Environmental Quality, Economic Growth, and Democracy: A Theoretical and Empirical Examination of the Linkages

by

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Abstract

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It is widely asserted in the trade and development literature that economic growth leads to environmental quality improvements once a given income level is achieved. I believe that this relationship is sporadic and, where it does exist, the causal mechanism is far more complex than this relationship implies. I hypothesize that the level of democracy in a country is a critical intervening variable (among others) that powerfully influences the effect of economic growth on environmental quality. Further, that the level of democracy in a country is more closely related to environmental quality than is the level of income.

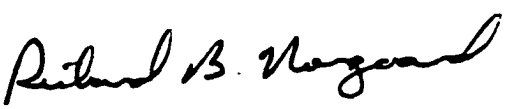
My dissertation consists of four chapters. In the first chapter I survey the existing statistical evidence for and theoretical underpinnings of a relationship between economic growth and environmental quality. I then scrutinize the results obtained by Grossman and Krueger (1991), a seminal paper in the debate over the relationship in question. I

find that their results are neither strong nor robust, and should not be viewed as evidence of a relationship between environmental quality and income level.

In the second chapter, I present a theoretical examination of the relationship between regime type and environmental quality focusing on the differences between democratic and authoritarian regimes.

The third chapter surveys the literature on democracy and environmental quality and then presents a cross-country empirical examination of urban air pollution concentrations and two measures of democracy. I find that a statistically significant and robust positive relationship exists between democracy and urban air pollution concentrations.

In the final chapter, I present a longitudinal case study of the regulation of urban air pollution in Santiago, Chile during the military dictatorship and then in the (relative) democracy that followed. I find that little was done to regulate urban air pollution under the military dictatorship and a far greater, though limited, effort was made under the democratic regime. This can in part be attributed to the institutions of democracy that allow for public input in the policy making process.



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Introduction

What accounts for the differences in environmental quality in different countries around the world? Some cities have high pollution levels, others low; some nations have many national parks, others none. Is there any identifiable relationship between environmental quality and other variables which might indicate public policy directions that should be pursued to increase the likelihood of a sustainable natural environment in the face of continued industrialization, growth in material consumption, and growth in human population?

Numerous attributes compose what one might think of as "environmental quality". The biological and physical systems that make up the environment are complex, and there are great differences in the ways in which humans interact with the environment in different countries, regions, and even communities. Therefor, it is unlikely that any single causal factor can be identified to be a determinant of environmental quality. More likely, different variables such as natural features of the landscape, resource endowments, population growth rates, education levels, rates of innovation, and political structure operate together to lead some countries towards the protection of natural resources and improvements in environmental quality. Granted, an extremely poor country may not have the resources to protect the environment no matter what other features it may possess. But barring the ability of countries to afford the

expenses associated with environmental protection, one could identify a variety of mechanisms influencing environmental quality, regardless of income level.

This dissertation considers the relevance of both economic growth and type of political regime within a country for protecting environmental quality. It argues that, although economic growth may provide resources for a government to devote to environmental improvement, economic growth alone does not lead to environmental improvements. Regime type is a critical intervening variable, among others, that influences the level of environmental quality.

Regime type is hypothesized to be important primarily because environmental quality is made up of public goods. Public goods can not, in general, be purchased on the market, and so the protection or improvement of environmental quality requires coordinated action, often (but not always) conducted by a central government body. This coordinated action could and does occur at many levels—national, regional, and local. For example, a company might stop polluting due to national laws, regional laws, local community regulations or local public pressure. It might be that rule making and enforcement occur at different levels. The focus of this thesis is on the national level of coordinated action: the actions of nation states to protect environmental quality. More specifically, it considers the proposition that higher levels of democracy in a nation are correlated with an increased likelihood of better environmental quality, regardless of income level. Improvements in and protection of environmental quality result largely from public policy decisions, and democratic governments are more likely to make decisions that favor environmental quality.

This work stems from my interest in the potential impacts of expanding international trade, an issue of increasing international importance and visibility as protests against globalizations gain steam. In the early 1990s, the debate over increasing levels of trade did not make the front page of major newspapers, nor were there large and sometimes violent protests in the street. Yet the debate occupied members of congress, the press, and many academics whose research focuses on the merits and potential hazards of lowering barriers to trade. The primary stimulus to this debate in the United States was the then proposed and now ratified North American Free Trade Agreement (NAFTA) which has lifted trade barriers between Canada, the United States, and Mexico. The central components of the debate were the effects of freer trade on workers and on the environment.

It was and is an interesting debate for a number of reasons. For one, it creates strange bedfellows. Environmentalist found themselves united with unionist and staunch conservatives in their efforts to block NAFTA's ratification. Secondly, there are no clear answers. Trade has been a boon to workers and the environment in some instances and a disaster in others. Freer trade has a mixed history for its effects on workers and the environment. Finally, economic theory was still catching up to the issue. Although neoclassical theory suggested only benefits from trade in the form of comparative advantage leading to increased efficiency and therefor welfare improvements. environmental and ecological economists were showing the disadvantages associated with increased distances between production and consumption and how this distance can limit the ability to internalize environmental externalities.

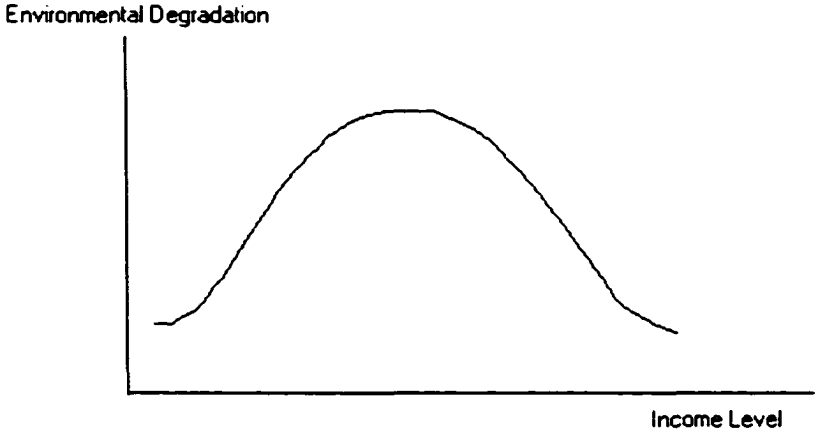
The notion of comparative advantage, originally developed by David Ricardo in 1817, suggests that trade will lead to welfare improvements because countries can specialize in the goods that they are most efficient at producing due to natural differences such as climate as well as social differences. For example, countries with limited capital but surplus labor can concentrate on labor intensive goods while countries with excess capital but limited labor can focus on capital intensive goods. With free trade, each country can focus their resources on the goods they can produce most efficiently and trade for goods they can not produce as efficiently. The cumulative global effect is a more efficient use of resources and a greater overall availability of goods: hence the welfare improvements.

Environmentalist and environmental economists have presented a number of arguments against freer trade. Among their concerns are that free trade regimes will restrict individual nations' abilities to implement environmental regulations, trade liberalization will force environmental standards down as countries vie for corporate investments, and increased trade will lead to increased and uncontrolled exploitation of natural resources in less developed nations. A plethora of articles and books have been published which debate these issues.(See, for example, Nader et al., 1993; Zaelke et al., 1993; and Cole, 2000)

An additional concern is that increased trade will lead to economic growth worldwide, which will also have negative impacts on environmental quality by increasing the consumption of natural resources and increasing the level of wastes being returned to the environment.

In 1991, during this debate but pre-NAFTA, a paper was circulated which was initially prepared for a conference on the U.S. - Mexico Free Trade Agreement, sponsored by SECOFI, and was later published in a collection of papers by the MIT Press (Grossman and Krueger, 1993). The title of the paper is "Environmental Impacts of a North American Free Trade Agreement" by Gene Grossman and Alan Krueger, economists at Princeton University.(Grossman and Krueger, 1991) This paper addressed this last concern directly. It concluded that urban air concentrations of sulfur dioxide (SO_2), as well as two types of suspended particulate matter (SPM) exhibit an inverted U-shaped relationship with national income level. At low-income levels, air quality deteriorates with economic growth, but above a certain threshold level of approximately $4000 to $5000 per capita per year, air quality improves with economic growth. Since Mexico was at this threshold, the authors argued that increased trade will lead to economic growth tipping them over this threshold and leading, therefor, to improvements in environmental quality – i.e. trade is good for the environment.

This inverted U-shaped relationship has been termed the Environmental Kuznets Curve (EKC) after a 1955 paper by Simon Kuznets hypothesizing a link between economic growth and income distribution.(Kuznets, 1955) The EKC hypothesis holds that at low income levels, environmental quality deteriorates with economic growth but, above a certain income level, as countries become wealthier, environmental quality improves. The figure below illustrates the Environmental Kuznets Curve. Income level increases as you move to the right on the X-axis and environmental quality decreases as you move up the Y-axis.



Although there is limited and only very weak empirical evidence for the EKC hypothesis, it has been widely cited as evidence that policies that promise economic growth, such as freer trade, are also potentially good for the environment. For example, Jagdish Bhagwati argues in a paper entitled "Trade and the Environment: The False Conflict?"(1993) that freer trade is not always in conflict with environmental quality as a result of increased growth because "..one may well find that specific types of pollution fall as per capita income rises, as indeed is the case with sulfur dioxide (SO_2) pollution, except for per capita incomes below $5000 in urban areas across the world, according to a much-cited study by...Professor Gene Grossman (co-authored with Professor Alan Krueger)."(p. 163)

The EKC hypothesis has also been roundly criticized in the literature. (see, for example, Arrow et al., 1995; Stern et al., 1996; Thomson and Strohm, 1996)

The idea that economic growth leads to environmental quality improvements warrants a closer examination as it has a number of potentially important policy consequences. A logical extension of this idea is that, since a country's environmental quality will improve "spontaneously" once a particular income level is reached, special care need not be taken of the environment at earlier stages of growth. However, the impairment of a country's ecosystem or depletion of natural resources in the present could preclude that country's potential for a sustainable future. Unable to meet its own basic needs, it could become a ward of the international system, or engage in resource related conflicts internally or with neighbors. This concern is particularly relevant today as the United States engages in a war with Afghanistan, a country that is unable to meet the needs of its citizens due, in part, to resource degradation and depletion.

Supporting the argument for the protection of environmental quality in earlier stages of growth, Edward Barbier (1994) discusses why the preservation of natural resources in less developed countries (LDCs) is important. Barbier argues that it is rare for capital obtained through depleting natural resources to be reinvested in a sustainable way. Usually this capital is diffused somehow or remains in the hand of a few wealthy citizens. Depletion of natural resources is therefore generally devastating, especially for resource dependent populations. Managing the resource base should be a high priority.

Another concern regarding the economic growth, environmental quality relationship is that, with the increase in global trade, wealthy countries might be better able to shift environmental degradation associated with consumption to poorer countries. (Rothman, 1998; Cole, 1999) The export of pollution and resource depleting activities to

poorer nations would give the impression that countries become cleaner as they grow wealthier, veiling the global environmental consequences of economic growth: that economic growth really has an overall negative impact on environmental quality, rather than the opposite. Also, if wealthy country are able to export environmental degradation, poorer nations will not be able to decrease their pollution levels with growth because they will have nowhere to shift their pollution.

A related concern is that perhaps the types of environmental degradation performed by wealthy countries can be shifted to the future while environmental problems of poorer nations are more evident in the present, again hiding world-wide consequences. It may be that as wealth increases, countries are better able to shift environmental problems from near to far, from local to global, and from present to future.

The changes in environmental problems, or, more specifically, the health risks associated with these environmental problems, that occur with economic development is what Kirk Smith terms the "Risk Transition".(Smith, 1990; Smith, 1997) As countries develop economically, many of the risks associated with poverty, such as indoor air pollution from cooking stoves, poor sanitation, and poor drinking water quality begin to decline. Other health risks increase with affluence, such as exposure to pesticide pollution and industrial toxins, and increased emissions of climate threatening gases. So society experiences a transitions from a preponderance of one type of risk to another. The risks associated with affluence may be less visible in the present but equally problematic in terms of impact on human health and ecosystem integrity.

Empirical studies supporting an EKC have provided a platform for those whose arguments rely on a positive correlation between income and environmental quality, and has been a particular boon to those who favor increased trade. The General Agreement on Tariffs and Trade's 1992 publication "International Trade" offers the following observations: "If the average citizen is convinced of the need to devote more material and human resources to achieve a better environment as his or her income rises, the growth of per capita income ultimately will lead to increases expenditure on the environment. The available evidence suggests that this is indeed happening."(p.20, cited in Thompson and Strohm, 1996)

The GATT further notes that "countries near the top of the development ladder are likely to have different priorities from countries further down the ladder, and... as a result are likely to have and enforce stricter environmental standards. This appears to be borne out quite well in practical experience."(1992, p. 29, cited in Thompson and Strohm, 1996) So a policy consequence of these studies has been to boost support for lowering trade barriers even though this could create further threats to the environment.

Perhaps most importantly, the belief that economic growth is the primary method for obtaining socially desirable outcomes could misdirect efforts towards the true goals of society. If economic growth is seen to be the best means for attaining common goals, policies and institutions will be structured to promote growth above all else. Yet, growth may not be the best means for reaching broadly desired social goals, and may actually be taking us further from these goals. Ecologists and economists alike have argued that economic growth is often antithetical to improvements in environmental quality. (See

Daly, 1979; Georgescu-Roegen, 1971) In the long run, it may well be that continued economic growth is not even possible.

The debate regarding the merits of economic growth for society and for environmental quality has been evident since the late 1960s. In 1967, E.J. Mishan published a book entitled "The Costs of Economic Growth." Briefly, in it he argues that, although economic growth can provide more goods and services, it can also produce socially undesirable effects such as traffic congestion, increased violence and deterioration of environmental quality. Once a society reaches satiation with consumer goods (a debatable idea in itself), the net effect of continued economic growth can be negative. In 1977, he furthered these ideas in a second book entitled "The Economic Growth Debate."

In 1971, Nicholas Georgescu-Roegen published "The Entropy Law and the Economic Process". Here he uses the first and second laws of thermodynamics to show that, due to finite stocks of energy and natural resources, as well as the finite ability of waste sinks, economic growth can not go on indefinitely.

In 1972, Dennis and Donella Meadows et al. published "The Limits to Growth". They develop a model of growth using a variety of variables and data from the first part of the 20th century. They find that limitations of certain resources will hinder continued growth and, even more problematic, environmental degradation will increase the death rate and lead to decreases in the growth rate. The model also finds that when they relax one limitation on growth, growth is hindered by another limit.

An additional contribution to the limits to growth literature is Herman Daly's 1977 book "Steady-State Economics". Building on the work of Mishan, he argues that there is indeed a limited carrying capacity of the biosphere. Increased growth brings us closer to these limits. He argues that absolute wants, as opposed to trivial, unnecessary wants, are fulfilled in affluent societies and rather than seeking further economic growth, we should be working towards a steady-state economy where resource depletion and environmental degradation are minimal and stocks of people and capital are steady.

Other essays were also published during this period that focus on the limits to growth. Although these works were broadly read, they had little impact on government policy or global institutions such as The World Bank or the International Monetary Fund (IMF).

Then, in 1987, the United Nations published "Our Common Future".(Brundtland et al.) This report looks at the ever-increasing rates of growth and development in the world economy during the 20th century and declares that a continued increase in the rate of growth is not sustainable. It particularly focuses on the need for less energy intensive growth and reductions in environmental contamination. However, rather than argue that continued growth is not possible, it argues for the importance of including environmental concerns in economic decision making. It does not declare that growth itself is unsustainable, and it focuses on the positive aspects of industrialization. The overall message is that growth is fine, as long as it is done in a sustainable fashion.(Chatterjee and Finger, 1994)

This report did stimulate change in international economic institutions. Sustainable development became a catchword, and social and natural scientists were hired to evaluate economic development programs to ensure that they did not proceed with unwanted environmental consequences leading to unsustainability. Yet the report undercut the more serious concerns of earlier authors regarding the sustainability of growth itself.

As the world financial community was adjusting to the idea that unfettered economic growth is not sustainable, Grossman and Krueger published their 1991 paper which concludes that economic growth alone can be good for environmental quality. This paper was most likely welcomed by members of the international financial community who stood to gain from unfettered economic growth. The paper was also fiercely refuted by environmentalists, economists and natural scientists who believe in the limits to growth, as well as others who found Grossman and Krueger's conclusions problematic and unlikely. So, Grossman and Krueger (1991) not only received a great deal of attention due to its contribution to the debate regarding the merits of increased trade, but because it turned the limit to growth debate on its head. Sustainability is no longer an issue because it will follow from growth once a certain income level is reached.

The relationship between democracy and environmental quality has received less attention in the literature than the relationship between income and environmental quality, especially in terms of empirical analysis. There are reasons for this beyond the controversial nature of the EKC hypothesis discussed above. For one, democracy is a more difficult variable to measure than income level. It is a more complex variable as

well, composed of many more abstract and subjective components than income level, so it is not as conducive to empirical analysis and blunt conclusions. Also, there are no powerful interest groups that benefit from the promotion of democracy, and there are groups who may perceive increased levels of democracy a threat.

The relationship between democracy and environmental quality has received some attention in the literature, mostly in the mid-1970s. Most of the work examining the relationship between democracy and environmental quality has been theoretical rather than empirical. The best known arguments were given by William Ophuls and Robert Heilbroner who argued that authoritarian regimes may be necessary to prevent ecological ruin. They felt that democracy could not cope with the increasing levels of resource scarcity and environmental degradation. (Ophuls, 1977; Heilbroner, 1974) A number of authors responded to these challenges and argued that democracy and environmental quality are compatible, and that the promotion of totalitarianism on environmental grounds did not serve the environmental movement. (For an overview, see Taylor, 1996) A body of literature has developed which supports, with qualifications, the relationship between democracy and environmental quality.(For example, see Dryzek, 1987; Paehlke, 1995 and 1996)

In the past five years, democracy's relationship to environmental quality has received increased attention, including empirical studies, and perhaps these studies will receive the attention of policy makers and international organizations such as The World Bank as much as the EKC studies have.

This dissertation has two principal objectives: to critically review the evidence supporting a relationship between environmental quality and income level; and to explore the relationship between environmental quality and democracy, both theoretically and empirically.

Chapter 1 is devoted to a critical examination of the EKC hypothesis. It begins with a review and summary of empirical studies of the relationship between income level and various aspects of environmental quality. It then focuses specifically on an internal critique of the 1991 Grossman and Krueger paper. This detailed look at Grossman and Krueger will be used to compare their empirical results linking environmental quality to income level to the regression results in Chapter 3 linking environmental quality to level of democracy. The relationship between environmental quality and income level will be further scrutinized through the regression analysis of an expanded data set of urban air pollution using the same model as used by Grossman and Krueger.

The chapter then turns to a consideration of why the existence of an EKC has been so readily accepted by some authors despite limited and weak empirical evidence, which was also discussed briefly above. It then considers the theoretical underpinnings of the EKC hypothesis: the various mechanisms said to link income and environmental quality that could lead to an inverted U-shaped relationship. The chapter concludes with a discussion of why income level is a poor determinant of environmental quality, and why environmental quality is more likely to be related to policy responses than income level.

