced to depend on chance alone... (But) American society adheres to the principle that personal liberty and personal fortune are the primary determinants of what individuals are allowed and able to do. Anyone who accepts the right of affluent parents to provide their children with an expensive private school education cannot use "unfairness" as a reason for rejecting the use of reprogenetic technologies. Indeed, in a society that values individual freedom above all else, it is hard to find any legitimate basis for restricting the use of repro-genetics... I will argue (that) the use of reprogenetic technologies is inevitable. It will not be controlled by governments or societies or even the scientists who create it. There is no doubt about it...whether we like it or not, the global marketplace will reign supreme." (pp 9-11)

3. James Watson

Watson shared the Nobel Prize for Chemistry in 1962 for the discovery of the structure of DNA, served as Director of the National Center for Human Genome Research and was responsible for establishing the Human Genome Project. In 1973 he offered this suggestion regarding pediatric care:

> "If a child were not declared alive until three days after birth, then all parents could be allowed the choice that only a few are given under the present system. The doctor could allow the child to die if the parents so chose and save a lot of misery and suffering." (*Time*, May 28)

An interviewer asked Watson how he felt about eugenics; he replied, "We do it right now...I wouldn't marry a stupid woman."[160] On another occasion Watson was asked if he feared that genetic engineering could be used for "enhancement" eugenic ends; he replied, "It's not much fun being around dumb people."[161] In a major address to molecular biologists held in Berlin in 1997, Watson urged Germans to overcome their hostility to genetics research. He said that the time has come "to put Hitler behind us."[162]

4. Daniel Koshland, Jr.

Koshland served as editor of the most prestigious peer-reviewed scientific journal in America, Science, for ten years. Since 1965 he has been a professor (now emeritus) of Molecular and Cell Biology at the University of California at Berkeley. He has a building named after him—Koshland Hall—on the U.C. Berkeley campus.

> "If a child destined to have permanently low IQ could be cured by replacing a gene, would anyone really argue with that? ...It is a short step from that decision to improving a normal IQ. Is there an argument against making superior individuals? Not superior morally, and superior philosophically, just superior in certain skills; better at computers, better musicians, better physically. As society gets more complex, perhaps it must select for individuals more capable of coping with its complex problems." (p 88) [163]

Koshland received widespread notice in 1989 when he defended the $3 billion Human Genome Project as "a great new technology to aid the poor, the infirm, and the underprivileged."[164] At the 1998 UCLA Symposium, Koshland said, "The demand for gene enhancement therapy will probably be very large, to give your children a better chance of success in the world."[165]

---

[160] Quoted in Appleyard, 1998 (p 82)

[161] Quoted in Eubank, 1998

[162] *Science*, 6 May 1997

[163] Quoted in Appleyard, 1998

[164] *Science*, 13 October 1989. Editorial (p 189)

5. LeRoy Hood

LeRoy Hood holds an M.D. from Johns Hopkins and a Ph.D. from Cal Tech. In 1982 he developed the first procedure for germline genetic engineering, using mice. He is currently William Gates Professor of Biomedical Sciences and founding chair of the Department of Molecular Biotechnology at the University of Washington. The department was established with a $12 million endowment from Bill Gates of Microsoft.

> "We could probably engineer people to be totally resistant to AIDS, or to certain kinds of cancers. We might engineer people to live much longer. I would say all these are good qualities....There will come a time when we will understand enough to manipulate even complex genetic systems.. For example, we will be able to dramatically affect intelligence. That, I think, will be pretty irresistible." (p 129) [166]

II.E.3.b. Others

1. Joseph Fletcher

Fletcher has been lauded as "America's patriarch of medical ethics." He has been praised as offering "an insightful and commonsense approach to ethical evaluation of the new genetic and reproductive technologies." Nobel Laureate Joshua Lederberg applauded Fletcher's "wise counsel," and suggested that Fletcher's outlook "will inspire many demoralized and confused people, especially parents..." Here are excerpts from Fletcher's 1988 book, "The Ethics of Genetic Control: Ending Reproductive Roulette"[167]:

> "Chimeras or parahumans might legitimately be fashioned to do dangerous or demeaning jobs. As it is now, low grade work is shoved off on moronic and retarded individuals, the victims of uncontrolled reproduction. Should we not "program" such workers thoughtfully instead of accidentally, by means of hybridization? Hybrids could also be designed by sexual reproduction, as between apes and humans. If interspecific coitus is too distasteful, then laboratory fertilization and implant could do it. If women are unwilling to gestate hybrids animal females could. Contrived in order to protect human beings from danger or disease, chimeras and cyborgs would be morally justified." (p 173)

---

[165] "Engineering the Human Germline," www.ess.ucla.edu:80/huge/ report.html. (p 10)

[166] New Scientist 3 October 1998 (p 29)

[167] Lederberg's quotes are from the Introduction. Other quotes are from the back cover.

"Good reasons in general for cloning are that it avoids genetic diseases, bypasses sterility, predetermines an individual's gender, and preserves family likeness. It wastes time to argue over whether we should do it or not; the real moral question is when and why." (p 154)

"...there is nothing inherently or absolutely wrong [about incest], yet the greatest good for the greatest number might best be served by disapproving it. Having said as much, however, we may then hold that in particular cases it could be right to practice incest. It would depend on the situation, presumably an odd and highly unusual situation." (p 174)

2. James Hughes

Hughes has served on the faculty of the University of Connecticut and acts as a bioethics consultant to individuals and businesses. In his 1995 article, "Embracing Change with All Four Arms," he writes,

"People desire different attributes and abilities, for themselves and their children; for every Aryan parent that chooses a blond, blue-eyed Barbie phenotype, I expect there would be a Chinese parent choosing a classic Chinese ideal of beauty. True, this might lead to the convergence toward few physical and mental ideals, though I suspect that phenotypic fashions will change quickly. But I see no ethical difference between permitting people to change their genes in conformity with social fashions, and permitting them to change their clothes, makeup and beliefs to do so."

"Parents will probably be less gene-obsessed when they can either have a child with all their parent's genetic flaws, or one that shares their facial features, but has been tweaked with someone else's good teeth, arched feet, height, and intelligence. It will be considered obsessive and dumb to give your kids only parental genes, and parenting will be the definition of parental ties, not parentage..... (f)ertility treatments, surrogacy and genetic technology do not reify the genetic bond, but cause its slow deconstruction... genetic intervention will force us to clarify the relationship of social ties and genetic ties. If you've picked most of your child's genes from a catalog, it's likely to reinforce the importance of your social parenting ties to your child."

"The right to a custom made child is merely the natural extension of our current discourse of reproductive rights. I see no virtue in the role of chance in conception, and great virtue in expanding choice... If women are to be allowed the "reproductive right" or "choice" to choose the father of their child, with his attendant characteristics, then they should be allowed the right to choose the characteristics from a catalog."

3. Rachel Fishman

Fishman is a legal scholar whose 1993 article, "Patenting Human Beings: Do Sub-Human Creatures Deserve Constitutional Protection?," appeared in the highly-regarded *American Journal of Law and Medicine*:

"To prevent the loss of legal rights of an altered human being who may no longer be found to be a member of the human species, it is imperative that the definition of "human being" be expanded. It is preferable that the definition be broad rather than narrow, as it is better to err on the side of generosity rather than parsimony when depriving a being of his or her legal rights."

Fishman proposed that the following clause be inserted at the end of section 100 of Title 35 of the United States Code:

"(e) The term "human being" means:
(i) any genetically altered animal possessing one or more higher faculties such as: the ability to reason...; the ability to evaluate principles and observations to arrive at reasoned decisions; the ability to formulate speech and communicate; the ability to write; the ability to develop meaningful personal relationships with other human beings on the basis of equality; the demonstration of awareness of self as a unique and separate being; the ability to feel concern for others; or any other higher faculty."
(ii) any creature born of the ovum and sperm of parents who are human beings..."

Fishman explains,

"If a researcher transfers human characteristics to his or her animal subjects so that the animal possesses significant human characteristics, section (i) ensures this newly altered creature has legal status as a "human being" with attendant rights. .. If half-human creatures are created, courts will have to define the scope of this section on a case-by-case basis." (pp 461-482).

4. Gregory Pence

Pence is professor of philosophy in the Schools of Medicine and Arts/Humanities at the University of Alabama. In his 1998 book, *Who's Afraid of Human Cloning?,* he writes:

"...many people love their retrievers and their sunny dispositions around children and adults. Could people be chosen in the same way? Would it be so terrible to allow parents to at least aim for a certain type, in the same way that great breeders... try to match a breed of dog to the needs of a family?" (p 168)

"As for what is best for "society" or "the community," these questions imply too much control over the family or creation of the child to be good questions. Besides, if it's good for the child and good for the family, society will be fine." (p 166).

5. Stephen Hawking

In May of 1998 the distinguished physicist Stephen Hawking spoke at a gala event held at the White House, attended by President and Mrs. Clinton and several hundred of our country's

political and scientific elite. To a "rapt audience," Hawking shared his vision of the human future:

> "...the human race needs to improve its mental and physical qualities if it is to deal with the increasingly complex world around it and meet new challenges like space travel. And it also needs to increase its complexity if biological systems are to keep ahead of electronic ones..." To do this we will have to "completely redesign" the human DNA. "Of course, many people will say that genetic engineering on humans should be banned. But I rather doubt if they will be able to prevent it. Genetic engineering on plants and animals will be allowed for economic reasons, and someone is bound to use it to change human DNA unless we have a totalitarian order. Clearly, developing improved humans will create great social and political problems...I'm not advocating human genetic engineering as a good thing. I'm just saying that it is likely to happen in the next millennium, whether we want it or not." (San Francisco Chronicle, 3/20/98, p 1)

6. Steen Willadsen

Willadsen developed the somatic nuclear cell transfer technology that Ian Wilmut later modified to produce cloned sheep He became wealthy as a result of a stock-option arrangement with an early employer, Alta Genetics, that hoped to use his techniques to clone prize cattle.[168] Willadsen is currently involved in private research concerning oocyte cytoplasm transfer and other reproductive technologies.

In her 1998 book, *Clone: the road to Dolly and the path ahead,* New York Times reporter Gina Kolata says that the "near mythical" Steen Willadsen "did not accept the notion that there should be insurmountable obstacles to cloning adults... throughout his scientific life, he had scoffed at the very idea that hypothetical biological or technical barriers might stymie him." She quotes Willadsen: "'The role of the scientist is to break the laws of nature, rather than to establish, let alone accept them'. " She says that Willadsen "tosses off judgmental statements and tends to outbursts that he immediately confesses sound brash, or arrogant..." His life goal is "to engage in great, absorbing endeavors while maintaining a high degree of freedom, and avoiding tedium and coercion." In graduate school, Kolata says, "he thought that just two subjects were [in his words] 'worth wasting time on' - the brain and reproductive physiology."

[168] Willadsen cashed out before the plan was abandoned and the stock crashed.

Willadsen "lives in a huge pink-stucco house...with thirteen foot ceilings and a swimming pool on an enclosed porch. He denied that his house was large or terribly luxurious, although, he noted in one of his inadvertently brash asides, 'it's not for the underprivileged.'" Willadsen "spends his days tending his lawn, writing, and working part-time at two in vitro fertilization centers...In between helping infertile women have babies, Willadsen experiments with mice and with human eggs that would otherwise have been discarded." *(passim.)*

Comments

Many of the statements by the authors noted above strike some readers as so preposterous that the first reaction is that they need not be taken seriously. This is incorrect---Watson, Silver, Stock, and the others are quite serious. They are by-and-large gifted, productive, and influential scientists who share a common social and political world-view and agenda, and are working very hard to make it happen.

II.E.4. POLICY REGIMES

How do we credibly counter the vision of the human future promoted by the scientists and others just quoted? In particular, how do we counter the claim that the "post-human" future is "inevitable, whether we like it or not"? We need to do at least two things. One is to give credible examples of the sorts of policies that would prevent such a future from happening. A second is to show that large numbers of people support, or could come to support, such policies. In this section we briefly note proposed and existing policies that address human genetic technologies. In the section after this we review public opinion about these technologies.

BOXES IIE-28 and **IIE-29** display sets of policy recommendations by Jedediah Purdy and Andrew Kimbrell, respectively, addressing a wide range of concerns raised by the new human genetic and reproductive technologies. Purdy is a writer for *The American Prospect,* a centrist/social democratic political journal. Kimbrell is director of the International Center for Technology Assessment, an activist NGO. Their recommendations cover much the same ground, although Purdy's is somewhat more permissive and Kimbrell's a bit more restrictive. Both lists touch on many important concerns not addressed explicitly in these notes, including privacy, discrimination and access issues, that would likely figure prominently in a full public engagement over human genetics policy. The global ban on "super enhancements" that Purdy proposes still leaves enormous latitude for germline manipulation.

The two countries that have gone the furthest in adopting policies of the sort recommended by Purdy and Kimbrell are the United Kingdom and Germany. In 1991 the British Parliament passed a bill establishing the Human Fertilization and Embryology Authority (HFEA). The HFEA has 21 members, directly appointed by the several health ministers of the UK. It is charged with making and enforcing rules concerning the responsible use of human genetic materials. Relatively few forms of human genetic modification are legislatively banned. Rather,

BOX IIE-28. JEDEDIAH PURDY'S PLATFORM
["Dolly and Madison", *The American Prospect*, June 1998]

1. Bar insurers from treating genetic illnesses as "pre-existing conditions."
2. Bar insurers from refusing general coverage to victims of genetic disorders.
3. Ban the use of tests that identify predilections to homosexuality or other stigmatized but harmless qualities.
4. Rule out, absolutely and in advance, the assignment of any institutional position on the basis of genetic profiles.
5. Ensure the absolute privacy of genetic profiles.
6. Ban the development of human organ farms.
7. Basic genetic therapeutic procedures should be incorporated into Medicaid and other programs for the poor.
8. Coverage of basic genetic therapeutic procedures should be mandated coverage by HMO's.
9. Develop global accords to ban "super-enhancements," such as:
    * the proposed extra chromosomes that would create new species of human beings.
    * any enhancement that adds capacities that are not now part of the human lot.
    * any deliberate reduction in human capabilities.
    * the engineering of specialized excellences focused on a particular function.

BOX IIE-29. ANDREW KIMBRELL'S PLATFORM
[*The Human Body Shop*, 1993]

1. A moratorium on the use of induced-abortion fetuses for transplantation and research until the profound ethical and legal problems surrounding this practice are fully discussed and resolved.
2. No eugenic use of "superior" sperm or eggs
3. No experimentation on embryos, and maximum attempts to see that frozen embryos are given a chance at life.
4. Limits on the use of genetic screening of the unborn (amniocentesis, CVS, or preimplantation genetic screening of embryos) to ensure that screening is used only for detecting life-threatening disease.
5. No genetic screening or monitoring of workers, and no discrimination against individuals in questions of employment or insurance or health coverage based on their genetic readout.
6. No use of genetically engineering drugs to alter or treat human traits that are the object of discrimination (height, pigmentation, and so on.)
7. Limitation of gene therapy to the treatment of life-threatening disease. No use of gene engineering of humans for cosmetic or enhancement purposes.
8. A moratorium on the germline alteration and cloning of animals, including the engineering of human genes into animals, until there has been a full public debate on the issue and the ethical and environmental consequences of the genetic engineering of animals are better understood.
9. A ban on germline genetic therapy for the foreseeable future. We do not have the wisdom to know which genes are "good" and which genes are "bad."
10. A complete ban on the cloning of human beings.

the HFEA is given broad latitude to set policies. This has the advantage of giving flexibility concerning a new and rapidly changing set of issues, but gives a relatively small, appointive body the final say over matters of far-ranging consequence. The most important structural feature of the HFEA is its authority to license and monitor all public and private institutions whose work involves the use of human gametes or embryos. This allows real public accountability and control, as distinguished from many proposals, notably by researchers and the fertility industry, for self-regulation, or for adoption of statements of principles and guidelines that have no enforcement mechanisms. See more about the HFEA in **IIE-30.**

The German *Embryonenschutzgesetz* (Embryo Protection Law) was also adopted in 1991 and is among the strictest sets of restrictions on human genetic and reproductive research and services world-wide. It bans all uses of human embryos for research purposes and pre-implantation genetic screening, and allows *in-vitro* fertilization and other assisted reproductive technologies only under tightly constrained conditions. Because these activities are banned outright rather than regulated, there is no need in Germany to establish a regulatory structure such as the HFEA. For more on the *Embryonenschutzgesetz* see **IIE-31.**

Legislation brought before the Canadian parliament in 1996 strikes a middle ground between that adopted by the British and the Germans. It bans outright more technologies than is the case in the UK British but less than in Germany, and establishes a regulatory body to oversee the remainder. The proposed Canadian legislation is interesting in having been developed after an extensive five year consultation with thousands of Canadian civil society organizations, experts and the general public, under the auspices of a Canadian Royal Commission. Provisions of the Canadian legislation are shown in **IIE-32.**

The single most significant human genetics policy instrument agreed upon in recent years is the *Convention on Biomedicine and Human Rights,* adopted by the Council of Europe in 1997. The Council itself was established after World War II as a body for coordinating European-wide policies on a large number of social, cultural and political matters, and currently has 44 members.

BOX IIE-30. The Human Fertilization and Embryological Authority (HFEA)
[main source: www.doh.gov.uk/embryo.htm]

The Human Fertilization and Embryology Authority (HFEA) was established in the United Kingdom in 1991 following extensive national consultation and debate. It remains one of the few statutory bodies of its kind in the world, and is often pointed to as a model for regulating reproductive and genetic technologies.

The main functions of the HFEA are:
1. To license and monitor all UK treatment clinics offering: in vitro fertilization (IVF) donor insemination (DI) storage of eggs, sperm or embryos;
2. To license and monitor all research involving human embryos.

The HFEA also produces a Code of Practice which gives guidelines to clinics about the proper conduct of licensed activities, and keeps a formal register of information about donors, treatments and children born from those treatments.

The HFEA has 21 members, appointed by UK Health Ministers. The HFE Act requires that the Chair, Deputy Chair and at least half of the HFEA's membership are neither doctors nor scientists involved in human embryo research or providing infertility treatment.

Licensed clinics are inspected annually, by an inspection team consisting of a clinician, a scientist, a person with a background in another field, such as counseling, as well as well as a member of the HFEA's executive staff. The HFEA employs 65 part-time inspectors.

To grant a research license the HFEA must be satisfied that the use of human embryos is "necessary or desirable" for at least one of the following purposes:
* to promote advances in the treatment of infertility
* to increase knowledge about the causes of congenital disease
* to increase knowledge about the causes of miscarriages
* to develop more effective techniques of contraception
* to develop methods for detecting the presence of gene or chromosome abnormalities in embryos before implantation

UK law does not permit certain activities involving human embryos. These include:
* keeping or using an embryo after the appearance of the primitive streak or after 14 days, whichever is earlier; placing a human embryo in an animal;
* replacing a nucleus of a cell of an embryo with a nucleus taken from the cell of another person, another embryo, or subsequent development of an embryo;
* altering the genetic structure of any cell while it forms part of an embryo;
* using embryos for any other purposes except in pursuance of a license.

In 1998 the HFEA reiterated its opposition to human reproductive cloning, and forbade clinics to engage in activities specific to human cloning. The HFEA also called for national legislation, just to solidify the case against cloning.

BOX IIE-31. The German Embryonenschutzgesetz (Embryo Protection Act)
[source: www.bundesregierung.de/en/News-by-subject/Science-and-Technology-,11165]

The Embryo Protection Act entered into force on January 1, 1991. Key provisions include:

1. a ban on all somatic cell nuclear transfer (human cloning) whether for research or reproduction
2. a ban on gene transfers in germ cells and embryos (germline manipulation)
3. a ban on gender selection, except in cases of sex-linked genetic diseases
4. a ban on the creation of chimeras and hybrids.
5. a ban on the implantation of human embryos into animals, and vise-versa.
6. a ban on artificial fertilization of egg cells with the sperm of persons who are dead,
7. strict controls over fertility clinic operations, including strict monitoring and accountability to guard against accidental or intentional misapplications (e.g., trafficking in embryos)
8. strict controls over operations of researchers involved with human genetic materials

BOX IIE- 32. CANADIAN BILL C-47: THE HUMAN REPRODUCTIVE AND GENETIC TECHNOLOGIES ACT

[Source: http://www.parl.gc.ca/bills/government/C-47/C-47_1/17946bE.html]

Bill C-47 was based on the 1993 Report of the Canadian Royal Commission on New Reproductive Technologies (1993) and considered by the 35th Parliament, 1996-97. Parliament adjourned before taking final action but the bill is expected to be re-introduced.

The intent of the bill was to draw boundaries concerning those human genetic and reproductive technologies where the lines were clear and social consensus was evident. Subsequent legislation was intended to establish a commission to oversee licensing and operations of those practices which were to be permitted.

Activities prohibited under Bill C47 included:

1. creating human zygotes by somatic cell nuclear transfer
2. creating human-animal zygotes
3. implanting human zygotes in animals, or vice-versa
4. germline alteration
5. creating zygotes intended for implantation from gametes harvested from cadavers or fetuses
6. sex selection for non-medical reasons
7. maintenance of embryos outside the human body
8. creating human embryos specifically for the purpose of research
9, commercialization of surrogacy
10. purchase and sale of ova, sperm, zygotes, embryos or fetuses
11. use of ova, sperm, zygotes and embryos for any purpose without informed consent of donors

The legislation provided that anyone guilty of violating these proscriptions is liable to fines up $250,000-$500,000 and/or prison terms up to four to ten years.

As noted in **IIE-33,** the *Convention* at once bans all germline engineering, whether therapeutic or "enhancement;" all enhancement applications, whether somatic or germline; sex selection; and the creation of human embryos for research purposes. The Convention explicitly does not prohibit research using human embryos. The Convention comes as close as any document has to date in embodying what might be an international policy consensus. States who sign the Convention commit themselves to seek to incorporate the Convention's provisions into domestic law. As of late 1999 the Convention had been signed by 30 member countries.

The only existing globally international policy document addressing the new human genetic technologies is the *Universal Declaration on the Human Genome and Human Rights* adopted by the United Nations Educational, Scientific and Cultural Organization (UNESCO) in 1997. Unlike the Council of Europe's *Convention* or national legislation, it is a declaration only, and has no force of law. The hope, however, was that the *Declaration* would encourage and set ground rules for national and regional legislation and treaties, and set the stage for a subsequent round of global negotiations. The UNESCO declaration is comparatively permissive. Most of its provisions are very general exhortations to respect individual and human rights, and the concerns of developing countries, when considering policies regarding human genetic research and applications. Although the document declares that human reproductive cloning is "contrary to human dignity" and should be prohibited, it takes a more equivocal position regarding germline modification, stating only that this practice "may" be contrary to human dignity. Other provisions are summarized in **IIE-34**. The generality and tentativeness of the Declaration is perhaps to be expected for a text agreed upon by representatives from 110 countries. It remains to be seen what steps UNESCO might take towards more explicit language.

The declarations, laws and regulations just reviewed, despite their differences, are existence proofs of the ability of societies to draw lines in just the right places and agree to support benign and beneficent applications of the new human genetic technologies while proscribing pernicious ones. However, the fact that in the instance at hand these laws and

BOX IIE-33. Council of Europe Convention on Biomedicine and Human Rights [1997]

[Source: Convention for the Protection of Human Rights and The Dignity of the Human Being with Regard to the Application of Biology and Medicine: Convention on Human Rights and Biomedicine. European Treats, ETS No. 164 (1997).]

The several chapters and articles cover a wide range of topics, including equitable access to health care, adherence to professional standards, informed consent, non-discrimination, genetic privacy, patient protection, organ donation and transplantation, and other topics. Articles dealing explicitly with human genetics topics include:

Article 11 - Non-discrimination
Any form of discrimination against a person on grounds of his or her genetic heritage is prohibited.

Article 12 - Predictive genetic tests
Tests which are predictive of genetic diseases or which serve either to identify the subject as a carrier of a gene responsible for a disease or to detect a genetic predisposition or susceptibility to a disease may be performed only for health purposes or for scientific research linked to health purposes, and subject to appropriate genetic counseling.

Article 13 - Interventions on the human genome
An intervention seeking to modify the human genome may only be undertaken for preventive, diagnostic or therapeutic purposes and only if its aim is not to introduce any modification in the genome of any descendants.

Article 14 - Non-selection of sex
The use of techniques of medically assisted procreation shall not be allowed for the purpose of choosing a future child's sex, except where serious hereditary sex-related disease is to be avoided.

Article 18 - Research on embryos in vitro
1.Where the law allows research on embryos in vitro, it shall ensure adequate protection of the embryo; 2.The creation of human embryos for research purposes is prohibited.

As of December 1999 the *Convention* had been signed by 28 of the Council's 44 member countries, and ratified by 6 of them.

BOX IIE-34. UNESCO'S UNIVERSAL DECLARATION ON THE HUMAN GENOME AND HUMAN RIGHTS
[http://portal.unesco.org/shs/en/ev.php@URL_ID=1881&URL_DO=DO_TOPIC&URL_SECTION=201.html]

In 1997 UNESCO approved a declaration on human genetic technologies and related issues, explicitly grounding its concern within a human rights framework. Key provisions include:

A. Human Dignity and the Human Genome

Article 1. "The human genome underlies the fundamental unity of all members of the human family, as well as the recognition of their inherent dignity and diversity. In a symbolic sense, it is the heritage of all humanity."

Article 4. "The human genome in its natural state shall not give rise to financial gains."

B. Rights of the Persons Concerned

Article 5 calls for "prior, free and informed consent" for any diagnosis, treatment, research and information sharing concerning genetic matters, and review procedures for genetic research.

Article 6 stands in opposition to genetic discrimination.

Article 7 affirms the need for confidentiality in the course of genetic research or other purpose.

C. Research on the Human Genome

Article 10 says no genetic research should prevail over basic human rights, freedoms and dignity.

Article 11: "Practices which are contrary to human dignity, such as reproductive cloning of human beings, shall not be permitted."

Article 12 affirms freedom of scientific research, but implies that genetic research should confine itself to "relief from suffering and improving the health of individuals and humankind."

D. Conditions for the Exercise of Scientific Activity

Articles 13 through 15 call on States to support human genome research, to establish comprehensive systems of oversight, and to encourage the establishment of independent review committees regarding human genetic research.

E. Solidarity and International Cooperation

Articles 16 through 19 emphasize the need for North-South cooperation concerning human genetics issues, and the need to ensure that research and development meets the needs of the South.

F. Promotion of the Principles set out in the Declaration

Articles 20 through 25 contain recommendations to States and other bodies on ways to support the principles stated in this declaration. Article 24 says that UNESCO's International Bioethics Committee should "give advice... regarding the identification of practices that could be contrary to human dignity, such as germ-line interventions."

regulations need to be universal if they are to be effective at all poses an immense practical challenge. It is reasonable to expect that when people come to realize all that is at stake, they would be motivated to support the needed policies. But this will not happen at the scale and in the time required without a major commitment on the part of social, political and other world leaders, and a popular base, working to make it happen. In the next section we review a range of surveys of general publics and their leaders concerning the new human genetic technologies.

II.E.5. PUBLIC OPINION[169]

This section reviews the results of surveys of public opinion concerning genetic engineering. We want to know which applications people support and which they oppose, and to what degrees, in order to help us assess the feasibility of various policy initiatives. Our main interest concerns human genetic engineering. However, we begin in Part A by reporting survey results concerning technology in general, and in Part B we consider attitudes about the genetic engineering of micro-organisms, plants and animals. These results provide a useful context and contrast for assessing attitudes towards human genetic engineering, covered in Part C.

II.E.5.a. Attitudes about Technology and Types of Technologies

Table 1 in **IIE-35** suggests that attitudes held by Americans about science and technology in general are largely positive, and have not varied greatly over the past 15 years. Tables 2 and 3 show that for many people this general endorsement of science and technology may be tempered by concerns over the pace of technological change, its impacts, and the suspicion that it is "out of control." **IIE-36** suggests that attitudes of people in industrialized countries such as Australia, Japan and the UK about science and technology in general may be roughly comparable to those held in the US.

This largely positive attitude about science and technology in general does not hold for all technologies in particular. The tables in **IIE-37** suggest that Americans regard nuclear power and genetic engineering more problematically than many other technologies or areas of scientific research. Skepticism about these two technologies appears to be even more pronounced in countries other than the US. The tables in **IIE-38** show that in Europe, Canada and Japan genetic engineering is looked upon less favorably than are any of six other major categories of technology, although majorities (in Europe, a strong plurality) still believe it will be, on balance,

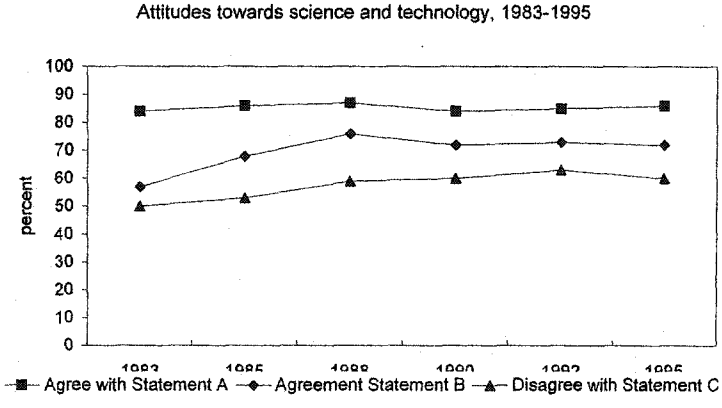
[169] All tables show the results of surveys of probability samples of residents of the United States, except where otherwise noted.

Box IIE-35. Attitudes towards science and technology (USA)
[percents]

Table 1
Now I would like to read you some statements like those you might find in a newspaper or magazine article. For each statement, please tell me if you generally agree or disagree.

Statement A: "Science and technology and making our lives healthier, easier, and more comfortable."
Statement B: "The benefits of science are greater than any harmful effects."
Statement C: "Science makes our way of life change too fast."

	1983	1985	1988	1990	1992	1995
Agree with A:	84	86	87	84	85	86
Agree with B	57	68	76	72	73	72
Disagree with C	50	53	59	60	63	60



source: Science and Engineering Indicators 1996. National Academy of Sciences, Washington, DC. Appendix Table 7-20 . N = 2006.
www.nsf.gov/sbe/srs/seind96

Table 2
Which of the following statements do you agree with more strongly?

Rapid technological change is producing some pain and economic dislocation, but in the long run will be good for the United States.	54
Rapid technological change is causing severe job losses and is harmful for the United States.	42
Both/neither/not sure	4

source: Business Week/Harris Poll survey, Feb. 16, 1996; IIPO 95-6:411. N = 1004.

Table 3
Please tell me whether you tend to agree or disagree: technology has almost gotten out of control.

	agree	disagree	not sure
1978	43	41	16
1990	45	53	2
1993	50	47	3
1994	53	46	1

source: Lou Harris & Associates, Equinox Survey,1994; APOI 1994:670. N (94) = 1250.

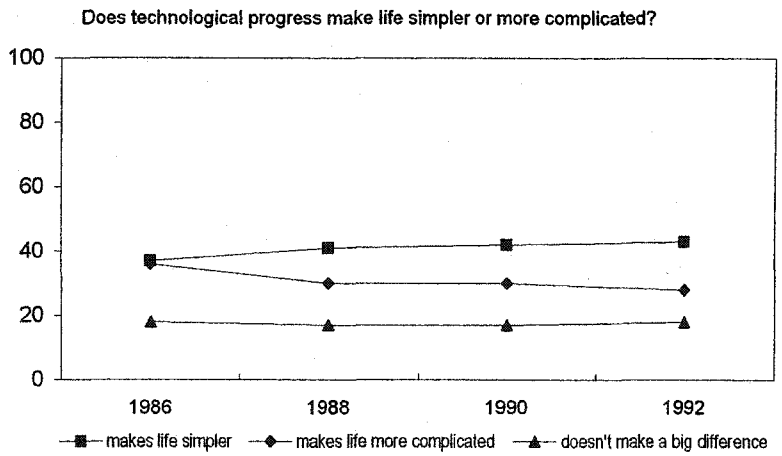
BOX IIE-36. ATTITUDES TOWARDS SCIENCE AND TECHNOLOGY (W. Germany, UK, Australia, Japan)

[percents]

Table 1.

Do you think that technical progress makes life simpler for people or does it make it progressively more complicated?" [West Germany]

	simpler	more complicated	about the same	don't know
1986	37	36	18	9
1988	41	30	17	12
1990	42	30	17	11
1992	43	28	18	11



source: Demoscopie Allensbach, July 1992; IIPO 92-3. N = 2100.

Table 2.

Most problems can be solved by application of more and better technology.

	Australia	Japan
agree	55	46
neither agree nor disagree	22	33
disagree	23	21

source: Macer, 1994, Int'l Bioethics Survey, Table 4b, p190. N (Aus) = 201, N (Jpn) = 352.

Table 3.

Overall, do you think that science and technology do more harm than good, more good than harm, or about the same of each?

	Australia	Japan	UK
more good	66	42	44
about same	27	45	37
more harm	4	5	9
don't know	3	8	10

source: Macer 1994, Int'l Bioethics Survey, Table 19, p 211.

BOX IIE-37. COMPARISONS OF TECHNOLOGIES (USA)
[percents]

Table 1

Now, let me ask you about some specific developments. From what you know or have heard, do you think (READ ITEM) will make the quality of life a lot better for people such as yourself, somewhat better, somewhat worse, or much worse?

	solar energy	organ transplants	genetic engineering	robots & automation	nuclear power
better	92	87	66	60	51
worse	4	9	22	33	43
don't know	4	4	12	7	6

source: Office of Technology Assessment, Public Perceptions of Biotechnology, 1987. Table 33, p. 49. N = 1273.

Table 2

Would you say that, on balance, the benefits of [ITEM] have outweighed the harmful results, or have the harmful results of [ITEM] been greater than its benefits?

	scientific research	nuclear power	genetic engineering
Benefits exceed harmful results	72	43	43
Beneficial and harmful results equal	16	14	22
Harmful results greater than benefits	13	42	35

source: Science & Engineering Indicators, 1996, National Academy of Sciences. Appendix Tables 7-21, 22, 23. N = 2006.

BOX IIE-38. COMPARISONS OF TECHNOLOGIES (EUROPE, CANADA, JAPAN)
[percents]

I am going to read out a list of areas in which new technologies are currently developing For each of these areas, do you think it will improve our way of life in the next 20 years, it will have no effect, or it will make things worse?

Table 1

EUROPE	will improve	no effect	will make things worse	don't know	ratio, improve/ make worse
Solar Energy	74	14	4	8	19
Telecommunications	81	9	7	6	12
New Materials or Substances	64	12	6	17	11
Computers & Info Technology	77	8	8	7	10
Space Exploration	49	28	8	15	6
Genetic Engineering	45	10	21	25	2

Table 2

CANADA	will improve	no effect	will make things worse	don't know	ratio, improve/ make worse
Solar Energy	85	9	3	3	28
Telecommunications	88	5	5	2	18
New Materials or Substances	76	10	7	7	11
Computers & Info Technology	83	4	11	2	8
Biotechnology	72	6	9	13	8
Space Exploration	55	31	9	5	6
Genetic Engineering	54	9	26	11	2

Table 3

JAPAN	will improve	no effect	will make things worse	don't know	ratio, improve/ make worse
Solar Energy	92	5	1	3	92
New Materials or Substances	71	7	3	19	24
Telecommunications	76	13	5	6	15
Space Exploration	54	17	6	23	9
Computers & Info Technology	77	4	9	11	9
Biotechnology	62	4	12	22	5
Genetic Engineering	54	7	12	27	4

Sources:
Table 1: Eurobarometer 46.1, Fall 1996. INRA (European Commission). The Eurobarometer polls upwards of 17,000 persons in the EU countries: Belgium, Denmark, Germany, France, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain and UK. Country results are weighted by population to give proportional aggregate results.
Web site: www.za.uni-koeln.de/data/en/eurobarometer.
Table 2: Einsiedel (1997) as reported in Macer (1997).
Table 3: Macer (1997); Eubios Journal of Asian and International Bioethics 7 (137-151).

beneficial. Table 1 in **IIE-39** suggests that Germans believe genetic and nuclear technologies will have mostly negative impacts on "worldwide environment problems," whereas six other categories of technology will have positive impacts. Table 2a in IIE-39 shows that Australians also rank genetic engineering and nuclear power unfavorably. The consistently low ranking of genetic engineering seen in the surveys just reviewed is less obvious in the results for Japan shown in Table 2b, although nuclear power once more comes in last.

Genetic engineering is one type of biotechnology, but it is central to the most consequential biotechnological processes. In many contexts the terms "genetic engineering" and "biotechnology" can legitimately be used interchangeably. Table 2 in IIE-39, as well as Table I and Table 2 in 1 IIE-38, suggest that people commonly evaluate "biotechnology" more favorably than "genetic engineering."

The intent of the remainder of these notes is to focus on attitudes about genetic engineering, but at points it is useful to consider attitudes about the broader topic of biotechnology. Part B focuses on human genetic engineering.