The next three chapters focus on the relationship between environmental quality and democracy. Chapter 2 presents the theoretical basis for a positive relationship between democracy and environmental quality. After defining the variables in question, it turns to a discussion of some basic reasons why democracy and environmental quality may not be compatible. A longer discussion of why democracies are likely to protect environmental quality, and why authoritarian regimes, in contrast, are less likely to protect environmental quality follows. The final portion of Chapter 2 is devoted to a discussion of how various aspects of environmental quality are likely to respond to democracy differently.

Chapter 3 surveys the empirical literature on the relationship between environmental quality and democracy. Then, using the same model and urban air pollution data used by Grossman and Krueger (1991), as well as the expanded data set described in Chapter 1, the relationship between urban air pollution and democracy will be explored. Two different measures of democracy, the Freedom House Index and Polity III, are used in the regression analysis. Although broad based, large N studies of this sort can not be expected to yield definitive answers about general relationships, they can be useful for comparing the relative strengths of different variables.

The final chapter presents a longitudinal case study of the response of different regime types to an environmental problem. It examines the regulation of air pollution in Santiago, Chile during the dictatorship of Augusto Pinochet and then in the democratically elected government of Patricio Aylwin that followed. This is an interesting study of the effects of regime type on environmental regulation because,

despite the dramatic shift in regime type that occurred in 1990, the economic system changed little, and so the effect of regime type on environmental regulation can be somewhat isolated.

The dissertation concludes with a summary of the findings and some final thoughts.

Chapter 1 Economic Growth and Environmental Quality

1.1 Overview

A decade ago, a debate emerged in the literature on whether economic growth is good for the environment. One paper in particular appears to be a cornerstone of the debate: "Environmental Impacts of a North American Free Trade Agreement", by Gene Grossman and Alan Krueger (1991). As the title suggests, this paper was motivated by the debate over the effects of increasing trade on environmental quality. Using urban air pollution data from the Global Environmental Monitoring System (GEMS), and a random effects (RE) model (which will be described below) the authors find that ambient urban sulfur dioxide (SO_2) and two typed of suspended particulate matter (SPM) concentrations, and annual gross domestic product (GDP) per capita have an inverted U-shaped relationship: as income increases at low levels of GDP per capita, air pollution also increases; at approximately $4000 to $5000 per capita per year, this trend changes and urban air pollution begins to decrease as income rises. Using a fixed effects (FE) model, they find the same relationship between income level and SO_2 but the SPM relationship is no longer significant.

Although there are a number of limitations with this paper (which will be discussed in depth below), this paper has been broadly cited as evidence that growth may

be good for the environment. A large body of literature has subsequently appeared debating the merits of this hypothesis.

This chapter begins with an overview of empirical studies of the relationship between income and various aspects of environmental quality. Following this survey, the focus turns to an examination of the internal limitations with Grossman and Krueger (1991). Their results are critiqued from both a theoretical and empirical basis. I focus closely on this paper for three reasons. For one, it is a seminal work in this field and is still commonly cited. Secondly, it provides some of the strongest support for the existence of an inverted U-shaped relationship between income and environmental quality, or an Environmental Kuznets Curve (EKC). Thirdly, a detailed description of their model and results are necessary because the same model will be used in Chapter 3 to compare their results to an alternative specification – one which uses democracy rather than income as the independent variable. So, much of this chapter is devoted to deconstructing Grossman and Krueger 1991 both to fully explore their findings and to enable comparison of their results to the results in Chapter 3.

Following the examination of Grossman and Krueger's work is an empirical study of the relationship between income level and urban air pollution with an expanded data set which encompasses more years and countries than the data set used by Grossman and Krueger. Using a model identical to Grossman and Krueger, I further test their results by seeing if they still hold with this expanded data set.

This empirical work is followed by a discussion of why the EKC has been so readily accepted by some authors, despite the limited empirical evidence supporting the relationship between income and environmental quality.

The chapter then turns to an examination of the theoretical reasons, and mechanisms identified, for why this relationship would exist, with a closer look at these mechanisms.

The chapter ends with a summary of the findings of the chapter and a discussion of these findings.

1.2 Literature Review

Subsequent to the first Grossman and Krueger paper, a number of other authors have investigated the relationship between income and a variety of measures of environmental quality. Douglas Holtz-Eakin and Thomas Selden (1992) use global panel data to estimate the relationship between carbon dioxide (CO_2) emissions and income per capita. Based on cross-country comparisons, they find a decreasing marginal propensity to emit CO_2 at higher income levels. However, emissions increase with economic growth for countries at all income levels.

Nemat Shafik and Sushenjit Bandyopadhyay (1992) and Shafik (1994) investigate the relationship between income and a wide variety of environmental quality measures including air and water quality, deforestation rate, and lack of urban sanitation. They conclude that there is no clear pattern of how environmental quality changes with income. Some indicators of environmental quality appear to improve with income while

other indicators continue to decline. The direction of the relationship appears to depend on whether these indicators directly effect human welfare or can be externalized.

For urban SO_2 and suspended particulate matter (SPM) they find an inverted U-shaped relationship with a turning point close to $4000, as did Grossman and Krueger. They find that river water quality as expressed by dissolved oxygen declines at higher income levels. Fecal coliform follows an S-shaped curve, peaking at $1400 per capita, decreasing, and then increasing again after $11,400 per capita. They also find that carbon emissions and municipal solid waste per capita increase steadily as income rises.

Thomas Selden and Daquing Song (1994) regress squared income level against aggregate air pollution emissions data for SO_2, SPM, Nitrogen Oxides (NO_x), and Carbon Monoxide (CO), rather than urban pollution concentrations data, which had been used by other authors. They use both a cross country, random effects (RE) model and a model which includes fixed site effects (FE), which focuses on a time-series comparison. They find that in most cases the RE model is rejected in favor of the FE model. Their results show that pollution levels increase as countries grow richer at low levels of income and then decrease at higher levels of income for SO_2 emissions, SPM emissions, and NO_x emissions, but not for CO emissions. However, the turning points they find are higher, ranging from $8900 to $12000 per capita per year. Given that the average global GDP per capita for the data set they are using (Summers and Heston, Penn Mark IV World Tables, in 1985 US$) is $3766, improvements in air quality due to increasing income level can not be expected in most countries in the near future, if ever. Based on the EKCs

from their regression results, they forecast that emissions will increase through the twenty-first century.

As an addition to their earlier work, in 1994 Grossman and Krueger published a paper that reports a positive correlation between river water quality and income level as well as between air quality and income level at low-income levels. Water quality, measured with level of fecal contamination and heavy metal contamination, begins to improve with higher income levels at annual income per capita levels of approximately $8-14,000/ year, which is higher than for air pollution.

Susmita Dasgupta et al.(1995) develop their own environmental quality measures based on environmental reports submitted to the United Nations Conference on Environment and Development (UNCED). Of 145 existing reports, the authors choose 31 at random and rated them on the bases of twenty five question for four areas: air, water, land, and living resources. The questions are broken into five categories: awareness, policy, legislation, control mechanism, and measure of success. With these areas and categories,100 data points were developed from each report.

They use a log linear model to regress these measures of environmental quality against a range of social indicators including income per capita, education level, and measures of political freedom. They find a strong linear cross-country correlation between overall environmental quality and income per capita, as well as security of property rights, and development of a legal and regulatory system. They do not investigate the possibility of an inverted U-shaped relationship.

Paul Ekins (1997) compares environmental performance based on 12 environmental indicators to GDP per capita in 22 OECD countries. He finds no correlation between income level and environmental performance. Ekins also conducts a thorough survey of empirical evidence of the relationship between income level and environmental quality and finds no consistent relationship. The author concludes that the variable that provides the strongest evidence of an EKC is ambient SO_2 concentrations, yet, even with this variable, different studies find a variety of turning points.

Jeffrey Vincent (1997) investigates the plausibility of the EKC by examining environmental quality and income level changes in a single country: Malaysia. Examining both air and water pollution, he finds that the results from cross-country analyses fail to accurately describe the changes in water and air pollution that occurred in Malaysia with income growth. Rather, changes in pollution levels were results of changes in resource availability, such as the discovery of large quantities of natural gas, changes in population level, environmental policies applied to only certain pollutants, and changing characteristics of both industry and households.

Vivek Suri and Duane Chapman (1998) investigate the relationship between income and environmental quality using per capita energy use as their dependent variable, citing the relationship between energy use and air pollution emissions. They also examine the relationship between energy use and GDP per capita with the additions of import and export manufacturing ratios data in their model. Including the trade ratios in their analysis, they find evidence for an EKC, but with very high turning points of income levels of $140,000 to $200,000 per capita.

R.K. Kaufmann et al.(1998) also consider the relationship between income levels and ambient SO_2 concentrations. Rather than an inverted U-shape, they find evidence of a U-shaped relationship between these variable, using a quadratic form equation and including intensity of economic activity, measured by GDP/area. However, they find an inverted U-shaped relationship between SO_2 levels and intensity of economic activity. These results suggest that reducing SO_2 levels depend on the rate of GDP growth vs. the rate of population growth (which effects income level measured as GDP per capita).

George Unruh and William Moomaw (1998) use nonlinear dynamical analysis to analyze changes in CO_2 emissions in 16 high-income countries. They find that many countries do go through an apparent EKC type shift from higher emission levels to lower, however these shift are not related to the income levels of the countries at the time they occur. The authors state that the shifts "do not appear to be the result of endogenous changes in economic growth, but instead result from rapid, co-temporal historical events and responses to external shocks."(p.222) In other words, the transition from higher to lower CO_2 emissions is not correlated with income levels as much as time and certain exogenous historical events such as oil price shocks.

Gary Koop and Lise Tole (1999) examine the relationship between GDP per capita and deforestation. Using data from 76 developing countries from 1961 to 1992, they find mixed evidence supporting an EKC for deforestation using a fixed effect model. The data supports an EKC for Latin America although not for Africa, Asia, or pooled data for all countries using this model specification. The turning point for the EKC for

Latin America occurs at $8660 per capita. There is no statistically significant result supporting an EKC using a random effect models.

They take their statistical analysis further by also analyzing the data using a random coefficients model. This model allows each country to have its own EKC. Koop and Tole find that, in most cases, the FE models and RE models that assume constant structure (slope and intercept) across countries are rejected in favor of the random coefficient model. This model finds no evidence of an inverted U-shaped relationship for the pooled country data or the data divided by continent. The authors conclude that there is no evidence for an EKC using this less restrictive model form.

Jean Agras and Duane Chapman (1999) explore the EKC hypothesis using energy use per capita, as a proxy for environmental quality. They find that income per capita is no longer a significant variable for determining energy use once energy prices and trade variables are included.

Hemamala Hettige et al.(2000) examine the effects of income level on three factors related to industrial water pollution: the share of industry in GDP, the share of polluting industry output in all industrial output, and the amount of end-of-pipe pollution emissions per unit polluting industry output. They find that the first of these three factors does follow an EKC shape. However, these factors combined do not follow and inverted U. Instead, overall pollution output rises with income until middle income levels are reached, and then it stays constant.

Focusing on high-income countries, Elisabetta Magnani (2000) explores the impact of economic growth on pollution emissions by examining public research and

development (R&D) expenditures for environmental protection in OECD countries. She finds that the distribution of income in a country is more important than mean income level for determining expenditure levels for research for environmental protection. More specifically, "a reduction in the gap between income shares of the first and the forth quintile of the population... unambiguously increases the expenditure in research for environmental protection".(p. 440) She explains that: "Income inequality produces a gap between a country's ability to pay for environmental protection and a country's willingness to pay."(p.431)

Majid Ezzati, Burton Singer and Daniel Kammen (2001) use structural equations to examine the interactions between environmental and socioeconomic variables that link income level and environmental quality. Rather than doing a macroeconomic analysis, as most others have done, they use microeconomic analysis. They find that an inverted U-shaped relationship will only arise in specific circumstances. The EKC is the exception, rather than the rule.

Jordi Roca et al (2001) focus their work on one country: Spain. They examine the annual emission flux of six types of air pollution. They find no correlation between air emissions and income levels for any of the pollutants except to SO_2, which is the only pollutant to go down during the years of study, 1980 to 1996.

Deforestation rates from 1972 to 1991 in 66 countries of Latin America, Asia and Africa is the focus of a study by Madhusudan Bhattarai and Michael Hammig (2001). They regress deforestation against a collection of independent variables, including income cubed. They find evidence of an EKC for Latin America and Africa with turning

points of $6,600 and $1,300 per capita per year respectively in 1985 US dollars. For Africa, the peak at $1,300 is followed by a trough at $5,000 after which point deforestation rates start to increase again.

For Asia, they also find a significant relationship between cubic income and deforestation rates but the shape is the opposite from that for Latin America and Africa. For Asia, the curve first drops down and then rises. Instead of an inverted U, they find a U-shape followed by an inverted U. The trough is at $2,200 and the peak is at $5,500. So although they do find significant correlations, the turning points are different for these three regions. They also find significant results for time, population growth, rural population density, political institutions (which will be discussed in the following chapters), and debt as a percentage of GDP.

David Stern and Michael Common (2001) examine the relationship between GDP per capita and sulfur emissions using a new data set that includes 73 countries with 31 annual observations. This data set is more extensive than the GEMS data used by some authors, the OECD data used by others, or estimates of emissions. They use both a fixed effects model and a first differences model. They use a quadratic model form, rather than a cubic form. The turning points they find are at $101,000/ cap and $53,000/cap for each model respectively. These are far higher than the results from Grossman and Krueger(1991) or Selden and Song (1994). Using the first differences method to analyze the data, they conclude, like Unruh and Moomaw with CO_2, that reductions in sulfur emissions are time related rather than income related.

The following table summarizes the results from studies cited above which relate specifically to income level. RE is for a random effects model, FE is for fixed effects. The differences between these models will be discussed below.

TABLE 1.1 SUMMARY OF SELECTED STUDIES OF ENVIRONMENT AND INCOME LEVEL RELATIONSHIP

Dependent Variable - Environmental Indicator	Author	Model Type	Relationship Between Income Level and Environmental Quality
Ambient Urban SO_2	Grossman and Krueger (1991)	Cubic, RE	Inverted U, TP* at $4000
		Cubic, FE	Inverted U, TP at $4500
	Shafik and Bandyopadhyay (1992), Shafik (1994)	Quadratic, FE	Inverted U, TP at $3700
	Kaufmann et al. (1998)	Quadratic, RE FE OLS. Includes intensity of economic activity	U-shaped relationship
Aggregate SO_2 emissions	Selden and Song (1994)	Quadratic, RE	Inverted U, TP at $10,681
		Quadratic, FE	Inverted U, TP at $8,916
	Stern and Common (2001)	Quadratic, FE	Inverted U, TP at $101,000
		Quadratic, first differences	Inverted U, TP at $53,000
Ambient urban particulate matter (SPM)	Grossman and Krueger (1991)	Cubic, RE	Decreasing at low income levels, no relationship at high
		Cubic, FE	Monotonically increasing
	Shafik and Bandyopadhyay (1992), Shafik (1994)	Quadratic, FE	Inverted U, TP at $3280
	Selden and Song (1994)	Quadratic, RE	Inverted U, TP at $9617
		Quadratic, FE	Inverted U, TP at $9811
Ambient urban dark matter	Grossman and Krueger (1991)	Cubic, RE	Inverted U, TP at ~$5000, rises again after $11,000
		Cubic, FE	Insignificant results
Aggregate NOx emissions	Selden and Song (1994)	Quadratic, RE	Inverted U, TP at $21,773
		Quadratic, FE	Inverted U, TP at $12,041
CO emissions	Selden and Song (1994)	Quadratic, RE	Insignificant results
		Quadratic, FE	Insignificant results
CO_2 emissions	Holtz-Eakin and Selden (1992)	Quadratic	Increasing emissions at all income levels
N0x emissions	Selden and Song (1994)	Cubic, FE	Inverted U, TP at $6200
		Cubic, RE	Inverted U, TP at $19,100
River water quality	Grossman and Krueger (1994)	Cubic, RE	Inverted U, turning point at $2000- $12,000
Dissolved O2 in rivers	Shafik and Bandyopadhyay (1992), Shafik (1994)	Quadratic, OLS	Quality decreases with income

Fecal coliform in rivers	Shafik and Bandyopadhyay (1992), Shafik (1994)	Cubic, OLS	Inverted U, TP at $1400, trough at $11,400
Deforestation	Shafik and Bandyopadhyay (1992), Shafik (1994)	Various	No statistically significant results
	Koop and Tole (1999)	Quadratic, RE	No statistically significant results
		Quadratic, FE	EKC for Latin American Countries only- TP at $8660
	Bhattarai and Hammig (2001)	Cubic	Latin America: Inverted U, TP at $6,600 Africa: Inverted U, TP at $1300, trough at $5,000 Asia: Trough at $2200, TP at $5500
		Quadratic, random coefficients model	No evidence of EKC
Composite environmental quality measure	Dasgupta et al. (1995)	Linear, cross-country	Positive linear correlation between environmental quality and income level
	Ekins (1997)	Comparison of ranks	No relationship
Per capita energy use	Suri and Chapman (1998)	Cubic, includes trade ratios	Inverted U, TP at $140,000
	Agras and Chapman (1999)	Model includes energy prices and trade variable	No relationship

* TP is turning point

As this table shows, empirical studies of the relationship between income level and various indicators of environmental quality find little support for an EKC. The strongest evidence is with urban SO_2 concentrations. With this variable, all studies but one found an EKC with a turning point within a range relevant to current world incomes. Some studies find evidence of an EKC with other environmental variables but with turning points either higher than most poor nations will reach even in the distant future, or even above current income levels of any country. This suggests that pollution levels will continue to increase and environmental quality will continue to decline with

economic growth well into the twenty-first century. Many studies find no evidence of an EKC.

The debate over the EKC is one of few debates in the economics literature that has received this much critical attention and in which economists question the findings of other economists so intently. The other hypothesis that also stimulated this heavy a response was Barnett and Morse's 1963 work regarding prices of natural resources being an indicator of their scarcity. They claimed that if prices do not increase, then resources are not becoming scarcer. Although their theory was roundly criticized, (see, for example Norgaard, 1990), the original theory still stands. As with the EKC hypothesis, this may be because those who stand to gain from this theory are the more powerful members of society.

As with the resource price debate, regardless of the mixed evidence supporting the EKC, the EKC hypothesis continues to have support, and often this support rests on the results from Grossman and Krueger, 1991 (Simply "Grossman and Krueger" from here on).

In the next section, Grossman and Krueger will be examined more closely and their results will be tested for robustness. In the following section, their results will be further tested through regression analysis of an expanded data set of urban air pollution concentrations.

1.3 A Closer Look at Grossman and Krueger, 1991

Grossman and Krueger consider the relationship between environmental quality and income level by looking at actual ambient pollution concentrations and relating this to GDP per capita. They focus on three types of urban air pollution: sulfur dioxide (SO_2), suspended particulate matter (SPM), and dark particulate matter or "smoke", as a proxy for environmental quality. Smoke is a measure of particulate matter that is large enough to be seen on a white screen. The particles are generally larger than 10 micrometers in diameter. SPM is a measure of smaller particulate matter of 10 micrometers or less in diameter.