II.E.5.b. Attitudes about Genetic Engineering in General, and of Micro-Organisms, Plants and Animals

Although Americans hold genetic engineering in lower regard than they do other technologies, they believe that it is, on balance, beneficial. Table 1 in **IIE-40** shows that by a strong margin (69 percent to 16 percent) New Jerseyans believe genetic engineering will improve the quality of their lives. Table 2 in IE-40 shows that by a thinner margin (43 to 35 percent) a national sample of Americans believes that the benefits of genetic engineering are greater than its risks. This evaluation has held roughly constant since at least the mid-1980's. Support for genetic engineering rises steadily with education, as shown in Table 3.

Box IIE-41 suggests that survey responses concerning genetic engineering may be strongly influenced by prefatory material provided for the question. In the example shown the

BOX IIE-39. FURTHER COMPARISONS OF TECHNOLOGIES (OTHER COUNTRIES)
[percents]

Table 1

Which technologies are seen as positive or negative with respect to the solution of worldwide environmental problems? [West Germany]

Responses on a scale from -5 (very negative) to +5 (very positive):

solar technology	+3.71
computer technology	+2.30
aerospace technology	+1.26
pharmaceutical industry	+1.14
communication technology	+0.89
chemical industry	+0.21
genetics	-1.06
nuclear technology	-1.18

source: Demoskopie Allensbach, 1993. IIPO 1993-94:447. N = 1500.

Table 2

Do you have any worries about the impact of research or applications of....

2a. AUSTRALIA	no worries	a few/ some	a lot	ratio of no/a lot
computers	51	37	12	4.25
biotechnology	33	50	17	1.94
in vitro fertilization	30	46	24	1.25
pesticides	19	48	33	0.58
genetic engineering	19	47	34	0.56
nuclear power	16	36	48	0.33

2b JAPAN	no worries	a few/ some	a lot	ratio of no/a lot
computers	57	41	2	28.50
biotechnology	37	58	5	7.40
genetic engineering	22	63	15	1.47
pesticides	21	62	17	1.24
in vitro fertilization	13	73	14	0.93
nuclear power	15	53	32	0.47

source: Macer 1994, Tables 6a-6f, pp 193-197. N (Aus) = 201, N (Jpn) = 352.

BOX IIE-40. PUBLIC ASSESSMENTS OF GENETIC ENGINEERING
[percents]

Table 1

From what you know or have read, do you think genetic engineering will make the quality of life for people such as yourself better or worse? [New Jersey residents]

much better	20
somewhat better	49
somewhat worse	10
much worse	6
not sure	14

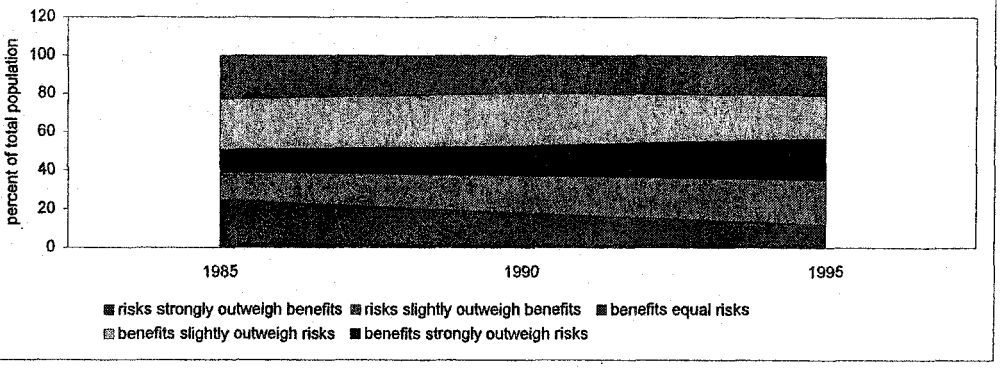
source: Hallman, W. & J. Metcalfe, 1995. Public Perceptions of Agricultural Biotechnology: a survey of New Jersey residents. N = 604.

Table 2

Some people have argued that the creation of new life forms through genetic engineering research constitutes a serious risk, while other persons have argued that this research may yield major benefits for society. In your opinion, are the risks of genetic engineering research greater than its benefits, or are the benefits of genetic engineering research been greater than its risks?

	1985	1990	1995
benefits strongly outweigh risks	23	20	21
benefits slightly outweigh risks	26	27	22
benefits equal risks	12	16	22
risks slightly outweigh benefits	14	19	23
risks strongly outweigh benefits	25	18	12

Figure 1. Public Assessments of Genetic Engineering



Note: In 1995 the survey question was "In your opinion have the benefits of genetic engineering research outweighed the harmful results, or have the harmful results of genetic engineering research been greater than its benefits?
source: Science and Engineering Indicators 1996. Appendix Table 7-23.

Table 3

by educational level, 1995
[percent]

	Benefits greater than risks	Benefits equal risks	Risks greater than Benefits
all adults	43	22	35
less than high school graduates	29	30	32
high school graduates	41	21	37
baccalaureats	65	16	20

source: Science and Engineering Indicators 1996. Appendix Table 7-23.

BOX IIE-41. ANOTHER ASSESSMENT OF GENETIC ENGINEERING
[percents]

In 'Jurassic Park' the dinosours were supposedly produced by genetic engineering. Genetic engineering means the process of changing genes or DNA in a cell for medical, agricultural or other scientific research. On balance, do you believe that the potential benefits of genetic engineering outweigh the risks or that the risks outweigh the benefits?

	Benefits outweigh risks	Risks outweigh benefits	Not sure
national	34	57	9
some high school	22	62	16
high school graduate	26	64	10
some college	34	58	8
college graduate	52	44	4
post-graduate	69	28	3

source: Harris survey, June 1993. APOI 1993:872. N = 1253.

prefatory material associates genetic engineering with the dinosaurs of "Jurassic Park". This is the single instance among all the surveys reviewed in these notes in which a national sample judged the risks of genetic engineering, in general, to outweigh the benefits.

Box IIE-42 suggests that European attitudes towards biotechnology and genetic engineering are roughly comparable to attitudes towards genetic engineering in the United States. However, the survey question shown combines the terms "biotechnology" and "genetic engineering" and thus obscures the distinction, noted above, that people draw between these.[170] (In fact, as we'll see shortly, Europeans are less supportive of many forms of genetic engineering than are Americans.)

Box IIE-43 shows results from the first major survey done in the United States on public attitudes towards biotechnology and genetic engineering, conducted in 1987 by the Office of Technology Assessment.

Table 1 and Table 2 in IIE-43 suggest that opinion has been roughly evenly divided between those who believe that genetic engineering is likely to pose serious dangers and those who believe this is unlikely, with those who believe this is likely having an edge.

Table 2 in IIE-43 suggests that a majority of Americans may be willing to tolerate risks at the level of perhaps 1 in 500 or so that a local species of plant or fish will go extinct as a result of the use of a genetically engineered organism.[171] But this judgment has no significance unless the meaning of the "use" of a genetically engineered organism has been specified.[172] In any

---

[170] The countries shown in Box IIE-42 are ranked according to the final column, which shows the ratio of those respondents who believe biotechnology and genetic engineering will improve things over those who believe these technologies will make things worse. The rank order of the results suggests possible correlations with per capita income, level of education, geographic location, and religion.

[171] Linear extrapolation of the approval rates shown between the risk levels of 1 in 100 and 1 in 1,000 suggest that 51% approval would be achieved for a risk level of about 1 in 700. An exponential extrapolation suggests 51% approval at a risk level somewhere between 1 in 300 and 1 in 500.

[172] "Use" might be defined as the commercial adoption of a particular engineered organism (say, a transgenic pest-resistant form of wheat), once and for all. Alternatively, "use" might refer to every instance in which the transgenic wheat is commercially deployed, in every discrete locality, for any given year or other time period. If a single local species of plant or fish was lost every 100 or 1000 times the transgenic

BOX IIE-42. ATTITUDES TOWARDS BIOTECHNOLOGY AND GENETIC ENGINEERING IN THE EUROPEAN UNION

[percents]

Table 8.1

Science and technology change the way we live. Do you think that biotechnology and genetic engineering will improve our way of life in the next 20 years, will have no effect, or will make things worse?

	will improve	no effect	will make things worse	don't know	no answer	ratio of improve/ make worse
Portugal	46	2	2	49	0	23
Spain	58	3	4	34	0	14.5
Ireland	48	10	5	36	0	9.6
Greece	39	2	6	52	0	6.5
Italy	56	6	10	29	0	5.6
EU	51	9	11	28	0	4.6
France	54	10	13	23	0	4.2
Belgium	49	8	12	30	0	4.1
Germany	44	19	12	25	1	3.7
UK	51	7	14	28	1	3.6
Luxembourg	48	14	14	24	0	3.4
Netherlands	48	8	19	24	0	2.5
Denmark	44	9	24	24	0	1.8

source: Eurobarometer 1991. From data presented in Lemkow (1993), Public Attitudes Towards Genetic Engineering.

BOX IIE-43. ATTITUDES ABOUT THE RISKS AND MORALITY OF GENETIC ENGINEERING
[percents]

All tables are from data presented in Office of Technology Assessment, 1987. N(9.1-4) = 1273; N(9.5) = 585.

Table 1

From what you have heard and read, how likely do you think it is that genetically engineered products will represent a serious danger to people or the environment--very likely, somewhat likely, somewhat unlikely, or very unlikely?

likely	52
unlikely	42
not sure	6

Table 2

From what you have heard or read, how likely do you think it is that the use of genetically engineered organisms in the environment will (READ ITEM) -- very likely, somewhat likely, somewhat unlikely, very likely...

	likely	unlikely	not sure
Create antibiotic-resistant diseases	61	28	11
Produce birth defects in humans	57	34	9
Create herbicide-resistant weeds	56	33	11
Endanger the food supply	52	42	7
Mutate into a deadly disease	46	44	10
Increase the rate of plant or animal extinction	45	46	9
Change rainfall patterns	42	46	12

Table 3

Suppose that a new genetically engineered organism had been developed which would significantly increase farm production with no direct risk to humans. Would you approve the environmental use of that organism if the risk of losing some local species of plants or fish was (READ ITEM)?

	Approve	Not approve	Not sure	No answer
Risk level unknown	31	65	3	1
1 in 100	40			0
1 in 1,000	55	37	9	0
1 in 10,000	65	27	3	5
1 in 100,000	71	21		
1 in 1,000,000	74	18	2	5
Unknown, but very remote	45	48	9	5

Table 4

If there was no direct risk to humans and only very remote risks to the environment, would you approve or disapprove the environmental use of genetically engineered organisms designed to produce...

	Approve	Disapprove	Not Sure
Disease-resistant crops	73	23	4
Bacteria to clean oilspills	73	23	4
Frost-resistant crops	70	27	3
More effective pesticides	56	40	4
Larger game fish	53	43	4

Table 5

Do you believe that creating hybrid plants and animals through direct genetic manipulation of DNA is morally wrong, or not?

morally wrong	24
not morally wrong	68
depends	4
not sure	4

event the precise calculation of risk levels is very difficult, and analysts typically conclude that risks are "unknown but very remote." The survey results suggest that a plurality of Americans (48%) would consider this level of risk to be unacceptable.

The question that generated the results shown in Table 4 in IIE-43 was designed to assess the level of support for using genetically engineering organisms based on the purely intrinsic value of refraining from their use. We see that the use of genetic engineering to produce disease and frost-resistant crops, and to produce oil-eating bacteria, is strongly approved, but that its use to produce more effective pesticides and larger game fish is significantly less approved of, although majorities are still supportive.[173] Opinions concerning the related question of the morality of genetic manipulation are shown in Table 5 in IE-43. These results are consistent with those shown in Table 4, and suggest that moral concerns are particularly strong motivators of opposition to genetic engineering, as described in the question, for perhaps just under 25% of Americans.

Box IIE-44 displays attitudes about genetic engineering held in 15 European countries and the United States. The pattern seen in Box IIE-42, where Germanic countries show higher concerns about genetic engineering than do Latin and Mediterranean countries, is evident in Table 1 in IIE-44, but not so strongly. Table 2 suggests that genetic engineering is perceived by Europeans as a greater food risk than artificial coloring, cholesterol, fat or sugar, but less of a risk than bacterial contamination, pesticide residues, mold and food irradiation.

Most of the surveys just reviewed evaluate genetic engineering in a general sense, but attitudes about genetic engineering can vary significantly depending on the type of organism

---

wheat was "used," far more local species would be lost if under the second definition of "use" than under the first.

[173] Note that the question above Table 4 in IIE-43uses the phrase "only very remote risks", rather than "unknown but very remote", which was evaluated in Table 3 in IIE-43. The first phrase implies a higher degree of certainty than is typically the case in these matters. The second phrase acknowledges this uncertainty, which presumably accounts for the low level of approval shown in Table 3

BOX IIE-44. EUROPEAN ATTITUDES ABOUT THE RISKS OF GENETIC ENGINEERING
[percents]

Table 1

Percent of respondents that perceive genetic engineering as a serious health hazard

> 50%		40%-50%		< 40%	
Sweden	65	Spain	49	UK	39
Portugal	62	Ireland	48	France	38
Austria	60	Netherlands	48	Luxembourg	38
Germany	57	Belgium	44	Greece	33
		Denmark	44	Italy	30
		Finland	41	Norway	28
				USA	21

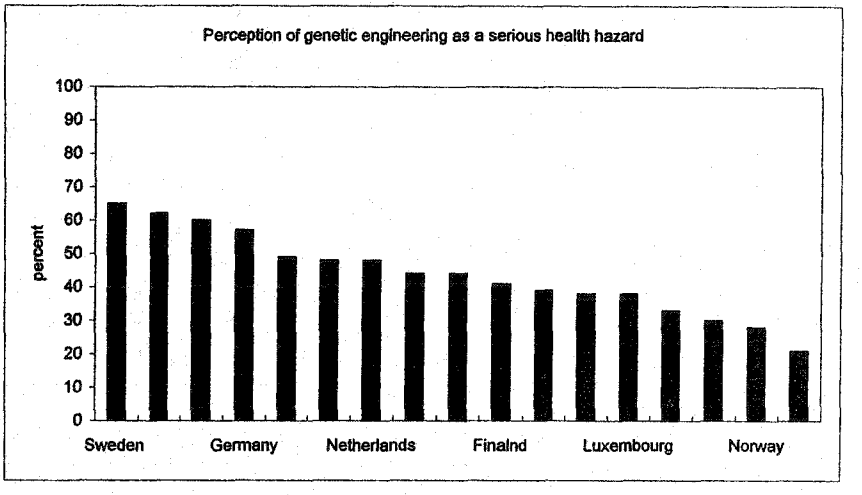
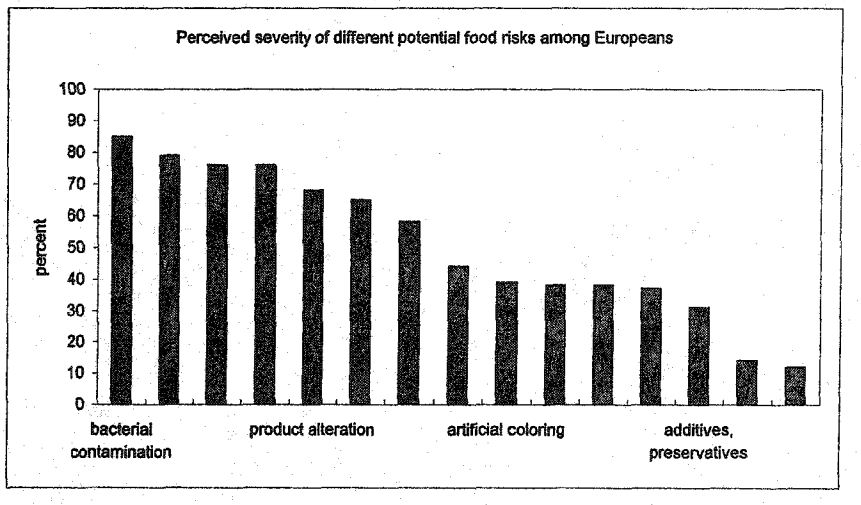


Table 2

Percent that perceive the items listed as potential food risks

bacterial contamination	85	artificial coloring	39
pesticide residues	79	nitrite	38
antibiotics,hormones	76	cholesterol	38
mold	76	fat	37
product alteration	68	additives, preservatives	31
food irradiation	65	salt	14
limit date passed	58	sugar	12
genetic engineering	44		



source: T.J. Hoban, Consumer acceptance of biotechnology: an international perspective. Nature Biotechnology 15 March 1997:232-234.

whose genes are being modified, the phylogenetic distance between the donor and recipient of a transgene, personal and social benefits and risks thought to be generated by the application, the likely extent of use, the possibility of irreversible impacts, ethical considerations, and other factors.

The tables shown in **IIE-45** demonstrate that people have significantly more reservations about genetic engineering involving animals than they do about genetic engineering involving plants, and that reservations are strongest about genetic engineering involving humans.[174] Table 4 in IIE-45 shows twelve applications of genetic engineering involving micro-organisms, plants and animals. Some applications are approved by upwards of 90% of people surveyed while others are approved by only 40% or less. Of the 12 applications listed, 10 meet with approval of a majority of respondents, with 5 of these receiving over 75% approval.

These results contrast somewhat with the generally high levels of skepticism about the safety of genetic engineering shown in Tables 1 and 2 of IIE-43. If we assume that the results shown accurately represent people's attitudes, a reasonable inference is that people judge the benefits of most of the products listed in Table 2, Table 3 and Table 4 in IIE-45, to outweigh the risks foreseen in Table 1 and Table 2 of IIE-43.

Opinion surveys commonly show that people who may express disapproval of genetic engineering in general will nonetheless approve of particular genetic engineering applications. An example can be seen by comparing Table 1 in IIE-45, in which 65% of respondents disapprove of using genetic engineering to create hybrid animals, with Table 3 in that box, in which 63% of respondents *favor* genetic engineering to make animals resistant to diseases. [175]

---

[174] The results shown in Table 5 in IIE-45 suggest that "genetic manipulation of human *cells*" is regarded by people to be unacceptable, but only slightly so. It is possible that the responses would have shown greater unacceptability had the question asked about "genetic manipulation of human *beings*".

[175] Of course, differences in the wording or interpretation of the questions, and fact that the sample populations are different, might account for some of this seeming discrepancy. All transgenic animals, including those engineered to be disease resistant, are, by definition, hybrids.

BOX IIE-46. PUBLIC PERCEPTION OF VARIOUS APPLICATIONS OF BIOTECHNOLOGY
[percents]

People surveyed were asked if they agreed completely, agreed somewhat, disagreed somewhat, or disagreed completely, with each of the four statements A through D, as applied to each of the six applications 1 through 6, shown below.

A. This application benefits society
B. This application involves risks for society
C. This application is morally acceptable
D. The application should be encouraged

Applications:

1. Using modern biotechnology in the production of foods, for example to make them higher in protein, keep longer, or change the taste (BETTER FOODS)

2. Taking genes from plant species and transferring them into crop plants to make them more resistant to insect pests (IPEST RESISTANCE).

3. Introducing human genes into bacteria to produce medicines or vaccines, for example to produce insulin for diabetics (SUPPLY OF MEDICINES)

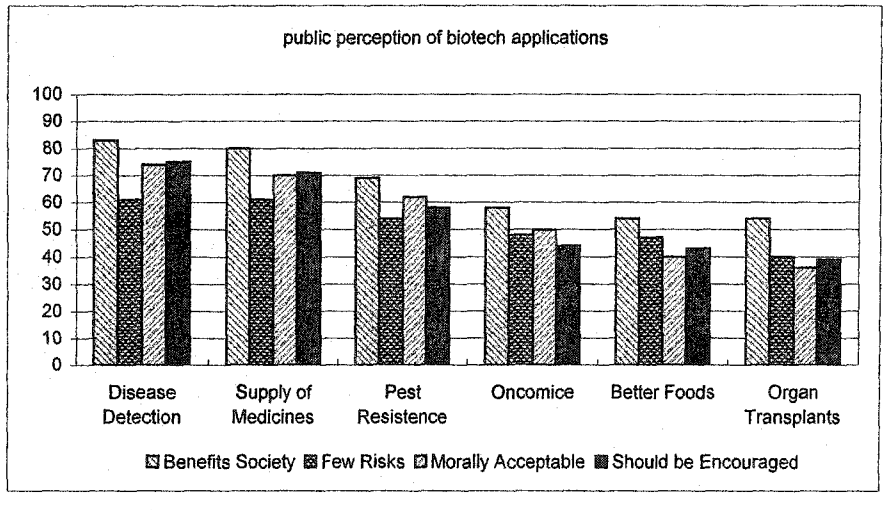
4. Developing genetically modified animals for laboratory research studies, such as a mouse that has cancer-causing genes (ONCOMICE)

5. Introducing human genes into animals to produce organs for human transplants, e.g. into pigs for human heart transplants (ORGAN TRANSPLANTS)

6. Using genetic testing to detect diseases we might have inherited from our parents, such as cystic fibrosis, mucoviscidosis, thalassaemia (DISEASE DETECTION)

Percents completely and somewhat in agreement with each statement

RESULTS	A. benefits society	B. little risk	C. morally acceptable	D. should be encouraged
Disease Detection	83	61	74	75
Supply of Medicines	80	61	70	71
Pest Resistence	69	54	62	58
Oncomice	58	48	50	44
Better Foods	54	47	40	43
Organ Transplants	54	40	36	39



sources: Eurobarometer 46.1, Fall 1996. N = 17198. Access via europa.eu.int/comm/dg12/press/1997/pr180997.html#graph

Box IIE-46 shows the results of an extensive European survey in which persons were asked to evaluate six possible applications of biotechnology with respect to social benefit, social risk, and moral acceptability. The results regarding benefits and risks are ambiguous, as explained in the footnote, but the results concerning moral acceptability, and whether or not the application should be encouraged, are straightforward. [176] We see that the use of biotechnology to develop genetic tests for human diseases, to produce affordable medicines, and to develop pest-resistant plants are all judged to be moral activities, and to be worthy of encouragement. The development of laboratory animal "disease models", genetically modified foods and animal-to-human organ transplants are not judged by a majority of persons to be morally acceptable, and they are not judged by a majority of Europeans to be worthy of encouragement.[177]

Table 1 in **IIE-47** suggests that the number of respondents who are willing to buy genetically engineered foods may be less than the number shown in Table 4 in IIE-45 who say they "approve of" genetically engineered fruits and vegetables.

Table 2 in IIE-47 suggests that the level of concern that New Zealanders and Japanese have about genetically engineered foods does not differ greatly among basic food categories. However, Table 3 shows that the acceptability of transgenic foods can vary greatly depending upon the source and object of the modification. In both Japan and Australia, vegetables modified with animal genes are less acceptable than vegetables modified with genes from other plants, and

---

[176] The fact that more people believe that a particular application "benefits society" than do the number that say the application "involves risk" says nothing about the *magnitude* of the benefits or risks that an individual ascribes to that application. Thus it is impossible to infer from the responses given whether the sample population believed that the benefits were greater than the risks for any of the applications, other than by assuming that the fourth question, "should this application be encouraged?" in fact incorporates that judgment. But in that case the first two questions are unnecessary.

[177] Oncomice and transgenic foods are commercially available in Europe and are the focus of considerable protest by activists there who seek to have such items banned or otherwise discouraged. Animal-human organ transplants (xenotransplants) are not currently allowed in Europe. Proponents believe that genetic engineering can make xenotransplants safe and available for tens of thousands of critically ill people each year. Opponents fear the spread of animal diseases to humans.

BOX IIE-47. PREFERENCES REGARDING GENETICALLY ENGINEERED FOOD
[percents]

Table 1

Would you be very willing, somewhat willing, not very willing, or not at all willing to buy genetically engineered (ITEM) if it were the same price as similar...

	willing	not willing	don't buy it anyway
corn	56	42	1
tomatoes	56	42	1
apples	55	42	1
milk	38	60	1
beef	37	60	1
baby food	27	64	5

source: W. Hallman and J. Metcalfe, 1995. Survey of New Jersey Residents, p 27. N = 604.

Table 2

If any of the following were to be produced from genetically modified organisms, would you have any concerns about using them?

NEW ZEALAND

	no concerns	few/some concerns	a lot
dairy products	27	42	31
vegetables	33	38	29
meat	25	40	35
medicines	38	41	21

JAPAN

	no concerns	few/some concerns	a lot
dairy products	16	66	18
vegetables	24	61	15
meat	14	67	19
medicines	22	59	19

source: D. Macer, 1994:199. N (Aus) = 201, N(Jpn) = 352.

Table 3

3a Genes from most types of organisms are interchangeable. Would potatoes made more nutritious through biotechnology be acceptable or unacceptable to you if genes were added from another type of plant, such as corn?

AUSTRALIA

acceptable	unacceptable	don't know
56	23	21

JAPAN

acceptable	unacceptable	don't know
39	25	36

3b Would such potatoes be acceptable or unacceptable to you if the new genes came from an animal?"

acceptable	unacceptable	don't know
23	54	23

acceptable	unacceptable	don't know
11	40	49

3c Would chicken made less fatty through biotechnology be acceptable or unacceptable if genes were added to the chicken from another type of animal?"

acceptable	unacceptable	don't know
40	40	20

acceptable	unacceptable	don't know
20	41	39

3d Would such chicken be acceptable or unacceptable if the genes came from a human?"

acceptable	unacceptable	don't know
16	66	18

acceptable	unacceptable	don't know
6	53	41

source: D. Macer, 1994:212. N (Aus) = 201, N(Jpn) = 352.

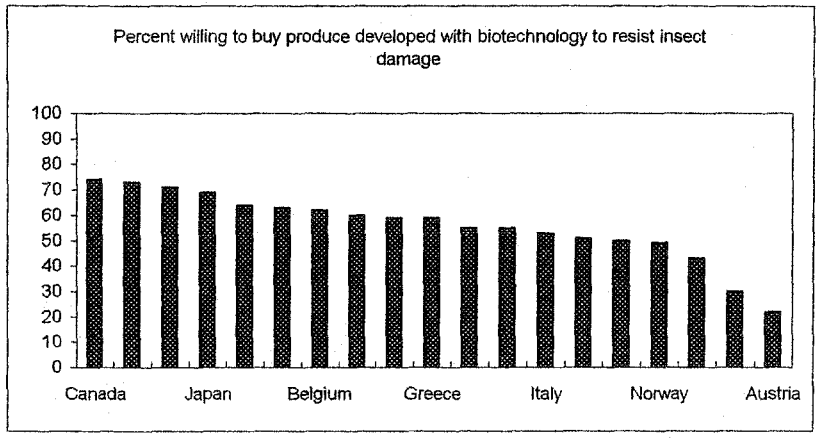
BOX IIE-48. WILLINGNESS TO BUY AND EAT GENETICALLY ENGINEERED FOOD

[percents]

Table 1

Percent of adults willing to buy produce developed with biotechnology to resist insect damage

60% +		50% +		< 50%	
Canada	74	Spain	59	Norway	49
USA	73	Greece	59	Luxembourg	43
Portugal	71	Finland	55	Germany	30
Japan	69	Denmark	55	Austria	22
Netherlands	64	Italy	53		
UK	63	Sweden	51		
Belgium	62	Ireland	50		
France	60				



Source: Hoban (1997)

Table 2

I personally would be happy to eat genetically modified food.

agreed	17
disagreed	67
neither	12
don't know	4

source: MORI/Greenpeace poll of adults in Britain, Denmark, Italy, Netherlands, and Sweden, Dec. 1996. N = 480. Cited in Macer, 1997.

Table 3

Genetically engineered food involves artifically changing the genetic make-up of a plant. For example, a vegetable might have a virus, bacteria or genetic material from another plant or animal inserted into it to make it tolerant to a pesticide or have a longer shelf-life. Genetically engineered food will shortly be available in New Zealand supermarkets. Would eating genetically engineering food cause you to worry, or not?

[5-point scale, where 1 = not worry at all, and 5 = worry a lot]

1	12
2	8
3	17
4	17
5	43

source: Macer, July 1997

chickens modified with human genes are much less acceptable than those modified with genes from other (non-human) animals.[178]

Table 1 in **IIE-48** suggests that majorities of all Western European countries except Austria, Germany, Luxembourg and Norway appear willing to buy produce "developed with biotechnology to resist insect damage." In only five of these countries, however, does this "willingness to buy" represent greater than 60% of respondents.

Table 2 in that box shows considerably stronger reservations about genetically engineered food among Europeans than does Table 1. But the results of these two surveys are not necessarily in contradiction--a person could be unhappy about eating genetically modified food and still be willing to buy it.

Table 3 suggests considerably stronger reservations about genetically engineered food among New Zealanders than do the results in Table 2 in IIE-47 The survey that produced the results shown in Table 2 in IIE-48. was sponsored by Greenpeace. The author of the survey that produced the results shown in Table 2 in IIE-47, Darryl Macer of the Eubios Institute, charges that the prefatory material for the question shown in Table 3 is "leading." (Macer, 1997). Macer's survey contains little or no prefatory material. Since the general public has only a sketchy understanding of genetic engineering, it's not obvious that the absence of prefatory material produces results that better reflect the public's sentiments about these issues.

Box IIE-49 shows some results from a survey of Wisconsin residents concerning Bovine Growth Hormone (BGH). The survey was taken shortly after dairy farmers could begin using BGH legally in February of 1994. At that time 64% of residents were still unsure about the safety of the BGH. Among those who felt they were well-informed about the issue, 30% felt it was safe and 40% felt it was unsafe. As might be expected, 97% of those who believed BGH to be unsafe opposed its use in cows, as did 78% of those who were unsure about it safety.

---

[178] Consumer resistance to foods that combine genes from life-forms far apart on the evolutionary tree has been attributed to the "yuk factor."

BOX IIE-49. ATTITUDES REGARDING BOVINE GROWTH HORMONE

[percent]

source: All tables are based on results of The Wisconsin Survey, Spring 1994. APOI 1994:858.

1 How familiar are you with the Bovine Growth Hormone issue? Would you say you are Very Familiar, Somewhat Familiar, or Not At All Familiar?"

Very familiar	19
Somewhat familiar	64
Not at all familiar	17

2 Do you feel that dairy products from cows treated with BGH are generally safe for consumption, unsafe for consumption, or are you unsure of their safety?

		Familiarity		
	total	very	somewhat	not at all
Safe	21	30	23	6
Unsafe	16	40	12	6
Unsure of safety	63	30	65	89

3 Do you favor or oppose the use of synthetic BGH in cows?

		Dairy products from treated cows are...		
	total	safe	unsure	unsafe
Favor	15	56	5	1
Oppose	70	23	78	97
Not sure	16	21	17	1

4 Do you favor or oppose the mandatory labeling of dairy products so consumers like yourself would know if the product contained synthetic BGH?

		Dairy products from treated cows are...		
	total	safe	unsure	unsafe
Favor	88	62	95	95
Oppose	9	34	2	3
Not sure	3	4	3	2

5 If you knew that a dairy product did contain synthetic BGH, would this make you more likely to buy the product, less likely to buy the product or would it not have any affect on your decision to buy the product?

		Dairy products from treated cows are...		
	total	safe	unsure	unsafe
more likely to buy	1	2	1	0
less likely to buy	70	20	81	95
no affect	28	79	16	5
not sure	2	0	3	0

6 Since February 3rd, the date when farmers could legally begin using BGH, would you say your household's consumption of dairy products has increased, decreased or remained about the same?"

		Dairy products from treated cows are...		
	total	safe	unsure	unsafe
increased	1	0	0	1
remained the same	91	96	93	75
decreased	7	4	5	22
don't know	1	0	2	3

BOX IIE-49. ATTITUDES REGARDING BOVINE GROWTH HORMONE

[percent]

source: All tables are based on results of The Wisconsin Survey, Spring 1994. APOI 1994:858.

1 How familiar are you with the Bovine Growth Hormone issue? Would you say you are Very Familiar, Somewhat Familiar, or Not At All Familiar?"

Very familiar	19
Somewhat familiar	64
Not at all familiar	17

2 Do you feel that dairy products from cows treated with BGH are generally safe for consumption, unsafe for consumption, or are you unsure of their safety?

		Familiarity		
	total	very	somewhat	not at all
Safe	21	30	23	6
Unsafe	16	40	12	6
Unsure of safety	63	30	65	89

3 Do you favor or oppose the use of synthetic BGH in cows?

		Dairy products from treated cows are...		
	total	safe	unsure	unsafe
Favor	15	56	5	1
Oppose	70	23	78	97
Not sure	16	21	17	1

4 Do you favor or oppose the mandatory labeling of dairy products so consumers like yourself would know if the product contained synthetic BGH?

		Dairy products from treated cows are...		
	total	safe	unsure	unsafe
Favor	88	62	95	95
Oppose	9	34	2	3
Not sure	3	4	3	2

5 If you knew that a dairy product did contain synthetic BGH, would this make you more likely to buy the product, less likely to buy the product or would it not have any affect on your decision to buy the product?

		Dairy products from treated cows are...		
	total	safe	unsure	unsafe
more likely to buy	1	2	1	0
less likely to buy	70	20	81	95
no affect	28	79	16	5
not sure	2	0	3	0

6 Since February 3rd, the date when farmers could legally begin using BGH, would you say your household's consumption of dairy products has increased, decreased or remained about the same?"

		Dairy products from treated cows are...		
	total	safe	unsure	unsafe
increased	1	0	0	1
remained the same	91	96	93	75
decreased	7	4	5	22
don't know	1	0	2	3

Interestingly, only 56% of those who believed BHG to be safe advocated its use. Thus the overall opinion of Wisconsin residents was 70% in opposition to the use of BGH. Further, fully 88% of residents, including 62% of those who felt it was safe, favored the mandatory labeling of dairy products made from milk produced by cows that had been treated with BGH. A lesser share--70%--declared that they would in fact tend to refrain from buying such milk. Despite these sentiments no labeling requirements were in force when farmers became eligible to use BGH, and only 28% of residents had clearly reduced their consumption of milk over the following few months.

Support for "strict" regulation of genetic engineering is strong, even in this anti-regulatory era, as can be seen in Table 1 of **IIE-50.** Table 2 of IIE-50 shows that 90% of Americans support labeling of foods produced by genetically engineered plants and animals. However, the definition of "strict," and the detailed specification of labeling requirements, are matters of contention. Table 3 and Table 4 show the results of a survey sponsored by the International Food Information Council, a research and publicity arm of the food industry. Table 3 shows that 78% of Americans voice support for current FDA labeling requirements. When informed that critics are calling for stronger labeling requirements, the level of support for the FDA policy drops to 57% (and the point spread between support and opposition drops from 58 to 17 percentage points). The IFIC interprets this as a vindication of its position that Americans do not support changes in the FDA labeling policy. However, the prefatory material for the question that generated the results shown in Table 4 is clearly leading.

Table 1 in **IIE-51** shows strong opposition to the introduction of genetically modified food into Europe. Table 2 shows that the need for stronger regulation of biotechnology is supported by majorities of Europeans. However, some sense of fatalism or discouragement is suggested when 53% of Europeans say they *agree* with the statement that "irrespective of the regulations, biotechnologists will do whatever they like."

BOX IIE-50. ATTITUDES ABOUT BIOTECHNOLOGY AND GENETIC ENGINEERING POLICY
[percents]

Table 1

The potential danger from genetic engineering is so great that strict regulations are necessary.

	Agree	Disagree	Not sure
OTA 1987*:	77	20	3
New Jersey 1995	65	28	7

* The OTA question used the phrase "altered cells and microbes" rather than "genetic engineering."
sources: Office of Technology Assessment (1987), table 60. New Jersey: Hallman and Metcalfe (1995).

Table 2

In your view, should food produced by genetically altered plants [animals] be labeled as such?

	yes	no	not sure
plants	90	7	3
animals	90	8	2

source: Time/CNN Poll, Dec. 6, 1993. APOI 1994:873.

Table 3

The U.S. Food and Drug Administration (FDA) requires that a label must indicate that biotechnology was used to produce a food under certain conditions: when biotechnology's use introduced an allergen or when it substantially changes the food's nutritional content, like vitamins or fat, or its composition. Otherwise special labeling is required. Would you say that you support or oppose this policy of FDA?

strongly support	45	
somewhat support	33	78
somewhat oppose	9	
strongly oppose	11	20
don't know/refused	1	

source: International Food Information Council/Wirthlin Group Quorum Survey, March 21-24, 1997. N = 1004.

Table 4

Some critics of the U.S. FDA policy say that any food produced through biotechnology should be labeled even if the food has the same safety and nutritional content as other foods. However, others, including the FDA, believe such a labeling requirement has no scientific basis, and would be costly and confusing to consumers. Are you more likely to agree with the labeling position of the FDA or with its critics?

agree with FDA	57
agree with critics	40
don't know. refused	3

source: International Food Information Council/Wirthlin Group Quorum Survey, March 21-24, 1997. N = 1004.

BOX IIE-51 OPINIONS ABOUT BIOTECH POLICY (OTHER COUNTRIES)

Table 1

Would you support or oppose the development and introduction of genetically modified food or food derived from genetic engineering? [asked of adults in Britain, Denmark, France, Italy, Netherlands, and Sweden]

would support it	22
would oppose it	59
neither	15
don't know	5

source: MORI/Greenpeace poll, Dec. 1996. (N = 4840)

Table 2 - EUROPE

	Please tell me whether you tend to agree to disagree:	Tend to Agree		Tend to Disagree		Don't Know	
		Europe	Japan	Europe	Japan	Europe	Japan
A.	It is not worth putting special labels on genetically modified foods	17	8	74	82	9	10
B.	The regulation of biotechnology should be left mainly to industry	19	6	63	73	18	21
C.	Modern biotechnology is so complex that public consultation about it is a waste of time	27	15	61	66	12	19
D.	We have to accept some degree of risk from modern biotechnology if it enhances economic competitiveness in Europe	29	12	55	71	16	18
E.	Current regulations are sufficient to protect people from any risks related to modern technology	24	8	52	62	24	30
F.	Irrespective of the regulations, biotechnologists will do whatever they like.	53	12	32	66	15	22

source: Eurobarometer 46.1, Fall 1996.

Table 3

Which of the following bodies do you think is best placed to regulate modern biotechnology?

		Europe	Canada	Japan	New Zealand
		(choose 1 body)		(choose up to 2 bodies)	
A.	international organizations: UN, WHO, etc.	35	40	62	62
B.	scientific organizations	21	28	24	40
C.	public bodies in (OUR COUNTRY)	12	13	62	21
D.	ethics committees	9	11	12	38
E.	don't know	8	-	10	3
F.	the European Union, public bodies in the EU	6	-	-	-
G.	our national parliament	5	5	3	14
H.	none of these (SPONTANEOUS)	3	3	1	1
I.	Maori organizations (NZ only)	-	-	-	9

source: D. Macer, 1997:13.

Table 4

People who create something original cna obtain financial reward for their efforts through patents and copyright. In your opinion, for which ofthe following should people abe able to obtain patents and copyright?

	Australia			Japan		
	patenting acceptable	not acceptabl	don't know	patenting acceptabl	not acceptabl	don't know
New inventions, such as consumer products	93	2	5	85	6	9
Books and other information	80	8	12	68	14	18
A medical treatment or drug to cure AIDS	60	26	14	60	21	19
New plant varieties	55	24	21	49	19	32
New animal breeds	45	29	26	41	26	33
Genetic material extracted from plants/animals	38	34	28	35	30	35
Genetic material extracted from humans	31	43	26	32	36	32

source: D. Macer, 1994:211.

Table 2 in IIE-51 shows that Japanese feel even more strongly than do Europeans that biotechnology needs to be regulated. Japanese differ, however, in strongly *disagreeing* with the statement the biotechnologists will do whatever they wish, irrespective of any regulations that might be passed. The difference of 39 percentage points between the Japanese and European responses to this question is the single largest difference shown between any two countries for any question reviewed in this survey.

Table 3 in IIE-51 shows that people in Europe, Canada, Japan and New Zealand believe that effective regulation of biotechnology will require the leadership of multi-lateral institutions such as the United Nations and the World Health Organization, with strong support from the scientific community.

A currently controversial policy issue concerns the extent to which the products and processes of biotechnology and genetic engineering can be patented. Table 4 in IIE-51 shows that Australians believe that new plant varieties and medicines should be patentable, but that new animal varieties, and any genetic materials extracted from plants or animals, should not be. Table 4 also shows that Japanese evaluate the acceptability of patents for various categories of items in precisely the same rank order as do Australians. The patenting of human genetic materials is acceptable to more than 30% of both Australians and Japanese; whether this is a large number or not is a matter of interpretation.

Summary and comments

We've seen that people living in industrial countries are generally supportive of most biotechnological research, techniques, and applications involving the genetic engineering of micro-organisms, plants and animals. Majority support is lacking for particular processes and applications that appear to commingle genes from species that are phyletically distant, or that might pose some threat to human health. Majorities want assurances that genetic engineering activities will be subject to government oversight and regulation, and they want labeling that will allow consumer choice. In most instances neither the majorities supporting genetic engineering,

nor those opposing it, are particularly large. On many issues large portions of the publics surveyed are undecided. These technologies and their applications are new, and attitudes are likely still in the process of formation. In most of the regards just noted Germans and Austrians, and to a lesser extent Northern Europeans in general, are less supportive of genetic technologies than are people in other industrialized countries.

II.E.5.c. Human Genetic Engineering

In Section IIE.2.a we surveyed the many new and proposed applications of human genetic science. Adults and children can be tested for the presence of genes that may lead to health problems in later years. They can also be tested for the presence of genes which, if passed on to a child, can lead to health problems. Fetuses can be tested for the presence of genes that may lead to later health problems, allowing parents to seek pre- or post-natal therapy, prepare for post-natal care, or terminate the pregnancy. New techniques of somatic gene therapy can modify genes in the body cells of adults, children or fetuses to correct for defective genes. Proposed techniques of germline gene therapy would not remedy physiological defects in an adult, child or fetus, but would prevent those defects from being passed to future generations. In addition to addressing recognized health problems, the genetic techniques just noted could be used to enhance otherwise normal, healthy characteristics. New reproductive technologies can be used in conjunction with the genetic technologies just noted to expand the control that parents have over the biological characteristics of their children. These techniques include artificial fertilization, surrogacy, and human cloning.

Table 1 and Table 2 in **IIE-52** show strong approval of the general idea of using of genetic testing to help identify disorders that might appear in people or their children. Table 3 shows that this approval holds for the particular application of population screening.[179] Table 4

[179] Genetic population screening is the practice whereby care facilities routinely offer pre- or post-natal tests for genetic defects. Mothers can decline these tests if they wish.

BOX IIE-52. ATTITUDES CONCERNING GENETIC TESTING AND SCREENING
[percents]

Table 1

One goal of gene mapping is to identify the genes associated with serious diseases. This would permit early diagnosis of those diseases before symptoms begin to develop. How do you feel about using genetic information for early diagnosis of disease?

Approve	Disapprove	No opinion/dk
93	7	1

source: Nat'l Center for Genome Resources, 1996 p 2 N = 1039.

Table 2

If genetic tests become available that indicate whether or not a person is likely to develop a fatal disease later in life, would you personally want to take such a test?

	Yes	No	Don't know
1990	52	43	4

source: Singer, 1993; N = 1006.

Table 3

Genetic tests can also identify whether an individual carries a disease gene that their children will be likely to inherit. How do you feel about using genetic tests to indicate whether future children are likely to have a serious disease?

Approve	Disapprove	No opinion/dk
88	11	1

souce: Genetic Needs Assessment, Washington State University, March 1993. N = 375.

Table 4

Now I'm going to read you a general definition: "POPULATION GENETIC SCREENING is testing of all people to find out whether they are at risk of developing or passing on a genetic disease. This kind of screening is or could be routinely offered, and can be refused by an individual." Population genetic screening can be done at different times of life. For each time, please tell me whether you favor or oppose population genetic screening at that time.

	favor	oppose	not sure/ refused
Newborn screening for genetic diseases like PKU	84	8	8
Screening children for genetic diseases or birth defects during the elementary years	85	10	6
Screening adults for genetic diseases	82	12	6
Screening future parents prior to pregnancy for genetic diseases	83	12	6
Screening an unborn fetus during pregnancy for genetic diseases or defects	74	20	6

souce: Genetic Needs Assessment, Washington State University, March 1993. N = 375.

Table 5

Today, tests are being developed that make it possible to detect serious genetic defects before a baby is born. But so far, it is impossible either to treat or to correct most of them. If (you/your partner) were pregnant, would you want (her) to have a test to find out if the baby has any serious genetic defects?

	yes	no	don't know
1991	63	28	9

source: NORC, General Social Survey, 1991 Codebook variable GENESELF. N = 917

and Table 5 suggest that the number of persons who would personally want to make use of adult or prenatal genetic testing is less then than the numbers that otherwise approve of these applications.

Table 1 in **IIE-53** shows that for the past quarter century over 80% of Americans have believed that a woman should be able to obtain a legal abortion if "serious defects" in the baby are anticipated. Table 2 shows that only 41% of respondents say that they would want to terminate a pregnancy in that situation, with another 21% unsure. Table 3 shows divided opinions as to whether a woman should abort a genetically defective fetus. Table 4 suggests that 10% of Americans support compulsory abortion of seriously genetically defective fetuses carried by poor women. Whether that value is considered to be large or small is a matter of interpretation.

People have different opinions about what constitutes a "serious" genetic defect. Table 1 in **IIE-54** suggests that less than 50% of British respondents support the "routine availability" of genetic testing even for such major genetic disorders as cystic fibrosis and early-onset cancer.

Table 1 in IIE-54 also shows attitudes concerning testing and selective abortion for human characteristics not typically considered to be diseases, such as one's sex, sexual preference or level of intelligence. It appears that only small percentages of respondents believe prenatal testing for these should be "routinely available." But "routinely available" is an ambiguous descriptor, so it is difficult to know precisely what is being affirmed or rejected.[180]

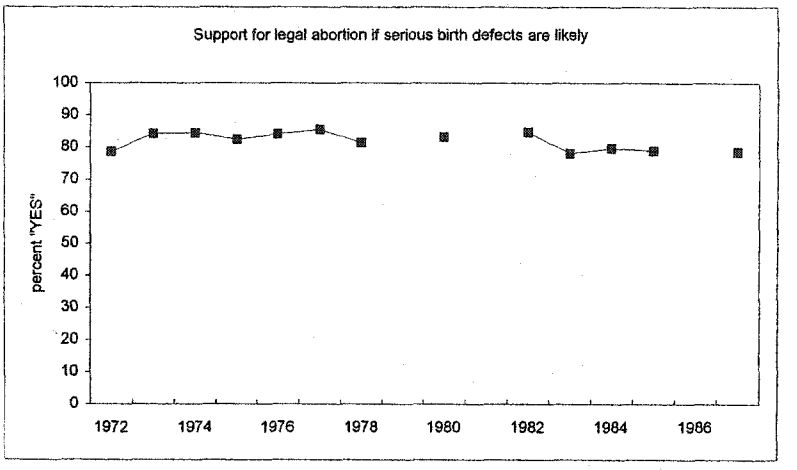
The policy of the government of the People's Republic of China is to discourage the birth of children with serious genetic disorders. Table 2 in IIE-54 shows that this policy is endorsed nearly universally by Chinese geneticists. Table 2 also appears to imply that perhaps upwards of

[180] For example, the fact that 13% of the population is shown as agreeing that prenatal testing for "low intelligence", with the possibility of abortion, should be *routinely* available doesn't appear to exclude the possibility that additional respondents might support the legitimacy of prenatal testing of that sort, albeit not *routinely*.

BOX IIE-53. ATTITUDES TOWARDS PRENATAL TESTING AND SELECTIVE ABORTION (1)
[percents]

Table 1

Please tell me whether or not you think it should be possible for a pregnant woman to obtain a legal abortion if there is a strong chance of serious defects in the baby?



source: NORC, General Social Survey, 1972-1994. Codebook variable ABDEFET

Table2

Suppose a test shows the baby has a serious genetic defect. Would you (yourself want to/want you partner to) have an abortion if a test shows the baby has a serious genetic defect?"

	yes	no	don't know
1991	41	38	21

source: NORC, General Social Survey, 1991. Codebook variable GENEABRT. N= 917.

Table 3

Regardless of what you would want for yourself, do you think a woman should have an abortion if the baby has a serious genetic defect?

	yes	no	depends (vol)	don't know	refused/ no answer
1990	22	38	34	4	2

source: Singer, 1993 p 239. N = 1006.

Table 4

The care of children with serious genetic defects is often expensive. Suppose the parents are poor, and probably will not be able to pay for their child's care. Do you think in that case a woman should be required by law to have an abortion, or do you think the government should help pay for the child's care?

Required abortion	Gov. should help pay	neither (volunteered)	don't know	refused/ no answer
10	65	15	7	3

source: Singer, 1993 p 239. N = 1006.

BOX IIE-54. ATTITUDES TOWARDS PRE-NATAL TESTING AND SELECTIVE ABORTION (2)
[percents]

Table 1

Imagine that reliable tests have been developed for each of the following diseases and characteristics. What are your views on testing with the possibility of ending the pregnancy? [Great Britain]

	% agreeing to routine availability	% who would or probably would use the test
Child of unwanted sex	9	3
Homosexuality	10	7
Low intelligence	13	3
Missing fingers	12	2
Cancer	34	16
Cystic fibrosis	47	32
Down syndrome	65	41
Anencephaly	71	63

Descriptions were added for the following:

Low intelligence: the child is able to attend regular school but needs extra help
Missing fingers: two missing fingers on the left hand.
Cancer: in early 30's that may be difficult to treat.
Anencephaly: the child will die soon after birth, ususally within the hour.
Cystic fibrosis: the child has lung & digestive problems requiring daily treatment. The majority are likely to reach adulthood.

source: Marteau et al. 1995, Public attitudes towards the selection of desirable characteristics in children. N = 973.

Table 2

Survey of geneticists, People's Republic of China, 1996 (N = 402):

	agree
1. People at high risk for serious disorders should not have children unless they use prenatal diagnosis and selective abortion	95
2. An important goal of genetic counselling is to reduce the number of deleterious genes in the population	90
3. from the letter: "More than half opposed sex selection by any means."	

source: Xin Mao, West China University of Medical Sciences; letter to Nature, 5 Dec. 1996.

Table 3

As you may know, it is now possible to determine in advance, with considerable accuracy, the sex of a child before conception. In your opinion, will this prove to be a good thing or a bad thing for society generally, or do you think it will not have much of an effect at all?

good thing	15
bad thing	26
no effect	48
don't know	11

source: Canadian Institute of Public Opinion, April 1993. IIPO 93-94, p 453. N = 1002.

Table 4

Tests during pregnancy also make it possible for parents to know ahead of time whether their baby will be a boy or a girl. Then, if it is not the sex they want, they can choose to have an abortion. Do you approve or disapprove of using prenatal testing for this purpose?

approve	disapprove	dont know	no answer
5	92	2	1

source: Singer, 1993. N = 1006.

Table 5

Suppose the parents already have three boys (girls), and wuld like to have a girl (boy). In that case, would you approve of using prenatal testing to find out a baby's sex before it is born?

	approve	disapprove	don't know	no answer
3 boys	39	56	4	2
3 girls	36	60	3	1

source: Singer, 1993. N = 1006.

40% of these geneticists apparently do not completely rule out abortion based on the sex of the fetus.

Table 3 in IE-54 shows that when Canadian respondents are asked, with little further elaboration, to evaluate the social impact of prenatal sex determination, 26% say they believe it will be bad for society and 48% believe there will be little impact. In Table 4 Americans are asked if they approve of prenatal sex determination, but now the option of selective abortion is made explicit. In this case fully 92% of respondents say they disapprove of prenatal sex determination. However, when these same Americans are presented with examples in which 3 children are of one sex and a fourth child, of the other sex, is desired, the share of respondents who disapprove of the use of sex determination and abortion to assure the desired outcome drops to 56-60%.

The next five boxes show attitudes concerning somatic and germline therapy and enhancement.

The tables in **IIE-55** indicate that somatic gene therapy to address potentially fatal conditions enjoys the support of over 80% of the publics of the US, Great Britain and Australia, and in the neighborhood of 70% of Japanese.

Table 1 in **IIE-56** shows the results of a 1992 survey conducted by the March of Dimes, and of a 1996 study, using many of the same questions, conducted by the National Center for Genome Resources (NCGR), an official unit of the Human Genome Project supported by the National Institutes for Health. The results appear to suggest that germline gene therapies for both fatal and non-fatal genetic diseases are supported by upwards of 70-80% of Americans, and that 35-40% of Americans approve of human germline engineering designed to "improve the physical characteristics/intelligence level that children would inherit." However, the survey questions are worded in a way that appears intended to encourage positive responses. Rather than ask for opinions concerning "genetic engineering" or "changing human genes", the survey asks about

BOX IIE-55. ATTITUDES TOWARDS PERSONAL USE OF SOMATIC GENE THERAPY
[percents]

Table 1

Doctors frequently transplant organs such as the heart or liver from one person to someone else whose life is in danger. They may soon be able to treat some inherited fatal diseases such as cystic fibrosis by a similar process of transplanting genes to repair the body's own processes. How willing would you be to accept this treatment if it could save your life? [Great Britain].

very willing	70
somewhat willing	17
not very willing	3
not at all willing	4
don't know	5

source: Social Surveys (Gallup Poll) Ltd. "Gallup Political and Economic Index, Aug. 1993". IIPO 93-4 p 455. N = 1000.

Table 2

If tests showed that you were likely to get a serious or fatal genetic disease later in life, how willing would you be to undergo therapy to have those genes corrected before symptoms appear?

	Australia	USA	Japan
willing	77	79	66
unwilling	10	18	21
not sure	13	2	13

source: Macer, D. p 205. USA results are from March of Dimes, 1992, Genetic Testing and Gene Therapy. N = 1000.

Table 3

If you had a child with a usually fatal genetic disease, how willing would you be to have the child undergo therapy to have those genes corrected?

	Australia	USA	Japan
willing	82	88	74
unwilling	4	9	11
not sure	14	3	15

source: Macer, D. p 205. USA results are from March of Dimes, 1992, Genetic Testing and Gene Therapy. N = 1000.

BOX IIE-56 ATTITUDES ABOUT SOMATIC AND GERMLINE THERAPY AND ENHANCEMENT
[percents]

Table 1

How do you feel about scientists changing the makeup of human cells to...	USA (1992) approve	USA (1992) don't approve	USA (1992) don't know	USA ('96) approve
cure a ususally fatal disease	87	12	1	85
reduce the risk of a usually fatal disease	78	19	3	84
prevent/stop children from inheriting a usually fatal genetic disease	84	13	3	86
prevent/stop children from inheriting a usually non-fatal genetic disease	66	32	3	72
improve the physical characteristics children would inherit	43	54	3	35
improve the intelligence level that children would inherit	42	55	3	

source: National Center for Genome Resources, National Survey, 1996. N = 1039.

Table 2

How do you feel about scientists changing the genetic makeup of human cells to...	AUSTRALIA approve	AUSTRALIA don't approve	AUSTRALIA don't know	JAPAN approve	JAPAN don't approve	JAPAN don't know
cure a usually fatal disease, such as cancer	89	8	3	83	5	12
reduce the risk of developing a fatal disease later in life.	81	11	8	75	6	19
prevent children from inheriting a usually fatal disease	87	7	6	80	4	16
prevent children from inheriting a non-fatal disease, e.g. diabetes.	79	13	8	62	17	21
improve the physical characteristics that children would inherit	28	63	9	28	51	21
improve the intelligence level that children would inherit	27	62	11	26	54	20
make people more ethical	34	44	22	24	53	23

source: D. Macer, 1994:202; N(Aus) = 201, N(Jpn) = 352. USA responses cited by Macer from March of Dimes, 1992; N = 1000.

"changing the makeup of human cells." This phrase is misleadingly innocuous--getting a suntan or exercising regularly will "change the makeup of human cells."

Table 2 in IIE-56 shows results of a survey of persons in Australia and Japan using questions similar to those used in the two American surveys shown in Table 1. Both the Australians and the Japanese appear to show roughly comparable levels of support for germline engineering to prevent diseases, including non-fatal ones, but show less support than do Americans for either physical or mental enhancement. Australians more explicitly disapprove of enhancement than do the Japanese, who show far higher levels of "don't know." Still, upwards of 25% of the populations of both Australia and Japan appear to support technologies of eugenic enhancement. However, the caveat just noted concerning the phrasing of the survey question must be kept in mind.

The 1996 NCGR survey that produced the results shown in IIE-56 also surveyed attitudes held by leaders of important social, political and professional groups. The results, shown in **IIE-57,** suggest that these leaders support all applications of human genetic engineering at very high levels, with the single exception of germline enhancement, in which case the levels of support drop to between 12% and 25%, with a weighted average of 17% for all 536 leaders surveyed. The significance of this level of support for germline enhancement is a matter of interpretation. On the one hand it can be understood as a clear rejection of such practices. But it also suggests that 1 of every 6 members of America's professional class appears to endorse a particularly strong form of eugenics. These results also appear to show that only 10% of religious leaders (and a weighted average of 7% of all leaders) consider human genetic manipulation to be immoral (compared with the 22% of the general public who feel this way), and that fully 20% of all religious leaders approve of the strong eugenic practice of germline enhancement.[181]

[181] Most official religious denominational bodies in the United States that have taken a position on genetic engineering are supportive of somatic gene therapy as a means to relieve suffering, oppose germline enhancement, and are unresolved concerning somatic enhancement and germline therapy.

BOX IIE-57. LEADERSHIP OPINIONS CONCERNING HUMAN GENETIC ENGINEERING
[percents]

The 1996 survey of leadership opinions conducted by the National Center for Genome Resources included the questions shown here as A-F. Responses are shown in the accompanying chart.

A Some people believe that genetic alteration of human cells to treat disease is simply another form of medical treatment. Other people believe that changing the genetic makeup of human cells is morally wrong, regardless of the purpose. On balance, do you feel that changing the genetic makeup of human cells is morally wrong, or not?

B How do you feel about changing the makeup of human cells to cure a usually fatal disease?

C How do you feel about changing the makeup of human cells to reduce the risk of developing a fatal disease later in life?

D How do you feel about changing the makeup of human cells to prevent/stop children from inheriting a usually fatal genetic disease?

E How do you feel about changing the makeup of human cells to prevent children from inheriting a usually non-fatal genetic disease?

F How do you feel about changing the makeup of human cells to improve the physical characteristics children would inherit?

	A is morally wrong	B approve	C approve	D approve	E approve	F approve
doctors	8	90	89	90	79	28
patient representatives	8	97	96	94	84	25
religious leaders	10	92	88	88	76	20
industry leaders	10	91	86	86	79	18
media leaders	4	94	88	86	82	16
policy makers	9	87	86	89	71	16
insurers	6	93	87	88	80	14
scientists	0	96	96	82	63	12
general public	22	85	85	88	71	35

Sample populations:

1. Doctors: mailed questionnaires and telephone follow-ups to a list of physicians in general practice, familiy practice, practice, internal medicine, obstetrics/gynecology and pediatrics, compiled by the American Medical Association and the American Osteopathic Association. The response rate of 18% (521 completed questionnaires) was not considered to be large enough to avoid "substantial self-selection bias."

2. Telephone interviews were conducted with 527 representatives of national leadership groups, as follows:

leadership group	number of completed interviews	description
patient representatives	100	leaders of national patient-based health organizations
industry representative	102	R&D directors from a national sample of pharmaceutical and biotech industries
religious leaders	50	national sample drawn from Who's Who in Religion
scientists	76	random sample of members of the American Society of Human Genetics
media representatives	50	medical science and health editors, columnists and writers
insurers	70	medical directors of a national sample of health and life insurers
policy makers	79	federal and state level policy makers

3. General public: telephone survey of 1,039 adult US residents.

source: National Center for Genome Resources, National Survey 1996. Chapters 7-9. Web site: www.ncgr.org/gpi/survey.

Table 1 in **IIE-58** suggests that the number of Americans who believe that genetic engineering is morally wrong decreased dramatically between 1986 and 1996, from 44% to 22%.[182] On the other hand, Table 2a suggests that approval of eugenic enhancement in particular has declined from 44% to 35%, over that period. Table 2b suggests that approval for eugenic enhancement declines markedly with higher levels of education. This is the single instance in all the surveys reviewed thus far in which more education is correlated with *lesser* support of various forms of genetic engineering (cf. Table 3 in IIE-40, and IIE-41).

The TIME/CNN survey shown in **IIE-59** uses the phrase "genetic engineering," and thus can be interpreted more straightforwardly than can much of the NCGR survey, but it is itself ambiguous in other ways. Regarding the first three applications noted—concerning disease, appearance and intelligence--it is unclear whether respondents would interpret the questions as addressing somatic manipulation, germline manipulation, or both. The fourth question, concerning embryo banks, is also ambiguous, because the practice of producing multiple embryos *in vitro,* testing them for the presence of desired genes, and implanting them selectively does not require genetic engineering. The final application appears to be intended to refer to mass eugenic programs promoted by governments, although a completely voluntary eugenics could itself generate the results described. An inferred interpretation of the responses shown in IIE-59 might be that somatic therapy receives 79% support, somatic enhancement receives between 25-34% support, germline enhancement receives 18% support, and governmentally-sponsored eugenics receives 8% support. These levels of support are significantly below the levels for comparable

[182] Note that the question that generated the results shown in Box IIE-58 does not make it clear if respondents who say "not morally wrong" are referring to *all* genetic engineering, or to particular applications of genetic engineering "to treat disease". A question consistent with the prefatory material would have asked if respondents feel that genetic engineering *to treat disease* is or is not morally wrong. Further, the question does not distinguish between somatic and germline genetic technologies.

BOX IIE-58. ATTITUDES ABOUT GENETIC ENGINEERING OVER TIME AND BY EDUCATION
[percents]

Table 1

Some people believe that genetic alteration of human cells to treat disease is simply another form of medical treatment. Other people believe that changing the genetic makeup of human cells is morally wrong, regardless of the purpose. On balance, do you feel that changing the genetic makeup of human cells is morally wrong, or not?

1a

	1986	1996
yes, it is morally wrong	42	22

1b

	yes, it is morally wrong (1996)
less than high school	38
college graduates	16

source: National Center for Genome Resource, 1996 National Survey, Chapter 5, p 2.

Table 2

How do you feel about scientists changing the makeup of human cells to improve the physical characteristics children would inherit?

2a

	1986	1996
approve somewhat	28	23
strongly approve	16	12
total approval	44	35

2b

	% approve (1996)
less than high school	61
high school graduate	40
some college	27
college graduate	28

source: National Center for Genome Resource, 1996 National Survey, Chapter 5, p 6.

BOX IIE-59. MORE OPINIONS ABOUT HUMAN APPLICATIONS OF GENETIC ENGINEERING

[percents]

Table 1

Do you approve or disapprove of the use of genetic engineering to:

	approve	disapprove	not sure
1. Cure a disease	79	16	5
2. Improve a person's physical appearance	25	71	4
3. Improve a person's intelligence	34	62	4
4. Establish embryo banks from which prospective parents could select a child with genetic characteristics they desire	18	78	4
5. Make it possible for nations to produce large numbers of individuals with genetically desirable traits	8	88	4

source: Time/CNN poll, December 1993. APOI 1993 p 872.

applications described in the NCGR survey (cf. Table 1 in IIE-56; IIE-57; and Table 2a in IIE-58).[183]

The tables in **IIE-60** show attitudes in the United Kingdom concerning germline enhancement. The questions posed more clearly distinguish germline from somatic engineering than do those in the surveys of Americans just reviewed. Table 1 shows bare majority support (51%) for germline engineering that addresses a genetic disability. This contrasts with support levels of 72% or more suggested in Table 2. Table 1 of IIE-60 also shows very low support for either negative eugenics (7%) or positive eugenics (4%), which contrasts with the much higher level of support (35%) shown in Table 1 of IIE-54. However, the explicit characterization of the traits in question as "socially" undesirable and "socially" useful may be a factor in generating these low levels of support. Overall, it's difficult to know how much the large differences regarding public support for germline engineering shown in the tables in IIE-56 and IIE-60 represent real differences between Britons and Americans, and how much they reflect the wording of the questions.[184]

Table 2 in IIE-60 goes beyond asking Britons about levels of "approval" and asks respondents whether they themselves would practice different types of germline manipulation. In 1993 78% of respondents said they would not engage in this practice "for any reason." Between 1993 and 1994 positive sentiment for engaging in one or more of the germline manipulations listed appeared to increase from a mean of 5% to a mean of 12%. This is a large

[183] On the other hand, if the first three applications—concerning disease, appearance and intelligence—were interpreted as referring to *germline* engineering, then the responses given would be comparable to those given in the NCGR survey. It is possible that the content or contexts of the full Time/CNN survey protocol sought to clarify the interpretation of the questions.

[184] Table 1 in IIE-44 shows that 39% of Britons and 21% of Americans perceive genetic engineering (in general) to be a health hazard. Table 1 in IIE-48 suggests that 63% of Britons and 73% of Americans would buy genetically engineered produce. A reasonable inference is that at least some of the surveyed differences between Britons and Americans regarding human germline manipulation may be real.

BOX IIE-60. OPINIONS ABOUT HUMAN GENETIC ENGINEERING IN THE UNITED KINGDOM

[percents]

Table 1

Do you believe it is right to select or to alter the genes for specific hereditary characteristics in the next generation of children?" (multiple answers)

	% yes
Yes, to relieve suffering or a disability	51
Yes, to prolong the life of somebody otherwise destined for an early death	29
Yes, to remove socially undesirable behavior characteristics	7
Yes, to breed socially useful behavior characteristics	4
No, all of these are wrong	35
Don't know	7

source: Social Surveys (Gallup Poll) Ltd. August 1993 N = 1000. IIPO 93-4 p 455.

Table 2

Science may some day enable parents to influence the appearance and behavior of a child by implanting selected genes or altering them. Would you do so?

If you could influence the appearance and behavior of a child by vitamin supplements would you do so?

	implanting selected genes		vitamin supplements
Yes, if linked with:	1993	1994	1994
Intelligence	7	11	41
Good looks	2	5	24
Specific skill	3	7	29
Aggression	7	18	41
Alcoholism	6	18	38
Homosexuality	6	10	22
No, not for any reason	78	n.a.	n.a
Don't know	6	n.a.	n.a.

source: 1993 data from Social Surveys (Gallup Poll) Ltd. August 1993, N = 1000; IIPO 93-94 p 455.
1994 data from Marteau et al, 1995, reporting Gallup Survey of that year, N = 973.

increase over such a short period. Marteau et al (1995) speculates that media coverage of the topic, or differing survey contexts, may be responsible.[185]

Box IIE-61 shows the results of surveys concerning two human reproductive technologies—surrogacy and cloning--that in combination with genetic engineering could offer a large array of future human reproductive options. Table 1 shows that British opinion is fairly divided as to whether surrogacy arrangements in which a woman gives birth to her daughter's genetic children (i.e., to her own grandchildren) is a good idea or not.

Table 2 in IIE-61 shows the results of an early survey of American opinion concerning human cloning, taken four years before the first successful adult mammalian cloning in 1997. At that time 75% of respondents felt cloning was a "bad thing to do" and 58% felt it was morally wrong. After the cloning of "Dolly", the percent of respondents who felt that human cloning was morally wrong increased to 89%, as shown in Table 3. Table 4 shows that the large share of persons who believe that human cloning is unacceptable hold that opinion very strongly.

Summary and comments

The results of surveys of opinions about human genetic engineering are difficult to interpret. The technologies are new and changing rapidly, public understanding is undeveloped, and the topic engages many complex personal and social values. Under such conditions simple questionnaire surveys should be used only in conjunction with a mix of other sources of information about public opinion on a topic.[186]

---

[185] The surveys reported in IIE-59 and IIE-60 raise many questions about public beliefs about the role that genetic factors play in influencing behavior, cognitive ability and sexual preference. Indeed, the way the questions are asked implies a far greater certainty regarding the links between genes and behaviors, and the eventual ability to influence certain behaviors via genetic manipulation, than most scientists in the field would endorse.

[186] Davison, Barns and Schibeci (1997) encourage the use of more dialogical instruments for assessing public attitudes about new, complex topics such as biotechnology. These instruments include public hearings, citizen review panels, small-scale group discussions, and consensus conferences.

BOX IIE-61. ATTITUDES CONCERNING SURROGACY AND HUMAN CLONING
[percents]

Table 1

An English woman is carrying twins for her daughter who is unable to bear children. Eggs from her daughter were fertilized with sperm from her son-in-law and implanted in her. What about this particular case, where the mother will be bearing her daughter's children? Do you think this is a good or a bad idea?

	1991	1995
good idea	39	37
bad idea	47	43
don't know	14	20

source: Gallup Organization, July 1995. N = 1024. IIPO 95-6 p 229.

Table 2

Time/CNN poll of Dec. 1993 (N = 872):

Table 27.2a In general, do you think cloning is a good thing or a bad thing to do?

Good thing	14
Bad thing	75
not sure	11

Table 2b Do you think cloning is morally wrong, or don't you think this way?

Yes, morally wrong	58
Don't feel this way	31
Not sure	11

Table 2c Do you think cloning is against God's will, or don't you think this way?

Yes, against God's will	63
Don't feel this way	26
Not sure	11

Table 3

Time/CNN Poll of March 1997 (N = 1005):

	yes	no	not sure
Are you willing to eat cloned fruits & vegetables?	49	40	11
Is it morally acceptable to clone animals?	66		
Are you willing to eat meat from cloned animals?	33	56	11
Is it morally unacceptable to clone humans?	89		
Is cloning humans against God's will?	74	19	7
Would you clone yourself if you had the opportunity?	7		
Would you participate in a demonstration against cloning humans?	29		

Table 4

On a scale of 1 to 5, where 1 is unacceptable and 5 is acceptable, how acceptable do you find the use of cloning to make copies of...

	humans	animals for food	plants for food
5 (acceptable)	2	14	29
4	1	7	11
3	3	16	19
2	6	9	9
1 (unacceptable)	86	54	30
don't know/refused	1	1	2

source: International Food Information Council/Wirthlin Group Quorum Survey, March 21-24, 1997. N = 1004.

If for the moment we take the results of the surveys just reviewed at face value, the following conclusions might be drawn. Americans appear to show consistently strong support for the use of somatic gene therapies for treating or preventing disease, with opposition limited to less than 15% of respondents. It is not clear from the surveys reviewed how Americans feel about genetic engineering for somatic enhancement. There appears to be general support for the use of germline therapy for preventing very serious diseases, although typically 20-30% of respondents are opposed. There is generally strong opposition to the use of germline engineering for enhancement, although typically 25-35% of respondents appear to support this. However, many of the questions that sought to assess opinions about germline engineering were worded in ways that might have suggested stronger levels of support than actually exist. Reproductive human cloning is very strongly opposed, with support limited to less than 10%.

None of the surveys reviewed explicitly sought to clarify differences of opinion that might be generated by giving different emphasis to individual and social frames of reference. [187] Many people might agree that a particular application of genetic engineering could be beneficial for an individual, but could be harmful for society as a whole, and should be discouraged. As a case in point, none of the surveys reviewed addressed the equity dimensions of the new human genetic technologies.[188] On the other hand, even those who believe that a particular genetic technology could be socially harmful might be reluctant to advocate its prohibition if its use was constructed as an individual right. In addition, none of the survey questions explicitly sought to explore attitudes towards "slippery slope" situations, in which the spread of certain applications

[187] Davison et al. (1997) note that surveys of the sort reviewed here generate opinions constructed in accordance with consumerist values rather than citizenship values: "A consumer discourse constructs social activity in terms of individual preferences and thus narrows the range of recognized and legitimate concerns of 'the public' to matters which directly affect their won immediate health and welfare. It assumes that society is a market with individual consumers pursuing their immediate self-interest, with little or no interest in wide civic questions. The discourse of citizenship, on the other hand, involves the conception of the citizen as a member of a political community, with the rights and responsibility to participate in the development of common purposes." (p 331)

[188] See Mehlman and Botkin (1998) for an extended discussion.

that are judged to be both individually beneficial and socially acceptable might nonetheless make it more difficult to prevent other, clearly undesirable applications. Finally, there were no efforts to assess opinions about the efficacy of opposition. This is especially important in the present instance because of the attempts by advocates of germline engineering and cloning to portray the use of these technologies as "inevitable." [189]

[189] Indeed, the Wellcome Foundation focus group study reported that although opposition to human cloning was "nearly universal," a large number of respondents believed that scientists "were going to do it anyway."

II.E.6. ASSESSMENT

The vision of the future advocated by the techno-utopians is one in which the entire natural world—plants, animals, humans, ecosystems—is reconfigured and transformed, continuously and forever. This process is either advocated as a desirable end in itself, or is pronounced to be inevitable regardless of human desires otherwise.

The case made by the techno-utopians is not a trivial one, and requires careful analysis if it is to be effectively refuted. Any attempts to end technological innovation as a general feature of human life would require a revolution in social values, norms, beliefs, and institutions on a scale difficult to imagine.

Scenario 3 advocates steady economic growth for the next century and beyond, which, as we've seen, implies steady technological innovation. Without this growth, poverty remains and distributional equity becomes very difficult to achieve. Technological innovation is also needed to ensure that economic growth proceeds in a way that maintains ecological integrity.

As discussed in sections II.A.3 and II.E.1, technological innovation increases the specificity of control over natural processes. The complex of technologies that will allow economic growth to continue, and to do so without endangering natural processes, give us the power to radically alter those processes, by choice or by accident.

If these assessments are accurate, what minimal critical conditions should we insist be adopted, to ensure that the new technologies support rather than subvert the achievement of Scenario 3?

We noted earlier the importance of adopting a generalized precautionary ethic concerning the new technologies. There are at least three guiding rules that such an ethic might support with respect to Scenario 3. One is that nothing is done that is irreversible. This is especially important with regard to fundamental natural processes and systems. A second is that no technologies should be developed that are judged likely to greatly increase economic inequality among

persons, households or countries, unless compensation is otherwise provided. And a third is that no technologies are developed that erode human personhood, dignity and autonomy. Granted, unforeseen and unintended consequences are a commonplace of technological innovation. But we can raise the bar on problematic technologies, both institutionally and culturally, and then use our best judgment.

Note that these rules would still permit the vast number of innovations cited in Sections II.E.1 and II.E.2. Under the restrictions noted here, the world after another 150 years would still be far more technologically dense than it is now. If we have the strength and maturity to draw some minimal critical lines on the applications of the new technologies, the world of 150 years from now can be better than today's world. It can be a world of economic well-being, ecological integrity, and social equity. But if we cannot or do not draw those few lines, we run the strong risk of generating runaway dsytopias of horrific consequence.