1.3.1 The Data.

The air pollution data they use are from the Global Environmental Monitoring System (GEMS), a cooperative effort of the World Health Organization (WHO) and the United Nations Environment Program (UNEP). The GEMS program was started as a pilot program in 1973 by the WHO. In 1975, the UNEP joined with the WHO to operate this program. The goals of GEMS has been to strengthen the monitoring capabilities in participating countries, allow for the comparability of air quality among different cities, and provide information on global trends in air pollution and the effects on ecosystems and human health. Over the years, GEMS has included over 50 countries. Due to funding limitations, GEMS has now been subsumed under the Air Management Information System (AMIS) which is part of the WHO's Healthy Cities Programme. The

Gems data is now available to the public through the United States Environmental Protection Agency's (USEPA) Aerometric Information Retrieval System (AIRS).

The GEMS data are given in annual mean and median values for the 50^{th} and 95^{th} percentile of daily observations at each site. The 50^{th} percentile measurement for a site is the level of contamination for which the daily mean measurement value for half of the days of the year were below this amount and half of the days were above. The 95^{th} percentile measurement is the level at which the daily mean value for 5% of the days were above this measure, and for 95% of the days were below this measurement. The data are given in micrograms per cubic meter ($\mu g/m^3$) of air.

Data were collected in a total of 42 countries from the years 1977 to 1991. The number of sites where it was collected varied over time. For example, SO_2 data were collected in 47 cities in 28 countries in 1977, 50 cities and 31 countries in 1979, 46 cities in 29 countries in 1983, and 27 cities in 14 countries in 1988. The average number of sites per city is three.

The GDP data used are from Summers and Heston World Tables Penn Mark 5. It is given in 1985 U.S. dollars.

1.3.2 The Model

Given that the data they use are panel data, readings from multiple locations over multiple time periods, a simple ordinary least squares (OLS) model can not be used to analyze the data. Instead, Grossman and Krueger use two types of random effects models to examine the relationship between GDP per capita and urban air pollution concentrations. The random effects model is used to take into account components of the

error term that are common to a given year's measurements at different sites in the same city. If there is correlation in the error term for different sites in the same city-year, an ordinary leas squares regression will lead to an underestimation of the standard errors.(Kennedy, 1996)

The first random effects model includes coefficients identified as having probable impacts on pollution concentrations. This model is designed to expose the relationship between GDP per capita and urban air pollution across countries.

The second model includes fixed site effects which is designed to expose the relationship between GDP per capita and pollution concentrations over time holding the site constant. In other words, the random effects model which includes fixed effects (which will be referred to as the "fixed effects model" or FE below) is more dependent on change over time than on cross-country comparison.

They use a cubic form because they determined through plotting blocks of data that this form would best fit the data.

The first model is as follows:

$$POL = \alpha + \beta_1 GDP + \beta_2 GDP^2 + \beta_3 GDP^3 + \beta_4 C + \beta_5 CC + \beta_6 I + \beta_7 R + \beta_8 COM + \beta_9 M + \beta_{10} POP + \beta_{11} Y + \varepsilon \quad (1)$$

Where POL is the pollutants studied, α is the constant, GDP is GDP per capita, β_4 through β_8 correspond to dummy variables for whether the site is near the coast (C), whether the location of the site is identified as central city (CC), industrial (I), or

residential(R), and whether the county is communist or not (COM). β_9 corresponds to the method of measurement (M) for SO_2 for the regressions using the SO_2 data. This variable is left out for the SPM and smoke data. POP is for population density of the city. Y is for year to identify a universal time trend that could be occurring for pollution concentrations. The time trend is used to remove the effects of worldwide changes in pollution concentrations. For the particulate matter, they also included a dummy for whether the city is located near a desert. The final term is the error term.

To eliminate the problem of correlated error terms within city-years (each city each year), the random effects model divides the error term as follows:

$$\varepsilon = \alpha_{it} + \upsilon_i \qquad (2)$$

where i indicates site, and t indicates time. α_{it} is the normal error term related to each observation. υ_i is the represents the variation of each site's intercept from the main intercept.

The second model they use is the same as the first except that fixed site effects are taken into consideration by including separate dummy variables for each site in the sample rather than dummies for single attributes of the location such as residential or coastal. With the fixed effect model, if some site has specific attributes, such as being in a particularly windy spot or being near a factory, this will be picked up by the dummy variable for that site. This second regression equation is:

$$POL = \alpha + \beta_1 GDP + \beta_2 GDP^2 + \beta_3 GDP^3 + \beta_4 Y + \beta_5 M + \beta_6 \text{ to } \beta_{244} FSE + \varepsilon \qquad (3)$$

where FSE stands for fixed site effect dummies of which they have 239 for all 239 sites in the SO_2 sample. For SPM there are 161 dummies and for smoke 87.

Regressions were performed for both the 50th percentile and 95th percentile concentrations of SO_2, SPM, and smoke at each site during the measured year.

1.3.3 The Results

With the 50th percentile SO_2 data and with both the RE and FE models, Grossman and Krueger find that countries with low levels of income (or GDP per capita) have rising levels of SO_2 concentrations as they grow wealthier. With the RE model, at approximately US1985 $4,100 per capita per year, SO_2 concentrations begin to fall with economic growth. At approximately $14,000 per cap per year, they begin to rise again. With the model including fixed effects, the turning point is approximately $4500 per capita, with the rise beginning at $18,700. In other words, the results suggest an inverted U correlation, with pollution levels increasing at lower income levels and then beginning to decrease as countries reach approximately $4200 per capita.

Using the 95th percentile data for SO_2, the results obtained using both the RE and FE models were not significant at the .05 level.

They also find an inverted U pattern with the 50th and 95th percentile observations for smoke using the RE model. The turning point for the 50th percentile measurements is approximately US1985 $4,700 per capita per year. The turning point for the 95th percentile is approximately $5,000.

The results using the FE model for smoke were not significant at the .05 level.

Using the RE model, Grossman and Krueger find that suspended particulates appear to fall with increases of income at all income levels up to $9,000 per capita per year, at which point there is no more effect. However, when they include fixed effects, they find *increasing* levels of particulate pollution as GDP increases within the relevant range. The turning point is at $18,000 per capita. So these two models give quite different results.

In summary, twelve regressions were performed: three pollutants, 50th and 95th percentile measurements, and two different models. Of the twelve regressions, the EKC is supported by the results from four of these regressions: the 50th percentile SO_2 data using both the RE and FE models; both the 50th and 95th percentile smoke using the RE model. These results are summarized in Table 1.2 below.

TABLE 1.2 SUMMARY OF GROSSMAN AND KRUEGER 1991 RESULTS

DATA	*Random Effects Model*	*Fixed Effects Model*
50th percentile SO_2	Turning point at $4,100	Turning point at $4,500
95th percentile SO_2	Insignificant results	Insignificant results
50th percentile Smoke	Turning point at $4,700	Insignificant results
95th percentile Smoke	Turning point at $5,000	Insignificant results
50th percentile SPM	Decreasing in relevant range	Monotonically increasing
95th percentile SPM	Decreasing in relevant range	Monotonically increasing

Although only some of the regressions found evidence for an EKC, the EKC-supporting results appear to be quite compelling. Upon closer examination, however, there are a number of weaknesses with these results.

1.3.4 Limitations with the Grossman and Krueger Study

Singular aspect of environmental quality.

The most obvious shortcoming with the Grossman and Krueger study is that they equate environmental quality with three aspects of ambient urban air pollution. There are many elements that make up what one might think of as "environmental quality". Although it would be difficult to measure all of these elements, Grossman and Krueger give no support for using urban air pollution as a proxy for environmental quality. The Shafik and Bandyopadhyay study cited above attempted to study more aspects of environmental quality and found no particular relationship with GDP per capita common to these elements.

It seems reasonable to assume that different components of environmental quality may respond to economic growth differently. A paper by Ramon Lopez (1994) explores this issue. He presents a neo-classical model of the effect of growth on environmental quality in a two-country system. The abstraction from reality inherent in the exercise diminishes the empirical value of the model results. However, he makes a number of interesting observations, including that the effect of economic growth on the environment depends on the nature of the natural resource in question and whether the costs to these resources are internalized by individual producers.

One might also expect that certain environmental problems might be influenced by increased income levels more than other problems, *depending on the current income level of the country.* For example, increased income levels in a poor country might lead to improvements in drinking water quality, but degradation in air quality. Increased

income in a richer country might lead to improvements in air quality, but resource depletion and increased solid waste disposal problems. This was discussed in the introduction in terms of the "risk transition".(Smith, 1997) Looking solely at changes in ambient urban air pollution, and assuming that this measures human health exposure, misses the fact that perhaps an increase in urban air pollution corresponds with a decrease in indoor air pollution, with a corresponding decrease in human health risks. Changes in ambient urban air quality tell us little about overall changes in human health risks. Although our concern with environmental quality goes beyond human health, arguably human health is the primary concern, and ambient urban air pollution is a poor measure of the risks to human health. Decreases in urban air pollution concentrations with income are not necessarily correlated with improvements in human health and therefor with "environmental quality".

The Grossman and Krueger study was limited due to the lack of data on many aspects of environmental quality that could be related to income level. Not only are they only analyzing air pollution in this study, but only urban air pollution because this was the best environmental data available. And, although air pollution data are collected city-wide, GDP data are country-wide, which might ignore large discrepancies between the wealth of different cities, the split between rural and urban populations in different countries, as well as structural differences between different economies.

Grossman and Krueger do include water pollution in their next paper, but in 1991, the GEMS air pollution data were the largest international data set related to environmental quality.

An additional problem with using urban SO_2 concentrations as a proxy for environmental quality is that with many pollutants, including SO_2, stocks are more important than flows. As Andries Nentjes and Doede Wiersma (1992) point out, "Even in the face of a sharp reduction in the present flow of SO_2 emissions in the atmosphere, forests will continue to die, since the stock of SO_2 deposited will go on growing and the buffering capacity of the soil has been used up in the past."(p156) Even if SO_2 emissions are lower in wealthier countries, this does not indicate that their environmental quality is better. Lower emissions are nonetheless desirable since they lead to a slower buildup of stock.

The stock of pollutants is particularly relevant to problems such as climate change where climate-change gases in the atmosphere can have detrimental effects for many years after they are released. Arguably, a country's cumulative releases of pollutants into the atmosphere is as relevant as current emission levels.(See Smith, 1996)

Quality of data.

There are a number of problems with using the GEMS database that are significant but practically unavoidable because of the limitations with international environmental data. The reliability of the GEMS data is questionable largely because of the collection methods use. The particular placement of a monitor in a city can have significant impacts on the results. Since most cities had three or fewer monitors, actual ambient air quality could be misrepresented. As discussed above, the primary concern with air quality is human exposure levels. The main reason urban air pollution is

monitored is to determine how the air quality may be affecting human health. There are other secondary concerns with air quality such as reduced visibility and damage to property, but the primary reason for efforts to reduce urban air pollution is to reduce human exposure to pollutant which can have both immediate and long term health impacts. Depending on the placement of monitors, the data collected may not be representative of true exposure levels.

A further problems is that monitors are often not functioning well and so their results can be skewed. Different methods were also used to collect ambient SO_2 concentrations samples and different laboratories analyzed these samples as well. A study comparing the results from the different laboratories found that their results "deviated considerably from the reference value"(p. 7, WHO 1983), and stated that only 75% of the results obtained were acceptable.

GDP as proxy for income.

Grossman and Krueger use GDP per capita as a proxy for income. They had little choice but to use GDP since few other measures are available. However, GDP and GNP (gross national product) as measures of a country's income are being questioned more rigorously over time since they do not take into account loss of resources as well as certain economic activities, while measuring some economic activities that do not truly reflect positive growth. GDP per capita also may not accurately reflect the quality of life of inhabitant, nor the availability of excess income, which are both relevant to claims

about the demand for environmental quality being related to income. (This will be discussed further below)

An additional problem with using GDP in the context of relating income level to ambient urban air pollution is that GDP is a national measure, not city based. Urban income levels are generally higher that rural income levels. In countries with a high proportion of citizens living in urban areas, national average GDP per capita might be a fairly accurate reflection of urban GDP per capita levels. In countries with high proportions of rural inhabitant, however, national average GDP per capita is most likely understating urban GDP levels.

Cross-country model

The results obtained using the random effects model without fixed effects dummies depend largely on cross-country comparisons. In other words, the results show that emissions are lower in the poorest countries, highest in the middle income countries, and then low again. However, this does not mean that individual countries will go through these stages: that as middle income countries become richer, their air pollution concentrations will fall. Perhaps the structure of the world economy only allows for the richest countries to have declining air pollution concentrations while other countries continue to have industries with high emission levels.

There are a number of reasons to question results that derive from cross-country comparisons. Just because a wealthy country has cleaner air and water than a poor country does not mean one should expect the poor country to become cleaner as its

income level increases. The current development paths for countries are different than they were for the developed countries for a number of reasons: (1) The world now has new pollutants that did not exist earlier in the century; (2) The development of new technologies has allowed for improved efficiency and pollution reduction. It also allows for a much more rapid industrialization process since counties can import technologies rather than developing their own. This more rapid industrialization can have unforeseen impacts on the environment; (3) The world has seen a change in relative prices of goods and patterns of output that change the development process; (4) The proliferation of the automobile allows for instant environmental problems. Perhaps most importantly, (5) there is now increased trade in polluting activities. The world has seen over a decade of movement of energy and resource intensive industries from the wealthier nations to less developed nations.

As was discussed above, it may be that wealthy countries are cleaner because they export their pollution to poorer countries, although the data on this is mixed.

Thompson and Strohm(1996) survey the literature on trade and the environment. While they question the existence of a U-shaped relationship between income and environmental quality, they argue that the most plausible explanation for this hypothetical relationship is not changing preferences, but an "historical accident". They write:

> ...the development process of the last 30 years or so has produced a natural evolution of comparative advantage that has induced changing international patterns of production that have nothing to do with preferences for environmental quality; moreover, it is simply a historical

> accident that the richest countries have developed a comparative advantage in technologies -- and skill-intensive industries that are, by good fortune, less polluting than labor-intensive heavy industries.(p.373)

Vivek Suri and Duane Chapman (1998) consider the environmental impact of energy consumption associated with the manufacturing of goods. They find that the exportation of manufactured goods by poorer countries has contributed to the upward slope of the EKC while the importation of goods by industrialized countries allows for the downward slope of the EKC. In other words, richer countries may appear cleaner because they have exported dirtier industries to poorer countries.

Cross-country analysis may also miss the facts that wealthy countries may be cleaner because they have superior environmental endowments in the first place. Also, it may be that wealth allows societies to delay environmental problems while the types of environmental problems that poor countries experience are more immediate. Environmental costs can be exported in space and time.

John List and Craig Gallet (1999) analyze the relationship between per capita emissions of sulfur dioxide and nitrogen oxide and per capita incomes at the state level in the United States. They find that although some states exhibit a U-shaped relationship between these variables, the turning points varied greatly. Their results suggest that the model used to analyze cross-country data may restrict the form of the results, suggesting erroneously that all countries follow the same pollution /income trajectory.

A fixed effects model's results do not depend on cross-country comparison, and so are a more reliable indicator of change over time within each country. Of the six FE

regressions that Grossman and Krueger ran (50^{th} and 95^{h} percentiles for three pollutants), only the 50^{th} percentile SO_2 model supports the EKC hypothesis. The 95^{th} percentile SO_2 results were insignificant as were the results for smoke, and the SPM results show rising concentrations at all relevant income levels.

Reduced form equation.

Grossman and Krueger use a reduced form equation (which simply identifies correlation), rather than a structural equation (which includes a specific form and parameterization). Reduce form equations have the advantage of not needing data for the parameters, which can be difficult to collect. By considering ambient pollution levels rather than the emissions of each sector of the economy and the factors influencing these emissions, Grossman and Krueger were able to take into account all of the potentially beneficial effects of economic growth, without information about the underlying processes.

The disadvantage of a reduced form approach is that it can not be used to separate direct from indirect effects of growth. They explain their results in terms of wealthier people caring more about the environment and inducing their government to regulate pollution, but their reduced form equation provides no information on causal mechanism so policy prescriptions should not follow from their results.

By considering ambient pollution levels rather than the emissions of each industry, Grossman and Krueger were able to take into account all of the ways in which economic growth and environmental quality may be related – i.e. focus on the left side of

equation. However, by using ambient air pollution data, their analysis also includes the effects of natural features of the landscape, natural endowments (ex. coal vs. natural gas), climate, and cultural attributes. So while they were able to encompass many more influences on environmental quality in their study, as opposed to focusing on changes in industrial composition alone for example, they lost the ability to determine what mechanisms lead to these pollution levels. Because of these problems, broad, multi-country, statistical analysis can not be expected to provide results that give us reliable information about the real world. We can not know, for example, whether a downturn in air pollution at a given income level is an artifact of structural features of national economies or a results of social factors.

It could be that there are intervening factors that lead to the apparent relationship between GDP and air pollution. Promotion of these other factors could lead to decreases in air pollution irrelevant of changes in GDP. As was cited above, Ezzati et al.(2001) construct a structural model that considers the socioeconomic and environmental variables that interact with economic growth. Using parameters estimated from empirical studies, they find that an inverted-U relationship between environmental quality and income level can arise only in very specific circumstances.

It is worth emphasizing that correlation does not imply causation. There may be certain factors that lead countries to both have higher income levels and protect environmental quality more. Or maybe the causal link goes in the opposite direction than normally thought. Maybe countries that protect the environment can then have higher levels of economic growth.

Regression analysis

An additional concern with the Grossman and Krueger study is the quality of their data analysis. They fit the data to a cubic form. This is just an approximation of the shape of the relationship. Also, although their results are statistically significant, the R^2 is small in many cases – as low as 0.125. This means that only 12.5 percent of the variation in air quality is explained by their model. Given the number of variables in their model in addition to income, this suggests that income may have only a small influence over environmental quality and actually there may be other factors that are more closely related to level of environmental quality.

Using cross-country analysis that restricts all countries to the same shape Kuznets Curve and the same turning point may also provide statistically biased results, as was shown by List and Gallet's (1999) results discussed above.

There are some additional statistical concerns related to the use of panel data. For one, these results are not corrected for autocorrelation, which could skew the results. Correcting for autocorrelation in unbalanced panel data is no easy feat, but, because of this problem, these results should be taken with a grain of salt. Furthermore, Grossman and Krueger do not test for the acceptability of using a random effects model. As will be presented below, the Hausman test rejects the random effects regressions I perform with Grossman and Krueger's data set using their model. This implies that Grossman and Krueger's fixed effects models gave more consistent results. Again, only the 50^{th} percentile SO_2 results support the EKC hypothesis using a fixed effects model.

Fixed effects results are limited in that they can not be extrapolated to pertain to cases outside of the data set. These results are only relevant to the cases represented by the data studied and can not be used to extrapolate to future behavior of countries within the sample, or to countries outside of the sample. This is not true of random effects. Random effect results can be considered to describe a wider set of cases than the ones studied.(Kennedy,1996) Yet, if RE models are not reliable and FE model results are not relevant beyond the data set in question, policy prescriptions should not be based on these results.