SECTION III: CONCLUDING COMMENTS

This dissertation sought to construct and advocate a credible scenario of global development for the coming 150 years that incorporates progressive and humanitarian values concerning economic well-being, ecological integrity and social equity. By doing so I hoped to encourage and empower people working to advance these values.

I constructed, and advocate, a scenario in which the world of 2150 is characterized by:

* high levels of per capita GDP;
* equality of per capita GDP among countries;
* the absence of poverty;
* moderate and non-increasing economic inequality among individuals;
* very slow economic growth;
* stable world population;
* moderately high and non-increasing levels of energy consumption;
* high technological density;
* a globally integrated, social-democratic/internationalist governance regime;
* strong social controls over potentially destabilizing technologies;
* a deeply embedded global ethos that supports these conditions.

The quantitative description of these scenario elements is shown in Boxes IA-17, IA-18 and IA-19, and identified there as Scenario 3. A summary quantitative description is shown on page xxv of the preliminary pages. The narrative description is summarized in Box IB-15, under the label "social democratic internationalism."

This is not quite the scenario that I had hoped to be able to present when I began this dissertation. I wanted to present a scenario that showed lower levels of consumption, less economic inequality among persons, lower levels of energy use, and a less intense commitment to high technology. As discussed in the text, I wasn't able to do this in a way that I believed was credible. The scenario does include two elements I had initially hoped to be able to include: equality of per capita GDP among countries and the elimination of poverty. Taken all together, I believe the scenario meets the criteria set out at the beginning of this exercise better than does any other scenario. I believe it can be seen as desirable, credible and compelling by large numbers of people. I am proud to be able to advocate it.

Two objective factors played critical roles in shaping the scenario as finally presented. One was the enormous disparity that exists between the rich and poor populations of the world, as documented in Section II.B. The other was the relative abundance of energy resources, and the lack of consequential limits to economic growth over the period of this scenario, as discussed in Section II.A. Together these factors made it difficult to argue that aggregate economic growth and consumption needed to be, or should be, strongly curtailed in the short term to medium term. To do this would consign the developing world to a permanent state of profound economic inequality, unless the wealthy populations of the world were willing, or could be compelled, to redistribute considerable portions of their incomes. But in the absence of objective, absolute limits that would inexorably bring economic growth to an end within the next 150 years or so, I could not make a credible case that the world's wealthy populations (i.e., those in the top 20% of households), could be expected or compelled to do this to the extent required. As a consequence the scenario calls for economic growth to continue, at high globally aggregated rates, for most of the next century.

At a finer grain, however, the scenario does call for *curtailed* growth. It calls for economic growth in the wealthy countries to slow to 0.5% a year by the middle of the 21st century, and to stabilize at that low rate; and it calls for developing countries to stabilize at that same low rate a century later, after per capita income equality among all countries has been achieved.

This staged pattern of growth rate reduction is necessary if we hope to achieve economic equality among countries within the next 150 years at an aggregate level of resource use that is ecologically sustainable over the indefinite future, and that doesn't force us to rely on unacceptable technologies. Conversely, a commitment to achieving equality among countries is a necessary precondition for any realistic global agreements that would seek to moderate economic growth, protect the environment, or control technological innovation.

The scenario calls for a strong commitment to ensure that income inequality within the developed countries gets no worse than it is today. The aggregate 80/20 ratio of the developed countries today is 6.5:1 Developed countries whose current 80/20 ratios are above 6.5, such as the United States and Australia, would be committed to reducing inequality to that level.

The scenario also calls for a commitment to ensure that inequality in the developing countries declines as they industrialize, until the advocated 80/20 ratio of 6.5:1 is reached. The aggregate 80/20 ratio of the developing countries today is about 8:1. Much of the desired decline in inequality can be expected to occur as large rural populations make the transition from agricultural to industrial modes of life. But structural and other policies will need to be called upon if necessary to ensure achievement of the distributive equity goal.

Are these conditions, taken as a whole, credible and desirable? The condition calling for slow growth in the wealthy countries by 2050 implies a new era in human values. It would require a massive social and personal engagement towards that end. But it requires no cutting back—incomes are intended to grow, continuously.

I believe that this positive-but-slow growth regime is more credible and desirable than are, for example, those Green sustainability scenarios which suggest that the growth of throughput or output must be brought to an end in the near or medium term future (i.e., within less than 150 years) in order to ensure sustainability.

I also believe that the positive-but-slow scenario is more credible and desirable than are scenarios of continued rapid economic growth, when the full implications of the rapid growth trajectory are understood. The major problem with the rapid growth trajectory is that it commits humankind to dependence upon a continually more complete technological transformation of the natural world—plants, animals, humans, and ecosystems—in ways that can be expected to be dangerously destabilizing, as described in Section II.E.

How about faster growth in the developing countries? Is it credible to imagine Asia, Africa and Latin America growing at steady rates of 3-5% for the coming seven decades? I

believe it is. Here we appeal to the logic of well-functioning and well-regulated free markets, and to the historical experience of other countries and regions. Continued technological innovation and global economic integration should be expected to make important contributions. I also believe that social learning and human agency can work to encourage sustained growth at these rates.

Is it credible, however, to imagine economic growth in developing countries continuing at a fast pace (3-5%/yr) while growth in the developed countries is slowing down (from 2% to 0.5%)? The historical record might suggest not; over many periods the dynamism of the West has driven the rest. But this connection will become increasingly less important as the internal and regional markets of the developing countries continue to grow, and as they account for an increasingly larger share of global output.

What about inequality? The distribution of incomes in the developing countries should become more equal as these nations industrialize, as discussed in Section II.B.2. The distribution of income in developed countries is more problematic. Its future dynamics depend importantly on the extent to which ascendant technologies are skill-intensive. This is a new topic of research, and difficult to model and quantify. It is very possible that the distributional impact of technological innovation at the level of production will need to become a concern of public policy. Beyond this, we saw in Section II.B.3 that a broad range of policy tools ostensibly designed to reduce income inequality could be expected to do so only to a small extent, if at all. Section II.B.4 showed strong public objection to those polices that would have a significant redistributive impact. However, the public also objects to the growth of income inequality, and it appears that the policy tools reviewed in Section II.B.3 would be capable of achieving this more modest goal. These factors motivate "holding the line" on inequality as a credible scenario element.

However, while an 80/20 ratio of 6.5 may be acceptable to people anticipating historical levels of strong economic growth, is it acceptable at the same time that growth rates are slowing

from 2% to 0.5%? And as a permanent rather than a transient condition? This is a major unknown. One reason for rejecting no-growth scenarios was the difficulty of imagining ways that distributive inequality of *any* level could be countenanced under that condition. But is 0.5% growth much different? I'm suggesting that it is. For one thing, it is still positive growth. A 40-year period of sustained 0.5% growth would move a country with an initial per capita GDP of $80,000 to $97,700. As just indicated, this slower rate of growth is taking place under conditions of prodigious affluence, by any standard. Still, 0.5% strikes the typical person today as unacceptably slow. A world of 0.5% would clearly represent a new era in human values. If we think of 2% per capita GDP growth as the rate that the West has sustained in its transition from an agricultural to an industrial world, and of 4-5% as the catch-up rates that developing countries are driven to achieve in order to attain economic (and political) parity, I'd like to think of 0.5% as the "mature" rate of economic growth, one that an affluent world of economic, political and technological equals can aspire to and sustain over a very long, perhaps indefinite, period.

That granted, let's return to the distributive implications. Scenario 3 shows a world in 2150 in which the top 20% of households have gross annual incomes of perhaps $676,000, while the bottom 20% have income of $104,000.[190] Is that fair? A household income of $104,000 is far above the median income of households in the United States today. There is very little of value that a household of four can't have or do on a stable income of $104,000; the rest is luxury. Our advocated 80/20 ratio of 6.5 is about equal to that of France today (6.4), less than that of Denmark or Japan (about 7.0 each) and considerably less than that of the United States (9.8).

Still, people tend to assess well-being by comparing their lots with those in closest physical and social proximity, so the question of fairness remains. I believe that the structure of income distribution shown in Scenario 3 could be experienced as fair under three conditions. One is that the commitment that the distribution will get *no worse* is firm and enforced. This means

[190] These figures are obtained by using the values for 2150 shown in the quantitative summary of conclusions shown on page xxv, using as our example a household of four persons.

that there is a strong societal consensus that effective policy measures will be taken, if necessary, to ensure a stable income distribution. Even more to the point, cultural norms would need to become deeply internalized in a way that would help preclude the need for policy, in much the same way that cultural norms result in lower levels of compensation for Japanese than for American corporate executives today. Such a commitment would remove a major source of uncertainty concerning the shape of the economic playing field. The second condition is that our national and global political economies are in fact grounded in social democracy. By this I mean that policies and institutions exist, perhaps along the lines suggested by Kaus and others in Section II.B.3, that strongly limit the social and political consequences of unequal economic resources. And the third condition is that a social ethos develops that simply lessens the extent to which economic resources and their signifiers are taken as measures of a person's status and worth, perhaps drawing on some of the values expressed by participants in the voluntary simplicity movement surveyed in Section II.C.3.[191] These three conditions may seem, to some, to be prohibitively difficult. I believe we'll be motivated to work through these difficulties when the implications of not doing so are thought through.

Our advocated scenario affirms greater global economic integration—globalization—as desirable. I'm persuaded that expanded trade, investment and exchange are likely, on balance, to greatly assist developing countries in attaining the rates of economic growth needed to eliminate poverty and achieve equality with the industrial countries, within the time period of 150 years that is necessary if we are to make a transition to a slow growth world at a level of world GDP still low enough to be ecologically acceptable. This endorsement of globalization is made possible by several other assessments, based on our review in Section II.D. One is that nation-states are not likely to disappear as units of political allegiance, accountability and agency, even as the nature of sovereignty evolves to accommodate greater multilateralism. Another is that a social

---

[191] In particular, consider the values expressed in the responses shown in Boxes IIC-28 and IIC-29.

democratic regime of global governance is practicable. Here I follow Keohane, Robertson, Hirst and Thompson and others. Such a regime would be more layered and diffuse that the national social democratic models of past experience. We have an unsettling period ahead during which the forces of economic integration will likely outpace the establishment of effective policy governance and accountability. But the case for coordination is rational, and communication is mostly easy, not difficult. The key uncertainty is not mechanism but commitment. In order for a social democratic regime of global governance to be established and sustained, mass publics will need to share the vision of the human future that it is intended to support, and will need to commit to its realization. Indeed, this dissertation is an effort sketch such a vision, and by doing so to help encourage commitments to its realization.

The advocated scenario presumes that the human future will be one of pervasive high technological density. As emphasized in Section II.E, I believe the challenges posed by the new technologies are the most profound we face. These technologies have the potential to dramatically change the way we experience ourselves, our relation to others and our relation to the natural world. Proposals for reversion to a past low-tech order are utopian. I believe a minimal credible stance towards technology has two parts. The first calls for adoption of a strong precautionary ethic regarding problematic technologies. The second calls once more for the establishment of a social democratic regime of global governance, sufficiently authoritative to proscribe technologies judged to be unacceptable.

Is this stance towards technology credible? As we saw in Section II.E.1, many people hold the opinion that technological development cannot be constrained in the manner just described. For some people this belief has the status of a natural law, rooted in interpretations of thermodynamics, evolutionary psychology, complex systems and the like. Others acknowledge that it is perfectly plausible to imagine that social institutions can constrain technology, but believe that in practice it will be very difficult to do so, given the numerous diffuse loci of technological innovation, the increasingly individualist values that higher education and

economic development appear to support, the dynamics of a market economy, the power of corporations, and other factors.

I agree with this view—it *will* be very difficult to constrain technological innovation. But that's a far cry from saying that it is impossible. My case for affirming the credibility of social control over technology is straightforward: as the dangers of particular types of new technologies become evident, the benefits of controlling them will be judged to exceed the costs. Of course, such societal decisions won't be based on spread-sheet calculations—they will be the result of political struggle. But if there were widespread agreement that the other particulars of our advocated scenario were desirable and credible, and if it were accepted that the development and use of certain technologies could make that scenario more difficult or even impossible to achieve, then that prior set of agreements in themselves helps change the balance of power in a way that increases the credibility of the scenario elements that call for social control of technology.

It is critical to remember that statements to the effect that a particular technological development is inevitable are often tactical moves calculated to demoralize persons who find the technology in question to be a cause of concern and who might be motivated to object to it. This move is particularly pernicious because it typically is made by scientists and other privileged elites who are using their authoritative position to intimidate, rather than educate, those with less access to technical information.

All this said, in my judgment there may only be a limited number of technologies of such potentially negative consequentiality that they should be proscribed. As I suggested in Section II.E., one rationale for banning a technology would be that its adoption could precipitate large, self-reinforcing and irreversible social and economic inequalities. Another rationale would be that a technology so greatly devalues or compromises human personhood, dignity and autonomy that its adoption would be taken as a signal that our systems of governance are unable to protect and support this minimal, essential element of civil society. As discussed in Section II.E.1 and II.E.2, I believe that germline genetic engineering and human reproductive cloning have these

undesirable qualities and will need to be banned. It is likely that additional powerful techniques of genetic manipulation, and the possible development of technologies able to manipulate human mental processes in a powerful way, would likewise need to be banned.

However, these constrained technologies represent only a small fraction of the total sum of technological innovations that are likely to become feasible over the coming century and beyond. In other words, there is no reason that our advocated scenario need not be full to the brim with many of the sorts of applications described by Coates *et. al*, Kaku, and others reviewed in Section II.e.

There are at least two important ways, however, in which our scenario differs from theirs. Whereas the great majority of technological futurists and techno-globo neoliberals assume and celebrate an undiminishing pace of innovation and application, our advocated scenario implicitly suggests an increasingly modest technological trajectory. We saw in Section II.A.3 that there is a close, almost definitional, relationship between economic growth and technological innovation. The exuberant economic growth of the past century and the dramatic development of technological power over that same period are two aspects of a roughly single process. In Scenario 3 we gradually bring this exuberant period to a close—first in the high income countries and later in the currently lower income countries—and we usher in a new era of slow aggregate growth, some 100-150 years hence.

Further, whereas the techno-enthusiasts appear to value the increasing manipulative power of their artifacts as an end in itself, under a social-democratic ethos technology would be evaluated by the degree to which it helps realize a broader set of human development values.

Of course, slower rates of per capita GDP growth do not *necessarily* imply slower rates of technological innovation. Much of the 1970's and 1980's saw high rates of innovation and low rates of economic growth. As we discussed in Section II.A.3, innovation can express itself in quality improvements or new products that do not show up in the national income accounts as contributions to output. But this is just a ledger-keeping effect. Somewhat more to the point, an

innovation needs to diffuse, integrate and mature before it has a noticeable impact on productivity. Still, this is just a lag effect. A true decline in the rate of technological innovation ultimately means a decline in the human, financial and physical capital devoted to this endeavor. But even this slower rate of innovation is positive. Thus, Scenario 3 remains a scenario of increasing technological density.

Who might be unhappy with the advocated scenario?

At the very beginning of this dissertation, in Section I.A.2, I described a business-as-usual scenario, Scenario 1, and asked if there were reasons that people might want the world to develop in some other ways. Now I ask the same question about our advocated scenario, Scenario 3. Who might be unhappy with it, and why?

Techno-globo neoliberals

Our advocated scenario was devised in part to refute the claim that there is no alternative to techno-globo neoliberalism, so I wouldn't expect that many who subscribe to that scenario would be receptive to this one. In general, neoliberals wouldn't necessarily share the same level of concern about economic inequality or ecological integrity, they are more concerned to protect individual prerogatives than to achieve socially-mediated outcomes, and they tend to trust and welcome the impacts of market-driven technological innovation.

Neoliberals believe that the experience of the past twenty years has largely supported their critique of authoritarian and social democratic political systems. In some regards this is true. Neoliberal policies have encouraged strong economic growth in both developing and developed countries, without generating the sorts of horrific negative consequences—economic collapse, ecological catastrophe—predicted by many of critics.

I believe, however, that techno-globo neoliberalism becomes increasingly problematic when its course is projected much beyond another 25 years or so. Inequality among countries declines only minimally, institutions of social governance erode, norms of corporate culture

permeate and condition the larger society, and technologies of unprecedented manipulative power continue to proliferate. If this scenario prevails, well before the quarter-century mark neo-liberal professionals in the most affluent regions will have begun modifying their children's genes to give them, as Daniel Koshland puts it, "a better chance of success."

I believe this trajectory ends in a catastrophe of global proportions. As discussed in Section II.E.2, I can't see how the conditions that enable any society to function cohesively can be maintained when the affluent techno-elite begin genetically engineering themselves and their children into a superior sub-species.

In short, if we desire stable, equitable and ecologically benign economic growth, constructive global integration, and technologies that support rather than undermine human well-being, we will want more rather than less social governance. Techno-globo neoliberalism may serve a useful role for a bit longer as a guiding ideology that will help countries make transitions to modern market economies, but it is not the governance regime of choice for a mature global society.

If truth be told, prudent neoliberals should find much in our advocated Scenario 3 that should give them reason to re-evaluate their opposition to it. After all, our advocated scenario calls for continuing positive economic growth for at least the next 150 years; a generally positive assessment of technological innovation, with bans advocated for only a few markedly destablizing ones; and for the distribution of incomes to be trusted largely to market forces, with policy measures held in reserve in the event that these are inadequate. Box IB-16 illustrates the possibility of a neo-liberal/social-democratic partnership, perhaps in support of quantitative Scenario 2.

Environmentalists

Some environmentalists, particularly those deeply committed to visions of Green sustainability, might be unhappy with Scenario 3. They might believe that a level of energy use in 2150 five times today's level, even if fixed at that point, is far too high. They might also believe

that a level of global per capita GDP *seventeen times* today's level ($82,000 in 2150 *vs.* $4,900 in 2000), no matter how artfully crafted, cannot help but be more destructive of ecological systems than is acceptable.

They might also object that even if the growth trajectory I show for the next 150 years is achievable in an ecologically benign manner, and even if a level of energy use of 60 terawatts is in fact sustainable indefinitely, the fact that I show output continuing to grow from that point on, even at the low rate of 0.5% a year, means that Scenario 3 is, ultimately, not sustainable much past 2150. An additional century of 0.5% output growth generates total output 65% greater than its level in 2150. Three centuries of 0.5% growth puts output at more than quadruple its 2150 level. To claim that these levels of higher output can be achieved using a constant rate of throughput is simply disingenuous—to do so is to invoke "angelic GDP" so well refuted by Herman Daly, and by common sense. Eventually, this argument goes, we will need to learn to live in a world of zero output growth as well as zero growth in resource inputs. The only alternative would be to bio-engineer ourselves into nano-tech life-forms that use solar energy to omnivorously incorporate all available matter into commodities or offspring, and to colonize three-dimensional space in this manner throughout the solar system and beyond.

These are important criticisms, and my response has several parts. First, the high level of output generated under Scenario 3 is credible only because resource limits to economic growth do not appear to be consequential over the relevant time horizon. I began this dissertation fully expecting that among the least problematic topics I would need to deal with was that of documenting the existence of resource limits to economic growth. I was surprised to find out how difficult that was. It's true that biogeophysical constraints, configuration-dependent limits to productivity improvement, and the growth of complexity can all impose increasing costs on marginal units of output that, if conditions remained unchanged, would bring an end to economic growth. The critical question then becomes: can technological innovations (of the configurational sort, in Ayers' terminology) more than offset these increasing costs? There is no way to answer

this question analytically, but I believe the material reviewed in Sections II.A.3 and II.E.1 gives good reasons to suspect that the process of technological innovation is very, very far from exhausting its potential.

The world in 2150 under the advocated scenario might succinctly be characterized as one of "high output, low growth." Most people, including those involved in the growth-environment-equity discourse, tend to associate high output with *high* growth, and low output with *low* growth. Part of the challenge that the advocated scenario presents for many environmentalists is that it argues that in order to create the conditions of economic equality that will enable a globally sustainable (i.e., slow) growth regime to be negotiated, we must first pass through an extended period of high growth.

In my opinion the major environmental challenges of the next decades are going to focus increasingly less on the issues of the period just past—clean air, clean water, preservation of wild places, and the like. While there is much left to do to complete this late 20th century environmental agenda, to a great extent we know what needs to be done, and public opinion is generally sympathetic. The new challenge we face is: how deeply and in what ways do we want to transform the workings of the natural world through technology? Where do we draw the lines?

The call in Scenario 3 for a social democratic/internationalist regime of global governance should be of critical interest for those concerned about environmental protection. Without a political system of this sort, it's difficult to see how the sorts of global policies needed to ensure environmental protection in the face of continued growth could be devised and implemented. This applies to both the conventional roster of environmentalist concerns and even more so to the new set of concerns that the new, deeply manipulative technologies pose.

All together, I believe that Scenario 3 is both pro-actively Green, and about as Green as can be advocated and still be at all credible. For the industrialized world to reduce its rates of economic growth to 0.5% per year over the next 50 years will require as close to a true social, political and economic revolution as democracies are probably capable of. The good news is that

we have 50 years over which to do this. The bad news is that we have *only* 50 years. Children in elementary school today will be running the world in 50 years. Within the next 10 years these children will begin defining the themes that will structure their life choices, and once set these tend to resist further change. It is difficult to see how Scenario 3 can succeed without strongly incorporating and nurturing values of the sort associated with Green, environmentalist, and voluntary simplicity sensibilities. Box IB-16 illustrates the possibility of social-democratic/Green sustainability partnerships in support of quantitative Scenarios 3, 4 or 5.

But what about the charge that in constructing Scenario 3 I've avoided confronting the inevitability of output limits to growth, and the social and political challenge that limits present, simply by declaring by fiat that world output can continue to grow at 0.5% after 2150, even as available resources remain constant?

In Section II.B.3.d I was critical of environmentalists who call for a near-term transition to a world of steady-state resource flows, but who then casually declare that economic growth can nonetheless continue at a healthy rate as a result of efficiency-enhancing technological change. Now it appears that I've done something similar, with the difference that instead of calling for this questionable situation in the near term, at existing levels of output, I call for it to begin in 2150, at dramatically higher levels of output. Is this really any different? Do I really believe that economic output can continue to grow, even at the low rate of 0.5%, indefinitely after 2150, while energy use remains constant at 60 terawatts? I believe I made a credible case in Section II.A.2 that a level of output consistent with a 60 terawatt world is in fact sustainable indefinitely, even in the absence of further significant technological innovation. But if I believe in addition that output growth could continue, indefinitely, under that resource constraint, then I should say so, and give good reasons for that belief. If not, I should say how long I believe output can grow until we will be forced to make the transition to a zero-growth world. And in *that* case, I would need to explain how I believe output should be distributed. Remember, one important reason for rejecting the zero-growth Scenario 5 in favor of the slow-growth Scenario 3 was that I could not imagine

how any degree of income inequality much beyond an 80/20 ratio of 2.5 to 1 could be justified under the former. So what's going on?

The unresolved tension

Some years ago a friend confided that despite his best efforts, he couldn't imagine a credible, desirable future. Economic growth could likely continue for many decades, but could it continue for centuries? Or millennia? He couldn't see how. On the other hand, he couldn't imagine how a no-growth world could be structured on anything other than a caste, feudal or authoritarian basis. He saw these choices as definitionally exhausting the options: either we grow forever, or we don't. This first is difficult to believe, and the second is difficult to feel good about.

The new techno-utopians offer a third option, or rather, a scenario that makes the first option at least arguably credible. We can continue to grow—forever—by continually reworking a fixed resource base into successively more deeply manipulated artifacts. But as argued in Section II.E.1, in short order this process begins to generate artifacts with much the same qualities as living systems, and living systems with the qualities of artifacts. For me, this is also difficult to feel good about.

Scenario 3 ends in 2150 with a high, more equitably distributed level of output, a fixed level of energy use, and output growth continuing at the slow rate of 0.5% annually. What happens after that?

The honest answer is: I don't know. It's likely that we could continue growing at 0.5%, with fixed resource use, for a very long time. But for centuries? Or millennia? At some point we would encounter limits, and would have to begin a transition to a 0.0% world. Unless, of course, we chose the techno-utopian route. Nothing in the preceding 628 pages of this dissertation offers any insight into means by which humankind might be able to avoid having to chose, someday, between what appear to be two or three very problematic futures.

Given these unresolved questions, how do I justify Scenario 3?

Scenario 3 gets us to a point that is both desirable in itself, and that will make it easier for us to negotiate the subsequent transitions, whatever they might be. Scenario 3 gets us economic and political equality among countries, a fair distribution of income among people, a high level of material well-being and technological competence, an indefinitely sustainable level of energy and resource throughput, and a political structure that allows protection of environmental and other public goods and control over dangerous technologies. By affirming a global ethos of moderation and precaution concerning economic growth and technology, Scenario 3 leaves more options available for our subsequent future. By affirming egalitarian and democratic values, it helps ensure that more people will have an equal say in what happens next, thus helping assure legitimacy and stability. If our descendents choose to move towards a zero-growth world, they will be doing so after already having learned how to live together in a very slow-growth world. If they choose a future of continued technological transformation and growth, they will be doing so after already having learned how to control certain particularly dangerous and destabilizing technologies.

Final queries

For all this, it's still fair to ask if I really believe that it's meaningful to specify quantitative goals for, say, per capita GDP of persons in the top 20% of households in China in 2150. A first-order answer is yes. At the beginning of this study I made a commitment to pursue each critical topic until I felt I could give a full and honest response. Without such a commitment the study would not have been worth doing. I do believe that Scenario 3 can be realized, as described, if enough people agree that it represents a future they are willing to work to make happen. Further, I believe that it is compelling enough that sufficient numbers of people would indeed be able to come to that agreement, after having considered all the alternatives. I don't believe it is a utopian scenario. There will be a world in 2150, and it will look like something,

and what it will look like will largely be the result of actions, big and small, that people decide to take. The existence of a credible scenario that large numbers of people find compelling increases the likelihood that the future will look more like that scenario, than like something else.

But there are second-order answers as well. Many aspects of the scenario, especially the quantitative aspects of the later decades, might be thought of as metaphors rather than as concrete policy goals. The high values given for per capita incomes in 2100 or 2150, for example, could certainly come to pass. But they might also be thought of as metaphors for the degree of technological density that would characterize the world of that period.

A further, and more telling, second-order answer has to do with the fact that the whole purpose of talking about goals for 150 years from now is to motivate actions that each of us will take today. We can all regard the quantitative values shown for 2150 with many grains of salt, yet still act, with a fuzzy sense of greater confidence, in ways that we might not have otherwise, had we not worked through the details of the construction of Scenario 3.

So what does Scenario 3 invite us to do *today?* I'd like to think that among other things it invites us to:

* celebrate moderation of consumption, being clear that there is room for all to grow, if the well-off learn to grow slowly;
* commit to ensuring that economic inequality in the developed countries does not increase beyond its current levels;
* continue and deepen our commitment to ecological integrity as a global imperative;
* affirm the development of technology in the service of society, and have the wisdom and strength to forego technologies of dehumanization and division;
* support the establishment of accountable institutions of global governance; and
* affirm human agency, and the ability of people to cooperate towards a desired common future.

If this dissertation can encourage and empower people working towards ends such as these, it will have accomplished its purpose.

# # #

EPILOGUE

As noted in the introduction, research and writing for this dissertation was largely completed by early 2000 and remained on hold until summer 2003. At that time I began preparing the dissertation for submission. Has anything happened during the hiatus or since that would require its presentation or conclusions to be revised? To the best of my knowledge, I don't believe so. Is the advocated scenario still credible and compelling? I believe it is.

Aggregate economic inequality has continued to increase in some countries and decrease in others, but not by great amounts either way. In many countries the income shares received by those few in the very highest income percentiles continues to grow dramatically. The depletion and degradation of natural resources continues to raise concern and demand attention, but there is still no clear indication that these impacts are likely to be severe enough to compel, over the period of the dissertation scenarios, an end to economic growth. Recent trends in climate change are increasingly recognized as being anthropogenic and deserving of preventive action, but no truly catastrophic risks have yet been shown to be likely. Environmental values remain an important thought not quite first tier set of motivating values on the world stage. Concern that the post-1975 productivity slowdown might represent an exhaustion of innovative potential has greatly lessened in the face of strong post-1995 productivity gains. Concerns over the impacts of globalization have increased and are fueling continued demands for responsible global governance. Despite the crash of technology sector investments in 2000, support by much of the public for high technology in general as a driving force of the human future continues to be strong. However, controversy has increased concerning many applications of biotechnology and proposed applications of nanotechnology. It remains uncertain if these will come to be perceived

as uniquely dangerous threshold technologies that need to be proscribed, or as defining technologies of a new human epoch. [192]

In my judgment, these developments tend to validate or reinforce the arguments put forth in the dissertation.

What about the events of September 11, 2001, and their aftermath? I gave little explicit attention in the dissertation to issues of international conflict and national security. I believe I would have been able to make the case that the values, policies and institutions that support quantitative Scenario 3 and the narrative scenario of social democratic internationalism would encourage a reduction in international conflict, and would enable such conflict as occurs to be successfully managed.

The dissertation might be faulted for seeming to put its faith in a naïve understanding of human nature. At points it reads as though the advocated scenario is to be agreed upon by global consensus, without serious dispute or rancor. I considered including a section addressing the contending beliefs about the nature of human nature and their implications for the various scenarios. But I left the dissertation as it was, for two reasons. One was that it was already very long. The other was that, in the final analysis, no theory of human nature relieves any of us of the

---

[192] For current inequality trends see the *World Development Report, 2001/2002,* published by the United Nations Development Program (2002). For reports on availability of energy resources, see *World Energy Outlook 2002* by the International Energy Agency (2002). For recent reviews of the potential impacts of climate change, see the *Third Assessment Report – Climate Change 2001* by the Intergovernmental Panel on Climate Change (2001). For the current state of the sustainability discourse see the *Report of the World Summit on Sustainable Development* (2002). See also the annual editions of the *State of the World Report* published by the Worldwatch Institute. For new projections of productivity gains see Jorgenson et al. (2003). For an analysis of the new productivity gains see Nordhaus (2001). For the current state of the globalization discourse see the reports from the 2004 World Social Forum, held in Mumbai, India: www.wsfindia.org. For current thinking on science, technology and society, see reports from the March 2002 conference, *Living with the Genie: Governing the Scientific and Technological Transformation of Society*: www.livingwiththegenie.org. For background on concerns about nanotechnology see *The Big Down: Atomtech Technologies Converging at the Nano Scale,* published by the ETC group (2003). For an overview of concerns about the new human genetic technologies see *The Threshold Challenge of the New Human Genetic Technologies* (2002), available on the website of the Center for Genetics and Society: www.genetics-and-society.org.

need to make choices. The fundamental social question is, "What kind of world do we want to help make happen?" As it stands, the dissertation offers one response.

APPENDICES

1. Cline's Growth Projections: Closing the Income Gap in 650 Years

2. Model A: Estimation of Initial Values and Rates of Change

3. The Model A Income Distribution Equations

4. Economic Inequality

5. Definitions of Growth, Well-Being and Related Key Concepts

6. Estimates of Stocks of Energy Resources

7. Calculation of Global Warming Trajectories

APPENDIX 1. CLINE'S GROWTH RATE PROJECTIONS: CLOSING THE INCOME GAP IN 650 YEARS

In 1992 William Cline prepared an influential study on the economics of global warming. In order to estimate benefits and costs of global warming, and of efforts to reduce it, some base-line projections of economic growth over the period of concern are necessary. Cline's base-line projections for the more developed countries (MDC's) and the less developed countries (LDC's) are shown in **A1-1.** In the case of global warming the period of concern is two or three centuries.

Equity considerations were not a major focus of Cline's study, but that makes a look at the equity implications of his assumed growth trajectories all the more telling. We see that Cline projects that the ratio between the per capita incomes of the more and less developed countries will decline from about 4.3:1 to about 3:1 over the next 275 years. If the growth rates projected for 2275 remain unchanged after that date, the LDC's will "catch up" with the MDC's after an additional 365 years.[1] Per capita incomes in 2650 would be about $390,000, and average income for a family of four would be about $1,600,000.

[1] (Given 185,397e^(.002t) = 61,376e^(.005t), then t = 365).

BOX A1-1. CLINE'S GROWTH RATE PROJECTIONS: CLOSING THE INCOME GAP IN 650 YEARS
Source: Cline (1992)

per capita income
(1990 US $)

	2000	2025	2050	2075	2100	2125	2150	2175	2200	2225	2250	2275
MDC's	17,020	22,934	30,902	41,639	56,106	71,953	92,274	112,614	137,438	155,689	176,364	185,397
growth rate (%/yr	1.2	1.2	1.2	1.2	1.2	1.0	1.0	0.8	0.8	0.5	0.5	0.2
LDC's	3,985	5,782	8,389	12,172	15,610	20,019	25,673	32,924	42,222	47,829	54,181	61,376
growth rate (%/yr	1.5	1.5	1.5	1.5	1.0	1.0	1.0	1.0	1.0	0.5	0.5	0.5
MDC's/LDC's	4.27	3.97	3.68	3.42	3.59	3.59	3.59	3.42	3.26	3.26	3.26	3.02

FIGURE 1.

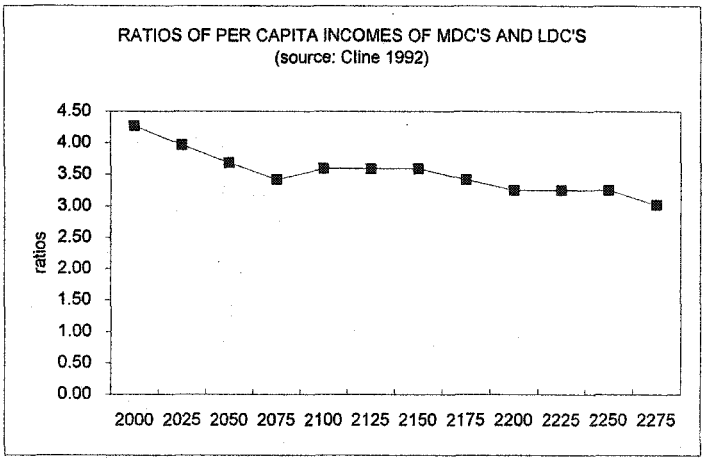


TABLE · COMPARISONS OF PER CAPITA INCOMES PROJECTED BY CLINE

Per Capita Income (1990 US $)

	World	family of 4	output growth rate
1995	6,319	25,276	
2100	21,000	84,000	
2275	77,700	310,000	
	"More developed countries"		
2275	185,400	742,000	.002/year
	"Less developed countries"		
2275	61,400	246,000	.005/year

APPENDIX 2. MODEL A: ESTIMATION OF INITIAL VALUES AND RATES OF CHANGE

For the Reference Scenario (Scenario I) I needed to specify initial values for population, per capita GDP, distribution of income by quintile, and energy intensity for each of the four world income/geographic sectors, i.e., high income, middle income, China, and low income. For each of these variables and sectors I also needed to estimate an initial value for the rates at which each are changing. I also needed to specify rates of change during successive periods over the 150 years covered in the reference scenario of this model.

The general procedure I used was to review several to many existing studies and use these to choose sets of values that appeared to have broad support and that I believed to be reasonable otherwise. Rates of change for population, per capita GDP and income distribution used in the five policy scenarios (Scenarios 2 through 6) are motivated in the main text. The process used to estimate rates of change of energy intensity used in the five policy scenarios is described in this appendix. Sources for all estimates are shown in **Box A2-1,** and the values projected by these sources are shown in the additional boxes.

I. INITIAL VALUES

For initial values I relied on those shown in the 1996 *World Development Report.* The only modification was to separate China from the *Report*'s low income category and show it as a separate sector. Calculations for population and per capita GDP are shown in **A2-2.** Estimates of energy intensity are shown in **A2-3.**

The most accurate way to compute the share of output received by income quintiles in a sector is to calculate mean incomes for each quintile of each country in that sector and then aggregate these, from lowest to highest, into new quintiles. I did this for the high income sector but the difference between using this technique and simply taking the mean of the values given for each country was small. For the remaining three sectors I simply used the

BOX A2-1. Sources Consulted for Population, GDP and Energy Growth Rate Projections

1. Energy Modeling Forum-14. 1996. John Weyant, co-ordinator. Stanford University.

2. Holdren, John. 1995. World Energy Futures, class handout for Energy and Resources 100/200, University of California, Berkeley.

3. Intergovernmental Panel on Climate Change. 1994. Climate Change 1994: Radiative Forcing of Climate Change and an Evaluation of the IPCC IS92 Emission Scenarios.

4. Lazarus, Michael., and Lisa Greber, Jeff Hall, Carlton Bartels, Steve Bernow, Evan Hansen, Paul Raskin, and David Von Hippel (1993). Towards a Fossil Free Energy Future: The Next Energy Transition. A Technical Analysis for Greenpeace International. Boston, Stockholm Environment Institute - Boston Center; Tellus institute.

5. Londono, Juan Luis. 1996. Poverty, Inequality, and Human Capital Development in Latin America, 1950-2025. Washington, D.C.: The World Bank.

6. Manne, Alan S., Robert Mendelsohn and Richard Richels. 1993. MERGE - A Model for Evaluating Regional and Global Effects of GHG Reduction Policies. Stanford University, Yale University and Electric Power Research Institute.

7. Sachs, Jeffrey, "Growth in Africa: It Can Be Done." The Economist, June 29, 1996.

8. Tol, Richard S. 1993. The Climate FUND. Vrije Universiteit. Amsterdam, Holland.

9. World Bank. 1996. World Development Report.

10. World Energy Council/IIASA. 1995. Global Energy Perspectives to 2050 and Beyond. Laxemburg, Austria.

BOX A2-2. INITIAL VALUES FOR POPULATION, GDP, AND AVERAGE ANNUAL GROWTH RATES, 1990-94

source: World Development Report, 1996. The World Bank

Calculated values that depend on growth rates use the exponential formula, r = ln(Q1/Q2)/n.

A. SEPARATION OF CHINA from LOW INCOME figures

GDP:	GDP '94 x10^12 (tbl 12, p210)	growth rate, 90-94 (%/yr) (tbl 11, p208)	GDP '90 x10^12 (calculated)
LOW INCOME COUNTRIES (including China)	1.21	6.20	0.94
CHINA	0.52	12.90	0.31

POPULATION:	POP 94 x10^6 (tbl 4, p 194-5) ==>	growth rate, 90-94 (%/yr)	POP 90 x10^6 (calculated)
LOW INCOME (including China)	3182.00	1.80	2960.95
CHINA	1191.00	1.20	1135.18

Per Capita GDP:	GDP/pop 94 (calculated) ==>	growth rate, 90-94	GDP/pop 90
LOW INCOME (including China)	379.76	4.40	318.47
CHINA	438.43	11.70	274.57

LOW INCOME COUNTRIES (WITHOUT CHINA):

	1994 (calculated)	growth rate, 90-94	1990
GDP (x10^12)	0.69	2.09	0.63
POPULATION (x10^6)	1991.00	2.17	1825.77
GDP/POP ($)	344.66	-0.08	345.77

B. MIDDLE INCOME COUNTRIES:

	1994	growth rate, 90-94 (average, %/yr)	1990
GDP (x10^12)	4070.00	0.20	4037.57
POPULATION (x10^6)	1570.00	1.50	1478.57
GDP/POP ($)	2592.36	-1.30	2730.73

C. HIGH INCOME COUNTRIES:

GDP (x10^12)	20120.00	1.70	18797.32
POPULATION (x10^6)	850.00	0.70	826.53
GDP/POP ($)	23670.59	1.00	22742.45

sources for middle and high income countries:
population '94 and population growth rate, '90-'94: Table 4 p194
GDP growth rate, '90-'94: Table 11 p 208
GDP '94: Table 12 p 210
all other values are derived

BOX A2-3. INITIAL VALUES FOR ENERGY INTENSITY

source: World Development Report, 1996. Tables 8 and 12

(kg = kg of oil equivalent}
(1 kg oil/year = 1.42 W)

	total commercial energy use, 1994		GDP, 1994 (x10^6)	GDP/kg	Watts/$GDP
	(x 10^6 kg)	(TW)	('87 US $)	('87 US $)	('87 US $)
all low income	1222928	1.737	1208422		
China	770000	1.093	522172	0.678	2.094
low income, minus China	452928	0.643	686250	1.515	0.937
middle income	2501145	3.552	4069532	1.627	0.873
high income	4392058	6.237	20120240	4.581	0.310
TOTAL	8116131	11.525	25398194	3.129	0.454
in WDR:	8035058	11.410	25223462	3.139	0.452

mean of the quintile shares for each country in a sector, as shown in **A2-4**. The values shown for each quintile incorporate the simplifying assumption that the entire GDP is received by households. I don't believe that adjustment for this tendency would greatly affect the overall results of the scenario exercises, but extended treatments of the topics addressed in this dissertation might test this assumption.

II. GROWTH RATE PROJECTIONS

I used the studies listed in Box A2-1 to develop assumptions concerning the rates of change of population, per capita GDP and energy intensity.

A. Population

I used the population growth rate assumptions used by the IPCC and Tellus, adjusted to account for the different aggregation of countries and regions.

B. Per Capita GDP

Summaries of the assumptions concerning growth of per capita GDP used in the source studies are shown in **A2-5.**

1. Near-term per capita GDP growth rates (1990-2000)

A. low income countries

The 1996 *World Development Report* shows negative growth for 1990-94 among the low income countries. However, the greatest part of this reflects the difficulties of 3 newly independent states (Tajikistan, Azerbaijan and Armenia), and Rwanda. The largest economies saw positive growth (India-2.9%; Pakistan-1.3%, Bangladesh-2%, Nigeria-1.2%). It's reasonable to assume that the aggregate negative growth results are temporary. Thus I chose 1% for the sector for the period 1994-2000. This is not inconsistent with the figures shown by other studies.

B. China

BOX A2-4. INITIAL VALUES FOR INCOME BY POPULATION QUINTILES

source: World Development Report, 1996. The World Bank.

A. LOW INCOME COUNTRIES			Q1	Q2	Q3	Q4	Q5
1	Rwanda		9.7	13.2	16.5	21.6	39.1
2	Mozabique						
3	Ethiopia						
4	Tanzania		6.9	10.9	15.3	21.5	45.4
5	Burundi						
6	Sierra leone						
7	Malawi						
8	Chad						
9	Uganda		6.8	10.3	14.4	20.4	48.1
10	Madagascar		5.8	9.9	14	20.3	50
11	Nepal		9.1	12.9	16.7	21.8	39.5
12	Vietnam		7.8	11.4	15.4	21.4	44
13	Bangladesh		9.4	13.5	17.2	22	37.9
14	Haiti						
15	Niger		7.5	11.8	15.5	21.1	44.1
16	Guinea-Bissau		2.1	6.5	12	20.6	58.9
17	Kenya		3.4	6.7	10.7	17	62.1
18	Mali						
19	Nigeria		4	8.9	14.4	23.4	49.3
20	Yemen,Rep.						
21	Burkina Faso						
22	Mongolia						
23	India		8.5	12.1	15.8	21.1	42.6
24	Lao PDR		9.6	12.9	16.3	21	40.2
25	Togo						
26	Gambia, The						
27	Nicaragua		4.2	8	12.6	20	55.2
28	Zambia		3.9	8	13.8	23.8	50.4
29	Tajikistan						
30	Benin						
31	Cent. Af. Rep						
32	Albania						
33	Ghana		7.9	12	16.1	21.8	42.2
34	Pakistan		8.4	12.9	16.9	22.2	39.7
35	Mauritania		3.6	10.6	16.2	23	46.5
36	Azerbaijan						
37	Zimbabwe		4	6.3	10	17.4	62.3
38	Guinea		3	8.3	14.6	23.9	50.2
39	China (see below)						
40	Honduras		3.8	7.4	12	19.4	57.4
41	Senegal		3.5	7	11.6	19.3	58.6
42	Cote d'Ivoire		6.8	11.2	15.8	22.2	44.1
43	Congo						
44	Kyrgyz Rep						
45	Sri Lanka		8.9	13.1	16.9	21.7	39.3
46	Armenia						
47	Cameroon						
48	Egypt		8.7	12.5	16.3	21.4	41.1
49	Lesotho		2.8	6.5	11.2	19.4	60.1
50	Georgia						
51	Myanmar						

	Population (10^6)	GDP (10^6)
totals:	1991	686270

Mean share of income for the Quintile (%)		6.16	10.18	14.55	21.10	48.01	= 100
Mean Income for the Quintile ($):		106.12	175.52	250.69	363.71	827.45	

B. CHINA	Population (10^6)	GDP (10^6)
totals:	1191	522172

		Q1	Q2	Q3	Q4	Q5	
Mean share of income for the Quintile (%)		6.20	10.50	15.80	23.60	43.90	= 100
Mean Income for the Quintile ($):		135.91	230.18	346.36	517.35	962.36	

[more...]

BOX A2-4. Initial Values (cont.)

	C. MIDDLE INCOME COUNTRIES	Q1	Q2	Q3	Q4	Q5
52	Bolivia	5.6	9.7	14.5	22	48.2
53	Macedonia					
54	Moldova	6.9	11.9	16.7	23.1	41.5
55	Indonesia	8.7	12.3	16.3	22.1	40.7
56	Philippines	6.5	10.1	14.4	21.2	47.8
57	Uzbekistan					
58	Morocco	6.6	10.5	15	21.7	46.3
59	Kazakstan	7.5	12.3	16.9	22.9	40.4
60	Guatemala	2.1	5.8	10.5	18.6	63
61	Papua New Guinea					
62	Bulgaria	8.3	13	17	22.3	39.3
63	Romania	9.2	14.4	18.4	23.2	34.8
64	Ecuador	5.4	8.9	13.2	19.9	52.6
65	Dominican Rep	4.2	7.9	12.5	19.7	55.7
66	Lithuania	8.1	12.3	16.2	21.3	42.1
67	El Salvador					
68	Jordan	5.9	9.8	13.9	20.3	50.1
69	Jamaica	5.8	10.2	14.9	21.6	47.5
70	Paraguay					
71	Algeria	6.9	11	15.1	20.9	46.1
72	Colombia	3.6	7.6	12.6	20.4	55.8
73	Tunisia	5.9	10.4	15.3	22.1	46.3
74	Ukraine	9.5	14.1	18.1	22.9	35.4
75	Namibia					
76	Peru	4.9	9.2	14.1	21.4	50.4
77	Belarus	11.1	15.3	18.5	22.2	32.9
78	Slovak Rep	11.9	15.8	18.8	22.2	31.4
79	Latvia	9.6	13.6	17.5	22.6	36.7
80	Costa Rica	4	9.1	14.3	21.9	50.7
81	Poland	9.3	13.8	17.7	22.6	36.6
82	Thailand	5.6	8.7	13	20	52.7
83	Turkey					
84	Croatia					
85	Panama	2	6.3	11.6	20.3	59.8
86	Russian Fed	3.7	8.5	13.5	20.4	53.8
87	Venezuela	3.6	7.1	11.7	19.3	58.4
88	Botswana					
89	Estonai	6.6	10.7	15.1	21.4	46.3
90	Iran					
91	Turkemistan	6.7	11.4	16.3	22.8	42.8
92	Brazil	2.1	4.9	8.9	16.8	67.5
93	South Africa	3.3	5.8	9.8	17.7	63.3
94	Maruitius					
95	Czech Rep	10.5	13.9	16.9	21.3	37.4
96	Malaysia	4.6	8.3	13	20.4	53.7
97	Chile	3.5	6.6	10.9	18.1	61
98	Trin & Tob					
99	Hungary	9.5	14	17.6	22.3	36.6
100	Gabon					
101	Mexico	4.1	7.8	12.5	20.2	55.3
102	Uruguay					
103	Oman					
104	slovenia	9.5	13.5	17.1	21.9	37.9
105	Saudi Arabia					
106	Greece					
107	Argentina					
108	Korea, Rep.					

	Population (10^6)	GDP (10^6)
totals:	1570	4069532

Mean share of income for the Quintile (%)	6.39	10.43	14.74	21.11	47.34	= 100
Mean Income for the Quintile ($):	828.09	1352.30	1910.96	2735.30	6134.99	

[more...]

BOX A2-4. Initial Values (cont.)

D. HIGH INCOME COUNTRIES

		population (10^6)	GDP (10^6)	20% of pop (10^6)	Q1	Q2	Q3	Q4	Q5
109	Portugal	10	87257	2					
110	New Zeala	3	50777	0.6	5.1	10.8	16.2	23.2	44.7
111	Spain	39	482841	7.8	8.3	13.7	18.1	23.4	36.6
112	Ireland	4	52060	0.8					
113	Israel	5	77777	1	6	12.1	17.8	24.5	39.6
114	Australia	18	331990	3.6	4.4	11.1	17.5	24.8	42.2
115	UK	58	1017306	11.6	4.6	10	16.8	24.3	44.3
116	Finland	5	97961	1	6.3	12.1	18.4	25.5	37.6
117	Italy	57	1024634	11.4	6.8	12	16.7	23.5	41
118	Kuwait	2	24289	0.4					
119	Canada	29	542954	5.8	5.7	11.8	17.7	24.6	40.2
120	Hong Kon	6	131881	1.2	5.4	10.8	15.2	21.6	47
121	Netherlanc	15	329768	3	8.2	13.1	18.1	23.7	36.9
122	Singapore	3	68949	0.6	5.1	9.9	14.6	21.4	48.9
123	Belgium	10	227550	2	7.9	13.7	18.6	23.8	36
124	France	58	1330381	11.6	5.6	11.8	17.2	23.5	41.9
125	Sweden	9	196441	1.8	8	13.2	17.4	24.5	36.9
126	Austria	8	196546	1.6					
127	Germany	82	2045991	16.4	7	11.8	17.1	23.9	40.3
128	USA	261	6648013	52.2	4.7	11	17.4	25	41.9
129	Norway	4	109568	0.8	6.2	12.8	18.9	25.3	36.7
130	Denmark	5	146076	1	5.4	12	18.4	25.6	38.6
131	Japan	125	4590971	25	8.7	13.2	17.5	23.1	37.5
132	Switzerlan	7	260352	1.4	5.2	11.7	16.4	22.1	44.6
133	UAE	2	35405	0.4					

totals:	850	20120240

Mean share of income for the Quintile (%)	6.23	11.93	17.30	23.87	40.67	= 100
Mean Income for the Quintile ($):	7373.48	14119.67	20475.30	28245.27	48134.72	

BOX A2-5. PER CAPITA GDP GROWTH RATE ASSUMPTIONS

This box displays the values that were used in a variety of studies as estimates of the rate at which per capita GDP would grow over the course of several to many decades in various parts of the world. These values were used to set per capita GDP growth rates used in the Model A reference scenario. As described in the Appendix 2 text, I chose values that appeared to have broad support, and that otherwise seemed reasonable.

A. LOW INCOME COUNTRIES
[All values shown are percent per year]

1. Tellus (based on IPCC 92)

Africa:	1990-2030:	.90
	2030-2100:	2.48
Southeast Asia:	1990-2030:	2.50
	2030-2100:	2.90
Middle East:	1990-2030:	.90
	2030-2100:	1.90

2. World Energy Council/IIASA (total growth rate, not per capita growth rate)

Africa:	1990-20:	hi = 3.3; mid = 3.0
	2020-50:	hi = 4.7; mid = 3.5
South Asia:	1990-20:	hi = 3.9; mid = 3.6
	2020-50:	hi = 4.6; mid = 3.5

3. Energy Modeling Forum

"other non-OECD":	1990-2000:	1.44
	2000-2025:	2.55

4. Tol (based on Manne-Mendelsohn-Richels)

Africa:	1990-00:	.0
	2000-10:	.25
	2010-20:	.75
	2020-30:	1.35

5. IPPC (survey of 21 studies)
Africa, 1990-2020:

minimum:	.01
median:	1.50
average:	1.56
max:	2.98

6. Sachs, The Economist, 6/29/96
a. Africa: between 87-94, output per capita fell at a rate of 0.6% per year. The IMF and World Bank project 1-2 percent annual growth rates for the coming decade or so. Sachs calculates that the realistic goal should be 4.4%, which is only slightly (.5%) below the rate for other developing countries.
b. Asia: output grew by 7% in 1995.

[more...]

BOX A2-5. Per Capita GDP Growth Rate Assumptions (cont.)

B. CHINA

1. Tellus (following IPCC 92)
Centrally Planned Asia [CPA]: 1990-2030: 3.1
2030-2100: 3.1

2. World Energy Council/IIASA (total growth rate, not per capita growth rate)
CPA: 1990-2020: hi = 7.2; mid = 5.0
2020-2050: hi = 4.4; mid = 4.0

3. Energy Modeling Forum
China: 1990-2000: 2.71
2000-2025: 2.66

4. Tol (after Manne-Mendelsohn-Richels)
China: 1990-2000: 6.5
2000-2010: 5.0
2010-2020: 3.25

5. IPPC SURVEY (21 studies)
CPA, 1990-2020:
minimum: 2.01
median: 3.91
mean: 3.73
max: 5.07

[more...]

BOX A2-5. Per Capita GDP Growth Rate Assumptions (cont.)

C. MIDDLE INCOME COUNTRIES

1. Tellus (following IPCC 90)
Latin America: 1990-2030: 1.9
2030-2100: 2.2
Eastern Europe: 1990-2030: 2.9
2030-2100: 2.0

2. World Energy Council/IIASA (total growth rate, not per capita growth rate)
Eastern Europe: 1990-2020: hi = 2.3; mid = 0.9
2020-2050: hi = 4.6; mid = 3.6

3. Energy Modeling Forum
Former Soviet Union: 1990-2000: -2.0
2000-2025: 3.9

4. Tol (after Manne-Mendelsohn-Richels)
Soviet Union &Eastern Europe: 1990-2000: 2.0
2000-2010: 1.75
2010-2020: 1.9

Tol (cont.)
Latin America: 1990-2000: 1.0
2000-2010: 1.0
2010-2020: 1.25
2020-2030: 1.25

5. IPCC SURVEY (21 studies):
Eastern Europe & FSU, 1990-2020:
minimum: 0.77
median: 1.73
mean: 1.85
max: 3.8

6. Londono
Latin America per capita GDP grew at 1.9% in first part of 90's, and could maintain this growth for the next 10 years.

[more...]

BOX A2-5. Per Capita GDP Growth Rate Assumptions (cont.)

D. HIGH INCOME COUNTRIES

1. Tellus (following IPCC 92)

USA	1990-2030:	1.6
	2030-2100:	1.3
Western Europe	1990-2030:	1.9
	2030-2100:	1.3

2. World Energy Council/IIASA (total growth rate, not per capita growth rate)

North America:	1990-2020:	hi = 2.3; mod = 2.0
	2020-2050:	hi = 1.6; mod = 1.4
Western Europe:	1990-2020:	hi = 2.2; mod = 1.9
	2020-2050:	hi = 1.6; mod = 1.3

3. Energy Modeling Forum

USA:	1990-2000:	2.18
	2000-2025:	1.97
EEC:	1990-2000:	2.15
	2000-2025:	2.09

4. Tol (Based on Manne-Mendelsohn-Richels)

OECD-America:	1990-2010:	1.5
	2010-2020:	1.75

5. IPCC SURVEY (21 studies)

USA, 1990-2020:

minimum:	.90
median:	1.96
mean:	1.91
max:	2.91

6. Londono:

per capita growth rate projected for industrialized countries is 2.4% for next decade.

E. TOTAL WORLD:

1. Greenpeace, following IPCC 90

total: 1990-2030: 1.3%; 1985-2100: 1.6%

2. Londono:

world, 1991-1994: 1.9%

The studies listed differ greatly in the assumptions they make about China's near-term economic growth. The *World Development Report* shows 11.7% for 1990-94. The Energy Modeling Forum estimates, which use an average of PPP and exchange rates, shows 2.71% for 1990-2000. The other studies show estimates of 3, 4, 5, and 6.5%. For the time being I chose the middle-range value of 5% as the growth of per capita income in China over the period 1994-2000.

C. Middle Income Countries

The recent negative growth rates shown by the World Bank for the middle income countries again largely reflect the experience of the newly independent states. The other countries in this sector are growing. In the other studies Latin America is projected to grow at about 1-2 %. I chose a figure of 1% as a reasonable expected growth rate of middle income countries between 1994 and the end of the decade.

D. High Income Countries

All the studies showed per capita GDP growth rates of 1.5-2% for the high income countries for 1990-2000. Since the historical rate is 1% for 1990-94, I chose 2% for 1994-2000.

II .Reference Scenario - Long Term Per Capita GDP Growth Rates (2000 - 2150)

I used the IPCC figures as reported by Tellus and IPCC as the basis for my per capita GDP growth rate estimates for 2000-2100. I used the values given in EMF-14 to help estimate these rates for 2100-2150.

The ten IPCC regions can be assigned to my four sectors roughly as follows:

Low Income: African + Southeast Asia
China: Centrally Planned Asia
Middle Income: Latin America + Middle East + USSR + Eastern Europe
High Income: JANZ + US + Western Europe

The Tellus per capita GDP growth rate assumptions give these results when recalculated using the 4-sector aggregation:

	2000-2030	2030-2100	2100-2150	2150-2200
1. Low	1.9	2.7	2.0	1.0
2. China	3.1	3.1	2.0	1.0
3. Middle	1.9	1.9	1.2	1.0
4. High	1.8	1.3	.8	.6

I adjusted these rates to show smoother transitions between decades, without changing the final output levels in a large way.

C. Energy Intensity

I used five studies listed in Box A2-1 to choose projected values for changes in energy intensity over time. Summaries of the values used in each of these studies are shown in **A2-6.** I based the estimate for the reference scenario, Scenario 1, on those used by Manne-Mendelsohn-Richels, and by Tol. The rates used in Scenario 2 are based on Holdren's estimates, but with an imposed upper limit of 2% on the annual rate of energy intensity improvement in the low and middle income sectors, and China. For Scenarios 3 to 6 I used Holdren's full estimates, including the very high rates of efficiency improvement he shows for the non-industrial world in the middle part of the coming century. I slowed the rates down in the final three decades before 2150 to offset these very high, continuing rates of improvement just a bit. The three scenarios are displayed in **A2-7.** All values shown are annual percentage declines in the ratio of energy use to GDP.

BOX A2-6. ENERGY INTENSITY CHANGE ASSUMPTIONS

Assumptions concerning the rate of change in energy intensity over coming decades are shown for five studies. These assumptions were used to help specify rates of change used in the Model A reference scenario and the several policy scenarios, as shown in Box A2-7. Citations are shown in Box A2-1. Energy intensity is the ratio of energy use to GDP. It is the inverse of energy efficiency, the ratio of GDP to energy use. A decline in energy intensity is an increase in energy efficiency.

1. Intergovernmental Panel on Climate Change (IPCC)

Values chosen for the IPCC scenarios, based on a review of 21 studies covering 1990-2020.

	World	CHINA & CPA	AFRICA	USA
1. NO INTERVENTION (= business-as-usual)				
max	1.84	2.85	.67	2.17
med	.94	1.59	.17	1.29
mean	.99	1.52	.30	1.35
min	.53	.22	.53	0.20
2. "POLICY"				
max	2.4	4.32	2.19	2.88
med	1.78	1.89	1.46	1.91
mean	1.74	2.24	1.31	1.87
min	1.08	.53	.30	.66

Calculation of overall energy intensity decline, 1900-2100:

USA	.904
CPA	1.46
EU & FSU	1.17
AFRICA	.543

2. Energy Modeling Forum 14 (1996)

	date						
Region	1990-2000	2000-2025	2025-2050	2050-2075	2075-2100	2100-2150	2150-2200
USA	.70	.63	.52	.37	.36	.26	.19
EEC	.70	.67	.51	.37	.36	.26	.19
other OECD	.72	.67	.51	.36	.36	.26	.19
CHINA	.87	.85	.94	.92	.91	.64	.32
FSU	-.66	1.25	1.07	.60	.62	.32	.26
other non-OECD	.46	.81	.77	.76	.83	.64	.32

EMF calculations are based on a formula by Arnulf Grubler of IIASA. Aggregate Energy Efficiency Improvements (AEEI) are a constant fraction, .32, of GDP/capita growth rates. Thus, if USA per capita growth rate for 1990-2000 is 2.18, short run AEEI is .32 x 2.18 = .70, as shown.

[more....]

Box A2-6. Energy Intensity Change Assumptions (cont.)

3. Mann-Mendlesohn-Richels (1993); also used by Tol (1993)

	90-00	00-10	10-20	20-30	30-40	40-50	2050-2100
OECD	.50	.50	.50	.50	.50	.50	.50
ME, LA, AFR, SA, SEA	0	0	.10	.20	.30	.40	.50
CHINA	1.00	1.00	.90	.80	.70	.60	.50
FSU & EE	.25	.25	.30	.35	.40	.45	.50

4. HOLDREN (1996)

	1990	2000	2010	2020	2030	2040	2050	2060	2070	2080	2090
Reference case:											
Industrialized	1.3	1.3	1.2	1.2	1.1	1.1	1.0	1.0	.90	.90	.80
Developing	0	.5	1.0	1.3	1.3	1.2	1.2	1.1	1.1	1.0	1.0
Maximum feasible improvements:											
Industrialized	1.5	2.5	3.0	3.0	2.7	2.4	2.0	1.5	1.0	1.0	1.0
Developing	.5	1.0	2.0	2.3	2.5	2.7	2.8	2.7	2.4	1.8	1.0

5. World Energy Council/IIASA (1995)

	High Growth	Middle Course	Ecologically Driven
World			
1990-2050	1.0	0.7	1.4
1990-2100	1.0	0.8	0.5
Regions (1990-2050)			
OECD	1.2	1.1	2.0
Reforming Economies	2.1	1.7	2.2
Developing Countries	1.6	1.2	1.9

BOX A2-7. MODEL A ENERGY INTENSITY CHANGE TRAJECTORIES
(Energy/GDP % change per year)

I. SCENARIO I - Reference Scenario

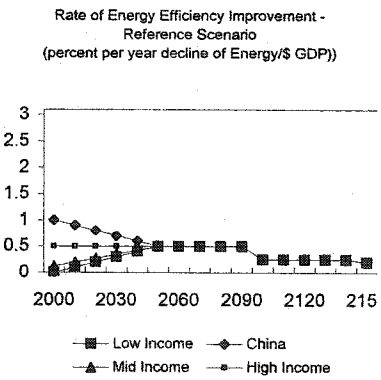
	2000	2010	2020	2030	2040	2050	2060	2070	2080	2090	2100	2110	2120	2130	2140	2150
Low	0	0.1	0.2	0.3	0.4	0.5	0.5	0.5	0.5	0.5	0.25	0.25	0.25	0.25	0.25	0.2
China	1	0.9	0.8	0.7	0.6	0.5	0.5	0.5	0.5	0.5	0.25	0.25	0.25	0.25	0.25	0.2
Mid	0.12	0.2	0.27	0.35	0.42	0.5	0.5	0.5	0.5	0.5	0.25	0.25	0.25	0.25	0.25	0.2
High	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.25	0.25	0.25	0.25	0.25	0.2

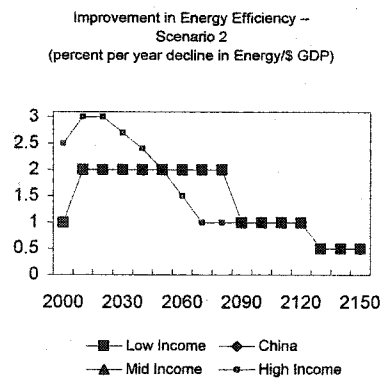
2. SCENARIO 2

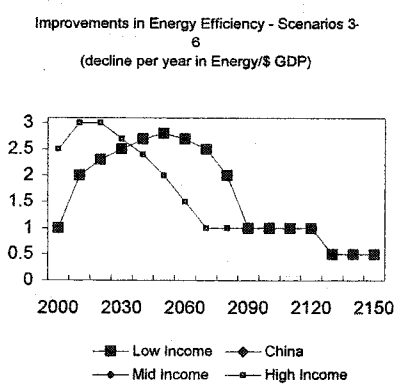
	2000	2010	2020	2030	2040	2050	2060	2070	2080	2090	2100	2110	2120	2130	2140	2150
Low	1	2	2	2	2	2	2	2	2	1	1	1	1	0.5	0.5	0.5
China	1	2	2	2	2	2	2	2	2	1	1	1	1	0.5	0.5	0.5
Mid	1	2	2	2	2	2	2	2	2	1	1	1	1	0.5	0.5	0.5
High	2.5	3	3	2.7	2.4	2	1.5	1	1	1	1	1	1	0.5	0.5	0.5

3. SCENARIOS 3-6

	2000	2010	2020	2030	2040	2050	2060	2070	2080	2090	2100	2110	2120	2130	2140	2150
Low	1	2	2.3	2.5	2.7	2.8	2.7	2.5	2	1	1	1	1	0.5	0.5	0.5
China	1	2	2.3	2.5	2.7	2.8	2.7	2.5	2	1	1	1	1	0.5	0.5	0.5
Mid	1	2	2.3	2.5	2.7	2.8	2.7	2.5	2	1	1	1	1	0.5	0.5	0.5
High	2.5	3	3	2.7	2.4	2	1.5	1	1	1	1	1	1	0.5	0.5	0.5



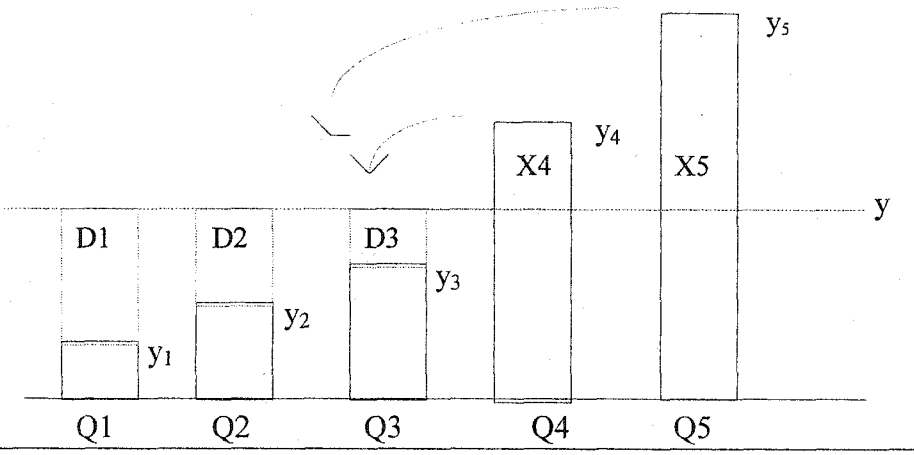




APPENDIX 3. MODEL A INCOME DISTRIBUTION EQUATIONS

The equations shown in Boxes IA-10 and IA-11 of the text allow us to model changes in the distribution of income among quintiles over time. **Box A3-1,** below, illustrates how this works.

Box A3-1. Model A Income Distribution Procedure



At the end of each period proportion "r" of the total income above the mean income y [r (X4 + X5)] is redistributed to the three quintiles below the mean in the same proportion "s" that each of them is below the mean. For example, for the bottom quintile, Q1, this proportion is: $s_1 = D1/(D1 + D2 + D3)$. We call "s" the redistributive proportionality factor.

This value can be expressed in terms of the mean income of the quintile (y_j) and the mean income of the sector as a whole (y), as:

$$s_1 = (y - y_1) / [(y - y_1)+(y - y_2)+(y - y_3)]$$

$$= (y - y_1) / [3y - (y_1 + y_2 + y_3)]$$

Which is equivalent to equation (6) shown in IIA-11 of the text (without the income sector subscript i). The values of s for the three quintiles to which it applies – Q1, Q2 and Q3 – are shown for all four income sectors in **A3-2.**

If a positive "r" is maintained over time the incomes for all quintiles will converge. A negative "r" will redistribute income from the three quintiles below the mean to the two above

BOX A3-2. MODEL A REDISTRIBUTIVE PROPORTIONALITY FACTOR ("s")

1	2	3	4	5	6
Income Sector	Quintile	Mean Income	Sector Mean	Total Gap	Value of "s"
low income			344.8	501.4	
	Q1	106			0.4763
	Q2	176			0.3367
	Q3	251			0.1871
	Q4	364			
	Q5	827			
China			438.2	602.6	
	Q1	136			0.5015
	Q2	230			0.3455
	Q3	346			0.1530
	Q4	517			
	Q5	962			
middle income			2592.2	3685.6	
	Q1	828			0.4787
	Q2	1352			0.3365
	Q3	1911			0.1848
	Q4	2735			
	Q5	6135			
high income			23669.6	29040.8	
	Q1	7373			0.5612
	Q2	14120			0.3288
	Q3	20475			0.1100
	Q4	28245			
	Q5	48135			

Notes:

Columns 1, 2 and 3 identify the four income sectors, the five quintiles for each sector, ar the per capita income of those each of those quintiles.

Column 4 shows the mean (or per capita) income for each income sector as a whole

Column 5 shows the "total gap" for each income sector, i.e., the sum of the amounts by which each of the first three quintiles are below the mean.

Column 6 shows the percent of the "total gap" represented by the "gap" of each quintile i a sector. This is the value of the redistributive proportionality factor, "s".

the mean.

The model allows a growth rate "g" to be exogenously specified for the economy as a whole. Thus the model can show how the per capita incomes of any quintile, and of the income sector as a whole, will change given assumptions about the aggregate growth rates of income and rates of change in the distribution of income.

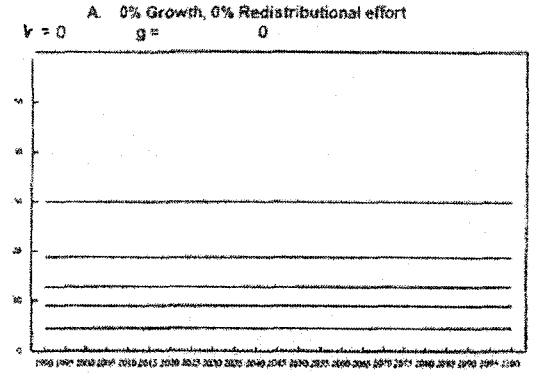
The figures in **A3-3** illustrate Model A's income distribution dynamics. Figure A shows the quintile distribution of income for the United States in 1990, in 1990 dollars, and illustrates the trivial scenario in which there is no change in the level of total income ($g = 0$), and no change in the distribution of income ($r = 0$), over the period between 1990 and 2100.

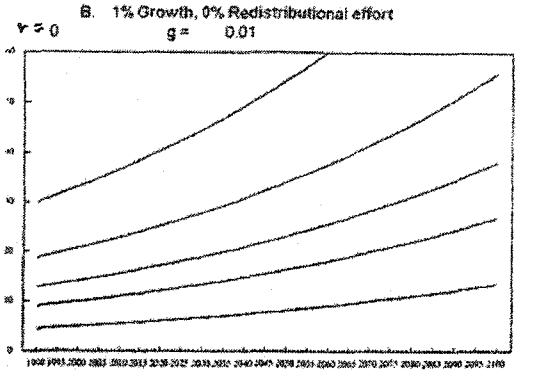
Figure B illustrates a scenario in which the economy grows at a constant rate of 1% per year ($g = .01$) but the distribution of income is unchanged ($r = 0$). Both the 80/20 ratio and the Gini Coefficient remain constant over time. However, the absolute difference between the incomes received by each quintile becomes greater.

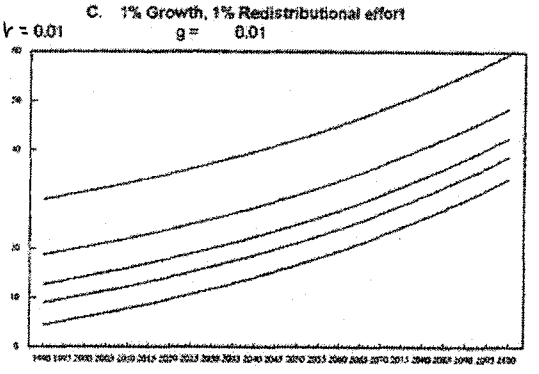
Figure C shows total income growing at the same rate of 1% as in Figure 1b, but now shows redistributive pressure of 1% ($r = .01$). This means that 1% of the income of the top two quintiles that is above the mean of all five quintiles is redistributed to the bottom three quintiles, at the end of each period. Now the 80/20 ratio and Gini Coefficients decline over time, while the absolute difference among quintiles remains constant.

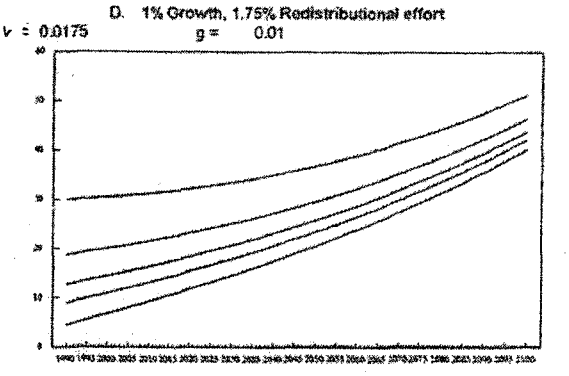
Figures D and E show the results of progressively stronger redistributive efforts, $r = .0175$ and $r = .04$, respectively. For any given rate of aggregate growth (in this example, 1%) there is a threshold level of redistributive effort above which the top quintile will be forced to undergo an absolute reduction in its income, rather than simply a reduction in its relative income share. In Figure D ($r = .0175$) incomes converge rapidly but at no point need the top income quintile forsake further income growth entirely. In Figure E however ($r = .04$), the incomes of

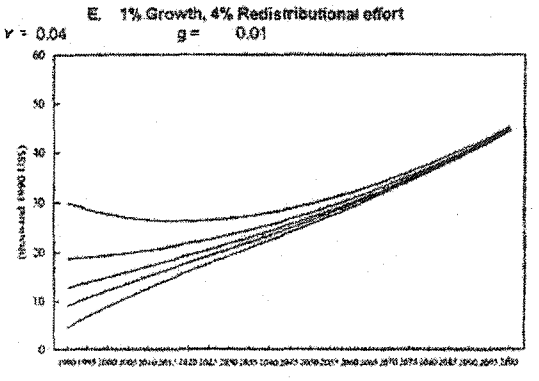
BOX A3-3. Model A Income Distribution Dynamics

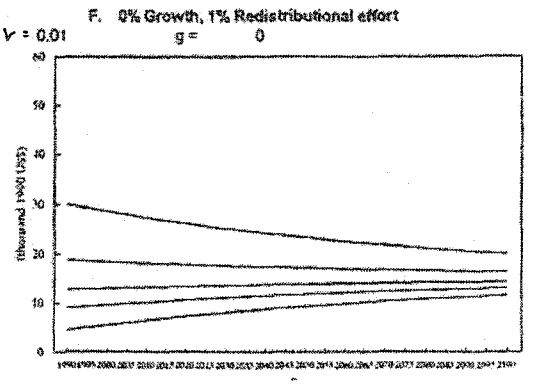












the top quintile must decline until 2025, at which time they can begin to grow once more. Note that as the average incomes of the quintiles converge, their rates of growth do so as well.