1.3.5 Data Analysis

To further scrutinize the results of Grossman and Krueger, I obtained a copy of the data used by Grossman and Krueger from Gene Grossman via his research assistant Jim Laity. The analysis below is focused on their results for the 50^{th} percentile SO_2. There are two reasons for this. For one, the results obtained by List and Gallet, as well as the results of the Hausman test I conduct, suggest that the FE model provides more reliable results with the data set being used. The only FE regression conducted by Grossman and Krueger that supports the EKC was with the 50^{th} percentile of SO_2 data. Secondly, other authors have found support for an EKC using ambient SO_2 concentrations as the independent variable, so this aspect of environmental quality deserves further scrutiny.

I made four changes to the data set provided so as better to approximate the data as described by Grossman and Krueger in their 1991 paper. One change was to add a dummy variable for communist countries, only China and Poland in this case, which was

not included in the data I received. A second change was to drop the data for Kuwait City, which had the highest GDP/cap, since this data was evidently not used by Grossman and Krueger. (They state that there are only two countries in their sample with per capita incomes over $16,000 – Canada and the United States. Therefor, Kuwait, with per capita income of approximately $23,000, must have not been used by Grossman and Krueger.)

The third change was to drop the three highest readings for the 50th percentile SO_2 since Grossman and Krueger state that the highest SO_2 reading is 291 micrograms per cubic meter of air, and there were three reading higher than this in the USA 1977 and Argentina 1988 and 1989. A final change was to eliminate data for the years 1989 to 1991, which was not used in Grossman and Krueger 1991. The data set provided had pollution data for these years but not GDP data.

I also tried replacing reported zero SO_2 concentration values with "missing" since it appeared that zero measurements were extremely unlikely in many cases. For examples, some sites in a city would have a high SO_2 value and another would have zero for the same year. Grossman and Krueger's reported mean and standard deviation of the data suggests that they used the zero values rather than "missing" values for SO_2.

The original data set as provided had 1497 observations of 50th percentile SO_2. After the changes listed above, the new data set had 1370 observations – the same number reported by Grossman and Krueger. The 50th and 95th percentile SO_2 means and standard deviations were also the same as those reported by Grossman and Krueger. The following table provides some descriptive statistics of the data base:

TABLE 1.3 SUMMARY STATISTICS OF GEMS SO_2 DATA CORRECTED BY THE AUTHOR

	Observations	*Mean*	*Standard Deviation*
SO_2 50th % as reported in G&K 1991	1370	33.08	33.11
SO_2 50th % in data provided	1497	34.34	38.86
SO_2 50th % after changes listed above	1370	33.08	33.12
SO_2 50th % with "0" SO_2 values replaced with "missing"	1070	42.3	31.80
GDP in data base as given	1375	7498	4868
GDP after changes	1370	7461	4817

As is shown in the table, the 50th percentile SO_2 data closely resembled that of Grossman and Krueger after these changes. Grossman and Krueger did not give summary statistics for GDP per capita so I do not know how closely the data set after these changes resembles theirs.

I also found that the data provided on population density of the cities, one of the variables used by Grossman and Krueger in their RE regressions, did not change over the years for each city, despite growth in population in these cities. Also, some of the values appeared to be population density of the country rather than the city in question. I was unable to find more reliable data on urban population density for the years covered in the data base. There were also 25 missing values. I do not know if Grossman and Krueger used this population density data or other, more reliable data that reflects population growth, in their regressions. In order to try to replicate their results without losing any observations, I replaced the 25 missing density values with approximations, using density data per country.

Using the data base provided, with the changes listed above, I was able to roughly replicate Grossman and Krueger's 1991 RE SO_2 results. The closest approximation was obtained without using the density variable and replacing "0" SO_2 with "missing". The regression results are given in Table 1.4.

TABLE 1.4 RE MODEL RESULTS FOR SO_2

	GDP	*GDP²*	*GDP³*	*sample size*	*R2*	*Turning Point*
1. G&K SO_2 50th % RE model results	7.14*	-1.12*	.041*	1370	.15	4119
2. RE results using density data as provided	11.22**	-1.62**	.057**	1347	.14	4561
3. RE results without using density variable	10.52**	-1.53**	.054**	1370	.14	4519
4. RE results using density variable with added density values	11.06**	-1.57**	.055**	1370	.14	4667
5. RE results using density data provided and replacing "0" SO_2 with "missing"	7.99*	-1.15**	.038*	1070	.09	4460
6. RE results without using density variable and replacing "0" SO_2 with "missing"	7.70*	-1.12**	.037*	1070	.09	4394

* Significant at the .10 level
** Significant at the .05 level

The turning points are all slightly higher than that found by Grossman and Krueger. The R^2s are all slightly lower. Although my results were closer to the results reported by Grossman and Krueger using the replaced zero values, the reported mean of the 50th percentile SO_2 data suggest that Grossman and Krueger used the zero values

rather than "missing". Therefor, for the remainder of the analysis I will use the data as provided with the zero values. I will also not include the density variable given the problematic nature of this variable.

The reliability of the RE model was tested using a Hausman test on model 3 above. The Hausman test strongly rejected the hypothesis that the random effects and fixed effects models provide the same results, with a probability greater than .0000. This implies that the random effects results can not by relied upon to give consistent results.

I then performed a regression including fixed-site effects identical to the one performed by Grossman and Krueger with their SO_2 data as shown in equation (3). The program used to analyze the data, STATA, now has the capability of transforming the data, eliminating the need to include dummy variables for each site in the regression. The mean of each variable for each site is subtracted from the data for that site, and then OLS is performed on the transformed data. So although the results are the same as those from equation (3), the equation is as follows:

$$POL = \alpha_i + \beta_1 GDP + \beta_2 GDP^2 + \beta_3 GDP^3 + \beta_4 Y + \beta_5 M + \varepsilon \qquad (4)$$

Here, rather than α_i being a component of the error term, it is treated as a regression parameter.

In addition to cubic GDP, the model includes two other independent variables: year (Y), to capture any global changes in emission level, and method of measurement (M), to capture differences in how SO_2 is measures. For this model, I regressed both 50^{th}

percentile SO_2 and 95th percentile SO_2 to see if my results were similar to those reported by Grossman and Krueger.

Again my results were quite similar to Grossman and Krueger's results. The results for 95th percentile are not significant, yet the results from 50th percentile are highly significant, as was the case for Grossman and Krueger. These results are shown in Table 1.5.

TABLE 1.5 COMPARISON OF GROSSMAN AND KRUEGER RESULTS AND MY RESULTS USING GEMS DATA SET

	GDP	*GDP2*	*GDP3*	*sample size*	*R2*	*Turning Point*
SO_2 50% FE results reported by G&K	12.54* (4.69)	-1.74* (0.52)	0.05* (0.02)	1370	0.76	4461
SO_2 50% FE results using data set provided	12.79** (4.87)	-1.82** (0.50)	0.063** (0.02)	1370	0.07	4624
SO_2 95% FE results reported by G&K	-8.28 (15.11)	0.10 (1.67)	-0.00 (0.06)	1370	0.77	--
SO_2 95th % FE results using data set provided	-16.55 (15.80)	1.18 (1.64)	-.03 (0.05)	1370	0.05	--

* Significant at the .10 level

** Significant at the .05 level

The importance difference between our results is the difference in R^2. Their R^2 is higher by a factor of 10. This is because their R^2 includes the influence of each site dummy on the regression rather than just the influence of cubic GDP, year, and the method of measurement. In other words, using the dummies, the importance of each dummy in the regression is included in the calculation of R^2. Using a fixed-site effects

model, only the influence of the independent variables specified on the dependent variable are reflected in the R^2.

To ensure that the results using the STATA transformed data are the same as using dummies for each site, I ran the same regression using a dummy for each site. It yields the same regression coefficients, yet the reported R^2 is 0.71, rather than 0.07.

So although Grossman and Krueger's FE results can be roughly replicated with the data provided, an R^2 of 0.07 suggest that the relationships between GDP and 50th percentile SO_2 is very weak, although still statistically significant.

1.3.6 Tests of Robustness

Data Subsets

An additional way to test the robustness of Grossman and Krueger's results is to see if their results hold for subsets of the data. I performed a number of regressions with different subsets of the data.

In one case, I created a subset by removing China from the data set. There are 152 observations for China, more than for any other country, so I hypothesized that this one country could have an important impact on the regression results. My hypothesis was correct. I found that the FE regression results of cubic income on 50th percentile SO_2 become insignificant (P>|t| = .31, .96, .65 for GDP, GDP2 and GDP3 respectively) if China is dropped from the data base. The RE results are still significant without China, however, once again, the Hausman test rejects the RE model in favor of the FE model.

In another case, I dropped the data that reported zero concentrations of SO_2. As was stated above, often the zero measurements seem implausible given that other sites in

the same city have high concentration measurements for the same years. Given the difficulties with the data, due to different measuring and analysis techniques discussed above, the zero measurements may well be erroneous. I found again that the regression results are insignificant if reported zero concentrations of SO_2 are dropped.

A fixed effects regression can also be performed with the data split into two groups – countries with GDP per capita less than $4500 and more then $4500. I selected $4500 as the place to split the data as it is the approximate turning point at which Grossman and Krueger find SO_2 concentrations decrease with income. In this case, linear and squared GDP, in addition to cubic GDP, were used to capture the first half and the second half of the curve.

For the subset of countries with GDP less than $4500 per capita per year, the results were not significant using a quadratic form. I found a negative coefficient, -7.40, with a significant greater that .10 using a linear model. Here, the results of 50^{th} percentile SO_2 concentrations against cubic GDP are significant at the .001 level. These results suggest a turning point at $1863/cap.

For the subset of countries with GDP greater than $4500 per capita per year I did not find significant results using a linear or quadratic form. However, the results of 50^{th} percentile SO_2 concentrations against cubic GDP are significant at the .10 level. These results suggest a turning point at $7,507/cap.

Using a fixed-site regressions for countries with GDP less than $7000 per capita per year (approximately the mean GDP for this data set), the results using cubic GDP are significant at the .001 level. The peak is at $2107 and the trough is at $5176. These

results contradict the results found with the entire data set. Again, the R^2 is very small. The results using squared GDP are insignificant. The linear relationship is significant at the .10 level, with a coefficient of –6.0, suggesting declining levels of SO_2 with income.

Results for the cubic form of 50th percentile SO_2 on income are insignificant for countries with income greater than $7000 per capita. For the quadratic form, the results are significant at the .10 level, showing a U-shaped relationship. And the results are insignificant for the linear form.

The following table summarizes these results.

TABLE 1.6 SUMMARY OF REGRESSION RESULTS USING SUBSETS OF THE 50TH PERCENTILE GEMS SO_2 DATA

Model	*GDP*
FE with China dropped	Results insignificant
FE with reported zero concentrations dropped	Results insignificant
FE with GDP<$4500	Linear Model: Significant at .10 level, coefficient of -7.4. Quadratic Model: Results Insignificant. Cubic Model: Significant at .001 level, turning point at $1863.
FE with GDP>$4500	Linear and Quadratic Models: Results insignificant. Cubic Model: Significant at the .10 level, turning point at $7505.
FE with GDP<$7000	Linear model: Significant at .10 level, coefficient of –6.0. Quadratic model: Insignificant results. Cubic Model: Significant at the .001 level, peak at $2107 and trough at $5176.
FE with GDP>$7000	Linear and Cubic Model: Insignificant results. Quadratic Model: Significant at .10 level, U-shaped relationship.

More interesting perhaps, if you split the cities in the database into two groups alphabetically, very different results again are obtained. Table 1.7 gives the mean GDP and 50th percentile SO_2, and the regression results from splitting the data in this way.

TABLE 1.7 SUMMARY STATISTICS AND RESULTS FROM DATA SET SPLIT ALPHABETICALLY

	Sample Size	*Mean GDP*	*Mean SO2 50*	R^2	*Turning Point*
Full data set	1370	7.46	33.1	.07	4624
Group 1	703	7.67	39.5	.18	2232
Group 2	667	7.24	26.3	.005	8666 but results insignificant

In summary, by splitting the data in various ways, I am not able to replicate the results obtained with the entire data set, which demonstrates the limited robustness of Grossman and Krueger's results.

Annual Mean Value SO_2 Concentrations

Additionally, although Grossman and Krueger looked at 50th and 95th percentile daily means of measured SO_2 levels, the GEMS data also provides the annual mean measurement for each site. The following table given shows how these values vary from the 50th and 95th percentile daily means.

TABLE 1.8 50TH PERCENTILE, 95TH PERCENTILE, AND ANNUAL MEAN SO_2 DESCRIPTIVE STATISTICS

	Sample Size	*Mean*	*Standard Deviation*	*Minimum*	*Maximum*
50th % SO_2	1370	33.1	33.1	0	291
95th % SO_2	1370	93.3	90.0	0	915
Annual Mean SO_2	1279	48.8	40.66	2.36	354

Regressions were performed using the annual mean measurement of SO_2 , rather than the 50th and 95th percentile measurements, to which Grossman and Krueger restricted their analysis. The following table gives the results. Again, the RE regression includes all of the variable used by Grossman and Krueger except for population density. The FE regression includes year and instrument of measurement type, as in equation (3).

TABLE 1.9 SO_2 REGRESSION RESULTS FOR RE AND FE MODELS

	GDP	*GDP²*	*GDP³*	*sample size*	*R^2*	*Turning Point*
RE model using annual mean values of SO_2	6.68 (3.44)	-0.98* (.43)	0.03* (.015)	1279	.17	4309
FE using annual mean values of SO_2	5.33 (5.45)	-0.90 (.57)	0.03 (.02)	1279	.09	3614

* Significant at the .10 level
** Significant at the .05 level

The RE regression's findings are similar to those for 50th and 95th percentile, however the Hausman test once again rejected this model at the .0001 level. The FE results are not significant at the .10 level.

National Averaged Data

I also tested to see if a relationship between SO_2 concentrations and GDP appeared if I calculated a national average pollution level for each country, each reporting year. I did this for two reasons. The GEMS data for air pollution concentrations are unbalanced in that some countries, such as the U.S. and China, have many data points while other countries have as few as two. By calculating a national average for each year a country has data, each country has equal weight for the years it reports data. The second reason is that GDP is a national level variable, yet the air pollution data is city level. By calculating a national average, both variables are at the national level. I chose to look only at SO_2 because, as was stated above, the results most commonly cited to support the EKC is based on this pollutant.

Of course there are many problems with calculating a national average. Some nations may have most monitoring sites in industrial and downtown areas while others also report data from residential areas, which tend to be less polluted. Also, some countries may have a large urban population who are exposed to the pollution levels detected at monitoring sites, while other countries may have large rural populations. Also, within a given country, some cities are more polluted than others are and in some countries the most polluted cities may be monitored while less polluted cities are not monitored. The cities from which pollution data is collected may not be representative of the nation as a whole. There are striking differences in SO_2 concentration levels in different small cities in Argentina for example. Some nations may appear to have higher

or lower urban pollution levels than the true national average due to the cities that were selected for the database.

Further, in some countries where many cities are monitored, some cities are more polluted than others are yet they may have very different population levels and so would not be weighted evenly when making a national average given that our primary concern with pollution levels is human exposure. Larger cities account for greater human exposure.

In order to take into account this last problem, I also calculated national average pollution levels using a population-weighted mean. Cities with larger populations are weighted more heavily than cities with smaller populations because cities with larger populations account for a greater amount of than cities with small populations. Of course there are a number of problems with calculating a national mean level in this way as well. For one, while there are multiple years of data, I only collected population data for a single year for each country, thus assuming that the proportional population differences between the cities does not change over time. Secondly, the population data itself can be unreliable for estimating exposure in that some city boundaries are broader than others are. Is the population data for the metropolitan region or just the city proper? Thirdly, the pollution data for some cities comes mostly from downtown areas while for others it includes residential or industrial areas which may not be representative of the city as a whole. Despite these shortcomings, population-weighted means are still superior to simple averages in that they attempt to take into account exposure levels.

For some countries, I did not calculate a population-weighted mean either because the pollution levels in the different cities were very similar or because of difficulty finding population data for small cities.

Because the regression includes only national level data, variables that are site or city specific can not be included in the analysis. I used a fixed country effects model, rather than fixed site effects as was used above. I did not use a random effects model because of the limited number of variables in the equation. The regression equation is the same as equation (7) above.

Using the national averaged data that are not weighted by city population levels the results of cubic GDP on 50th percentile and mean concentration levels were not significant. For the 95th percentile, the results were significant and are given in Table 1.10 below. Using the population-weighted average for SO_2 level, the regression results were very similar with only 95th percentile SO_2 giving significant results. These are also reported in the table below.

TABLE 1.10 NATIONAL AVERAGED SO_2 REGRESSION RESULTS FOR FE MODELS

	GDP	*GDP2*	*GDP3*	*sample size*	R^2
95th percentile SO_2	-86.2 (28.6)**	7.27 (2.87)**	-0.192 (0.10)**	324	.11
95th percentile SO_2 population weighted	-86.8 (28.3)**	7.35 (2.84)**	-0.196 (0.09)**	324	.12

* Significant at the .10 level
** Significant at the .05 level

With both of these regressions, we find a U-shaped relationship rather than an inverted U, as can be calculated from the regression coefficients. The trough is at approximately $6000 per capita per year. The peak is not until approximately $350,000

per capita per year. In summary, regressing SO_2 levels and cubic GDP using average pollution levels for each country-year does not give results that support the EKC hypothesis. Testing the relationship between GDP and urban air pollution using nationally averaged data has some limitations, as discussed above. However, given that GDP is a national level variable, it makes sense to test this relationship using nationally averaged air pollution. The fact that the results are the opposite of those found using site specific data again casts doubt on the reliability of Grossman and Krueger's results.

Quadratic Model Form

It is interesting to note that although Grossman and Krueger restrict their analysis to the cubic form of GDP, a U-shaped or an inverted U-shaped relationship between two variables is usually demonstrated with a quadratic form, rather than a cubic form. A cubic form suggests that as the dependent variable increases, the independent variable first rises, then falls, then rises again, or vice versa. Grossman and Krueger are not arguing that above a certain income level, pollution levels increase again. The EKC actually could be better described by a quadratic form.

Grossman and Krueger chose the cubic form of GDP because they felt that this better fit the data. However, one could also fit the data to a quadratic form, similar to equation (4):

$$POL = \alpha_i + \beta_1 GDP + \beta_2 GDP^2 + \beta_3 Y + \beta_4 M + \varepsilon \qquad (5)$$

The results of a FE regression using 50th percentile SO_2, 95th percentile SO_2 and mean concentrations are not significant. This also suggests a weakness with the EKC hypothesis. The data does not hold up to an alternative model form that is equally viable given the proposed relationship.

Cook-Weisberg test for heteroskedasticity

One final test for robustness is the Cook-Weisberg test for heteroskedasticity. This test on Grossman and Krueger's fixed effects results shows that one can reject the hypothesis of constant variance with a certainty greater than .0001. Therefor, the residuals are heteroskedastic and the results may be inconsistent.

1.3.7 Conclusion to Examination of Grossman and Krueger Results

The broadly cited "evidence" of an EKC found by Grossman and Krueger in their 1991 paper is based primarily on their findings for smoke and SO_2 concentrations. Further examination of these results has shown that the RE model results are inconsistent and therefore only the 50th percentile SO_2 results support an EKC. However, the low R^2 of these results suggest that the relationship between SO_2 and income is weak at best. Tests for robustness of these results by splitting the data, using alternative measures for SO_2 concentrations, using national-averaged data, and using an alternative model form did not support the EKC hypothesis.

1.4 Data Analysis with the AIRS Data Set

The relationship between income level and urban air pollution concentrations can be further explored with the use of an expanded and updated data set. Updated GEMS data are available from the United States Environmental Protection Agency (EPA). Public access to this data is available through the EPA's Aerometric Information Retrieval System (AIRS).

The AIRS database was obtained from William Harbaugh of the University of Oregon.(Harbaugh et al., 2000) He generously sent me a database that he had already compiled which includes the AIRS data from EPA as well as other variables such as GDP per capita. The variables provided by AIRS are slightly different than those provided by the GEMS database. The EPA does not include in their database the method of measurement used to collect samples, which was included in the Grossman and Krueger regressions. More importantly, the AIRS data does not give 50^{th} and 95^{th} percentile measurements for each site each year. It just gives the mean annual measurement, which was also included in the GEMS database. Analysis of the AIRS data must therefor focus on annual mean measurements rather than the 50^{th} and 95^{th} percentile measurements, which were the focus of Grossman and Krueger's work.

The AIRS database does not only expand upon the GEMS data used by Grossman and Krueger by adding the more recent year of data, from 1989 to 1992. The AIRS database also includes new data for the years 1971 to 1976, and revises some of the data for the years 1977 to 1988, which were in the original GEMS data set. Harbaugh et al.

(2000) compare the GEMS data used by Grossman and Krueger 1994 with the updated AIRS data. They find that there were a number of duplicated observations. They eliminated these duplicates in the new AIRS data set. After these eliminations, the number of observations for SO_2 contained in the AIRS data base is 2401. In the GEMS database used by Grossman and Krueger the number is 1370. There are 1092 observation for SPM as opposed to 1021 in the earlier data set. There are 710 observations for smoke as opposed to 506 for smoke in Grossman and Krueger 1991. There are a total of 77 cities in the Grossman and Krueger GEMS database for SO_2 and 130 cities represented in the AIRS SO_2 database.

The following table gives the summary statistics of the air pollution concentrations data provided in the AIRS database.

TABLE 1.11 SUMMARY STATISTICS FROM AIRS DATA BASE

	Sample Size	*Mean*	*Standard Deviation*	*Minimum*	*Maximum*
SO_2 Annual Mean	2401	49.4	50.9	.78	1159.8
SPM Annual Mean	1092	176.5	145.7	9.8	795.8
Smoke Annual Mean	710	56.7	50.6	1.3	306.8

The income data Harbaugh et al. used in their database is an updated version of that used by Grossman and Krueger 1991. It is GDP per capita chain method in 1985 US$ from the Summers and Heston (1991) Penn Mark 5 World Tables.

Following Grossman and Krueger, I tested two different models using the updated data: A random effects model and a fixed effects model of similar form to equations (1)

and (3) above . However, since the available variables differ slightly, the models are not identical to the models used above. The random effects model is as follows:

$$POL = \alpha + \beta_1 GDP + \beta_2 GDP^2 + \beta_3 GDP^3 + \beta_4 C + \beta_5 CC + \beta_6 I + \beta_7 R + \beta_8 D + \beta_9 COM + \beta_9 Y + \varepsilon \quad (6)$$

Where POL is mean annual concentration of the pollutant, α is the constant, GDP is GDP per capita, β_4 through β_8 correspond to dummy variables for Coast, Central City, Industrial, Residential, Desert (used for SPM and smoke but not for SO_2) COMmunist country or not, and Y is for year to identify a universal time trend.

The fixed effects model is:

$$POL = \alpha_i + \beta_1 GDP + \beta_2 GDP^2 + \beta_3 GDP^3 + \beta_4 Y + \varepsilon \quad (7)$$

where i is for each site in the database. As was explained above, the fixed effects model transforms the data before running OLS such that the results are equivalent to including a dummy for each site in the regression. There are 282 site dummies for SO_2. For SPM there are 148 site dummies and for smoke there are 92 site dummies.

The results for these regression models for SO_2, SPM and smoke are given in the following table:

TABLE 1.12 INCOME LEVEL AND AIR POLLUTION CONCENTRATIONS USING AIRS DATA

	SO_2 RE	*SO_2 FE*	*SPM RE*	*SPM FE*	*Smoke RE*	*Smoke FE*
GDP	-15.20**	-20.93**	-16.02*	40.87**	68.30**	55.35**
GDP^2	1.43**	1.94**	.878	-1.94	-9.36**	-7.24**
GDP^3	-.038**	-.051**	-.016	.032	.385**	.298**
Peak	$17,440	$17,580	--	--	$5540	$6180
Trough	$7640	$7780	--	--	$10,660	$10,010
Number of Observations	2381	2381	1085	1085	687	687
Hausman Test Results[a]	.0035	--	.0000	--	.0038	--
R^2	.059	.08[b]	.50	.08	.22	.18

* Significance greater than .10
** Significance greater than .05
[a] Result gives the probability that the difference in coefficients between two models (RE and FE) is not systematic. A test result less than .10 suggests that the RE model should be rejected in favor of the FE model.
[b] R_2 for the Fixed Effects models reports the R_2 within rather than R_2 overall since this model depends on results from changes within each site.

The regression results for smoke support an inverted U-shaped relationship between income per capita and the pollutant studied, as well as a turning point within the range found by Grossman and Krueger. For SO_2, the results suggest a U-shaped relationship, rather than an *inverted* U-shaped relationship, with a trough preceding the peak pollution level. The peak of approximately $17500 is at an income level far above most countries per capita income, and at a level that many countries may never reach. For SPM, the results of the cubic form are not significant. I did not therefor calculate turning points.

Given the insignificant of the regression coefficients using a cubic form GDP for SPM, I tried a regression using squared GDP to see if I would obtain significant results between SPM and income, supporting the inverted U-shaped relationship. The Hausman

test rejected the RE model. The results of the FE model were significant for both coefficients at the .05 level. They suggest an inverted U with a turning point at $16,920. In other words, pollution will increase with income until income reaches $16,920 per capita. Again, this income level may never be reached by some countries.

In summary, regression analysis conducted with an expanded database also found little support for an EKC. Only the regression results for smoke suggest the existence of an EKC with a turning point in the range of $5000-$6000. However, at approximately $10,000 per capita per year, smoke concentrations start to rise again. So, although empirical investigations of urban air pollution, as a proxy for environmental quality, and income level are found to be the strongest evidence of an EKC, both the results from Grossman and Krueger (1991) and the regression analysis presented in this section suggest that this relationship is weak at best.

Despite the limited empirical evidence of an EKC, the belief in the existence of an EKC seems to persist. The next section will consider reasons why this might be the case.

1.5 Why Has Link Between Income and Environmental Quality Been So Readily Accepted?

Even though existing studies find no consistent relationship between economic growth and various aspects of environmental quality, the idea that economic growth leads to environmental quality improvement has been readily adopted by many authors. (See, for example, The World Bank, 1992; Beckerman, 1992; Copeland and Taylor, 1995)

This might in part reflect the fact that those who benefit most readily from economic growth, also may have an interest in controlling the policy debate. There is no doubt that focusing on solving problems through increased economic growth benefits those who control capital in a society and who profit more directly from production. If it is believe that economic growth will ultimately solve many of society's problems, then there is little need to regulate how this growth occurs along the way, which may lead to increased profits for some members of society.

The focus on economic growth perhaps also reflects the increased belief in economic growth as the solution to many public problems. John Kenneth Galbraith (1958) discusses this phenomenon in terms of "the paramount position of production." He argues that modern economists see economic growth as the panacea to a variety of social problems such as security, equality and productivity, and this has blinded policy makers as well as portions of the public to the genuine goals of true increased equity and security . He argues that this preoccupation with growth results from the science of economics itself, which focuses on production more than demand. Herman Daly (1993) discusses the evolution of the faddish "political economy of growth" which has supplanted the traditional "political economy of scarcity". Uday Desai notes that: "Whether economic growth is used in reality to relieve the desperate poverty of the millions or to enrich a small elite, the goal of economic growth has become an overwhelming justification for public policies."(1998b, p. 295)

Perhaps the focus on income level reflects the current preoccupation with economics in our society. Free market mechanisms are being adopted to solve policy

problems as they are seen as more efficient and therefor superior. The market is admired as the way to allocate resources and direct growth. Westerners have to some extent adopted an economic world view. The social science disciplines are becoming more like economics. Positive political economy, which uses equations to understand actions of individuals and groups, has become a popular sub-discipline in political science. The economics paradigm is used to understand many complex social phenomenon such as rates of resource extraction and optimal control of externalities, even though evidence abounds that what the economic theory predicts rarely obtains. (See Daly and Cobb, 1989; Giddens, 1990; Norgaard, 1994)

It is also true that it is easy to measure income level using GDP as a proxy (which certainly has problems in and of itself) so researchers who wish to do multinational, large scale comparisons may be attracted to income as a variable. Other variables may be more difficult to measure and less amenable to numerical analysis, so they receive less scrutiny. For example, in the 1950s, it was held that the greatest determinant of population growth rates was income level. Subsequent research showed that the level of education for women plays a significant role in determining fertility levels. Data on education level had not been as accessible as data on income levels during earlier periods of this research.

As was noted in the Introduction, it is also more difficult to study the relationship between environmental quality and other variables such as democracy because other variables may be harder to define and measure. Perhaps this partially explains why income has received more attention recently.

The focus on the relationship between income and environmental quality might also reflect a strong theoretical foundation supporting this relationship: that wealthy people care more about the environment than poor people do. As income increases and preferences change, environmental quality will improve. In other words, increased income leads to an increased demand for environmental quality. For example, Shafik and Bandyopadhyay (1992) state that the improvement of some environmental indicators with higher income levels reflect social choice. Wilfred Beckerman (1992) states "As people become richer, their priorities change and environment moves up in the hierarchy of human needs."(p.7). And from Nancy Birdsall and David Wheeler (1992), "Higher income in developed countries produces greater demand for clean air and water."(p.159)

The idea that environmental quality will improve at higher income levels rings true to many people because of this belief in demand for environmental quality changing with income level. The existence of an EKC in turn reinforces the belief in increasing demand for environmental quality at higher income levels which also serves the interests of certain segments of global society. Steven Brechin and Willett Kempton (1994) write, "..the assumption of lower developing-country environmental concern has simultaneously served conservative and pecuniary arguments that industry should be developed without concern for its environmental impacts in poor countries...This stereotype – that only rich people and nations are environmentally concerned – has such political utility that it would probably survive without theoretical support."(p.246) Or, evidently, without much empirical support either.

Even if it is true that there is a positive relationship between income and some aspects of environmental quality, the studies cited above that support the EKC provide no evidence as to what causal mechanisms make up this relationship, limiting the feasibility of making policy prescriptions based on this relationship. These studies fail to separate out the direct effects from the indirect effects of economic growth. They suggest that undifferentiated economic growth alone will act to improve environmental quality.

A number of mechanisms in addition to changing demand have been identified in the literature that link environmental quality and economic growth. The evidence for the existence of these mechanisms is mixed. In the next section, I will briefly discuss these mechanism. I will begin with four of the ways that environmental quality and income can be linked: the scale effect; the composition of GDP effect; the composition of industry effect; and the technique effect. I then will present the results of empirical work related to a these mechanisms. A full survey of the literature related to these mechanisms is unfortunately beyond the scope of this dissertation, although certainly these mechanisms warrant further study.

Two other mechanisms, population growth rates and the supply side of environmental protection, will then be considered briefly. The section finishes with an examination of the idea of changing demand for environmental quality with income. Changing demand is considered more fully than the others due to the relative importance of this belief in supporting the EKC hypothesis.

1.6 Mechanisms linking economic growth and environmental quality

A number of ways have been identified in the literature in which economic growth can effect environmental quality.

The first way is through overall growth in the economy, or what might be called the scale effect. Increased output is associated with increased use of natural resources, increased fuel use for production and transportation of goods, and increased manufacturing and the related emission. As the economy grows, so does production and consumption leading to increased levels of resource use and increased waste entering the environment. This suggests a negative relationship between economic growth and environmental quality.

A second way is through changing composition of output. Increased wealth is associated in the poorest countries with a shift in composition of GDP from agriculture and fishing to industries and in wealthier countries from industry to services. This mechanism suggests that countries will have different environmental problems at different levels of development. Overall, the EKC theory suggests that this leads countries to have better environmental quality at the extremes of the income scale.

A third way is that as countries grow wealthier they may also alter their industrial composition to focus less on polluting industries like steel manufacturing and more on cleaner industries such as computer industries. These two mechanisms, changing composition of GDP and changing composition of industrial activity, are called the composition effect.

A fourth way that economic growth can affect environmental quality is that increased income can lead to changes in pollution levels and resource consumption rates through changing technologies with which goods are manufactured. As a country grows richer, it may invest in cleaner techniques for paper production or in more efficient metal smelting. This mechanism creates a positive correlation between economic growth and environmental quality, and is known as the technique effect.

The relationship between these four components of economic growth and any one aspect of environmental quality can be captured in the following equation.

$$D_i = \text{GDP} \times \frac{A_{ij}}{\text{GDP}} \times \frac{P_{ij}}{A_{ij}}$$

Where D_i is the type of degrading activity such as CO_2 emission, soil erosion, or deforestation. GDP represent the scale effect. A_{ij} is the different activities associated with the degrading activity of type i given in value added. So, the term A_{ij}/GDP represents the portion of GDP composed of this activity – i.e. the composition effect. P_{ij} is the level of degradation associated with each unit of value added of activity A_{ij}, such as the level of pollution a particular industrial facility emits per unit of output. This represents the technique effect.

This generalized equation is similar to an equation given in published comments by Gunnar Eskland(1992) in response to a World Bank paper by Birdsall and Wheeler(1992) for industrial pollution in particular.

$$\text{Industrial Pollution} = \text{GDP} \times \frac{\text{V.A. Ind}}{\text{GDP}} \times \frac{\text{V.A. Dirty Ind}}{\text{V.A. Ind}} \times \frac{\text{Poll. in Dirty Ind}}{\text{V.A. Dirty Ind}}$$

where V.A. Ind is the value added of industry and Dirty Ind are those industries that are relatively more polluting such as steel and chemicals, compared to say cotton textiles or food processing.

The first term on the right hand side, GDP, represents overall growth in the economy and, as was stated above, is generally considered to have a positive effect on pollution. The next two terms reflect the composition effect split into two components, the first being the level of industrial value added out of total value added in the economy and the second showing the type of industries that make up the industrial sector. The final term reflects the technique effect: the amount of pollution dirty industries release due to the production technologies they use as well as the control equipment installed.

One could develop similar equations for other aspects of environmental quality as well. For example, the following equation illustrates the relationship between income level and resource consumption.

$$\text{Resource Consumption} = \text{GDP} \times \frac{\text{V.A. Ind}}{\text{GDP}} \times \frac{\text{V.A.R.C. Ind}}{\text{V.A. Ind}} \times \frac{\text{Consum. Level R.C. Ind}}{\text{V.A.R.C. Ind}}$$

where R.C. Ind is industries that are relatively resource consuming such as oil refining and smelting. Consum. Level R.C. Ind refers to the level of consumption of the individual manufacturer relative to other manufacturers in the same industry. So paper

manufacturers who use a high level of recycled fibers would have a low consumption level. As with the equation above, in this equation one would expect the first term to be positively correlated with resource consumption, the second and third terms to be mixed, and the forth term to be negatively correlated.

According to these equations, in order for environmental degradation to decrease with economic growth, decreases in degradation, be it industrial pollution, resource use, or any other environmental problem, due to the technique and composition effects, must outweigh the pollution-increasing effects of growth. For an EKC to exist, at some income level, the importance of the pollution-increasing effects of growth must be outweighed by the effects that reduce pollution with further growth. In other words, $A_{ij}/GDP \times P_{ij}/A_{ij}$ must decline at a rate faster that GDP increases in order for D_i to decrease, and this must be true for all D_i. So, although the scale effect is likely to increase pollution levels, these other mechanisms could act to more than offset the scale effect once a certain income level is met. This can lead to an overall decrease in environmental problems as income increases, resulting in an EKC.

Let us briefly consider some of the evidence supporting the composition and technique effects.

1.6.1 Shifting Composition of GDP.

There is some evidence that as higher income countries become wealthier, the composition of GDP does shift away from dirtier industries. Because changes in industrial composition may imply a movement of dirty industries from richer to poorer countries, this aspect of environmental quality changes due to growth may not be

desirable in terms of changes in global environmental quality. Pollution is just moving from one country to another.

Industrial pollution has been the focus of many studies because it is easier to track than widely distributed pollution sources, such as automobiles and home furnaces. Also, industrial pollution is often concentrated in urban areas where it has the potential to degrade the health of large urban populations. There has additionally been a concern that freer trade may induce polluting industries to move to countries with fewer or no environmental regulations -- generally poorer countries -- or that freer trade will lead to increased industrial activity in poorer countries leading to more pollution. This is the concern that motivated the Grossman and Krueger study. The following studies have examined different aspects of the equation above. The first three are from a World Bank report on free trade and the environment.

Robert Lucas, David Wheeler, and Hermamala Hettige (1992) focus on the effect of production mix on pollution intensity. They examine the relationship between income and industrial pollutants by looking at the composition of industries in different income level countries. (They do not consider techniques used by individual plants, only the emission levels associated with industry types based on U.S. emission levels for these industries.) They do not find declining emission rates at higher incomes per unit of output, only per unit of GNP. In other words, as rich countries grow richer, emissions of some toxins do begin to decline per unit of GNP, but not per unit of manufacturing output. This suggests that the composition of industries does not change significantly at higher income levels but manufacturing output as a fraction of GNP declines. So the

second term for the industrial pollution equation given above does decline as high income countries grow wealthier but the third term does not change. These results only hold for open economies. For closed economies, the authors find that toxic emissions and GNP have a positive correlation at all income levels.

Nancy Birdsall and David Wheeler (1992) find similar results in their cross-country comparison of different industrial mixes. They find that richer countries have a higher level of polluting industries in their industrial mix, however they may have a smaller portion of their GDP derived from industry than poorer countries.

Through the examination of trade flows, Patrick Low and Alexander Yeats (1992) find that dirty industries do appear to be moving from richer to poorer countries. They suggest that growth in poorer counties would be correlated with increased pollution in these countries and decreased pollution in richer countries.

Dale Rothman (1998), using a consumption based approach to analyze environmental impacts, finds that there is little evidence of a decline in environmental impacts at higher income levels, but there is likely an increased ability to export these impacts through trade.

A study by Sander de Bruyn (1997a) considers more directly the effect of compositional changes of GDP on pollution emissions. He uses decomposition analysis to examine the effects of structural change on sulfur emissions in European and North American countries. He finds no evidence that sulfur emissions decrease as a result of structural changes as economies grow, and suggests that variations in environmental policy is a stronger explanation for variation in sulfur emissions. Another study by de

Bruyn (1997b) found that changes in SO_2 emissions over time and as income levels increased in the Netherlands and Western Germany were the result of the scale and technique effects and that structural change was not relevant. He states that other studies find similar results for SO_2 emissions, as well as for energy efficiency and for some other pollutants.