Figure F illustrates a scenario in which there is no aggregate economic growth (g = 0) but the distribution of income becomes more equal. In this situation there is no choice but that the top quintiles undergo an absolute decline in their average incomes. It is instructive to compare Figure F with Figure C. Both show a redistributive pressure of 1% (r = .01) and thus show the same 80/20 ratios and Gini coefficients at every point in time. But in C this takes place while aggregate income is growing at 1%, while in F there is no growth of aggregate income.

Interpretation of "r"

As noted in the text, the term "redistributive pressure" is used here in a very general sense. It might refer to policies that take from the rich and give directly to the poor. It might refer to policies that tax the rich to provide educational services that increase the earnings abilities of the poor. Or it might refer to market mechanisms that are thought to generate greater income equality.

If we think of "r" as a tax, how heavy a tax does a value of r of say, 1%, imply? Suppose per capita income growth in the United States is expected to average 1% over the coming decades, and that in the absence of redistributive policy this growth would be shared equally by all income quintiles. This is the scenario of Figure B. Now suppose we wished to effect a more equal distribution of incomes, say along the lines shown in Figure C. What proportion of their total incomes would the upper quintiles have to forego, and how big a transfer would this represent for the lower quintiles?

We see in Table 1 of **A3-4** that a value of r of .01 implies a tax on the top quintile (Q5) of .495%, or $450 on a total household income of $90,900. The 4th quintile (Q4) is taxed at .211%, or $120 on a total household income of $56,820.

BOX A3-4. MODEL A GROWTH AND REDISTRIBUTION DYNAMICS

Table 1 shows that for a single period, an "r" value of .01 represents transfers of $450, or less than 1/2 of 1%, of the income of the fifth quintile to the bottom three quintiles.

Table 1. Growth and Redistribution over one period (g = .01, r = .01)

	mean household income			
	before	after	dollars	tax rate/
	redistribution	redistribution	transferred	grant rate
quintile				(%)
Q5	90900	90450	-450	-0.495
Q4	56820	56700	-120	-0.211
Q3	38640	38700	60	0.155
Q2	27270	27450	180	0.660
Q1	13650	13950	300	2.198

Table 2 shows that over 60 periods an "r" value of .01 represents a much larger transfer of income. By the final period over 22% of the income of the fifth quintile is being transferred to those in the bottom three quintiles.

Table 2. Growth and Redistribution over 60 periods (g = .01, r = .01)

Q5	mean household income				
	before	after	dollars	tax rate	80/20
year	redistribution	redistribution	transferred	(%)	ratio
1990	90900		-450	-0.495	6.67
2010	109830	100470	-9360	-8.522	4.29
2030	134010	111990	-22020	-16.432	3.16
2050	163500	126750	-36750	-22.477	2.52

Q1	mean household income				
	before	after	dollars	grant rate	80/20
year	redistribution	redistribution	transferred	(%)	ratio
1990	13650		300	2.198	6.67
2010	16470	23400	6930	42.077	4.29
2030	20100	35490	15390	76.567	3.16
2050	24540	50250	25710	104.768	2.52

Whether these are considered to be heavy taxes or not depends on the story that the model is interpreted to be telling. If the tax dollars are thought to be used for purposes that will increase the earnings of the lower three quintiles in the subsequent period by the amount of the transfer, then the effective tax rate can stay near the low levels shown in the first period.

However, if the model is thought to describe a system of direct income subsidies, then the amounts taxed and transferred become much larger. In this case we assume that the earned incomes of the lower quintiles increase by no more than 1% a year. In order to effect a meaningful redistribution the amounts transferred from the upper quintiles (the incomes of which are also increasing at 1% annually) must increase each year. This is shown in Table 2 in Box A3-4. A redistributive pressure of 1%, applied continuously, requires the effective tax rate on household incomes in Q5 in the years 2010, 2030 and 2050 to grow to 8.5%, 16%, and 22%, respectively. Similarly, by 2050 the level of income supplement being received by the bottom quintile ($25,710) is greater than the income received through earnings ($24,540).

APPENDIX A4. ECONOMIC INEQUALITY

1. Definitions and Measures

Measures of economic inequality used in these notes include:

a) ***frequency distributions and histograms.*** A frequency distribution shows the number of income units (individuals, families, nations, etc.) that fall within a set of income ranges. The graphical display of this data is a histogram. Box IIB-9 in the text shows a simple frequency distribution and histogram of household income in 1992.

b) ***percentile ratios.*** A simple measure of the inequality of a frequency distribution is the ratio between two percentiles from opposite ends of the distribution. The 80/20 and the 90/10 ratios are commonly used. The 80/20 ratio is calculated by taking the ratio of the total income (or mean income) of all income units in the fifth quintile of a population to that of the first, or bottom, quintile. The 80/20 ratio of the frequency distribution of household income shown in Table 1 of Box IIB-10 is 91.5 / 7.3, or 12.4 to 1.

c) ***Lorenz curves.*** The Lorenz curve is a graph of cumulative share of a variable, such as income or wealth, against the cumulative population share. The greater the convexity of the Lorenz curve with respect to the bottom right corner of the display, the greater the inequality of the distribution. The diagonal line represents a distribution of perfect equality. The Lorenz curve of the frequency distribution shown in Table 1 of Box IIB-10 is shown in Figure 1 of that box.

d) ***Gini coefficient.*** This is the most commonly used single statistic of inequality. It is the ratio of the area enclosed by the Lorenz curve and the diagonal, and the total area under the diagonal line. A Gini coefficient of 0.0 indicates perfect equality, and a ratio of 1.0 indicates perfect inequality. Some authors multiply the fractional Gini coefficient by 100, so that 0

indicates perfect equality and 100 indicates perfect inequality, as a convenience. The Gini coefficient can be calculated directly from a frequency distribution by using the formula[1]:

$$G=1+\left(\frac{1}{N}\right)-\left(\frac{2}{N^2\,\bar{y}}\right)\sum_{i=1}(N-i+1)y_i$$

where:

N = the number of percentiles
y = the relative shares of income of each percentile
y bar = the mean income share of the percentiles
i = the index number of the percentiles (1, 2, ...N)

2. Interpreting the Gini coefficient

In general, one or two Gini points are not very significant, but ten Gini points is very significant.

Box A4-1 shows quintile distributions that typify groups of countries situated at different points along the gradient of inequality as measured by the Gini coefficient. We see that the 20 countries with the greatest income equality have an average Gini of about 28, while the 28 with the least income equality have a Gini of about 54.

Box A4-2 shows the amount of redistribution that would be required to change the Gini coefficient of the United States by one Gini point, from its current .37 to .36. This could be done by a tax of 5.7% on the incomes of the top quintile (Q5) of households, with the proceeds transferred to the next lowest quintile (Q4). Or it could be done if a tax of 1.5% was levied on Q5 but transferred to the bottom quintile (Q1).

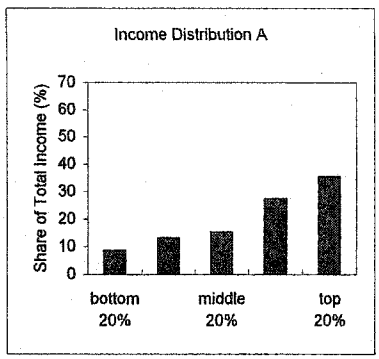
[1] See Cowell (1995) and Lambert (1993) for a review the technical tools for measuring economic inequality.

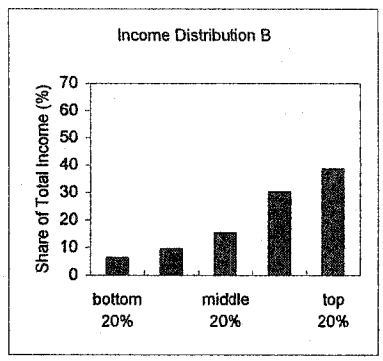
BOX A4-1. COMPARISON OF INCOME DISTRIBUTIONS

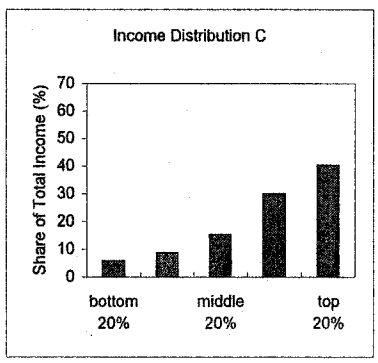
[source: Box IIB-1]

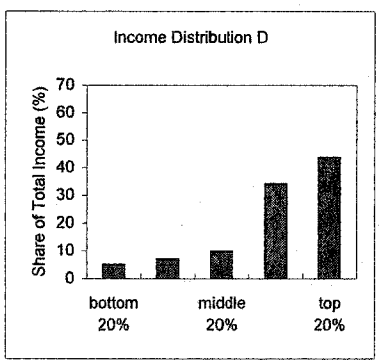
The five displays illustrate the sorts of income distributions that characterize different countries. See the key at the bottom.

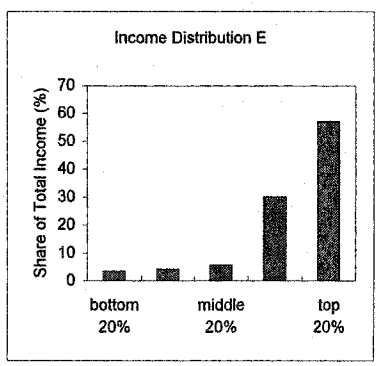
	income share (%)
Distribution A:	
bottom 20%	8.6
second 20%	13.2
middle 20%	15.3
fourth 20%	27.4
top 20%	35.5
Distribution B:	
bottom 20%	6.3
second 20%	9.6
middle 20%	15.3
fourth 20%	30.2
top 20%	38.6
Distribution C:	
bottom 20%	5.8
second 20%	8.7
middle 20%	15.3
fourth 20%	30.0
top 20%	40.2
Distribution D:	
bottom 20%	5.1
second 20%	7.1
middle 20%	9.9
fourth 20%	34.2
top 20%	43.7
Distribution E:	
bottom 20%	3.4
second 20%	4.0
middle 20%	5.6
fourth 20%	30
top 20%	57











Income Distribution	descriptions	mean Gini	mean 80/20	Typical Examples
A	20 most equal countries, ranked by Gini	27.6	4.1	Canada, Russia, Spain, Bangladesh
B	next 20 countries, ranked by Gini	34.5	6.1	Germany, Indonesia, Ghana, India
C	next 20 countries, ranked by Gini	35.5	6.9	Japan, USA, China, Nigeria
D	next 20 countries, ranked by Gini	43.5	8.5	Australia, Peru, Uganda, Iran
E	28 most unequal countries, ranked by Gir	54.1	17.1	Mexico, Kenya, Thailand, Brazil

BOX A4-2. Changes in Income Distribution Needed to Change the Gini Coefficient of the United States by 1 Point

quintiles		current % shares ('92)	Transfers between Quintiles: Q5 => Q4	Q5 => Q3	Q5 => Q2	Q5 => Q1
Q1	lowest 20%	4.5	-	-	-	5.15
Q2	second 20%	10.7	-	-	11.6	-
Q3	middle 20%	16.6	-	17.9	-	-
Q4	fourth 20%	24.1	26.6	-	-	-
Q5	top 20%	44.1	41.6	42.8	43.2	43.45
Gini		0.37	0.36	0.36	0.36	0.36
80/20		9.8	9.2	9.5	9.6	8.4

		mean income	Q5 => Q4	Q5 => Q3	Q5 => Q2	Q5 => Q1
Q1	lowest 20%	5553	-	-	-	6355
Q2	second 20%	13204	-	-	14314	-
Q3	middle 20%	20484	-	22089	-	-
Q4	fourth 20%	29739	32824	-	-	-
Q5	top 20%	54419	51334	52815	53309	53617

		gross tax & transfer (%)	Q5 => Q4	Q5 => Q3	Q5 => Q2	Q5 => Q1
Q1	lowest 20%	-	-	-	-	14.4%
Q2	second 20%	-	-	-	8.4%	-
Q3	middle 20%	-	-	7.8%	-	-
Q4	fourth 20%	-	10.4%	-	-	-
Q5	top 20%	-	-5.7%	-2.9%	-2.0%	-1.5%

		amounts transferred	Q5 => Q4	Q5 => Q3	Q5 => Q2	Q5 => Q1
Q1	lowest 20%	-	-	-	-	802
Q2	second 20%	-	-	-	1110	-
Q3	middle 20%	-	-	1604	-	-
Q4	fourth 20%	-	3085	-	-	-
Q5	top 20%	-	-3085	-1604	-1110	-802

APPENDIX 5 DEFINITIONS OF GROWTH, WELL-BEING AND RELATED KEY CONCEPTS

As most commonly used, the word "growth" simply means an increase. In many contexts "growth" applies more generally to any change over time, and thus allows negative growth. In these notes we might be interested in the growth, or change over time, of output, consumption, utility (or welfare, well-being, or happiness), throughput (or resource use), population, pollution, the stock of natural or human-made capital, information, complexity or any of many other things.

For our purposes it is particularly important to have clear definitions of *well-being, throughput,* and *output.* There is a large literature on how these might be defined and measured, but the rough definitions below will serve our purposes for now.

"Well-being" refers to the most general, inclusive sense of human satisfaction and contentment. The question "what determines well-being?" is among the most important questions there are.

"Throughput" is the flow of natural resources used to generate output. Some throughput generates output directly, but most becomes output only after a series of manipulations. During these manipulations some of the throughput becomes waste. Particular flows of resources can be easily measured but there is no practical common unit with which to measure throughput in the aggregate.

"Output" is throughput manipulated by human activities intended to increase well-being. It can equivalently be defined as all final goods and services produced by an economy during a time period. To the extent that prices reflect value, output can be measured as the sum of the prices of these goods and services, or gross domestic product (GDP). The proper measurement of output, or GDP, should include imputed prices for both positive and negative non-market goods. While any particular act of producing output is intended to increase well-being, it may

not. As defined here output has an important bearing on well-being but is hardly synonymous with it. In these notes the term "economic growth" is used to mean the growth of output.

Well-being, throughput and output can each increase, decrease or remain constant. We can imagine 3^3 = 27 scenarios, some more plausible than others, showing how these three variables might change with respect to one another over time. Three scenarios are shown in Figures 1, 2 and 3 in **A5-1**.

Figure 1 illustrates a conventional interpretation of the historical experience of the industrial world over the past three centuries or so. Greater throughput enables production of more output, which increases well-being.

Figure 2 is a "green" scenario. Technological innovation allows a constant level of output to be produced with less throughput, while skillful craftwork changes qualities of that output in such a way that well-being increases.

Figure 3 is a mixed bag. A constant level of throughput is maintained, perhaps because a transition to a renewables-based economy has been successfully completed. And technological innovation is robust enough to generate a steady increase in output. But well-being declines nonetheless, perhaps because this materially sustainable, technologically productive world is being run as an increasingly authoritarian police state.

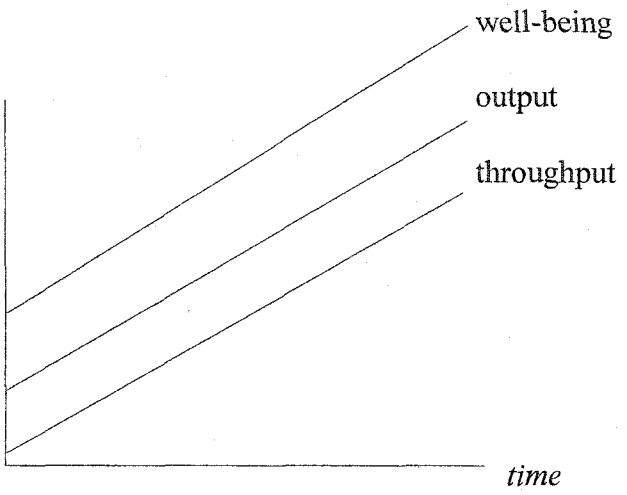
As defined, output represents a link between the fundamentally more important variables of well-being and throughput. Output is of interest to us primarily because it contributes to well-being and uses throughput.

The five scenarios shown in Figures 1 through 5 in **Box A5-2** dispense with "output" and illustrate different sorts of relationships that may obtain more directly between the level of well-being and the level of throughput.

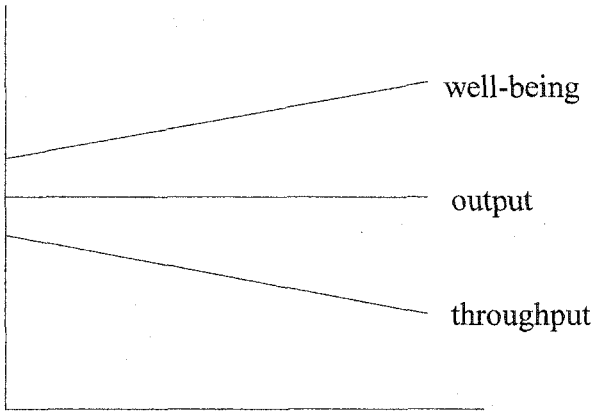
BOX A5-1. WHAT GROWS? (1)

The figures show well-being, output and throughput increasing, decreasing and remaining constant over time.

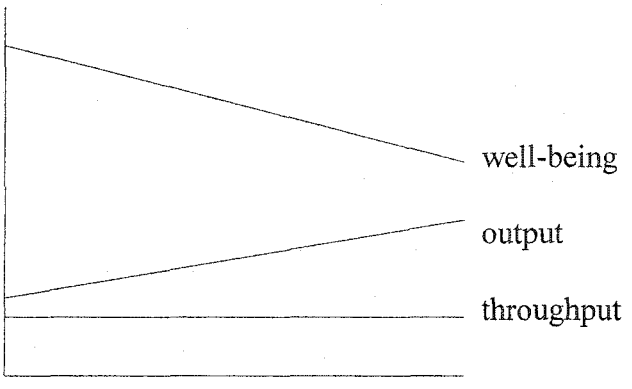
1.



2.

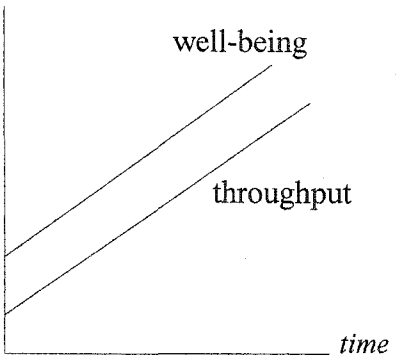


3.

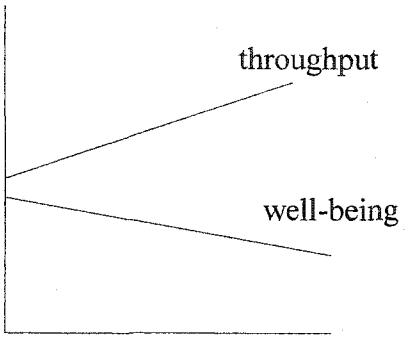


BOX A5-2. WHAT GROWS? (2)

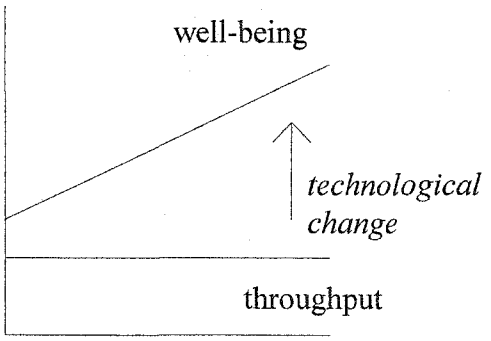
The figures show different ways that trajectories of throughput might bear upon trajectories of well-being, as discussed in the text.



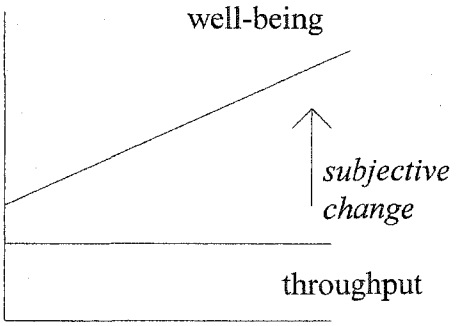
1. "the metal eaters"



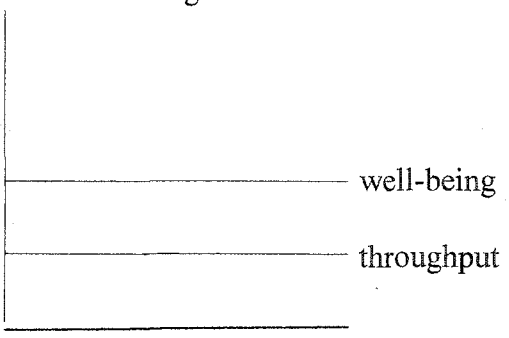
2. "gloomy Sunday"



3. "techno-green"



4. "subjective green"



5. "green minimal case"

Figure 1 illustrates, once more, the conventional account.[1]

Figure 2 shows the unhappy case in which throughput continues to grow but well-being declines.

Figures 3 and 4 are both green scenarios and show the same formal relationship between throughput and well-being, but they are driven by very different processes and represent very different outcomes. Figure 3 shows the "techno-green" scenario. Human technological skill allows a constant level of throughput to be manipulated in increasingly efficient and innovative ways. As a result, human well-being can increase without endangering the environment.

Figure 4 is the "subjective-green" scenario. It shows a constant level of throughput, but this time there are no technological improvements. The same stuff is made in the same way, century after century. However, the quality of the services provided by the output improves. The design and construction of a saxophone may not change over the course of a century, but the beauty and variety of the compositions written for it, and of the performances given with it, can grow indefinitely.

There is a second, more subtle interpretation of the scenario shown in Figure 4. Neither the saxophone, the compositions, nor the performances change over the course of time, but the listeners develop an increasingly keener appreciation for the music. Throughput remains constant but well-being grows.

Figure 5 is the "green minimal claim" scenario. The minimal claim is simply that a constant level of throughput can indefinitely support some constant, fulfilling level of well-being.

Limits and constraints on the rates and levels of growth

The phrase "limits to growth" is ambiguous because the thing whose growth is limited is unspecified. It is also ambiguous because "growth" can refer either to the growth *rate* or to the *level* to which something can grow. We can say that output (for example) is limited to a growth

[1] "The metal eaters" is a translation of "Металлические едоки," used by Russian environmentalists to

rate of 2% per year, or that output is limited to an absolute level of $30 trillion. Note that a limit to the level of growth implies an eventual limit to the rate of growth, i.e., 0%.

The term "limits" can be used to mean either an absolute level that cannot be exceeded, or a softer set of constraints short of an absolute limit. In these notes we'll try to use "limits" when speaking of values that cannot be exceeded, and "constraints" for the more general set of impediments. As used here, "constraints" is the inclusive term: a limit is a very strong constraint, but a constraint need not, although it might, impose a limit.

Thus we can speak, hopefully unambiguously, of limits to the level to which something can grow, limits to the rate at which something can growth, constraints on the level to which something can grow, and constraints on the rate at which something can grow.

The Rhetoric of Growth

President Ronald Reagan once offered the opinion that "there are no limits to growth, because there are no limits to the human imagination." Put less succinctly but more precisely, he might have been expressing the opinion that "there are no limits to the ability of technology to manipulate any given level of throughput such that human well-being continues to increase."

Some environmentalists say, "There are limits to growth, but not to well-being." One interpretation of this statement might be that technology will allow us to manipulate an environmentally sustainable, constant level of throughput in a way that can allow human well-being to increase indefinitely.

Other environmentalists say, "There are limits to *throughput,* but there are *no* limits to *growth.*" In the previous statement "growth" referred to throughput, but here it could refer to well-being, or to output, or to both well-being and output.

Can We Measure Well-Being?

---

describe the institutions of industrial civilization.

The Standard National Accounts were developed in the 1940's in order to track the flows of economic variables, including output, consumption, saving and public spending, that were needed to help develop policies intended to ensure steady output growth and low unemployment. In the wake of the Great Depression and the Second World War, a steady growth in output was experienced by most persons as a major contribution to well-being. The availability of GDP as an analytically convenient measure of output led to its identification among professionals and the public as a measure of well-being.

The inadequacies of conventional GDP as a measure of both output and well-being are well known. Its most important inadequacy as a measure of output is that it doesn't account for goods or bads external to market.

Attempts to deal with the shortcomings of the GDP have gone in two directions. One is to strengthen its use as a measure of output, while disclaiming any role as a measure of well-being. This entails converting as many non-market goods and bads as possible into dollar terms and incorporating these into the national income accounts, and other reforms.

A second direction seeks to devise genuine measures of well-being which over time could supplant GDP in that role. One approach involves the use of (fully inclusive) GDP in association with satellite accounts of variables that are judged to have a bearing on well-being, such as literacy rate, longevity, infant mortality, or stocks and flows of natural resources. A second approach is to combine these measures into a single statistic by means of an indexing formula. The choice set of satellite accounts, and any indexing weights they might be given, are of course strongly normative statements.

Some examples of efforts along the lines described are shown in **A5-3.** Figure 1 shows the measure that Nordhaus and Tobin (1989) call Net Economic Welfare (NEW). NEW takes Net National Product, which is GNP less depreciation, and adds the value of leisure time, domestic activities, "underground" transactions, and other non-market goods. It subtracts non-

BOX A5-3. MEASURING WELL-BEING

These figures illustrate how differing measures of "well-being" have changed in recent years.

Figure 1. Net Economic Welfare

(Reprinted from Samuelson and Nordhaus, 1989, p 119)

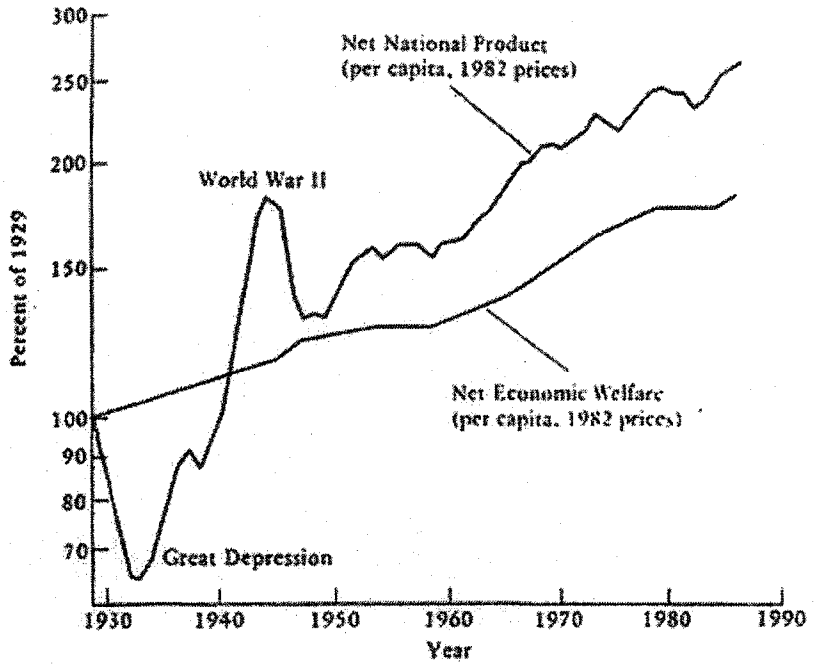
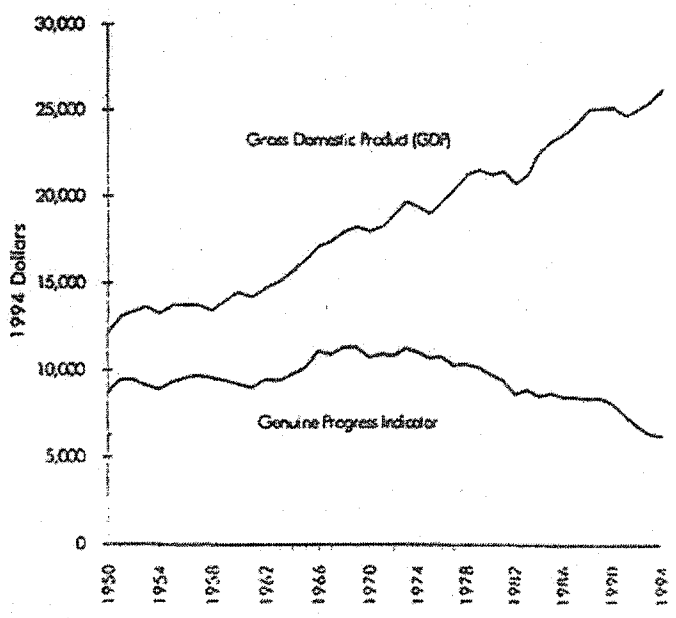


Figure 2. GPI versus GDP

(Reprinted from Cobb et al, 1995)



Box A5-3. MEASURING WELL-BEING (cont.)

Figure 3. Human Development Index, 1960-1993
(United Nations Development Program, Human Development Report, 1996)

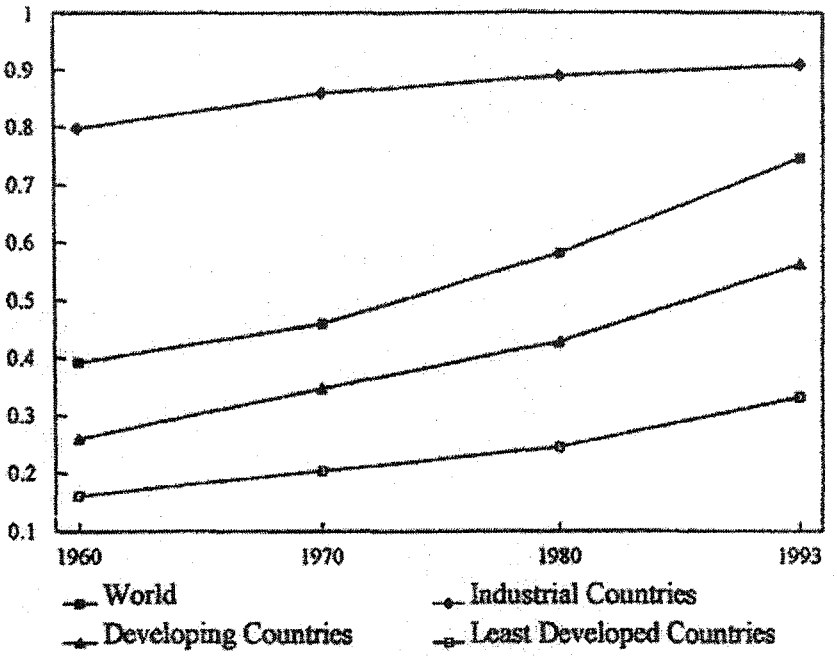
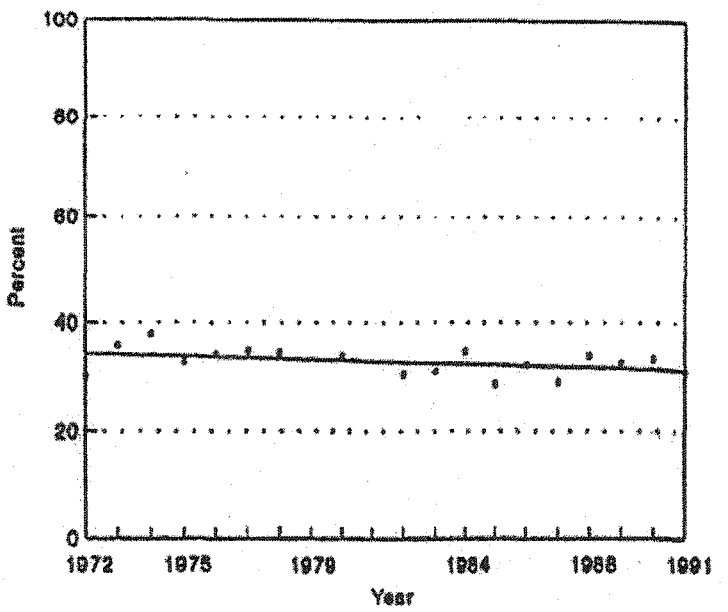


Figure 4. Happiness
(Reprinted from Easterlin, 1995)



The vertical axis shows the "percent very happy," based on National Opinion Research Center for Genetics and Society surveys through 1991.

market bads such as economic damages resulting from pollution and urban congestion. Nordhaus defines NEW as "an adjusted measure of total national output that includes only consumption and investment items that contribute directly to economic well-being." In general, the growth rate of NEW has paralleled the growth rate of conventional GDP.

Figure 2 displays the Genuine Progress Indicator (GPI) developed by the organization Redefining Progress (1995), based on work by Daly and Cobb (1989). Like NEW, the GPI adds the value of domestic activities to GDP. However, the GPI shows a decrease in leisure time rather than an increase. In the GPI environmental pollution and resource depletion reduce GDP by larger amounts than they do in the NEW. In addition, GPI incorporates an indexing factor that records the growth of economic inequality as a decrease in well-being. These plus other modifications of the GDP accounts generate a path over time very different from that displayed by NEW.

Figure 3 shows the Human Development Index developed by the United Nations Development Program (1996). This relatively simple index has three components: life expectancy, educational attainment (based on adult literacy rates and mean years of schooling), and adjusted income. Income is GDP per capita computed on a Purchasing Power Parity basis, subject to a strongly diminishing marginal index value.

Easterlin (1995) doubts that any set of objective measures can accurately model all the determinants of well-being, and suggests that surveys of how people assess their own well-being can provide a better guide. Figure 4 shows how people in the United States responded to a question asking them how happy they are. The slight trend shown by the regression line is not statistically significant. Reported happiness in the United States over the past twenty years has been constant, despite a major increase in output during that time.

Applied to the United States, these alternatives to conventional GDP move in different ways over time. The NEW and HDI increase, the GPI decreases, and the proportion of people stating that they are happy remains unchanged.

APPENDIX 6. ESTIMATES OF STOCKS OF ENERGY RESOURCES

Boxes A6-1 through **A6-7**, below, show the source data used to estimate stocks of energy resources used in Section IIA.2.a. **Box A6-8** shows the conversion factors used to convert all estimates to terawatt years.

Box A6-1. HOLDREN
source: Energy & Resources 200 course handout:
Recent World Energy and Economic Data, 10/95.

Estimated Remaining Recoverable Resources of Fuels (TWy)

oil					
petroleum liquids		500			
oil shale		30000			
heavy oils		500			
natural gas					
conventional		500			
unconventional		1000			
coal		5000			
TOTAL Fossil Fuels		37500	7500	(w/o oil shale)	
uranium (in LWRs)		3000			
uranium (in LMFBRs)		3000000			
lithium (DT fusion)		1.4E+08			
deuterium (fusion)		2.5E+11			

Box A6-2. World Energy Council
(source: Global Energy Perspective to 2050 and Beyond. Report, 1995. p 36.)