Ekins (1997) surveys a number of studies that consider the composition effect on pollution levels. He concludes that the studies show that the composition effect acts to decrease environmental quality with economic growth at low levels of income. In higher income countries, the composition effect acts to reduce environmental degradation but not enough to counter the scale effect.

In sum, some studies find no evidence of a change in industrial mix as high income countries grow wealthier, but there is a shift in the composition of GDP away from industry. Other studies find evidence of movement of dirty industries from high income to poorer nations as these nations become wealthier. So, while countries with higher incomes may shift to cleaner industries, these dirty industries may then migrate to poorer nations. If this is the case, economic growth can not be attributed with cleaning the environment, only with shifting pollution from one nation to the next. Furthermore, while rich countries appear to become cleaner as income increases, this is because they are shifting their pollution to poorer nations. These poorer nations can not then be expected to follow the same environmental trajectory as they become wealthier because they have nowhere to shift their polluting industries. In other words, the EKC is simply an artifact of the current world structure of inequality between nations as well as trade

patterns, rather than a generalizable relationship between environmental quality and economic growth.

A paper by Michael Rock (1996) emphasizes the importance of trade in environmental quality. He finds that developing countries with more open trade policies between 1973 and 1985 had higher pollution intensity per unit of GDP than countries that focused on import substitution and had inward oriented development.

Overall, it is far from conclusive if the composition effect leads countries to cleaner environments once a given income level is met, and, if it does, whether this is simply a result of dirty industries moving from richer to poorer nations.

In order for the composition effect to be able to effect improvements in environmental quality across all nations, one would need to look at changes in consumption patterns with changing income levels to see if above a certain income level a dematerialization of spending patterns was evident. If people started spending more income on services and such as back massages and education, and goods with cleaner and less resource intensive production processes, and eschewed large houses, large cars, and pollution intensive material goods, then it would be the case that increased income led to a change in composition of GDP away from resource consumption and polluting activities. However, we generally witness increased material consumption as countries grow wealthier, suggesting that any improvements in the composition of GDP in terms of decreases in environmental degradation reflex the movement of environmentally degrading activities to other nations.

1.6.2 Improved technologies.

Improved technology holds the greatest promise for all countries to improve environmental quality with rising levels of GDP. There is great variability in pollution per unit output due to different technology options. Swee Chua (1999) cites a collection of studies supporting the effectiveness of innovations for low-polluting technologies. Some technologies can reduce greater than 99% of pollution emissions, such as electrostatic precipitators reducing particulate emissions from coal burning power plants.

There is an enormous body of literature which examines the development, adoption, and diffusion of new technologies.(For an overview, see Ruttan, 2001) A small portion of this literature considers the links between technological change and economic growth.

A number have studies have documented the decrease in energy use per unit output as income increases in wealthier nations – or, what has been termed, the decoupling of energy use from GDP. (Unander et al., 1999; Howarth et al., 1993) Energy consumption is somewhat analogous to various types of environmental degradation, so decreases in energy intensity are correlated with decreases in environmental degradation per unit GDP. While some of these improvements can be attributed to shifting composition of GDP, a number of technologies have been developed and adopted by countries of different income levels which improve energy efficiency.

While increased energy efficiency with GDP growth appears to occur in wealthier nations, energy intensity continues to growth with GDP in most developing countries. (Goldemberg, 1998). In other words, there is an inverted U-shaped relationship between

income level and energy intensity per unit GDP: at low income levels, energy use per unit increases as income level increases but, above a certain income level, energy intensity begins to decline with further economic growth – although not necessarily overall energy use. So, for example, carbon emissions may continue to rise above a given income level, but at a slower rate.

This decoupling could contribute to an EKC for environmental problems associated with energy use. A study by J.Timmons Roberts and Peter Grimes (1997) finds evidence for an inverted U-shaped curve for carbon dioxide emissions per unit output versus GDP. They find that this is a result of efficiency improvements in a collection of wealthier countries since 1970 while other countries became less efficient. They also find that the scatter in the regression has increased over time, reducing the r-squared term. They write, "This suggests that other social and political factors are increasingly important in determining which countries institute efficiency measures..."(p. 196)

While it may be that energy efficiency improves with economic growth for wealthier countries, as Goldemberg points out, since most energy growth is in the less developed countries, overall growth of global energy use continues to rise, which "portends a potential energy and environmental disaster."(1998, p.731)

The changes in energy use over time results from both structural (compositional) change as well as technological change. Unander et al. (1999) find that the majority of the change in energy intensity of GDP in 13 OECD countries over a 25 year period was the result of technological improvements. It is not clear however whether these

improvements are a direct result of rising income levels. Increased efficiency can be attributed to high energy prices, public policies, and technological innovation.

Because of the difficulty of conducting plant by plant research on technological adoption, most work relating environmental quality to income level is at the macro-economy level. Less work has been conducted to look at environmental quality improvements as a result of economic growth, due to changing technology within an industry or at the plant level. However, a number of studies at the industry and plant level have been conducted.

Two papers that focus on the effects of trade on the adoption of more environmentally benign technologies also consider GDP per capita as a variable. Wheeler and Martin (1992) examine the adoption of cleaner technologies in the pulp and paper mill industry. They find that income level is not related to the rate of technology adoption. Valerie Reppelin-Hill (1998) considers the adoption of cleaner technologies for steel manufacturing. She finds that income level is unrelated to rate of adoption for higher income countries, but there is a positive correlation for lower income countries. Interestingly, she includes GDP in her analysis as a proxy for "presumed ability and willingness to absorb the new technology"(p.287). This is for two reasons: the increased ability of wealthier nations to afford the new technology; and a close correlation between income level and "regulatory strictness". She cites Grossman and Krueger (1991) as evidence for this.

A number of studies have looked at technological diffusion and adoption at the plant level associated with trade and foreign investment, but not growth per se.(For an

overview, see Chua, 1999) In as much as trade and foreign investment are seen as contributing to economic growth, these studies are relevant to the growth, environmental quality debate.

Increased trade can promote the diffusion of new technologies as economies interact more with one another. Foreign investment can also promote technology transfer by helping poorer countries afford more expensive technologies and through the direct use of these new technologies by foreign firms.

A study of Mexican manufacturing firms finds that increased plant size and foreign investment are positively correlated with technological diffusion but international trade is not.(Grether, 1999)

Chua (1999) cites studies that find contrary results on the effect of foreign ownership on pollution emissions. In one study, energy efficiency in manufacturing in three less developed countries is positively associated with foreign ownership. In another study of pollution performance in the pulp and paper industry in four less developed countries, foreign presence was not found to be significant.

Overall, the literature does not present a clear view of the mechanisms linking economic growth and environmental technological change. It can be observed, however, that technologies that allow for reducing the impact of production activities on environmental quality are more available in wealthier countries due to the overall technological advancement in these countries. This results, in part, from greater financial support for research and development.(Ruttan, 2001) One of the great promises for these technologies is that they can be transferred to less developed countries so that these

countries can "leapfrog" over intermediary technologies which tend to be more polluting.(Goldemberg, 1998) For example, there is no reason that a country should go from using dung to coal to oil to solar to meet much of its fuel needs when it can jump from dung to solar. By leapfrogging technologies, low-income countries can avoid growing dirtier while they grow. So, if an EKC exists due to technologies being used in countries of different income levels, there is no reason for this necessarily to be the case.

Technology transfer and adoption alone can not be expected to be an effective method for reducing environmental degradation in countries that do not have the infrastructure to effectively use these technologies. Jose Goldemberg writes:

> Technology is often interpreted in the narrow sense of the hardware of production. However, such 'hard' technologies can only be successfully absorbed and developed if complementary 'soft' technologies – training, institutional capacity, and infrastructure support – are in place. A major constraint on many countries' technological development has been the tendency of hard technology to run ahead of the soft technologies that sustain them.(1998, p.739)

So, while income level may not be a determining factor for the adoption and use of advanced technologies, a country's capacity to successfully use the technology may be related to income level.

While technological improvement holds promise for allowing for economic growth without increased environmental degradation, a paper by Michael Huesemann (2001) discusses the inherent limits with depending on technology to reduce

environmental degradation in the face of economic expansion. He discusses three issues: 1) the inability of science to provide all of the information about the environment and environmental problems needed to address these problems; 2) the principle of the conservation of mass as well as the second law of thermodynamics which suggest that, while remediation technologies may solve environmental problems in one place and time, they will shift environmental impacts to other places or into the future; and 3) it is impossible to design any type of production process that does not have some undesired environmental impacts due to the entropy law as well as the negative environmental consequences of energy generation. These second two issues are integral to the work of the economists Georgescu-Roegen (1971) and Daly (1979).

Huesemann concludes that:

> ...it is clear that modern science and technology have very limited potential to alleviate the numerous environmental problems facing western industrialized countries...In many cases, environmental science and technology appear to be successful only because attention is focused narrowly (in space and time) on specific objectives while wider, long-term impacts are ignored.(p.283)

Ekins (1997) also points out that technological change can have hidden consequences. There are many examples of wealthier nations adopting technologies that allow for more efficient resource use, substitution of resources, and better containment of wastes. However, some of these new technologies lead to secondary environmental impacts, and he cites the use of nuclear power in France. This reduced CO_2 emissions but increased other problems.

Also, technology transfer may not necessarily be environmentally friendly. There are many instances of more industrialized nations exporting polluting technologies to poorer nations under the guise of technological assistance.(Jancar-Webster, 1993a)

In summary, in terms of worldwide environmental quality, the composition effect is not very promising. The technique effect is more promising for reducing environmental degradation and resource consumption in the face of economic growth but it has its limitations. It may be that the technique effect is related to income level, wealthier countries having easier access to new technologies and better availability of resources with which to implement these new technologies, but this is not necessarily the case. Changes in technologies may reflect the effects of government environmental regulations and enforcement of these regulations, which may be more likely in wealthy nations, yet, again, not their exclusive domain. This will be discussed further below. They may reflect level of international trade or level of foreign investment or a host of other variables such as community pressure (See O'Rourke, 1999; Blackman and Bannister, 1998; Pargal and Wheeler, 1995)

There are additional mechanisms said to influence levels of environmental degradation at different income levels. I will briefly discuss two of these, population growth rates and costs of control, and will then turn to a mechanisms often cited in the literature as a reason for improved environmental quality with economic growth: increased demand for environmental amenities.

1.6.3 Additional Mechanisms.

A relationship has been proposed between slower population growth and environmental quality, both because a slower population growth rate allows environmental services to keep up with the population and ultimately fewer people cause less environmental degradation. It is true that increased income is in general associated with decreased population growth rates, yet this is not a linear relationship – there is some variation in this relationship. Also, population and pollution level are not synonymous. Citizens of the United States are responsible for far greater levels of carbon emissions and resource consumption per capita than citizens of poorer nations for example. There is no doubt that reducing population growth rates *can* ease impact on natural resources and decrease pollution all else being equal, but not by itself.

Economic growth and environmental quality are also related due to the costs of administering and monitoring environmental regulations. This is the supply side of environmental protection. Poor countries may not have the resources to expend in environmental monitoring and control. As countries grow richer, their capacity for environmental management increases. Although wealthier nations have more resources to monitor and enforce environmental regulations, having these resources is no guarantee that they will be used for these purposes, especially in countries with high levels of corruption.(See Lopez and Mitra, 2000) Countries of similar income levels devote varying amounts to environmental quality protection.

1.6.4 Changing demand

A final way that economic growth is said to affect environmental quality is that, to use economic terminology, environmental quality is a normal good or even luxury good. As was discussed above, as populations become richer, they will demand more environmental quality. In other words, environmental quality is income elastic. This demand may be translated into public policy changes towards pollution regulation. This is the other side of the scale effect, in which overall growth in the economy leads to a decrease in environmental quality. Here, growth leads to improvements in environmental quality through changing preferences that in turn are translated to abatement efforts.

This is, I believe, the most important argument supporting the EKC because it is imagined to be intuitively obvious and is often cited to explain higher pollution levels in poorer nations. The basic argument is that poorer nations accept environmental degradation as an inescapable side-effect of economic growth. Poor people are more concerned with satisfying basic needs and are therefor not concerned with environmental degradation. As they become wealthier, they value environmental quality more.

Although it *may* be true that wealthier people care more about some aspects of environmental quality, such as endangered species and parkland, many aspects of environmental quality are issues of livelihood and health. I would expect poor fisherman to care about water pollution that kills fish, and rice farmers to care about deforestation that effects the hydraulic cycle where they grow their rice. Deteriorating environmental quality can also have direct consequences on human health and certainly poor people care about their children dying from diarrhea or asthma.

Additionally, since the poor are less likely to be able to escape environmental degradation through purchasing bottled water or spending weekends in a country home for example, there are reasons to expect they might care *more* about environmental quality than wealthy people. Just because a poor person may be too preoccupied with feeding his or her family to take actions to protect environmental quality does not mean that this person does not care about environmental quality. Shafik (1994) writes that: "There are some environmental problems where thresholds like survival are at stake. Here, the willingness to pay to avert the damage is close to infinity and the level of per capita income only affects the capacity, not the willingness, to pay."(p.757)

A number of surveys have been conduced over the years that examine attitudes towards environmental quality in countries around the world. One of the better know surveys is The World Value Survey, which examines attitudes towards various social issues including environmental issues. It is an effort of Ronald Inglehart (1995a), Program Director at the Institute for Social Research at the University of Michigan in Ann Arbor, and was conducted from 1990-1993. It consists of interviews of people in 43 different countries. The results suggest that concern for environmental quality runs across different income levels and results more from cultural differences and overall level of pollution in a nation than with income level per capita.

Consider the following results from the World Value Survey:

TABLE 1.13 1990-1991 WORLD VALUE SURVEY RESULTS RELATED TO ENVIRONMENTAL PROTECTION

Country	*A* *Percent*	*B* *Percent*	*GDP/cap* *1990 US$*	*GDP/cap rank*
Sweden	69	41	23680	3
Denmark	65	30	22090	6
Netherlands	64	54	17330	12
Norway	59	47	23120	4
South Korea	58	74	5400	18
Iceland	54	37	21150	8
Russia	53	73	*	
Turkey	53	52	1630	27
China	52	56	370	28
Czechoslovakia	52	54	3140	20
Mexico	50	70	2490	23
Brazil	48	82	2680	22
Finland	48	28	26070	1
East Germany	47	79	*	
Japan	47	59	25430	2
Chile	46	77	1940	26
Moscow	46	83	*	
Slovenia	46	54	*	
India	45	52	350	29
Bulgaria	44	76	2210	25
Latvia	44	48	*	
Lithuania	43	54	*	
Britain	42	47	16070	14
Canada	42	54	20450	9
West Germany	41	70	22730	5
Belarus	40	78	*	
United States	40	47	21700	7
Austria	39	73	19240	11
Estonia	38	49	*	
Northern Ireland	36	38	*	
Portugal	36	76	4890	19
Ireland	34	50	9550	17
Belgium	33	49	15440	15
Italy	31	51	16850	13
Argentina	30	77	2370	24
France	30	50	19480	10
Spain	30	68	10920	16
Nigeria	27	59	270	30
Hungary	24	70	2780	21

* indicates that the GDP was not available for this country in this time period.
a. From the World Bank Atlas 1991

Column "A" is an index of four variables relating to support for environmental protection. Respondents either "agree" or "strongly agree" that: "I would be willing to give part of my income if I were sure that the money would be used to prevent environmental pollution"; and "I would agree to an increase in taxes if the extra money is used to prevent environmental pollution". They also "disagree" or "strongly disagree" with the statements that: "The government should reduce environmental pollution, but it should not cost me any money"; and "protection the environment and fighting pollution is often less urgent than suggested".

Column "B" is the percentage of respondents who answered that they "strongly approve" of the Ecology Movement.

Surveys are notoriously faulty, especially with questions regarding how much people are willing to pay for a certain good. People may claim that they are willing to pay far more than they would actually pay were the situation needing a payment were to arise. And, although all respondents were asked the same questions, different cultures in different countries could lead to a distortion in the results. For example, some population might have a different attitude towards taxes of any sort than another due to a history of government corruption for example.

Even if there is a margin of error in how accurately these results portray true support for environmental protection, clearly the results do not follow income level. Different income level countries are scattered across the ranking for support for environmental protection.

Brechin and Kempton (1994) cite a 1992 Gallop poll that finds similar results. This poll finds that citizens of low to middle income countries were generally more concerned about environmental problems than citizens of advanced industrial counties. They also cite a 1989 Harris poll which finds that, not only do citizens of poorer countries care as much or more about environmental quality, citizens from poorer countries as compared to richer countries are willing to pay almost as much to reduce environmental problems and are willing to put in more volunteer hours towards reducing environmental problems than citizens of wealthier countries. These three surveys bring into question the changing demand thesis.

Other studies have considered the effect of income level on demand for environmental quality. Begnt Kristrom and Pere Riera (1994) studied the income elasticity of environmental improvements in a cross-country comparison. They found no evidence that the elasticity is not less than one. In other words, economic growth leads to increased demand for environmental quality but not enough to keep up with the level of growth.

Kenneth McConnell (1997) investigates the income elasticity of demand by decomposing the link between environmental quality and income to separate out the effects of changing preferences. He finds that a positive income elasticity of demand for environmental quality is neither sufficient nor required for environmental quality to change with income. He also surveys existing studies of changing preference for environmental quality with income and finds little evidence to support the theory of changing demand with changing income level.

As was cited above, Magnani (2000) finds that absolute income level in a county is not as important as distribution of income for determining level of environmental degradation. Using data for R&D expenditures for environmental protection in OECD countries, she finds that increased income *equality* is positively correlated with increases in R&D expenditure.

A number of authors have conducted case studies that bring into question the idea that poorer people do not care about environmental quality, and that is why poverty is linking to environmental degradation.

Ramon Lopez (1992) surveys a collection of case studies that examine the relationship between poverty and environmental quality in developing countries. He finds that environmental destruction usually follows from the break down in community institutions and the expansion of large scale agricultural, livestock, and lumber activities, not poverty per se.

Robin Broad (1994) uses Philippine case studies to deconstruct the idea that poverty increases environmental degradation. Broad asserts that degrading activities by the poor are largely dependent on whether or not they are in a position to control environmental degradation, even if they do care about protecting the environment. Her work identifies environmental problems starting with development activities such as mining, which had direct harmful effects on the ecosystem used by the indigenous people, or deforestation, which caused direct effects as well as massive migration. Newcomers to an area are more likely to degrade land as they have no established

relationship with the land, so forced migration itself can lead to degrading activities by the poor. Insecurity over control of land resources can also lead to degrading activities.

Broad cites a number of authors who argue that the rich play a central role as environmental degraders through inequitable land-holdings and activities such as commercial logging, and that the poor can effectively protect and steward fragile ecosystems. She also states that numerous studies show how poor communities prevent environmental degradation.