Estimates of Energy Reserves, Resources and Occurrences
(GTOE)

	Reserves	Resources	Resource Base	Additional Occurrenc	ultimately recoverable		
oil							
conventional	150	145	295		200		
unconventional	193	332	525	1900	553	(511-595)	
natural gas							
conventional	141	279	420		220		
unconventional	192	258	450	400			
hydrates				18700			
coal	606	2794	3400	3000	3400		
TOTAL Fossil Fuel:	1282	3808	5090	24000			
uranium (LWRs)	57	203	260	150			
uranium (LMFBRs)	3390	12150	15540	8900			
TOTAL ALL:	4729	16161	20890	33050			

World Energy Council: conversion to terawatt years

Estimates of Energy Reserves, Resources and Occurrences
(TWy) 1GTOE = 1.42 TWy

	Reserves	Resources	Resource Base	Additional Occurrenc	ultimately recoverable		
oil							
conventional	213	206	419		284		
unconventional	274	471	746	2698	785		
natural gas							
conventional	200	396	596		312		
unconventional	273	366	639	568			
hydrates				26554			
coal	861	3967	4828	4260	4828		
TOTAL Fossil Fuels	1820	5407	7228	34080			
uranium (LWRs)	81	288	369	213	(+ 17,000 tons U		
uranium (LMFBRs)	4814	17253	22067	12638	ultimately recoverable)		
TOTAL ALL:	6715	22949	29664	46931			

Box A6-3. IPCC
(source: IPCC, Climate Change 1995: Impacts, Adaptations and Mitigations of Climate Change. Working Group II Report)

(EJ)		Conventional Resources			Unconventional Resources:		Resource	Additional
	Reserves	to be discovered. w/ probability:			a. currently	b. recoverable with	Base	Occurance
	Identified	0.95	0.5	0.05	recoverabl	technological progress		(> than...)
oil								
conventional	6000	1800	2500	5500			8500	10000
unconventional	7100					9000	16100	
natural gas								
conventional	4800	2700	4400	10900			9200	10000
unconventional	6900				2200	17800	26900	22000
hydrates								800000
coal	25200				13900	86400	125500	130000
TOTAL Fossil Fuels	50000	4500	6900	16400	16100	113200	186200	987000
uranium (LWRs)	1800		2300		4100	6000	14200	1000000
TOTAL ALL:	51800	4500	9200	16400	20200	119200	200400	1987000

IPCC: conversion to terawatt years

(TWy)
1 EJ = 0.03175 TWy

	Conventional Resources			Unconventional Resources:		Resource	Additional
Reserves	to be discovered. w/ probability:			a. currently	b. recoverable with	Base	Occurance
Identified	0.95	0.5	0.05	recoverabl	technological progress		
oil							
conventional	191	57	79	175		270	318
unconventional	225				286	511	
natural gas							
conventional	152	86	140	346		292	318
unconventional	219				70	565	854	699
hydrates								25400
coal	800				441	2743	3985	4128
TOTAL Fossil Fuels	1588	143	219	521	511	3594	5912	31337
uranium (LWRs)	57		73		130	191	451	31750
TOTAL ALL:	1645	143	292	521	641	3785	6363	63087

Box A6-4. ENERGY MODELING FORUM
(source: Demographic, Economic, and Energy Assumption, EMF 14. http://soe.stanford.edu/ees/design.html)

(EJ)					
	Reserves	Undiscovered	ultimately recoverable		total
		Resources, 95%-ile	resources		
crude oil +					
nat. gas liquids	7362	6833			14195
natural gas	5537	10805			16342
coal			300000		300000

ENERGY MODELING FORUM: conversion to terawatt years

(source: Demographic, Economic, and Energy Assumption, EMF 14. http://soe.stanford.edu/ees/design.html)

(TWy)
1 EJ = 0.03175 TWy

Reserves	Undiscovered	ultimately recoverable		total
	Resources, 95%-ile	resources		
crude oil +				
nat. gas liquids	234	217		451
natural gas	176	343		519
coal			9525	9525

Box A6-5 . HERMAN KAHN: THE NEXT 200 YEARS (1976) (10^18 Btu)					
source		proven reserves	long term potential resources		
oil		3.7	14.4		
natural gas		1	15.8		
coal		95	170		
shale oil		19	2000		
tar sands		1.8	1.8		
total fossil fuels		120.5	2202		
U-235 (free world)			15		
U-235 (oceans)			3000		
Uranium for breeders			100000	+	
Li-6 (D-T fusion)			320		
Deuterium (D-D fusion)			1E+09	+	
HERMAN KAHN: THE NEXT 200 YEARS (1976)					
	Conversion toTerawatt years				
10^18 Btu =	33.49	TWy			
source		proven reserves	long term potential resources		
oil		124	482		
natural gas		33	529		
coal		3182	5693		
shale oil		636	66980		
tar sands		60	60		
total fossil fuels		4036	73745		
U-235 (free world)			502		
U-235 (oceans)			100470		
Uranium for breeders			3349000	+	
Li-6 (D-T fusion)			10717		
Deuterium (D-D fusion)			33490000000	+	

BOX A6-6. ROGER HINRICHS: Energy: Its Use and Environment (text; 1996) 10^18 Btu						
		proven reserves				
oil		5.9				
natural gas		5				
coal		50				
tar sands		1.7				
shale oil		0.87				
total fossil fuel		63.47				
ROGER HINRICHS: Energy: Its Use and Environment (text; 1996)						
	Conversion to Terawatt years					
10^18 Btu =	33.49	TWy				
		proven reserves				
oil		198				
natural gas		167				
coal		1675				
tar sands		57				
shale oil		29				
total fossil fuel		2126				

BOX A6-7. Freeman & Jahoda: WORLD FUTURES, 1978
(10^9 tce)

fuel	proven & possible reserves	ultimately recoverable resources	
coal	1000	7700	
oil	375	2760	
natural gas	200	1500	
shale oil	-	1200	
tar sand	-	225	
sub-total, for fossil hydrocarbons	1575	13385	
Uranium thermal	100		?
Uranium breeder	0	5000	+
Thorium breeder	0	4000	+
Fusion	0	virtually unlimited	
geothermal wet rock	60	1500	
geothermal dry rock	0	50 million	
TOTAL (excl fusion & geothermal dry rock)	1735	23885	

Freeman & Jahoda: WORLD FUTURES, 1978
Conversion to Terawatt years
(10^9 tce)
10^9 tce = 0.929 TWy

fuel	proven & possible reserves	ultimately recoverable resources	
coal	929	7153	
oil	348	2564	
natural gas	186	1394	
shale oil		1115	
tar sand		209	
sub-total, for fossil hydrocarbons	1463	12435	
Uranium thermal	93		?
Uranium breeder	0	4645	+
Thorium breeder	0	3716	+
Fusion	0	virtually unlimited	
geothermal wet rock	56	1394	
geothermal dry rock	0	50 million	
TOTAL (excl fusion & geothermal dry rock)	1612	22189	

BOX A6-8. CONVERSION FACTORS

The conversion factors used in Boxes A6-1 through A6-7 are:

1 EJ = 10^18 J
1 TWy = 31.5 EJ
1 EJ = 3.175 x 10^-2 TWy
1 J = 9.484 x 10^-4 Btu
1 Btu = 1055 J
1 Q = 10^18 Btu
1 bbl = 5.8 x 10^6 Btu = 6.12 x 10^9 J
1 ton U235 = 70 x 10^12 Btu
1 mbdoe = 50 x 10^6 tons oil equivalent/year = 2.2 x 10^18 J/yr
10^15 Btu = 36 x 10^6 tons coal equivalent

where:

EJ = Exajoule
TWy = Terawatt year
Btu = British thermal unit
Q = Quad
bbl = billion barrels of oil equivalent
mbdoe = million barrels per day oil equivalent

APPENDIX 7. Calculation of Global Warming Trajectories

Section II.A.2a offered several scenarios in which anthropogenic global warming is prevented from exceeding 3.6° C, as displayed in Box IIA-15. These scenarios were generated using my extension (Hayes 1995) of the model developed by Cline (1992).

The key equations of the extended Cline model are shown and described below.

We begin with Cline's equations for income and population:

$$(1) \quad y_t^D = y_t^D (1+g_D)^t$$

$$(2) \quad y_t^L = y_t^L (1+g_L)^t$$

$$(3) \quad P_t^D = P_0^D (1+n_D)^t$$

$$(4) \quad P_t^L = P_0^L (1+n_L)^t$$

where:
y = per capita income
P = population
D = developed countries
L = less developed countries
t = time; t = 1 in 1991
g = per capita growth in income
n = per capita growth in population

These give Gross World Product, Y:

$$(5) \quad Y_t = y_t^D P_t^D + y_t^L P_t^L$$

Cline's proposed carbon emissions ceiling (K) [4 Gt/year] is subtracted from baseline emissions (E) to give the needed amount of annual emissions reductions (R):

$$(6) \quad R_t = E_t - K$$

The amount of global warming (W) in any given year (t) is given by the linear functions:

$$(7) \quad W_t = \Delta S + [(W^* - S)/225](t-60); \quad t \geq 60$$

$$(8) \quad W_t = S(t/60); \quad t < 60$$

where:

S = climate sensitivity parameter
[1.5°, 2.5°, and 4.5° for low, medium and high cases]
W* = equilibrium warming under very-long-term global warming conditions
[6°, 10° and 18° for low, central and high climate sensitivity parameters]

I extended Cline's model to allow alternative warming trajectories to be calculated. The equations are shown below. Further details can be found in Hayes (1995).

First apply the subscript t to K, to show that K can vary with time, with $t_0 = 1966$.

$$(9) \quad R_t = E_t - K_t$$

Next we add the climate model, beginning with equations for atmospheric CO2 stock and concentration. For this purpose I used an equation from the Nordhaus (1996) DICE model. The superscript B denotes business-as-usual values.

$$(10) \quad M_t^B = [590 + \beta E_t + (1 - \delta_M)(M_{t-1}^\beta - 590)]$$

In this equation 590 is the pre-industrial carbon stock (in GtC), β is the short-term emissions retention fraction (.64), E_t are emissions, and δ_M is the long-term CO2 decay constant, set at .00825.

Next we multiply by the constant .47 to convert atmospheric stock to a concentration:

$$(11) \quad CON_t^B = .47 M_t^B$$

Next we use the standard formula to calculate radiative forcing due to CO2:

$$(12) \quad RFC_t^B = 6.3 \ln\left[\frac{CON_t^B}{280}\right]$$

Then we add the radiative forcing that results from trace gases:

$$(13) \quad RFT_t^B = -0.184 + 1.8024(RFC_t^B) - 0.047(RFC_t^B)^2; \qquad RFC_t^B \leq 6$$

$$(14) \quad RFT_t^B = 1.45 RFC_t^B; \qquad RFC_t^B > 6$$

Now we calculate warming commitment:

$$(15) \quad WC_t^B = RFT_t^B \lambda\beta\alpha$$

In this equation λ is .3 w/m^2 and the feedback variable β takes upper bound, central case and lower bound values of 3.4, 1.9, and 1.1, respectively, which generate climate sensitivity factors of 1.5, 2.5 and 4.5 degrees C. The factor α, set at 1.18, adjusts for the masking effects of SO2, NOx and O3, and for the use of Nordhaus' stock equation.

Finally we get warming at any time t by adjusting for the 25-year-lag:

(16) $W_t^B = WC_{t-25}^B; \qquad t \geq 25$

(17) $W_t^B = 0; \qquad t < 25$

BIBLIOGRAPHY

Abramson, Paul R., and Ron Inglehart. 1995. *Value Change in Global Perspective*. Ann Arbor: University of Michigan Press.

Adam, Herrbert, and Kogila Moodley. 1993. "Forecasting Scenarios for South Africa." *FUTURES* 25: 404-413.

Adelman, Irma and Cynthia Taft Morris. 1973. *Economic Growth and Social Equity in Developing Countries*. Stanford, CA: Stanford University Press.

Adelman, Irma, and Sherman Robinson. 1978. *Income Distribution Policy in Developing Countries: A Case Study of Korea*. Stanford, California: Stanford University Press.

Alesina, Alberto, and Roberto Perotti. 1993. "Income Distribution, Political Instability, and Investment." NBER Working Paper 4486.

Alesina, Alberto, and Dani Rodrik. 1991. "Distributive Politics and Economic Growth." NBER Working Paper w3668.

Anderson, Walter Truitt. 1990. *Reality Isn't What It Used To Be*. New York: Harper and Row.

Andrews, Cecile. 1997. *The Circle of Simplicity: Return to the Good Life*. New York: Harper Collins.

Appleyard, Bryan. 1998. *Brave New Worlds: Staying Human in the Genetic Future*. New York: Viking.

Ausubel, Jesse. 1994. "Technical Progress and Climatic Change". 1994. In *Integrated Assessment of Mitigation, Impacts, and Adaptation to Climate Change*, N. Nakicenovic, W.D. Nordhaus, R. Richels, and F.L. Toth, eds., International Institute for Applied Systems Analysis, Laxenburg, Austria.

Ausubel, Jesse, David G. Victor, and Iddo K. Wernick. 1995. "The Environment Since 1970". In *Consequences,* Volume 1, Number 3.

Ayers, Robert U. 1968. *Transportation: Technology and Urban Environmental Quality Considerations.* Croton-on-Hudson, New York: Hudson Institute.

Ayers, Robert U. 1992. "Toward a non-linear dynamics of technological progress." *Journal of Economic Behavior and Organization.* 24: 35-69.

Ayers, Robert U. and Steven M. Miller. 1980. "The Role of Technological Change." *Journal of Environmental Economics and Management* 7: 353-371.

Baker, Dean. 1996. "The Inflated Case Against the CPI." *Electronic Policy Network.* http://epn.org/prospect/24.

Bannock, Graham, R.E. Baxter and Evan Davis. 1992. *Dictionary of Economics.* Fifth Edition. New York: Penguin Books.

Barber, Benjamin. 1996. Jihad vs McWorld. New York: Times Books.

Barlow, Maude, and Tony Clarke. 1998. The Multilateral Agreement on Investment (MAI) and the Threat to American Freedom. Toronto: Stoddart.

Barney, Gerald O. 1980. *The Global 2000 Report to the President of the United States.* New York: Pergamon Press.

Becker, Gary S. 1993. *Human Capital: a theoretical and empirical analysis with special reference to education.* Chicago: University of Chicago Press.

Becker, Gary S. and Kevin M. Murphy. 1993. "The Division of Labor, Coordination Costs, and Knowledge," in Gary S.Becker, *Human Capital.* Chicago: University of Chicago Press.

Begley, Sharon. 1998. "Designer Babies." *Newsweek.* November 9.

Bello, Walden. 1998. "The End of the Asian Miracle." *The Nation.* 16-21.

Benabou, Roland. 1996. "Inequality and Growth." Syracuse, New York: Syracuse University Luxembourg Income Study.

Berger, Suzanne, and Ronald Dore, eds. 1996. *National Diversity and Global Capitalism.* Ithaca, NY: Cornell University Press.

Bergstrand, J.H., T.F. Cosimano, J.W. Houck and R.G. Sheehan, eds. 1994. *The Changing Distribution of Income in an Open U.S. Economy.* New York: North-Holland.

Berlin, Kenneth, and Jeffrey M. Lang. 1996. "Trade and the Environment," in *New Forces in the World Economy,* edited by Brad Roberts. 157-174. Cambridge, MA: MIT Press.

Berman, Eli, John Bound, and Zvi Griliches. 1993. "Changes in the Demand For Skilled Labor within U.S. Manufacturing Industries: Evidence from the Annual Survey of Manufacturing." *NBER Working Paper* 4255.

Bernauer, Thomas. 1995. "The Effect of International Environmental Institutions: How We Might Learn More." *International Organization* 49.

Berry, Albert, Francois Bourguignon, and Christian Morrisson. 1991. "Global Economic Inequality and Its Trends Since 1950." In *Economic Inequality and Poverty: international perspectives,* edited by Lars Osberg. Armonk, New York: M.E. Sharpe.

Bessant, John, and Sam Cole. 1985. *Stacking the Chips: information technology and the distribution of income.* Totowa, New Jersey: Rowman & Allanhead.

Binmore, Ken. 1990. *Essays on the Foundations of Game Theory.* Cambridge, MA: Basil Blackwell Inc.

Blinder, Alan S. 1974. *Toward an Economic Theory of Income Distribution.* Cambridge, Massachusetts: The MIT Press.

Block, Ned, Owen J. Flanagan and Güven Güzeldere, eds. 1997. *The Nature of Consciousness: Philosophical Debates.* Cambridge, Massachusetts: The MIT Press.

Bonnicksen, Andrea. 1997. "Fetal Motherhood: Towards a Compulsion to Generate Lives?" *Cambridge Quarterly of Healthcare Ethics*: 19-30.

Boskin, Michael , et al. 1996. *Toward a More Accurate Measure of the Cost of Living.* Final Report to the Senate Finance Committee from the Advisory Commission to Study the Consumer Price Index. Office of Senate Finance. Washington, D.C.

Bound, John, and George Johnson. 1992. "Changes in the Structure of Wages in the 1980's: An Evaluation of Alternative Explanations." *American Economic Review* 82: 371-392.

Breslow, Mark. 1996. "Is the U.S. Making Progress?" *Dollars and Sense*. 16-21.

Brinkman, Richard I. 1980. "Mankind at the Starting Point." *Journal of Economic Issues* XIV. 567-582.

Brown, Christopher. 1995. "International Political Theory and the Idea of World Community," in *International Relations Theory Today*, edited by Ken Booth and Steve Smith. 90-109. University Park, Pennsylvania: Pennsylvania State University Press.

Bruce, James P., Hoesung Lee, and Erik F. Haites. 1996. "Climate Change 1995: Economic and Social Dimensions of Climate Change. Report of Working Group III." New York: Intergovernmental Panel on Climate Change.

Buchanan, Patrick. 1997. Quoted in Anne-Marie Slaughter, 1997, p 192. "The Real New World Order." *Foreign Affairs*: Vol 76 No.5.

California Institute of Technology, RAND, and World Resources Institute. 1997. "Hyperforum Scenarios on Sustainability." www.hf.caltech.edu/HF.

Calvin, William H. 1993. "Cautions on the Superhuman Transition." *Whole Earth Review* Winter 93.

Canadian Royal Commission on New Reproductive Technologies. 1993. *Proceed with Care: Final Report of the Royal Commission on New Reproductive Technologies*. 2 vols. Ottawa: Minister of Government Services.

Center for Arab Unity Studies. 1991. *The Future of the Arab Nation: Choices and Options.* London: Routledge.

Cerny, Philip G. 1995. "Globalization and the changing logic of collective action." *International Organization* 49: 595-625.

Cha, K.Y., J.J. Koo, J.J. Ko, D.H. Choi, S.Y. Han, and T.K. Yoon. 1991. "Pregnancy after *In vitro* Fertilization of Human Folliclar Oocytes Collected from Non-stimulated Cycles, Their Culture *in vitro* and their Transfer in a Donor Oocyte Program," *Fertility and Sterility* 55. 109-13.

Chalmers, David. 1996. *The Conscious Mind: In Search of a Fundamental Theory.* London: Oxford University Press.

Chenery, Hollis, Montek S. Ahluwalia, C.L.G. Bell, John H. Duloy, and Richard Jolly. 1974. *Redistribution with Growth.* London: Oxford University Press.

Chichilnisky, Graciela and Sam Cole. 1978. "A model of technology, distribution and North-South relations." *Technological Forecasting and Social Change,* 13.

Cline, William R. 1992. *The Economics of Global Warming.* Washington, DC: Institute of International Economics.

Cline, William R. 1997. *Trade and Income Distribution.* Washington DC: Institute for International Economics.

Coates, Joseph F., John B. Mahaffie, and Andy Hines. 1997. *2025: Scenarios of US and Global Society Reshaped by Science and Technology.* Greensboro, NC: Oakhill Press.

Cobb, Clifford, Ted Halstead and Jonathan Rowe. 1995. "The Genuine Progress Indicator: Summary of Data and Methodology." San Francisco: Redefining Progress.

Cohen, Joel. 1995. *How Many People Can The Earth Support?* New York: W.W. Norton.

Cole, H.S.D., Christopher Freeman, Marie Jahoda, K.L.R. Pavitt, eds. 1973. *Models of Doom: A Critique of The Limits to Growth.* New York: Universe Books.

Cole, Sam and Henry Lucas, eds. 1979. *Models, Planning and Basic Needs.* New York: Pergamon Press.

Cole, Sam and Ian Miles. 1984. *Worlds Apart: Technology and North-South Relations in the Global Economy.* Totowa, NJ: Rowman & Allanheld.

Coleman, Andrew M. 1982. *Game Theory and Experimental Games: The study of strategic interaction.* Oxford: Pergamon Press.

Colin, Norman. 1983. "Clerics Urge Ban on Altering Germline Cells." *Science* 220: 1360-1361.

Cooke, Robert. 1998. "Pushing a Human Limit: Gene therapy that could affect future generations, too," in *Newsday*, August 30. Long Island, New York.

Council of Economic Advisors, 1995. *Economic Report of the President.* Washington, D.C.: U.S. Government Printing Office.

Cowan, George A., David Pines, and David Meltzer, eds. 1994. *Complexity: Metaphors, Models, and Reality.* Sante Fe Institute Proceedings Vol XIX. Reading, PA: Addison-Wesley.

Cowell, Frank A. 1995. *Measuring Inequality.* 2nd Edition. New York: Prentice-Hall.

Criswell, David R. 1985. "Solar System Industrialization: Implications for Interstellar Migrations," in Ben R. Finney and Eric M. Jones, eds., *Interstellar Migration and the Human Experience*. Berkeley: University of California Press.

Dacyczyn, Amy. 1993. *The Tightwad Gazette: Promoting Thrift as a Viable Alternative Lifestyle*. New York: Random House.

Daly, Herman E. and John B. Cobb, Jr. 1989. *For the Common Good: Redirecting the economy toward community, the environment, and a sustainable future*. Boston: Beacon Press.

Danziger, Sheldon, and Peter Gottschalk. 1993. *Uneven Tides: Rising Inequality In America*. New York: Russell Sage Foundation.

Danziger, Sheldon, and Peter Gottschalk. 1995. *America Unequal*. Cambridge, Massachusetts: Harvard University Press.

Das Gupta, Partha, and Geoffrey Heal. 1974. "The Optimal Depletion of Exhaustible Resources." *Review of Economic Studies Vol 41*: 3-27.

Davis, Morton. 1970. *Game Theory: A nontechnical introduction; Revised Edition*. New York: Basic Books, Inc.

Davison, Aidan, Ian Barns, and Renato Schibeci. 1997. "Problematic Publics: A Critical Review of Surveys of Public Attitudes to Biotechnology." *Science, Technology and Human Values* 22: 317-348.

de Santis, Hugh. 1996. *Beyond Progress: An interpretative odyssey to the future*. Chicago: Chicago University Press.

Deininger, Klaus, and Lyn Squire. 1996 (a). "A New Data Set Measuring Income Inequality." *The World Bank Economic Review* 10: 565-592. The full spreadsheet data set can be downloaded from www.worldbank.org/research/growth/dddeisqu.htm.

Deininger, Klaus, and Lyn Squire. 1996 (b). "New Ways of Looking at Old Issues: Inequality and Growth." Washington, D.C.: The World Bank Policy Research Department.

Dervis, Kemal, Jaime De Melo, and Sherman Robinson. 1982. *General Equilibrium Models for Development Policy*. New York: Cambridge University Press.

DeVore, Paul W. 1980. *Technology: An Introduction.* Worcester, Mass: Davis Publications.

Drexler, K. Eric. 1986. *Engines of Creation: The Coming Era of Nanotechnology*. New York: Anchor Books/Doubleday.

Drexler, Eric. 1987. "Nanotechnics and Civilization." *Whole Earth Review* Spring 1987.

Drexler, K. Eric. 1992. *Nanosystems: Molecular Machinery, Manufacturing and Computing*: NewYork: John Wiley & Sons.

Dyson, Freeman. 1988. *Infinite in All Directions*. New York: Harper & Row.

Dyson, Freeman. 1997. *Imagined Worlds*. New York: Harper & Row.

Easterbrook, Greg. 1995. *A Moment on the Earth.* New York: Viking.

Easterlin, Richard A. 1995. "Will Raising the Incomes of All Increase the Happiness of All?" *Journal of Economic Behavior and Organization*. #1. June. 27: 35-47.

The Economist. 1992. "Changing Your Genes." April 25: 11-12.

The Economist. 1995. "Forward to Methusala." January 7: 65-68.

The Economist. 1997. "Bearing the Weight of the Market." December 6: 88-89.

Edelman, Gerald M. 1992. *Bright Air, Brilliant Fire: on the matter of the mind.* New York: Basic Books.

Ehrlich, Paul R., Anne H. Ehrlich, and Gretchen C. Daily. 1995. *The Stork and The Plow: The Equity Answer to the Human Dilemma.* New York: G.P. Putnam's Sons.

Einstein, David. 1996. "Physicist Hawking Focusing on Life." *San Francisco Chronicle.* Saturday, April 13, p D1.

Ekins, Paul, Mayer Hillman and Robert Hutchison. 1992. *The Gaia Atlas of Green Economics.* New York: Doubleday.

Elgin, Duane. 1981. *Voluntary Simplicity: Towards a Life that is Outwardly Simple, Inwardly Rich.* New York: Morrow.

Elgin, Duane S., David C. MacMichael, and Peter Schwartz. 1975. *Alternative Futures for Environmental Policy Planning: 1975-2000.* Palo Alto: Stanford Research Institute.

El-Issawy, I.H. 1993. 'The Future of the Arab Nation - A Critical Review of the Perspective Study Carried Out by the Center for Arab Unity Studies." *Arab Economic Journal* Vol.1, 1993.

Energy Modeling Forum 12, 1995. John Weyant, coordinator. Palo Alto: Stanford University.

Energy Modeling Forum. 1995. "Demographic, Economic and Energy Assumptions." Palo Alto: Stanford University.

Energy Modeling Forum 14. 1996. John Weyant, coordinator. Palo Alto: Stanford University.

Esty, Daniel. 1994. *Greening the GATT: Trade, Environment and the Future.* Washington, DC: Institute for International Economics.

The ETC Group. 2002. *The Big Down: Atomtech Technologies Converging at the Nano-Scale.* Manitoba, CA. www.etcgroup.org

Ettinger, Robert. 1964. *The Prospect of Immortality.* New York: Doubleday.

Etzioni, Amatai. 1998. "Voluntary Simplicity: Characterization, select psychological implications, and societeal consequences." *Economic Psychology* 19, pp 616-643.

Ewbank, Jonathan. 1998. Letter to the Editor. *Nature* 392 (April) p 645.

Evans, Peter. 1997. "The Eclipse of the State? Reflections on Stateness in an Era of Globalization." *World Politics* 50: 62-87.

Farrell, Christopher, Michael Mandel, and Joseph Weber. 1995. "Riding High," *Business Week*, October 9. 134-146.

Federal Reserve Bank of New York. 1994. Cited in Theodore Hershberg, 1997, "New Standards in Education: Meeting America's Human Capital Development Challenge." *Education Week*, Vol. XVII, Number 16, December 10.

Fehilly, Carole B., Steen M. Willadsen, and Elizabeth M. Tucker. 1984. "Interspecific Chimarism Between Sheep and Goat." *Nature*: 634-636.

Felix, David and Ranjit Sau. 1996. "Revenue Raised by the Tobin Tax." In Mahbub ul Haq et al., ed, 1996. *The Tobin Tax: Coping with Financial Volatility*. New York: Oxford University Press.

Feynman, Richard. 1960. "Plenty of Room at the Bottom." *Engineering and Science* 23.

Fiddler, Morris, and Eugene Pergament. 1996. "Germline Gene Therapy: It's Time is Near." *Molecular Human Reproduction* 2: 75-76.

Finney, Ben R., and Eric M. Jones, eds. 1985. *Interstellar Migration and the Human Experience*. Berkeley, CA: University of California Press.

Fischer, Ronald D., and Pablo J. Serra. 1996. "Income Convergence Within and Between Countries." *International Economic Review* 37: 531-551.

Fischer, Stanley. 1988. "Symposium on the Slowdown in Productivity Growth." *Journal of Economic Perspectives* 2: 3-7.

Fishman, Rachel. 1993. "Patenting Human Beings: Do Sub-Human Creatures Deserve Constitutional Protection?" *American Journal of Law and Medicine* XV: 461-482.

Fletcher, Joseph. 1988. *The Ethics of Genetic Control: Ending Reproductive Roulette*. New York: Prometheus Books.

Fletcher, John, C. and W. French Anderson. 1992. "Germ-line Gene Therapy: a new stage of debate." *Law, Medicine and Healthcare* 20: 26-39.

Fletcher, John C., and Gerd Richter. 1996. "Human Fetal Gene Therapy: Moral and Ethical Questions." *Human Gene Therapy* 7: 1605-1614.

Forbes. 1995. "America's Highest Paid Bosses." May 22.

Frank, Robert H., and Philip J. Cook. 1995. *The Winner-Take-All Society*. New York: The Free Press.

Frankel, Jeffrey. 1996. "How Well Do Markets Work: Might a Tobin Tax Help?" In *The Tobin Tax: Coping with Financial Volatility*, M. ul Haq, I. Kaul and I. Grunberg, eds. 41-82. New York: Oxford University Press.

Freeman, Christopher, and Marie Jahoda. 1978. *World Futures: The Great Debate*. New York: Universe Books.

Fukuyama, Francis. 1992. *The End of History and the Last Man.* New York: The Free Press.

Galor, O., and J. Zeira. 1993. "Income Distribution and Macroeconomics." *Review of Economic Studies* 60: 35-52.

The George H. Gallup International Institute. 1992. *Health of the Planet Survey.* Princeton, New Jersey:

Gelehrter, Thomas, Francis Collins, and David Ginzburg. 1998. *Principles of Medical Genetics.* 2nd Edition. Baltimore: Williams & Wilkins.

Georgescu-Roegen, Nicolai. 1971. *The Entropy Law and the Economic Process.* Cambridge: Harvard University Press.

Gershenfeld, Neil. 1999. *When Things Start to Think.* New York: Henry Holt.

Giddens, Anthony. 1990. *The Consequences of Modernity.* Cambridge: Polity Press.

Gingrich, Newt. 1995. *To Renew America.* New York: Harper Collins.

Glenn, Jerome and Theodore Gordon. 1997. *State of the Future 1997.* Washington, DC: American Council for the United Nations University.

Goldenweiser, A.A. 1936. "Loose Ends of a Theory of the Individual: Pattern and Involution in Primitive Society," in *Essays in Anthropology*, R.H. Lowie, ed. 99-104. Berkeley, CA: University of California Press.

Goldstein, Alan. 1995. "Info highway on 'fast forward'." *San Francisco Examiner*. A15. San Francisco, CA.

Gomulka, Stanlislaw. 1990. *The Theory of Technological Change and Economic Growth.* New York: Routledge.

Goodland, Robert. 1991. "The Case That the World Has Reached Limits." In Robert Goodland, Herman Daly and Salah El Sarafy, editors, *Environmentally Sustainable Economic Development: Building on Brundtland* [Environment Working Paper No. 46] Washington, D.C.: World Bank, July. pp 5-11

Gormely, Patrick. 1996. "The Human Development Index in 1994: Impact of Income on Country Rank." *Journal of Economic and Social Measurement* 21: 253-267.

Gottschalk, Peter, and Timothy M. Smeeding. 1996. *Cross-National Comparisons of Levels and Trends in Inequality (revised)*. Working Paper No. 126. Syracuse, New York: Syracuse University/Luxembourg Income Study.

Gramlich, Edward M., Richard Kasten, and Frank Sammartino. 1993. "Growing Inequality in the 1980s: The Role of Federal Taxes and Cash Transfers." In Sheldon Danziger and Peter Gottschalk, eds., *Uneven Tides: Risking Inequality in America.* 1993. New York: Russell Sage Press. pp 225-250.

Gregg, Richard. 1936. *The Value of Voluntary Simplicity.* Wallingford, Pa: Pendle Hill.

Greider, William. 1997. *One World, Ready or Not.* New York: Simon & Schuster.

Griliches, Zvi. 1988. "Productivity Puzzles and R&D: Another Nonexplanation." *Journal of Economic Perspectives* 2: 9-21.

Gross, David and Edward Witten. 1996. "The Frontier of Knowledge." Opinion Editorial. *The Wall Street Journal.* 12 July 1996.

Grossman, Gene M. and Elhanan Helpman. 1993. *Innovation and Growth in the Global Economy.* Cambridge, MA: MIT Press.

Grossman, Gene M., Elhanan Helpman. 1994. "Endogenous Innovation in the Theory of Growth." *Journal of Economic Perspectives* 8: 23-44.

Group of Eight. 1997. "Executive Summary of Finance Ministers Report: New measures urged to promote global financial stability." www.summit8.gov/exec.htm.

Gundlach, and Nunnenkamp. 1996. "Some Consequences of Globalization for Developing Countries." Kiel Working Paper 756, Institut fur Weltwirtschaft. http://ssrn.com/abstract=1471

Haas, Peter M., Robert O. Keohane and Marc A. Levy. 1003. *Institutions for the Earth: Sources of Effective International Environmental Protection*, MIT Press, Cambridge, Mass.

Hacker, Andrew. 1997. *Money: Who Has How Much and Why.* New York: Scribner.

Hafele, Wolf. 1981. *Energy in a Finite World: Paths to a Sustainable Future.* Cambridge, MA: Ballinger Publishing Co.

Hall, Peter. 1994. *Innovation, Economics and Evolution: Theoretical Perspectives on Changing Technology in Economic Systems.* New York: Simon & Schuster.

Hall, Stephen. 1997. *A Commotion in the Blood.* New York: Holt.

Hallman, W., and J. Metcalfe. 1995. "Public Perceptions of Agricultural Biotechnology: a Survey of New Jersey Residents." Ecosystem Policy Research Center: Rutgers State University of New Jersey.

ul Haq, Mahbub, Inge Kaul, and Isabelle Grunberg, ed. 1996. *The Tobin Tax: coping with financial volatility*. New York: Oxford University Pres.

Harding, Ann. 1993. *Lifetime Income Distribution and Redistribution: Applications of a Microsimulation Model*. New York: North-Holland.

Harrison, Bennett, and Barry Bluestone. 1988. *The Great U-Turn: corporate restructuring and the polarization of America*. New York: Basic Books.

Harte, John. 1988. *Consider a Spherical Cow*. Mill Valley, CA: University Science Books.

Haveman, Robert H. 1994. "The Changing Distribution of Income in an Open U.S. Economy: Findings and Lessons." in *The Changing Distribution of Income in an Open U.S. Economy*, edited by Jeffrey H. Bergstrand. New York: North-Holland.

Hawken, Paul, James Ogilvy, Peter Schwartz. 1982. *Seven Tomorrows*. New York: Bantam Books.

Heston, Alan, Robert Summers and Bettina Aten, *Penn World Table Version 6.1*, Center for International Comparisons at the University of Pennsylvania (CICUP), October 2002.

Hayes, Brian. 1993. "Balanced On A Pencil Point." *American Scientist* 81: 510-516.

Hayes, Brian. 1996. "The End of Science Writing?" *American Scientist.* 84 no. 5, September-October.

Hayes, Kathy J., Daniel J. Slottje, Michael Nieswiadomy, Michael Redfearn, and Edward N. Wolff. 1994. "Productivity and Income Inequality Growth Rates in the United States." In *The Changing Distribution of Income in an Open U.S. Economy*, J. H. Bergstrand, ed. New York: North-Holland.

Hayes, Richard A. 1996. *An Extension of Cline's Global Warming Benefit-Cost Model*. M.A. Thesis. Energy and Resources Group, University of California at Berkeley.

Heilbroner, Robert L. 1974. *An Inquiry into the Human Prospect*. New York: W.W. Norton.

Heilbroner, Robert. 1993. *21st Century Capitalism*. New York: W.W. Norton & Co.

Heilbroner, Robert. 1995. *Visions of the Future*. New York: Oxford University Press.

Held, David. 1995. *Democracy and the Global Order: from the modern state to cosmopolitan governance*. Stanford, CA: Stanford University Press.

Held, David. 1997. "Democracy and Globalization." www.mpi-fg-koeln.mpg.de/publikation/working_papers/wp97-5_e/wp97-5_e.html.

High Performance Systems. 1994. *Introduction to Systems Thinking: A Guide to the Stella Modeling Software*. [High Performance Systems is now ISEE Systems Inc.: www.iseesystems.com]

Hinderaker, John H., and Scott W. Johnson. 1996. "Income, Inequality and Work." *The American Enterprise* 7: 35-40.

Hinrichs, Roger A. 1996. *Energy: Its Use and the Environment.* New York: Saunders College Publishing.

Hirsh,Fred. 1976. *The Social Limits to Growth.* Cambridge: Harvard University Press.

Hirst, Paul, and Grahame Thompson. 1996. *Globalization in Question: the international economy and the possibilities of governance*. Cambridge: Polity Press.

Hoban, T. J. 1997. "Consumer Acceptance of Biotechnology: An International Perspective." *Nature Biotechnology*. Vol 15 March 7. 232-34.

Holdren, John. 1995. Energy and Resources 200 course handout: "Recent World Energy and Economic Data." October. University of California at Berkeley.

Holdren, John P. 1996. "World Energy Future." Unpublished spreadsheet calculations, April 30. Energy and Resources Group. University of California at Berkeley.

Holdren, John P. and Paul R. Ehrlich. 1971. *Global Ecology: Readings Toward a Rational Strategy for Man*. New York: Harcourt, Brace, Jovanovich.

Holm, Hans-Henrik, and Georg Sorensen. 1995. *Whose World Order? Uneven Globalization and the End of the Cold War*. Boulder: Westview Press.

Holton, Gerald. 1962. "Scientific Research and Scholarship: Notes Toward the Design of Proper Scales." *Daedalus.* Vol 91 No.62 (Spring).

Horgan, John. 1995. "From Complexity to Perplexity." Scientific American, June 1995. 104-109.

Horgan, John. 1996. *The End of Science: Facing the Limits of Knowledge in the Twilight of the Scientific Age*. New York: Helix Books/Addison-Wesley.

Hughes, Jay. 1995. "Embracing Change with All Four Arms." www.changesurfer.com/Hlth/Genetech.html.

Huntington, Samuel P. 1996. *The Clash of Civilizations and the Remaking of World Order*. New York: Simon & Schuster.

Hutton, Will. 1994. "Markets threaten life and soul of the party." *The Guardian.* Jan. 4, p 13.

Inayatullah, Sohail. 1992. "The Futures of South Asia." *FUTURES* 24: 851-955.

Inglehart, Ron, and Paul Abramson. 1995. *Value Change in Global Perspective.* Ann Arbor: University of Michigan Press.

Intergovernmental Panel on Climate Change. 1994. *Climate Change 1994: Radiative Forcing of Climate Change and an Evaluation of the IPCC IS92 Emission Scenarios.* New York: Cambridge University Press.

Intergovernmental Panel on Climate Change. 1994. *An Evaluation of the IPCC IS92 Emission Scenarios.* New York: Cambridge University Press.

Intergovernmental Panel on Climate Change. 1996. *Climate Change 1995: Economic and Social Dimensions of Climate Change.* New York: Cambridge University Press.

International Energy Agency. 2002. *World Energy Outlook 2002.* Paris, France.