In regards to the proposition that wealthy people care more about environmental quality than poor, Broad writes that "Grossman and Krueger hypothesized that enrichment brings environmental values and motivations. While under certain circumstances this may be true, our research suggests that looking at growth and poverty alleviation as a means to instill environmentalism misses a key point: in the Philippines environmentalism was a demand of the poor, not the rich." (p.814)

Edward Barbier (1994) notes that even in cases where poverty and environmental degradation may be correlated, this does not imply causation. Often there is an indirect link that stems from bad public policies.

1.6.5 Summary of mechanisms linking economic growth and environmental quality

In summary, a number of mechanisms have been identified in the literature that link environmental quality with economic growth. Some mechanisms are associated with a positive correlation, others with a negative correlation, and for some it depends on the income level. In order for an EKC to exist, there must be a income level at which further economic growth will lead to improvements in environmental quality. Therefor, the

effects of mechanisms where there is a positive correlation between environmental quality and economic growth must outweigh the mechanisms where there is a negative correlation.

The above section considered a number of these mechanisms: the scale effect, the composition effect, the technique effect, population growth, and costs of control. There is not conclusive evidence that these mechanisms would lead to a EKC. One of the most commonly cited reasons for the existence of an EKC, changing demand, is also lacking support in the literature. Survey results and other studies suggest that increased demand for environmental quality at higher income levels is not a truism. Although the overview of the studies supporting and refuting these mechanisms is brief, it suggests that the evidence that these mechanisms would lead to an EKC is not irrefutable.

1.7 Conclusion

Where does this leave us in terms of the EKC? The empirical evidence supporting and EKC is mixed at best. The Grossman and Krueger (1991) results, which provide some of the strongest evidence, can not be held up as evidence of a inverted U-shaped relationship between income per capita and urban air pollution concentrations. Given the mixed results found by other authors using a variety of measures of environmental quality, as well as the mixed results obtained using the AIRS data base, it is difficult to say anything definitive about the relationship between environmental quality and income level.

Arrow et al.(1995) point out that even the studies finding support for the EKC use pollutants that have relatively local, short-term impacts. Environmental contaminants, such as CO_2, which have more long term effects have not demonstrated a decrease at higher income levels.(Shafik and Bandyopadhyay, 1992)

This difficulty in demonstrating a relationship between income and environmental quality may be in part due to the lack of international environmental data as well as the heterogeneity of the elements that make up what one thinks of as environmental quality. While certain aspects of environmental quality may well improve with income, other aspects can be expected to grow worse. As was noted above, different aspects of environmental quality can be expected to improve or worsen at different income levels. Economic growth for poorer nations might lead to improved municipal water quality but increasing air pollution. For richer countries, growth might lead to improved air quality but more resource depletion. Given the ever growing levels of international trade, it becomes increasingly likely that actions in one country will have consequences in another, making the income-environmental quality relationship even more complex. Where there is evidence of an EKC, this could be an artifact of richer nations exporting polluting industries to poorer nations such that poorer nations can not follow suit. Roberts and Grimes (1997) write:

> ..the relationship between economic growth and environmental protection should not be seen as necessary or stage based. Rather than countries passing through stages and eventually reducing their pollution through economic development, we would argue that the history of the world

> economy suggests that only a few countries have ever successfully moved up substantially in the global hierarchy of income stratification. Empirical world-system analyses have supported the observation that most countries are structurally limited from ever ascending...Most poorer countries will not repeat the history of European and North American development, party because those world powers already exist.(p. 196)

A variety of mechanisms are indicated as the links between income level and environmental quality. Among these are overall growth in the economy, changing composition of industry and GDP, changing techniques, population growth, costs of control, and changing demand for environmental quality.

There is mixed evidence about the strength of these links. Changing demand in particular has come under fire in the literature, yet is still commonly cited. Yet, even if it were true that wealthy people cared more about environmental quality, how would this preference be translated into improvements in environmental quality? Environmental quality is not something that can be purchased at the market place. Improvements in environmental quality require coordinated action, usually by governing bodies. If the government, be it local, regional or national, does not support restrictions on environmental degradation, it will be difficult to maintain or improve environmental quality at any income level.

The Broad (1994) case study in the Philippines cited above maintains that the level of environmentally degrading activities that the poor engage in are a results of their ability to control these activities, not whether they care about the environment.

Environmental degradation may not be related to income as much as power – power over one's resources and environment.

Given the public good nature of environmental quality, one would think that form of governance over resources would be an important factor in the maintenance of environmental quality. The next chapter will examine this issue. It will consider the relationship between regime type and environmental quality. More specifically, it will explore why countries that are more democratic are more likely to protect environmental quality.

Chapter 2 Democracy and Environmental Quality

2.1 Overview

Given the complexity and multiplicity of ways in which individuals and societies interact with the natural world, one would be hard pressed to find a single cause of "environmental protection" that held true across all nations. However, there are compelling reasons to expect the degree of equity, in the form of economic equality and level of democracy, within a society to have an impact on environmental quality. In general terms, this is because the winners from environmental degradation are more often, though not always, the more powerful members of society. The more evenly power is distributed between winners from environmental degradation and the losers who bear the cost of this degradation, the more likely this degradation will be controlled.

Although a number of studies have looked at local-scale regulation of environmental quality, few authors have looked at the relevance of regime type at the nation-state level to the preservation and promotion of environmental quality. This chapter focuses on regime type and, more specifically, how the level of democracy in a nation state may influence the intensity of a nation's efforts to protect environmental quality.

The chapter begins with a brief discussion of the variables being discussed: environmental quality and democracy. It then turns to a theoretical examination of how democracy and environmental quality are related. It begins with a discussion of reasons generally given for why democracy may be antithetical to environmental protection: the need for scientific decision making for environmental issues, commons problems, free riders, and short term thinking. The next section covers the promising aspects of democracy in relations to environmental quality: the distribution of power, the accountability of leaders, public involvement in policy making, access to information, the presence of non-governmental organizations (NGOs), civil litigation, technology, free markets, and international aspects of democracy.

The promise of democracy is followed by a section discussing why authoritarian regimes are less likely to protect environmental quality: lack of accountability, concentration of power, the need for coercion and/or legitimacy, and the use of violence to control green activists.

Section 2.7 presents insights of John Dryzek on the issue of the democracy and environmental quality.

Section 2.8 considers how different aspects of environmental quality are related to democracy and then 2.9 provides a brief discussion of the geographic level of environmental decision making.

The chapter concludes with a summary of the ideas presented.

2.2 Defining Environmental Quality

As was discussed above, there is no one definition of environmental quality because environmental quality is not one-dimensional. It is made up of many components: urban air pollution, water pollution, toxic dumps, indoor air pollution, indoor radon, mine tailings, stratospheric ozone depletion, loss of wetlands, park land preservation, depletion of fisheries, deforestation, etc. The type of environmental problem being considered is relevant to the relationship the problem has with regime type, as will be explored in greater depth below. For the following discussion, let it suffice to define environmental quality broadly as "The sustainable use of natural resources and the protection of environmental quality to the extent necessary such that public health and livelihood are not adversely affected".

2.3 Defining Democracy

Democracy is also multidimensional. A working definition of democracy needs to be adopted before discussing the relationship between democracy and environmental quality. Robert Dahl, in his well-respected book *Democracy and Its Critics* (1989), provides a definition of democracy that focuses on the institutional aspects. These are the elements of democracy that are more easily measured, allowing for the comparison of the level of democracy in different nations. This will be discussed further in the empirical analysis presented in the next chapter.

Dahl begins his book by explaining that there are two distinct uses of the word "democracy". The first is the ideal state in which all members of a society have equal say in the governing of the society. In this sense, a country would either be a democracy or not. However, no nation in the world fits this definition. The second use of "democracy" is the descriptive term used for nations that approximate this ideal more or less. Within this definition, a country may be more or less democratic depending on characteristics of the government structure as well as the civil society. Dahl uses the term polyarchy rather than democracy to identify the governmental systems that actually exist in the world, to distinguish it from the ideal system in which all citizens participate equally. A democratic country uses a system of polyarchy. I will use the term "democracy" for Dahl's "polyarchy" below.

Dahl defines polyarchy as a "set of institutions necessary for the democratic process on a large scale"(p.219). It consists of the following seven institutions (p.221):

1. Elected officials.
2. Free and fair elections.
3. Inclusive suffrage.
4. Right to run for office.
5. Freedom of expression.
6. Alternative information.
7. Associational autonomy.

He notes that these rights and institutions must be actually substantially present, not just nominal. Two countries could both have these institutions and rights nominally

in place but could vary significantly in terms of how truly democratic they are because of variations in how substantially these institutions and rights are manifested. Further, some countries might satisfy certain requirements more fully than other requirements. How "democratic" one considers a particular country would depend on which institutions are deemed the most important.

In terms of his first requirement, it is important to note that in no government does the public elect all officials. Many posts are appointed and are career positions. Although laws might be passed by elected officials, many policy decisions are made at the level of minister or administrator. This is an important consideration for environmental regulations because the enforcement of regulations often depends largely on non-elected officials. The best laws in the world can be passed only to have these regulations weakly enforced. The public might pressure elected officials to pass desired regulations but then find its hands tied when it comes to enforcement. The public might be able to pressure elected officials to ensure that laws are enforced by the relevant bureaucracies. In as much as elected officials are seen to represent the government as a whole, they may be held accountable for the action or lack of action.

Beyond Dahl's requirements listed above, there are also a number of features of civil society that influence the level of democracy in a country. Patrick Chabal (1998), in his examination of democratization in Africa, discusses four approaches to determining to level of democracy in a country: instrumental, institutional, cultural, and historical.

The instrumental and institutional approaches are those reflected in Dahl's list of requirements for polyarchy above. Instrumental aspects of democracy refer to the

procedural means that ensure a democratic process. The legal and constitutional framework must provide for multiple parties and public voting, free speech, etc. The institutional approach to evaluating a democracy focuses on the institutions necessary to uphold a democratic system: a democratic constitution, an independent judiciary, and a structure that provides for representation, a working parliament, and an effective system of political accountability.(p.296-297)

By the cultural aspects of democracy, Chabal means a culture in which rulers and those being ruled believe in the desirability of this type of political system as well as the effectiveness of this system. They believe in the importance of individual representation manifested through one person, one vote. Further, the accountability of political leaders through democratic means is widely accepted. Accountability is tied to the electoral process so if the electoral process fails or is suspect of corruption, the democratic means of accountability fails as well. Sidney Verba (1965) earlier stressed the importance of political culture: "A new constitution, for instance, will be perceived and evaluated in terms of the political culture of a people. When put into practice in one society it may look quite different from the same constitution instituted in another nation with another political culture."(p. 517)

There is also the historical aspect of democracy, which subsumes the cultural aspect in that culture evolves over time. Chabal writes, "Although it is true that democracy is a system with a well-defined and well-regulated constitutional, legal, procedural, and institutional framework, it cannot be stressed enough that what makes it work is not so much that framework as the general consensus within society about the

legitimacy and efficacy of the democratic political order."(p.299) As Karl Popper (1963) says of democracy: "Institutions alone are never sufficient if not tempered by traditions...Traditions are needed to form a kind of link between institutions ands the intentions and valuations of individual men."(p. 351)

Democracy in a country with a history of democracy will look very different than democracy in a country that was recently under authoritarian rule and that has never had democratic representation before. Likewise, authoritarian rule in a country with a history of democracy, such as Chile under Pinochet, will also be different than authoritarian rule in a county that has never experienced anything else. Clearly, democracy has many aspects. Even if a country has well established the seven institutions given by Dahl above, other aspects of civil society can impede the democratic aspects of a political system.

Beyond the cultural and historical aspects of democracy emphasized by Chabal, there are other basic aspects of civil society that can affect the level of democracy such as income distribution and level of education. A country in which there is a small group of citizens with high incomes while the majority lives in poverty will obviously not attain a level of power equity possible in a country with a more equitable distribution of income. Highly skewed income levels inevitably limit democracy. There are few existing democracies with highly skewed income levels. The most stable democracies in the world have large middle classes. Countries in which the large majority is poor tend to have social unrest during elections and often the resulting governments are unstable.

In democracies with skewed income, not only do the elites have more power, but the general public may be less able to assert their agenda due to lack of education, lack of access to decision makers due to class boundaries, and even lack of ability to mobilize through limited access to channels of communication. Poor people are less likely to be able to send out information via mail or computers. Organization of a demonstration can be difficult, as can be providing educational information about the issues at hand.

Education is another important component of a democracy. If a large segment of the population is illiterate, they can not participate in policy making to a great extent because they will be unable to follow policy debates presented in the press, communicate effectively with each other in print, nor even communicate effectively with policy makers in distant places.

Level of education may be of particular relevance to environmental problems because of the scientific nature of many environmental problems. People need to have some understanding of the nature of the problems in order to be concerned about the problems and pressure the government to control these problems. Many problems are complex in nature, such as climate change.

Access to information is also critical to the functioning of a democracy. The public needs to be aware of the candidates views, the problems facing the nation, proposed solutions, etc. People can only make informed choices if they have access to the information necessary to make an informed choice. Access of information is also important for preventing environmental problems as will be discussed further below.

Now we have a basic outline of what constitutes "democracy": a collection of institutions, cultural and historical aspects, and a variety of conditions in civil society. A more concise, yet useful, definition of democracy, or, what he terms "polyarchy', is provided by John Dryzek, in his 1987 book, *Rational Ecology*. He defines polyarchy as a system in which, "collective choices are the outcomes of interactions between relatively large numbers of actors, none of which is capable of exercising anything remotely approaching authoritative control over the system." (p.111). In other words, there is a balance of power within policy decision making. Dryzek also considers the importance of freedom of information: "Interaction should proceed in the context of relatively free exchange of argument, information, and influence, such that choices are arrived at through 'mutual adjustment' between partisans of different interests."(p.111)

Dryzek's concise definition of polyarchy summarizes well the main aspects of democracy that will be used in the discussion below regarding the ability of democratic systems to protect environmental quality.

Before considering the reasons why more democratic countries are more likely to protect environmental quality, let us briefly consider arguments that question the ability of democracies to protect environmental quality specifically. These arguments broadly relate to two aspects of environmental quality policy problems that set these problems apart for many other public policy issues – the scientific nature of many environmental problems and the public goods nature of environmental quality.

2.4 The Case Against Democracy

There are a number of arguments related to the nature of environmental problems that bring into question the ability of democratic governance to promote environmental quality. I will briefly consider four of these before turning attention to the promising aspects of democracy.

A fundamental belief belying the efficacy of democracy is that environmental problems need to be solved based on scientific and technical rational. Because of the scientific nature of many environmental problems, it is often argued that decision making related to environmental protection can not be left up to the general public. The level at which to regulate environmental contaminants and decisions affecting resource use should be made by a group of individuals who have the ability to understand the complexity of the problems at hand. A system in which power is vested in the hands of a few technocrats or in a Philosopher King would be far more desirable than a democratic system where the majority does not understand the complexities of ecosystems, human health impacts, or resource depletion rates. The ideal, in this view, would be to have a group of scientists who can "get the policy right", and then the policy would be vigorously enforced. There would be little or no public input.

There are three defenses for democracy in light of this argument. The first is that the freedom of information, collaboration and expression, including intense lobbying of government agencies, that usually goes hand in hand with democracy, actually helps get the science right. Complex environmental problems often need many groups of people

working to understand the problem and find a solution, or many solutions that can be tested and rejected.

An environment of free access to information will facilitate this kind of research allowing for better decision making than would be possible under the limitations of centralized decision making. Interest group participation in decision making often actually helps administrators obtain the information and ideas necessary for scientific problem solving.

Secondly, due to the scientific uncertainty associated with many environmental problems, solutions may be based on value judgments, and not on scientific information alone. Often it is impossible to assess the exact risk level associated with an environmental contaminant or ecosystem disruption. Because of the uncertainty and risk, there is no one correct policy prescription. There are trade-offs to be assessed and reviewed. Although it might be known at what concentration ambient ozone can cause individuals to suffer some health effects, if elimination of all ambient ozone is impossible, the level of emission control is largely a value judgment. Some pollutants have threshold effects which provide a better scientific basis for decision making, but even when such thresholds exist, the exact level at which their effects occur is very often uncertain.

Thirdly, as a result of the uncertainty, the risk, and particularly the trade-offs associated with many environmental problems, many decisions related to environmental quality have a moral dimension. Are we willing to risk an endangered species in order to have cleaner energy? What if the energy is cleaner and cheaper? Should we store

nuclear waste in a place where people may be contaminated hundreds or even thousands of years from now? These are not questions for scientists or technocrats. Scientists can provide the parameters for the debate but not the answers.(Dahl, 1989) Dahl (1989) notes that due to the specialization necessary for experts to become experts in their area, they may be ignorant of issues outside their specialty, limiting their ability to make good policy decisions.

It is argued that scientific advancement occurs most easily in open societies.(Popper, 1963) Although the Soviet Union made some scientific achievements, such as with their space program, these were in limited areas of specialization. In other areas they fell far behind the West. Open societies allow for the skepticism and sharing of knowledge that allows scientific achievement to be nurtured.(Gadgil and Guha, 1995.)

A second argument against the ability of democratic decisions making to effectively manage environmental quality is that individuals in a democracy are likely to pursue their own self interests. Because of the public goods nature of environmental amenities and natural resources, this could lead to a tragedy of the commons situation. If everyone is involved in decision making, they will all want access to natural resources. The pursuit of individual benefits will outweigh public benefit and the resources will be over-used to the detriment of everyone. The classic example is of a common grazing land that becomes over-grazed because everyone wants to maximize the number of animals that they put on the public land. There are other examples such as everyone wanting to have a gas guzzling car, polluting the air and raising the greenhouse-gas

levels, or everyone wanting to irrigate from a watershed, leaving inadequate water for maintaining the existing ecosystem.

As will be argued below, in as much as these "selfish" activities are detrimental to public health and welfare, individuals and groups can begin to recognize the impacts of these activities and will push for the activities to be controlled. Humans are able to impose self-constraints when situations arise that clearly show that selfish activities are destructive.

Elinor Ostrom, in her book *Governing the Commons* (1990), has compiled a large collection of common property cases in which the public was able to protect common resources even though this is counter to economic theory in which individuals act out of selfish motivations. She concluded that with the proper collection of incentives and institutions, common properties would be protected. She discusses, for example, the necessity of institutional incentives to effectively monitor and report on environmental problems.

Madhav Gadgil and Ramachandra Guha (1995) also find that democratic decision making at the local level was able to protect environmental amenities in rural India. They write, "Recent historical research suggests that pre-colonial community-based management systems had elements of equitable sharing and democratic decision making, and on the whole functioned quite effectively." (p.38)

It must be noted that these cases are small scale and local. We can not necessarily deduce that common properties can be managed at the nations state level based on

Ostrom's prescriptions. These studies do show, however, that the tragedy of the commons is not inevitable.

A third argument against the ability of democracy to protect environmental quality is that interest groups or individuals will not work to promote environmental quality at the level necessary for sustainability because there is a cost to those groups and individuals to promote environmental quality, although everyone can benefit from their efforts. Individuals will not make an effort to work for the common good since they feel that they can count on others to make the effort and they can still reap the rewards. Therefor, society will end up with a shortage of public goods and public benefits, and an excess of private goods. This situation is what is known as the "free rider problem" and it is not a situation exclusive to environmental amenities. This is a problem for the provision of any public good such as national defense or public education.