Intergovernmental Panel on Climate Change. 1996. *Climate Change 1995: Impacts, Adaptations and Mitigation of Climate Change; Scientific-Technical Analysis.* New York: Cambridge University Press.

Intergovernmental Panel on Climate Change. 2001.*Third Assessment Report – Climate Change 2001.* New York: Cambridge University Press.

International Institute for Applied Systems Analysis (IIASA). 1995. *Implementation and Effectiveness of International Environmental Commitments.* Laxenburg, Austria.

International Institute for Applied Systems Analysis/World Energy Council. 1995. "Global Energy Perspectives to 2050 and Beyond." Laxemburg, Austria.

Irvin, David R. 1993. "Technology Forecasters: Soothsayers or Scientists?" *IEEE Science & Technology Magazine.* Spring 1993.

Johansson, Thomas B., Henry Kelly, Amulya K.N. Reddy, Robert H. Williams, ed. 1993. *Renewable Energy: Sources for Fuels and Electricity.* Washington, DC: Island Press.

Johnson, Warren. 1979. *Muddling Toward Frugality: A Blueprint for Survival in the 1980's.* Boulder: Shambala.

Jones, Charles L. 1995a. "Time Series Tests of Endogenous Growth Models." *Quarterly Journal of Economics*: 495-525.

Jones, Charles L. 1995b. "R&D -Based Models of Economic Growth." *Journal of Political Economy*: 759-784.

Jones, R.J. Barry. 1995. *Globalisation and Interdependence in the International Political Economy: Rhetoric and Reality.* New York: Pinter.

Jorgenson, Dale. 1988. "Productivity and Postwar U.S. Economic Growth." *Journal of Economic Perspectives* 2: 23-41.

Jorgenson, Dale W., Mun S. Ho, Kevin J. Stiroh. 2003. "Lessons from the U.S. Growth Resurgence." Paper prepared for the First Annual Conference on the Economic and Social Implications of Information Technology, U.S. Dept. of Commerce, Jan. 27-28, 2003.

Kahn, Herman. 1979. *World Economic Development: 1979 and Beyond.* New York: Morrow Quill.

Kahn, Herman and Anthony Wiener. 1967. *The Year 2000: A Framework for Speculation on the Next Thirty-Three Years*. New York: MacMillan.

Kahn, Herman, William Brown and Leon Martel. 1976. *The Next 200 Years: A Scenario for America and the World.* New York: William Morrow and Company.

Kaku, Michio. 1997. *Visions: How Science Will Revolutionize the 21st Century*. New York: Doubleday.

Kapstein, Ethan B. 1996. "Governing Global Finance." In *New Forces in the World Economy*, Brad Roberts, ed. 31-362. Cambridge, MA: MIT Press.

Karni, Edi, and Itzhak Zilcha. 1994. "Technological Progress and Human Inequality: A Model with Human Capital and Bequests." In *The Changing Distribution of Income in an Open U.S. Economy*, edited by J. H. Bergstrand. New York: North Holland.

Kauffman, Stuart. 1995. *At Home in the Universe: The Search for Laws of Self-Organization and Complexity*. New York: Oxford University Press.

Kaul, Inge, and John Langmore. 1996. "Potential Uses of the Revenue from a Tobin Tax." In *The Tobin Tax: coping with financial volatility*, Mahbub ul Haq, Inge Kaul, Isabelle Grunberg, eds. 55-272. New York: Oxford University Press.

Kaus, Mickey. 1992. *The End of Equality*. New York: Harper Collins.

Kelly, Kevin. 1994. *Out of Control: The Rise of Neo-Biological Civilization*. New York: Addison-Wesley.

Kempton, Willet, James S. Boster, and Jennifer A. Hartley. 1995. *Environmental Values in American Culture*. Cambridge, MA: MIT Press.

Kennedy, Paul. 1993. *Preparing for the Twenty-First Century*. New York: Random House.

Keohane, Robert O. 1995. "Hobbes's Dilemma and Instituional Change in World Politics: Sovereignty in International Society." In *Whose World Order? Uneven Globalization and the End of the Cold War*, Hans-Henrik Holm and Georg Sorensen,eds. 165-186 Boulder: Westview Press.

Kimbrell, Andrew. 1993. *The Human Body Shop*. San Francisco: HarperSanFrancisco.

King, David. 1998. "Technologies which may contribute to human genetic engineering and eugenics: a summary." November 1998. Prepared for the UC Berkeley Workshop on the New Human Genetic Technologies.

Klaassen, H. L., G. Ooms, J. Paelinck, W. Willemsen. 1980. "A Study of the Formal Structure of J.W. Forrester's World Dynamics Model." *Ecological Modeling* 8: 259-274.

Kleinknecht, Alfred. 1996. Determinants of Innovation: The Message from New Indicators. Houndmiklls (Eng): Macmillan Press

Kleinknecht, Alfred, and Donald Bain, eds. 1993. *New Concepts in Innovation Output Measurement.* New York: St. Martins Press.

Kluegel, James R., and Elliot R. Smith. 1986. *Beliefs about Inequality: Americans' Views of What Is and What Ought to Be*. New York: Aldine de Gruyter.

Kolata, Gina. 1998. *Clone: The Road to Dolly and the Path Ahead.* New York: William Morrow.

Krimsky, Sheldon. 1991. *Biotechnics and Society: The Rise of Industrial Genetics*. New York: Praeger.

Krueger, Alan B. 1993. "How Computers Have Changed the Wage Structure: Evidence from Microdata, 1984-1989." *The Quarterly Journal of Economics* February 33-60.

Krugman, Paul. 1994. *The Age of Diminished Expectations*. Cambridge, Massachusetts: MIT Press.

Krugman, Paul. 1997. "All Work and No Play Makes William Greider a Dull Boy". *Slate.* January 4. http://slate.msn.com/id/1916/

Kurzweil, Ray. 1999. *The Age of Spiritual Machines: When Computers Exceed Human Intelligence.* New York: Viking.

Kuznets, Simon. 1955. "Economic Growth and Income Inequality." *American Economic Review* XLV: 1-28.

Kvevholden, K. 1988. "Methane Hydrates and Global Climate." *Global Biochemical Cycles* 3. 221-229.

Laboratory for Interactive Learning. 1993. "World 3 Model Software." Durham, New Hampshire: University of New Hampshire.

Ladd, Everett C., and Karlyn H. Bowman. 1998. *Attitudes Toward Economic Inequality.* Washington, DC: American Enterprise Institute Press.

Lambert, P.J. 1993. *The Distribution and Redistribution of Income- a mathematical analysis.* New York: Manchester University Press.

LaPorte, Todd R., ed. 1975. *Organized Social Complexity: Challenge to Politics and Policy.* Princeton, New Jersey: Princeton University Press.

Lappé, Marc. 1991. "Ethical Issues in Manipulating the Human Germline." *Journal of Medicine and Philosophy* 16: 621-639.

Lashof, Daniel A. 1989. "The Dynamic Greenhouse: feedback processes that may influence future concentrations of atmospheric trace gases and climate change." *Climatic Change* 14: 213-242.

Lawrence, Robert Z., Albert Bressand, Takatoshi Ito. 1996. *A Vision for the World Economy: Openness, Diversity and Cohesion.* Washington, DC: The Brookings Institution.

Lazarus, Michael, and Lisa Greber, Jeff Hall, Carlton Bartels, Steve Bernow, Evan Hansen, Paul Raskin, and David Von Hippel. 1993. "Towards a Fossil Free Energy Future: The Next Energy Transition. A Technical Analysis for Greenpeace International." Boston: Stockholm Environment Institute/Tellus Institute Boston Center.

Lemkow, L. 1993. "Public Attitudes Towards Genetic Engineering: some European Perspectives." in *Office of Official Publications of the European Communities*. Luxembourg.

Lemonick, Michael. 1998. "Tapping the Biological Motherlode." *Time* 11/16: 25-30.

Lempert, Robert, Michael E. Schlesinger, and James K. Hammitt. 1994. "The Impact of Potential Abrupt Climate Changes on Near-Term Policy Choices." *Climatic Change* 26: 351-376.

Leontief, Wassily, et al. 1977. *The Future of the World Economy*. New York: Oxford University Press.

Levy, Frank, and Richard J. Murnane. 1992. "U.S. Earnings Levels and Earnings Inequality: A Review of Recent Trends and Proposed Explanations." *Journal of Economic Literature* XXX: 1333-1381.

Levy, Steven. 1992. *Artificial Life: the quest for a new creation*. New York: Pantheon.

Lewin, Roger. 1992. *Complexity: Life at the Edge of Chaos*. New York: Macmillan.

Lewis, W. Arthur. 1954. *Economic Development with Unlimited Supplies of Labor.* The Manchester School of Economic and Social Studies. 22, 139-191.

Li, Hongyi, Lyn Squire, and Heng-fu Zou. 1996. "Explaining International and Intertemporal Variations in Income Inequality." Washington, DC: The World Bank.

Lind, Michael. 1995 *The Next American Nation: the new nationalism and the fourth American revolution*. New York: The Free Press.

Lipschutz, Ronnie D., and Judith Mayer. 1996. *Global Civil Society and Global Environmental Governance: the politics of nature from place to planet*. Albany, NY: State University of New York Press.

Livingston, M.S., cited in Gerald Norton," Scientific Research & Scholarship: Notes towards the Design of Proper Scales." Daedelus vol. 91 #62. Spring 1962.

Lloyd, Seth. 1995. "Complexity." *Scientific American* June 1995.

Londono, Juan Luis. 1996. Poverty, Inequality, and Human Capital Development in Latin America, 1950-2025. Washington, D.C.: The World Bank.

Loury, Glenn C. 1981. "Intergenerational Transfers and the Distribution of Earnings." *Econometrica* 49: 843-867.

Luard, Evan. 1990. *The Globalization Of Politics: The Changed Focus Of Political Action In The Modern World.* New York: New York University Press.

Lyle, Jeff, and Peter Corner. 1995. *Altered Fates*. New York: W.W. Norton.

Macer, Darryl. 1994. *Bioethics for the People, by the People*. Christchurch, NZ: Eubios Ethics Institute.

Macer, Darryl. 1997. "Attitudes to Biotechnology in Japan and New Zealand in 1997, with International Comparisons." *Eubios Journal of Asian and International Bioethics* 7: www.biol.tsukuba.ac.jp/~macer/EJ75ej75h.html.

Macer, Darryl, Shiro Akiyama, Angeles Tan Alora, Yukiki Asada, Jayapaul Azariah, Hilda Azariah, Maureen V. Boost, Prasert Chatwachirawong, Yuko Kao, Vijay Kaushik, Frank J. Leavitt, Nobuko Y. Macer, Chin Choon Ong, Peerasak Srinives, and Miho Tsuzuki. 1995. "International Perceptions and Approval of Gene Therapy." *Human Gene Therapy* 6: 791-803.

Madrick, Jeff. 1997. "The Cost of Living: A New Myth." *New York Review of Books*: 19-24.

Mahdjoubi, Darius. 1996. "An Innovation Model for the Real World." In *Engineering Dimensions,* January/February.

Mahdjoubi, Darius 1997. "The Linear Model of Technological Innovation." In: www.gslis.utexas.edu/~darius/lnr_mdl/lnr_mdl.html#1

Makhijani, Arjun. 1992. *From Global Capitalism to Economic Justice*. New York: Apex Press.

Manabe, Syukuro, and Roger Stouffer. 1993. "Century-Scale Effects of increased Atmospheric CO2 on the Ocean-Atmosphere System." *Nature* 364: 215-218.

Mander, Jerry, and David C. Korten, eds. 1996. *The Case Against the Global Economy: and for a turn toward the local*. San Francisco: Sierra Club Books.

Mandle, Jay. 1997. "The Good Side of Going Global." *Commonweal*: July 11.

Mankiw, N. Gregory. 1994. *Macroeconomics*. Second edition. New York: Worth Publishers.

Manne, Alan, Robert Mendelsohn, and Richard Richels. 1993. "MERGE- A Model for Evaluating Regional and Global Effects of GHG Reduction Policies." Palo Alto: Stanford University.

Mao, Xin. 1996. "Chinese Ethics" Letter to the Editor, *Nature*, 3 December.

Marcel, T., and David Brausz. 1996. "The TMC Worldwide Gene Therapy Enrollment Report." *Human Gene Therapy*: 2025.

March of Dimes. 1992. *Genetic Testing and Gene Therapy: National Survey Findings.* 18. September. New York.

Market and Opinion Research International. 1995. "International Environmental Monitor." www.mori.com/polls/icm.

Marteau, Theresa, Susan Michie, Harriet Drake, and Martin Bobrow. 1995. "Public Attitudes Toward the Selection of Desirable Characteristics in Children." *Journal of Medical Genetics* 32: 796-798.

Martino, Joseph P. 1993. "Technological Forecasting: An Introduction." *The Futurist.* July-August.

Masini, Eleonora. 1994. "The Future of Cultures." *UNESCO Future-Oriented Studies*: 167. Paris.

Mathews, Jessica T. 1997. "Power Shift." *Foreign Affairs* 76: 50-66.

McCorduck, Pamela and Nancy Ramsey. 1996. *The Futures of Women: Scenarios for the 21st Century*. Mass: Addison-Wesley Press.

McGinn, Colin. 1991. *The Problem of Consciousness.* London: Oxford University Press.

McGrew, Anthony. 1992. "The Third World in the New Global Order." *Poverty and Development in the 1990s*, ed. by Allen and Thomas. Oxford: Oxford University Press.

McNamee, Mike, with Paul Magnusson. 1996. "Let's Get Growing." *Business Week.* July 8: 90-98.

Meadows, Donella L, Dennis L. Meadows, Jorgen Randers, William W. Behrens. 1972. *The Limits to Growth.* New York: Universe Books.

Meadows, Donella H., Dennis L. Meadows, Jorgen Randers. 1992. *Beyond the Limits to Growth: confronting global collapse, envisioning a sustainable future*. Post Mills, Vermont: Chelsea Green.

Mehlman, Maxwell J., and Jeffrey R. Botkin. 1998. *Access to the Genome: The Challenge to Equality*. Washington, DC: Georgetown University Press.

Merck Family Fund. 1995. *Yearning for Balance: Views of Americans on Consumption, Materialism and the Environment.* Tacoma Park, Maryland.

Merkel, Ralph. 1989. "Molecular Repair of the Brain." *Cryonics* 10.

Mesarovic, Mihajlo, Eduard Pestel. 1974. *Mankind at the Turning Point*. New York: H.P. Dutton.

Minsky, Marvin. 1986. *The Society of Mind.* New York: Simon & Schuster.

Mittelman, James. 1997. "Global Transformation and Civil Society: A project proposal by the Center for Research on the Global South." http://heiwww.unige.ch/~krause/gtnet/americu.htm.

Moravec, Hans. 1988. *Mind Children: The Future of Robot and Human Intelligence*. Cambridge: Harvard University Press.

Moravec, Hans. 1993. "Pigs in Cyberspace." *Extropy: the journal of transhumanist thought* 4: 5-7.

Moreland, R. Scott. 1984. *Population, Development and Income Distribution-A Modelling Approach (Bachue International)*. New York: St. Martin's Press.

Murphy, K., and F. Welch. 1993. "Industrial Change and the Rising Importance of Skill." In *Uneven Tides*, edited by Sheldon Danziger and Peter Gottschalk. 101-132. New York: Russell Sage Foundation.

Nagel, Thomas. 1974. "What is it like to be a bat?" *The Philosophical Review* LXXXIII, 4 (October) 435-50.

National Academy of Sciences. 1996. "Science and Engineering Indicators." Washington D.C.: U.S. Government Printing Office.

National Center for Genome Resources.1996. "National Survey of Public and Stakeholders Attitudes and Awareness of Genetic Issues." Washington, D.C.

National Opinion Research Center. 1996. *General Social Survey.* www.icpsr.umich.edu/gss/codebook.

National Opinion Research Center. 1998. "General Social Survey" www.icpsr.umich.edu/gss/codebook.

New York Times. 1982. "Whether to Make Perfect Humans." Editorial. 22 July.

Nicholson, Michael. 1989. *Formal Theories of International Relations*. New York: Cambridge University Press.

Nicolis, Gregoire, and Ilya Prigogine. 1989. *Exploring Complexity: An Introduction*. New York: W.H. Freeman & Co.

Nordhaus, William. 1973. "World Dynamics: Measurement Without Data." *Economic Journal.* Vol. 83 (332). 1156-83.

Nordhaus, William D. 1992. "Lethal Model 2: The Limits to Growth Revisited." *Brookings Papers on Economic Activity*: 1-43. Washington, D.C.: The Brookings Institution

Nordhaus, William D. 1994. *Managing the Global Commons: The Economics of Climate Change.* Cambridge, MA: MIT Press.

Nordhaus, William D. 2001. "Productivity Growth and the New Economy." NBER Working Paper No. w8096.

Nordhaus, William D. and John Tobin. 1972. "Is Growth Obsolete?" Fiftieth Anniversary Colloquium V (National Bureau of Economic Research, Columbia University Press.

Nordhaus, William D. and Zilli Yang. 1996. "RICE: A Regional Dynamic General Equilibrium Model of Optimal Climate-Change Policy." Yale University, Dept. of Economics.

Norgaard, Richard B. 1994. *Development Betrayed: The end of progress and a coevolutionary revisioning of the future.* New York: Routledge.

Ogden, Joan M. and Robert H. Williams. 1989. *Solar Hydrogen: Moving Beyond Fossil Fuels.* Washington, DC: World Resources Institute.

Ogilvy, James. 1992. "Future Studies and the Human Sciences: The Case for Normative Scenarios." *Futures Research Quarterly* 8: 5-65.

Ohmae, Kenichi, ed. 1985. *The Evolving Global Economy.* Boston, MA: Harvard Business School Publishing.

Ohmae, Kenichi. 1990. *The Borderless World: Power and strategy in the interlinked economy.* New York: Harper Collins.

Ohmae, Kenichi. 1995. *The End of the Nation State.* New York: Simon & Schuster.

Olson, Mancur. 1988. "The Productivity Slowdown, The Oil Shocks, and the Real Cycle." *Journal of Economic Perspectives* 2: 43-69.

O'Neill, William. 1977. *The High Frontier: Human Colonies in Space.* New York: William Morrow.

Ophuls, William. 1977. *Ecology and the Politics of Scarcity.* New York: W.H. Freeman and Company.

Ophuls, William and A. Stephen Boyan Jr. 1992. *Ecology and the Politics of Scarcity Revisited: The Unraveling of the American Dream.* New York: W. H. Freeman and Co.

Osberg, Lars, ed. 1991. *Economic Inequality and Poverty: International perspectives.* Armonk, New York: M.E. Sharpe.

Pack, Howard. 1994. "Endogenous Growth Theory: Intellectual Appeal and Empirical Shortcomings." *Journal of Economic Perspectives* 8: 55-72.

Pagels, Heinz. 1988. *The Dreams of Reason: The computer and the rise of the sciences.* New York: Simon & Schuster.

Pan, Haoran. 1996. "An Applied General Equilibrium Model of Primary Income Distribution." Unpublished dissertation draft.

Paul, Gregory S. and Earl D. Cox. 1996. *Beyond Humanity: CyberEvolution and Future Minds.* Rockland, MA: Charles River Media.

Pauly, Louis W., and Simon Reich. 1997. "National structures and multinational corporate behavior: Enduring differences in the age of globalization." *International Organization* 51: 1-30.

Pence, Gregory. 1998. *Who's Afraid of Human Cloning?* New York: Rowman & Littlefield.

Persson, Torsten, and Guido Tabellini. 1991. *Is Inequality Harmful for Growth? Theory and Evidence*. NBER Working Paper 3599. Cambridge, MA: National Bureau of Economic Research.

Pestel, Eduard. 1989. *Beyond the Limits to Growth: A Report to the Club of Rome*. New York: Universe Books.

Pew Center for People and the Press. 1997. *Values Update Survey.* Washington, D.C.

Pezzey, John. 1992. "Sustainable Development Concepts: An Economic Analysis." . Environment Dept. Working Paper 15. Washington, DC: The World Bank.

Phillips, Kevin. 1990. *The Politics of Rich and Poor: Wealth and the American Electorate in the Reagan Aftermath.* New York: Random House.

Porritt, Jonathon. 1984. *Seeing Green: The Politics of Ecology Explained.* Oxford: Basil Blackwell.

Porter, Mitchell. 1997. "The Singularity." *www.thehub.com.au/~mitch/extro/sing.html*.

Powell, Maggie. 1997. "WRI Hyperforum Scenarios - Five Scenarios of China to 2030." *www.hf.caltech.edu/HF*. New York: Global Policy Forum.

Preamble Center for Public Policy. 1997. *The Multilateral Agreement on Investment.* www.globalpolicy.org. New York: Global Policy Forum.

President's Commission for the Study of Ethical Problems in Medicine and Biomedical and Behavioral Research. 1982. "Splicing Life." Washington, DC: U.S. Government Printing Office.

Prigogine. 1989. *Exploring Complexity: An Introduction.* New York: W.H. Freeman.

Pryor, Frederic L. 1996. *Economic Evolution and Structure: The Impact of Complexity on the U.S. Economic System*. New York: Cambridge University Press.

Purdy, Jedediah. 1998. "Dolly and Madison." *The American Prospect.* Vol 9 no. 8 (May-June).

Raj, Baldev, and Daniel J. Slottje. 1994. "The Trend Behavior of Alternative Income Inequality Measures in the United States from 1947-1990 and the Structural Break." *Journal of Business & Economic Statistics* 12: 479-487.

Rapoport, Anatol. 1989. *Decision Theory and Decision Behavior: normative and descriptive approaches*. Norwell, MA: Kluwer Academic Publishers.

Ravallion, Martin, and Shaohua Chen. 1996. "What Can New Survey Data Tell Us about Recent Changes in Distribution and Poverty?" Washington, DC: The World Bank.

Regis, Ed. 1990. *Great Mambo Chicken and the Transhuman Condition*. New York: Addison-Wesley.

Reich, Robert. 1991. *The Work of Nations: Preparing ourselves for 21st century capitalism.* New York: A.A. Knopf.

Robertson, Roland. 1992. *Globalization: Social Theory and Global Culture.* London: Sage.

Robinson, Ian. 1995. "Globalization and Democracy." *DISSENT.* Summer. 373-380.

Robinson, Peter. 1996. "Technology Changes Economics, but How? Paul Romer May Win the Nobel Prize for Telling Us." *Forbes ASAP*: 67-72.

Robinson, Sherman. 1976. "Income Distribution in Developing Countries: Toward an Adequate Long-Run Model of Income Distribution and Economic Development." *American Economic Review* 66: 122-127.

Rochlin, Gene. 1997. *Trapped in the Net: The unanticipated consequences of computerization.* Princeton, N.J.: Princeton University Press.

Rodrik, Dani. 1997. *Has Globalization Gone Too Far?* Washington DC: Institute for International Economics.

Roemer, John. 1994. *A Future for Socialism: Planning For the Future in an Uncertain World.* Cambridge, MA: Harvard University Press.

Rohatyn, Felix. 1995. Quoted in Simon Head, 1996."The New, Ruthless Economy." *New York Review of Books*. February 19.

Romer, David. 1994. *Advanced Microeconomics*: (manuscript). University of California, Berkeley. Department of Economics.

Romer, Paul. 1986. "Increasing Returns and Long-Run Growth." *Journal of Political Economy* 94: 1002-1037.

Romer, Paul. 1987. "Growth Based on Increasing Returns Due to Specialization." *American Economic Review Papers and Proceedings,* May. 56–62.

Romer, Paul. 1990. "Endogenous Technological Change." *Journal of Political Economy* 98: S71-S102.

Romer, Paul. 1994. "The Origins of Endogenous Growth." *Journal of Economic Perspectives* 8: 3-22.

Romer, Paul. 1996. Personal Communication. Western Economic Association, San Francisco, CA. July 1996.

Rosenau, James N. 1997. *Along the Domestic-Foreign Frontier: Exploring Governance in a Turbulent World.* New York: Cambridge University Press.

Rubenstein et al. 1995. "Germ-Line Therapy to Cure Mitochrondrial Disease: Prototypes and Ethics of in vitro Ovum Nuclear Transplantation." *Cambridge Quarterly of Healthcare Ethics* 4: 316-339.

Ruggiero, Greg, and Stuart Sahulka, eds. 1995. *The New American Crisis: Radical Analyses of the Problems Facing America Today*. New York: The New Press.

Sachs, Jeffrey, "Growth in Africa: It Can Be Done." The Economist, June 29, 1996.

St. Norbert College Survey Center. 1994. "Bovine Growth Hormone." DePere Wisconsin: The Wisconsin Survey.

Saltzman, Amy. 1991. *Downshifting: Reinventing success on a slower track*. New York: Harper Collins.

Samuelson, Paul A. and William D. Nordhaus. 1989. *Economics*. 12th ed. New York: McGraw-Hill.

Sandberg, Anders. 1998. "Genetic Modifications" www.starsgroup.com/biouniversity/course2.html

Sandler, Todd. 1997. *Global Challenges: an approach to environmental, political and economic problems*. New York: Cambridge University Press.

Sau, David Felix and Ranjit. 1996. "On the Revenue Potential and Phasing in of the Tobin Tax." In *The Tobin Tax: Coping with Financial Volatility*, M. ul Haq, I. Kaul and I. Grunberg, eds. 223-254. New York: Oxford University Press.

Schlesinger, John M. 1996. "The Business Cycle is Tamed, Many Say." *Wall Street Journal*. November 15: 1. New York.

Scholte, Jan Aart. 1996. "Beyond the Buzzword: Towards a Critical Theory of Globalization." in *Globalization: Theory and Practice*, edited by Eleonore Kofman and Gillian Youngs. New York: Pinter.

Schor, Juliet. 1995."A Sustainable Economy for the Twentieth Century." In Greg Ruggiero and Stuart Sahulka, 1995, *The New American Crisis: Radical Analyses of the Problems Facing America Today*. New York: The New Press. pp 266-287.

Schwarz, Benjamin. 1995. "American Inequality: Its History and Scary Future." *The New York Times*, Tuesday, December 19, p. A25.

Schwartz, Peter. 1991. *The Art of the Long View: Planning for the Future in an Uncertain World*. New York: Doubleday.

Searle, John R. 1992. *The Rediscovery of the Mind*. Cambridge, Mass: MIT Press.

Segal, Jerome M. 1999. *Grace for Simplicity: Towards a Philosophy and Politics of Simple Living*. New York: Holt.

Sforza-Roderick, Michelle, Scott Nova, and Mark Weisbrot. 1998. "Writing the Constitution of a Single Global Economy: A Concise Guide to the Multilateral Agreement on Investment - Supporters' and Opponents' Views." *www.rtk.net:80/preamble/mai/maioverv.html.*

Shi, David. 1985. *The Simple Life: Plain Living and High Thinking in American Culture.* New York: Oxford University Press.

Silver, Lee. 1998. *Remaking Eden: How Cloning and Beyond Will Change the Human Family.* New York: Avon.

Simai, Mihaly. 1994. *The Future of Global Governance: Managing risk and change in the international system.* Washington DC: United States Institute of Peace.

Simon, Julian. 1981. *The Ultimate Resource.* Princeton, N.J.: Princeton University Press.

Simon, Julian L., and Herman Kahn. 1984. *The Resourceful Earth.* New York: Basil Blackwell.

Singer, Eleanor. 1993. "Public Attitudes Toward Fetal Diagnosis and the Termination of Life." *Social Indicators Research* 28: 117-136.

Sinsheimer, Robert. 1969. "The Prospect for Designed Genetic Change." *American Scientist* 57: 134-142.

Slaughter, Anne-Marie. 1997. "The Real New World Order." *Foreign Affairs*: Vol 76 No.5. 183-197.

Smeeding, Timothy M., and Peter Gottschalk. 1996 *The International Evidence on Income Distribution in Modern Economies: Where Do We Stand?* Working Paper No.137. Syracuse, New York: Luxembourg Income Study.

Smith, Jackie, Charles Chatfield, and Ron Pagnucco, eds. 1997. *Transnational Social Movements and Global Politics.* Syracuse, NY: Syracuse University Press.

Smith, John Maynard. 1965. "Eugenics and Utopia." In *Utopias and Utopian Thought,* Frank E. Manuel, ed. 150. Cambridge: Houghton Mifflen.

Smith, William C. 1993. *Democracy, Markets and Structural Reform in Latin America.* New Brunswick,NJ: Transactions Publishers.

Sogolo, Godwin. 1992. "AFRICA: Three Scenarios." In *The Futures of Cultures.* 1994. Coordinated by Eleonora Masini (Gregorian U, Rome). Paris: UNESCO Future-oriented Studies, December.

Solow, Robert. 1974. "Intergenerational Equity and Exhaustible Resources." *Review of Economic Studies* vol. 41. 29-45.

Soros, George. 1998. "Toward a Global Open Society." *The Atlantic Monthly*: January.

Stiglitz, Joseph. 1974. "Growth with Exhaustible Natural Resources: efficient and optimal paths." Review of Economic Studies Symposium on the Economics of Exhaustible Resources. Vol 41. 123-137.

Stix, Gary. 1996. "Trends in Nanotechnology: Waiting for Breakthroughs." *Scientific American.* April. 94-99.

Stock, Gregory. 1993. *Metaman: the Merging of Humans and Machines into a Global Superorganism.* New York: Simon and Schuster.

Stock, Gregory. 1998. "Engineering The Human Germline." University of California, Los Angeles Science, Technology, and Society Program. www.ess.ucla.edu:80/huge/report.html.

Suzuki, David, and Peter Knudtson. 1989. *Genethics.* Cambridge, MA: Harvard University Press.

Szirmai, Adam. 1988. *Inequality Observed: A Study of Attitudes towards Income Inequality.* Newcastle-upon-Tyne: Avebury.

Tainter, Joseph A. 1988. *The Collapse of Complex Societies.* New York: Cambridge University Press.

Taylor, J. Serge. 1975. "Organizational Complexity in the New Industrial State: The Role of Technology." In Todd R.La Porte, ed., *Organized Social Complexity: Challenge to Politics and Policy.* Princeton: Princeton University Press.

Taylor, Lance, and Frank Lysy. 1979. "Vanishing Income Redistributions: Keynesian Clues about Model Surprises in the Short Run." in *Models, Planning and Basic Needs*, edited by Sam Cole and Henry Lucas. New York: Pergamon Press.

Taylor, Robert. 1998. "Superhumans." *New Scientist.* October 3 (cover story).

Thirring, Hans. 1958. Energy for Man. Bloomington: Indiana University Press.

Thoreau, Henry David. 1854. "Walden." In *Walden (World Classics)*, edited by Stephen Fender. New York: Oxford University Press.

Thurow, Lester C. 1996. *The Future of Capitalism: How Today's Economic Forces Shape Tomorrow's World.* New York: William Morrow.

Time. 1973. "Endorsing Infanticide?" May 28.

Tipler, Frank J. 1994. *The Physics of Immortality: Modern Cosmology, God and the Resurrection of the Dead.* New York: Doubleday.

Toffler, Alvin and Heidi Toffler. 1995. *Creating a New Civilization: The Politics of the Third Wave.* Turner Publishing.

Tol, Richard S.J. 1993. "The Climate Fund: Modelling Costs and Benefits." Amsterdam: Vrije Universiteit.

Trainer, Ted. 1996. *Towards A Sustainable Economy: The Need for Fundamental Change*. Chicago: Logan Publishers.

Udayakumar, S.P. 1995. "The Futures of the Poor." *FUTURES* 27: 339-351.

Uchitelle, Louis. 1997. "Measuring Productivity in the 90's: Optimists vs. Skeptics." *New York Times,* August 2.

UNESCO. 1997. *Universal Declaration on the Human Genome and Human Rights.* http://www.unesco.org/shs/human_rights/hrbc.htm.

United Nations Development Program. 1994. *Human Development Report 1994.* New York: Oxford University Press.

United Nations Development Program. 1996. *Human Development Report 1996.* New York: Oxford University Press.

United Nations Development Program. 2002. *Human Development Report 2001/2002.* New York: Oxford University Press

U.S. Bureau of the Census. 1993. *Money Income of Households, Families and Persons in the United States: 1992*. Washington, D.C.: U.S. Government Printing Office.

U.S. Bureau of the Census. 1995. *Statistical Abstract of the United States: 1995* (115th edition). Washington, D.C.: U.S. Government Printing Office.

U.S. Department of Commerce. 1993. Current Population Reports. Consumer income. Money Income of Households, Families and Persons in the United States: 1992. Washington, DC: U.S. Government Printing Office.

U.S. National Academy of Sciences. 1996. "Science and Engineering Indicators." Washington DC: U.S. Government Printing Office.

U.S. Office of Technology Assessment. 1987. *Public Perceptions of Biotechnology.* Washington, DC: U.S. Government Printing Office.

van der Heijden, Kees. 1996. *Scenarios: The Art of Strategic Conversation*. New York: John Wiley & Sons.

van Zon, Hans. 1992. "Alternative Scenarios for Central Europe." *FUTURES* 24: 471-482.

Verba, Sidney, and Gary R. Orren. 1985. *Equality in America: The View From The Top.* Cambridge, MA: Harvard University Press.

Vinge, Vernor. 1981. *True Names and Other Dangers*: Baen Books.

Vinge, Vernor. 1993. "What is the Singularity?" Original version presented at the VISION-21 Symposium sponsored by NASA Lewis Research Center and the Ohio Aerospace Institute, March 30-31. An edited version appeared in the *Whole Earth Review,* Winter 1993.

Vitousek, Peter, Paul Ehrlich, Anne Ehrlich, and Pamela Matson. 1986. "Human Appropriation of the Products of Photosynthesis." *BioScience* 36: 368-373.

von Weizsäcker, Robert K. 1993. *A Theory of Earnings Distribution*. Cambridge: Cambridge University Press.

Wade, Nicholas. 1998. "Human Cells Revert to Embryo State, Scientists Assert." *New York Times*, November 12.

Wade, Robert. 1996. ""Globalization and its limits: the death of the national economy has been greatly exaggerated". In *National Diversity and Global Capitalism*: Cornell University Press.

Walters, LeRoy. 1986. "The Ethics of Human Gene Therapy." *Nature* 320: 225-227.

Walters, LeRoy. 1991. "Human Gene Therapy: Ethics and Public Policy." *Human Gene Therapy* 2: 115-122.

Walters, LeRoy. 1994. "The Ethics of Human Germ-Line Genetic Intervention." In *Genes and Human Self-Knowledge: Historical and Philosophical Reflections on Modern Genetics*, R. Weir, S.C. Lawrence and E. Fales, eds. 228. Iowa City: University of Iowa Press.

Walters, LeRoy, and Julie Gage Palmer. 1997. *The Ethics of Human Gene Therapy*. New York: Oxford University Press.

Wapner, Paul. 1995. "Politics Beyond the State: environmental activism and world civic politics." *World Politics* 47: 311-40.

Waters, Malcolm. 1995. *Globalization*. New York: Routledge.

Watson, James D. 1973. "Children From the Laboratory." *Prism* 13. May.

Weiss, Rick. 1998. "Engineering the Unborn." *Washington Post.* March 24. A01.

Whalen, Charles J., ed. 1996. *Political Economy for the 21st Century: contemporary views on the trend of economics*. Armonk, New York: M.E. Sharp.

Wilkinson, Lawrence. 1995. "How to Build Scenarios." *WIRED* Dec. 1996.

Wilmut, Ian. 1998. "Cloning For Medicine." *Scientific American*: December. 58-63.

Winner, Langdon. 1977. *Autonomous Technology: Technics-out-of-control as a Theme in Political Thought.* Cambridge, MA: The MIT Press.

Wivel, Nelson, and LeRoy Walters. 1993. "Germ-line Gene Modification and Disease Prevention: Some Medical and Ethical Perspectives." *Science* 262: 533.

Wolff, Edward N. 1987. "Estimates of Household Wealth Inequality in the U.S., 1962-1983". *Review of Income and Wealth,* September. 231-56.

Wolff, Edward N. 1992. "Changing Inequality of Wealth." *American Economic Review* 82: 552-558.

Wolff, Edward W. 1996. "The Productivity Slowdown: The Culprit at Last?" *American Economic Review* 86: 1239-1252.

World Bank. 1996. *World Development Report 1996.* New York: Oxford University Press.

World Commission on Environment and Development. 1987. *Our Common Future.* New York: Oxford University Press.

World Summit on Sustainable Development. 2002. For the Report and other documentation see www.un.org/jsummit.

Wysocki Jr., Bernard. 1997. "For Economist Paul Romer, Prosperity Depends on Ideas." The Wall Street Journal. January 21.

Yoffee, Norman, and George L. Cowgill, eds. 1988. *The Collapse of Ancient States and Civilizations*. Tucson, Arizona: The University of Arizona Press.

Yotopoulos, Pan A. , and Jeffery B. Nugent. 1976. *Economics of Development: Empirical Investigations*. New York: Harper and Row.

Yudkowsky, Eliezer S. 1996. "The Low Beyond." *http://yudkowsky.net/beyond.html.*

Zimmerman, Burke. 1991. "Human Germ-Line Therapy: The Case for its Development and Use." *Journal of Medicine and Philosophy* 16: 593-612.

Zuboff, Shoshana. 1988. *In the Age of the Smart Machine: The Future of Work and Power*. New York: Basic Books.