It is likely that, due to free riders, democratic societies will end up with lower levels of public goods than are desired by the public. However, in virtually all democratic countries, interest groups pushing for different public goods such as improvements in environmental quality, education, and animal rights, have arisen and promoted their agendas. Although the free rider problem may limit the provision of public goods in a democracy, authoritarian regimes can not be attributed with the advantage of avoiding this problem, as they often restrict lobbying of all sorts.

An additional concern regarding the ability of democracies to control environmental degradation is that, due to the frequency of voting, leaders may be tempted to ignore future problem and seek short term gains which will help them stay in office.

For many environmental problems, such as the depletion of natural resources or the build-up of persistent toxins, the solutions require long time-horizons. Since authoritarian regimes are in for good, they can pursue policies that provide benefits in the distant future.

Although it is true that democratic regimes can suffer from short-term thinking, authoritarian regimes can suffer from this even more so, as will be argued below. Leaders will suffer from short-term agendas only inasmuch as their constituents are focused on short-term gains. Where constituents are able to identify the need for long term solutions to environmental problems, leaders will not be reluctant to press for solutions. A clear example of this is the difficulty in finding storage areas for nuclear wastes.

2.5 Democracy and Environmental Quality

Despite these arguments against the efficacy of democracy for managing natural resources, when one looks across the global landscape, there appears to be ample evidence of a link between the existence of democratic institutions and environmental protection. The nations of Europe, Canada, the United States and Japan all have developed capacity to protect environmental quality. The worst environmental degradation appears to occur in authoritarian or formerly authoritarian republics such as countries of Eastern Europe and the Former Soviet Union (Desai 1998a; Jancar-Webster 1993b; Singleton 1987), as well as non-communist authoritarian regimes such as Nigeria

and Indonesia (Areola, 1998; Cribb, 1998). These cases suggest a relationship between regime type and environmental protection.

There are a number of arguments for why democratic regimes are more likely to protect the environment than authoritarian regimes, and, likewise, why authoritarian regimes are less likely to protect the environment. Let us start with the arguments for why democracies work better.

2.5.1 Distribution of Power

A decisive aspect of democratic regimes is that they, to a lesser or greater extent, hold the power of elites in check. No one group can control the policy agenda or direction of government policies. This sharing of power can work to the advantage of environmental quality because of the distribution of benefits and losses from environmental degradation. It is the elites of a society who generally benefit the most from activities that degrade the environment such as timber harvesting or industrial polluting.(Paehlke, 1988) Although everyone in a society may suffer more or less equally from some forms of environmental degradation in terms of poorer health, lost landscapes, and decreased available of natural resources, those who benefit in the form of financial gains do so relatively more than they suffer. Therefore, they are likely to increase these degrading activities unless or until their activities are restricted.

Although the losses from some forms of environmental degradation are distributed evenly across different sectors of society, for some types of environmental problems, we would not expect the consequences to be evenly distributed. It is the elites who are more likely to be shielded from some of the effects of environmental

degradation. For example, the poor may suffer from urban air pollution more than wealthy people who can live outside of the cities may. Poor people are more likely to live in or near places with severe environmental problems that threaten their health and livelihood.(Ekins,1997) The poor are also more likely to suffer livelihood losses from degrading activities of the elite. For example, the deforestation activities by friends of Ferdinand Marcos in the Philippines changed the hydraulic cycle in some areas, reducing the productivity of poor rice farmers.(Broad, 1994) So, the losses from environmental degradation may in fact fall more heavily on the poor. Therefor, due to the way the benefits and the losses from environmental degradation are distributed, a sharing of decision making would be expected to lead to greater levels of environmental protection than leaving decisions making in the hands of a small elite. The elites tend to gain more and lose less from many types of environmental degradation.

There is no society in which power is distributed evenly across all members. The equal distribution of power can be assaulted in many ways, and this distribution of power inevitably influences environmental policy making and enforcement. The relative level of power which the elites, whether business, government or military, have over the direction of public policy varies from country to country, and year to year, at times blurring the line between democracy and dictatorship, as will be shown in the case study of Chile in Chapter 4.

Even in a democratic regime, there are numerous ways in which elites can control the shape of policy changes. In the case of business elites, because of financial resources at their disposal, they can threaten to withdraw financial support for candidates, hurting

their chances for reelection. They can also threaten to withdraw financial support for the economy (investing) which could slow economic growth. Government officials, recognizing the importance of economic growth for legitimacy from the public may well not want this economic slowdown and will concede to business elites on policy issues. Business elites can also support their agenda by controlling media and other forms of information to the public such that the public is swayed to believe that what is in the best interest of the elites is in their best interest as well. Money speaks. Finally, they can control the direction of science and technology development in directions that may further their accumulation of wealth.

Government elites can support their personal agendas to the extent that they can avoid risking being voted out of office. They may count on public ignorance and pursue policies that are not in the general public's best interest. They can appear to vote for particular policies but then not provide the financial and administrative support necessary for the enforcement of the policies. Corruption can also increase the power of government and business elites by allowing them to forge invisible bonds to push particular agendas without the scrutiny of the pubic. Elites have opportunities to push their agenda on many levels.

Military elites regimes push their agenda largely through the threat of destabilizing the government through the use of force. This is not a problem in countries with established democratic histories, such as the United States and the nations of Western Europe. The power of military elites is far more relevant in countries with a history of military control. The agenda of military elites is less relevant to environmental

problems than the agenda of the business elites. However, the need to provide resources to keep the military happy may force a government to abandon some environmental goals. This will be discussed further below.

Despite the imbalances in power in democratic regimes due to the power of elites, power is distributed more equally in a democratic society where leaders are elected by the public and held more accountable to the public. These leaders are more likely to try to balance the losses of the general population with the gains of the business elites. The institutions of democracy that provide for a balancing of power in public decision making are, therefor, likely to work in favor of environmental protection.

2.5.2 Accountability of Leaders.

Democracy is also likely to work in favor of environmental protection because democratically elected governments are held more accountable to the public for policies than authoritarian governments. Democratic leaders remain in power not through coercion but through public approval and legitimacy. If the government is not acting to prevent activities which are commonly understood to harm public health, and not acting to protect the public good as it is perceived by citizens, legitimacy will decrease. Democratic governments therefor must respond more fully to public desires and concerns than authoritarian regimes. The governments are more likely to be responsive to the citizens, and the citizens, in turn, are more likely to press their governments to follow their wishes.

Due to accountability, democratic leaders are also less likely to take advantage of personal gains that can be made from environmentally destructive activities. This is not

to say that there will not be a leader with ties to an industry that engages in environmentally destructive activities, such as the oil industry, resulting in under-regulation of that industry. But it is less likely that democratic leaders will reap personal financial gains from allowing industries to operate without regulation because this would affect their credibility. Public accountability acts to curb financial ties between leaders and environmentally damaging activities, increasing the likelihood that these activities will be restrained. Where the curbs breakdown, such as with campaign finance and gift giving, we also see a breakdown in democracy itself.

2.5.3 Public Involvement in Policy Making

Often the solutions to environmental problems result in winners and losers. Some groups will benefit from regulations while others will have to pay. For example, a regulation may require the purchase of pollution control equipment, which is an expense to the polluting industry, but is a benefit to the companies that make the equipment, as well as to the public now exposed to less pollution. More public involvement allows for the complexities of the problems, as well as the ways the problems interact with society, to be recognized and taken into account. The winners and losers from environmental problems and from legislated solutions can bring their interests and concerns to the policy-making arena.

As was argued above, increased public involvement also allows for dispersed knowledge to be brought to bear on environmental problems which decreases the burden on decision makers to understand the complexity of the problem and to develop various

solution options. Public involvement in policy making also allows for newly developing environmental problems to be brought to the public.(Lafferty and Meadowcroft, 1996)

Increased public involvement in policy making can also expand compliance with regulations because groups involved with the development of regulations are more likely to feel compelled to comply.

Democracies are more likely to protect environmental quality because the democratic political process, which allows for public input in electing leaders and developing and adopting policies, increases the variety of input in the policy making process, by including many more members of society. John Dryzek (1987) argues that the dynamic aspect of polyarchy due to multiple decision-makers can allow for cooperative solutions to emerge. He stressed that the iterative aspect of polyarchy, resulting from multiple decision-makers, allows for it to cope with public goods problems.

Public involvement in policy making also enhances the free flow of information.

2.5.4 Access to Information

Since many environmental problems are not readily apparent, a first step in solving these problems is increasing awareness of the problem. The more individuals are aware of how pollution and resource depletion are affecting their lives, the more likely they will pressure the government to take care of these problems. Democratic regimes are far more likely than authoritarian regimes to have free and open access to information. This is partially because individuals need to have information in order to select leaders and make other voting decisions such as voting on referendums. Also,

democratic leaders stay in power based on legitimacy, not coercion, and are less likely to suppress the free flow of information. A free press and the right to assembly are keystones in a democratic system.

Although both sides of a debate are free to provide their views to the public, in general, open information usually helps environmental causes. Environmentalists have won battles based on the weight of evidence alone.(Payne, 1995) This is partially because so many environmental problems can be invisible, such as pesticide residue on foods. Although there may be a debate between the groups involved regarding how dangerous these residues are, this debate is likely to increase the chance of controlling residues more than if nothing is said at all. Also, pubic involvement in policy making through participatory democracy can increase people's efforts to educate themselves on issues.

Where capital markets exist, information regarding a firm's environmental performance can further provide stimulus for firms to reduce environmentally degrading activity. There is evidence that stock prices react unfavorably to reports of a firm's poor environmental record and favorably to reports of good environmental stewardship. This drop in stock prices can then act as stimulus for firms to reduce emissions or other environmentally damaging activities.(Hamilton, 1995; Konar and Cohen, 1997; Lanoiea et al. 1998; Dasgupta et al. 2001)

The access to information and the ability to participate in public decision making may not only enhance the public's education regarding environmental problems, but may facilitate the transformation of consciousness to a more eco-friendly awareness that some

authors deem necessary for society to adopt environmentally sustainable development patterns.(Press, 1994; Czech, 2001) This awareness can allow for shifts in individual behavior towards more environmentally-friendly lifestyles of less consumption and more recycling, for example.

Paehlke (1995) claims that it is much easier for a democratic government to motivate its citizens to make these behavior changes. Citizens under authoritarian regimes are likely to be resistant to and cynical of government requests for modified behavior. In a democracy, where people have chosen their government and perceive that the government and industry have made changes in their behavior as well, the public is more likely to be swayed by a sense of efficacy and belonging.

2.5.5 Presence of NGOs

Democratic regimes are more likely to have environmental NGOs and these NGOs are more likely to have an effect on policy making. Environmental NGOs can help disseminate information to the public as well as to policy makers. They can help organize the public against policies and actions that will adversely affect the environment. They can bring information to the government regarding actions and events in areas of the country where the government might otherwise have limited knowledge. They can act as intermediaries between scientists and government officials, bringing the latest information regarding environmental issues to the government in an abbreviated and digested form. They can also lobby the government directly, working to offset the presence of business elites in policy making.

2.5.6 Civil Litigation

Democracies are more likely to have a well-developed legal system that allows for the redress of environmental problems through civil litigation. In fact, functioning legal systems are a central component of democracies. Legal battles in the United States have played a significant role in the enforcement of existing regulation and halting polluting activities by industries. The legal system provides another means for the public to halt degrading activity by elites without waiting for the wheels of government to turn. Authoritarian regimes in general can not allow for public litigation of this sort since this would threaten the stability of the power of the leaders.

2.5.7 Technology

An additional reason for why democracies are more likely to protect environmental quality is that the development of new technologies is more likely to favor environmental protection. Powerful and wealthy groups tend to control the agenda of technology development. They might favor technologies that promise high profits at the expense of future costs, and in which capital can be easily concentrated. An example of this is the efforts made to develop nuclear power while solar power has been largely neglected. The more the power of elite groups is held in check, the greater chance that technologies with long term benefits will be selected over technologies with short term benefits – especially if these benefits are concentrated in the hands of a small portion of the population while the costs are diffused.(Boyce, 1994)

2.5.8 Free Markets

Rodger Payne (1995) puts forth an additional argument for why democracies are more likely to protect environmental quality than authoritarian regimes. He argues that democracies generally have free markets and free markets can take advantage of market based mechanisms for protecting the environment. These mechanisms include tradable permits, pollution taxes, and shadow pricing. Environmental costs can also be included in commodity prices and green taxes can be imposed.

In many ways, the market system is a mixed blessing for the environment. Although centrally planned economies have seemed to have faired worse in terms of their environment, it is not clear if this is a result of the economic system or political system. Although free markets may be an essential part of a democracy, it is debatable whether free markets themselves should be attribute with beneficial aspects regarding environmental protection. Although the merits of markets for promoting environmental quality is an important issue, only the fundamental elements of this extensive debate will be presented here.

There are a number of purported beneficial aspects of markets in regards to environmental quality. One is that markets are seen to be able to reduce the risk of resource depletion through the price mechanism. Briefly, as a resource becomes scarcer, the price of this resource increases, so that users of the resource are more efficient in their use or find substitutes. Price signals can therefor coordinate the use of resources on a global level. (Hayek, 1932) Markets are also seen to preserve resources as long as property rights are well defined, so as to eliminate a commons problem. Didia (1997)

argues that the privatization of tropical forests associated with free markets acts to protect tropical forests, even in the absence of methods to internalize the externalities associates with deforestation. Also, regardless of how property rights are assigned, markets can help achieve an "optimal" level of pollution or resource degradation through equating the benefits from degradation (increased profits) with the costs, assuming low transaction costs. These aspects of "Free Market Environmentalism" have been heralded as economically sound methods for preserving environmental quality. (Anderson and Leal, 1991)

Capital markets can also provide an additional incentive for firms to regulate their own pollution. As was cited above, studies show that stock prices will drop if firms are reported to have poor environmental records, which provides additional incentives for firms to clean up their production activities.

Markets also have their downside in terms of environmental quality. On the broadest level, in order for capitalism to function, there must be economic growth. This enables capital to produce interest and employment levels to remain high. This growth entails the extraction, transformation and destruction of natural resources, leading to increases pollution levels and resource depletion. This need for growth is exacerbated by an additional aspect of capitalism: the need for inequality of income as a motivational force. As long as there are stratifications in wealth, people will work hard to advance economically and will want to obtain the material levels of the better off members of society, or, if they are better off members, will want to maintain this higher material status. In order to avoid social unrest, governments seek economic growth so that there is

a bigger pie to divide among all citizens. This economic growth placates the have-nots and reduces the need for a redistribution of wealth, which would irritate the haves. So capitalist societies depend on growth to maintain contentment.

Markets also depend on positive interest rates on capital to induce lenders to lend. Positive interest rates have the unfortunate affect of discounting both future benefits and costs. Therefore, preserving resources for the future becomes less valuable today, and potential or even certain environmental consequences of present day activities are discounted as well. This intensifies the propensity for short-term thinking regarding ecosystem services and resource use. Ultimately, the goal of markets is profit and so profits will always take priority over environmental protection.

In addition to the downside of markets for promoting environmental quality, the promise that markets hold for rationally and efficiently protecting environmental quality through market mechanisms has yet to be substantially realized. It is not always easy to internalize into the market the costs associated with degradation of public goods through privatization – either because the public good in question is difficult to privatize or transaction costs are too high.

The coordinating effects of prices that indicate scarcity and therefor reduce the risk of resource depletion have also been found to be problematic. Richard Norgaard (1990) observes that there is a "logical fallacy" in looking to prices to indicate resource scarcity when resource scarcity is supposed to inform price levels. Prices also fall short in other ways in relation to environmental quality. Price can reflect short term thinking with resources in order to make a fast profit, ignoring long term sustainability, future

economic production, and valuation by future generations. Prices also do not take into account unequal distributions of income.

Market mechanism have also not proved, as of yet, to be an effective way to protect environmental quality. Tradable permit schemes have run into problems varying from unanticipated organizational hurdles, to institutional barriers, to high transaction costs.(Hahn, 2000) There have been few successful broad-based tradable permit schemes, although trading within utilities and the moderate trading that has occurred with some programs, have shown significant cost savings.(Hahn, 2000; Burtraw, 1996) These problems make tradable permits, and, to a lesser extent, other market-based methods for environmental protection, even less tenable in developing countries where regulatory infrastructure is generally less developed.(Blackman and Harrington, 1999)

Valuing environmental amenities has also proven to be difficult and has spurred a multi-level debate about the merits of this approach, ranging from the technical feasibility to ethical questions about putting a value on other species.(Grove-White, 1997; Jacobs, 1994) Even where market mechanisms for environmental protection might be useful, their design and implementation are subject to political forces which could reduce their effectiveness.(Hahn, 2000)

This is not to say that centrally planned economies are more likely to protect the environment than market systems. Centrally planned economies in the second half of the twentieth century proved to have terrible environmental records. There are a number of reasons for this, including the difficulty of planning for the coordination of all resources while also taking into account environmental problems, and the lack of incentives to

conserve resources.(Dryzek, 1987; Hubbell and Selden, 1994) Despite the visible failings of these economies in terms of protecting environmental quality, markets can not necessarily be credited with the higher levels of environmental quality found in many countries with market economies.

2.5.9 International Aspects of Democracy

There are also aspects of democratic nations' presence in the world community which increase the likelihood that they will protect the environment more than authoritarian regimes. Democratic nations do not need to close themselves off from the world community because of lack of acceptance or fear of destabilizing actions by other governments or even international NGOs. The openness within democratic governments is usually translated to an openness between democratic governments. Payne(1995) points out that information on technologies and science is more likely to flow freely between democratic nations, allowing them to cope better with complex problems. A new, cleaner technology developed in one nation is also more likely to be adopted in another.

Furthermore, environmental policies adopted in one nation are likely to influence policies in other nations. For example, the United States' clean air standards have been widely adopted in other nations (although not necessarily enforced as fully). Nations with similar political structure can see how well a policy functions elsewhere before trying it themselves.

Democratic nations are also more likely to participate in international organizations. They may pressure each other to work on preserving environmental

quality domestically and to participate in international environmental treaties such as the Montreal Protocol. Authoritarian regimes are more likely to be isolated from the world community and not be subject to international pressure to improve environmental quality.

2.5.10 Summary

In summary, there are a number of reasons for why democracies are better equipped to protect environmental quality than authoritarian regimes. Certainly, democracies are not masters in this realm. There are numerous examples of severe environmental degradation occurring in democracies – from oil spills like the Exxon Valdez, to toxic spills as happened in Bhopal, India. Also, there is tremendous variation in environmental quality in the democracies found around the world. This may be a result of how democratic these states really are or a result of other features of these nations.

Arguably, where we see democracy failing to protect environmental quality, we also see a failing in the ideals of democracy. Power is not evenly distributed. Democracies suffer many of the same problems that hinder authoritarian regimes from protecting environmental quality. Leaders are friends with members of the business elite and do not want to hinder their activities. Corporations are able to gain favors through campaign contributions, threatening reductions in economic growth if they are regulated, or threatening to move abroad leading to increased unemployment. Democratic leaders need to curry favor with elites as well. And this breakdown in democratic ideals has repercussions not just for environmental quality but for social equity issues as well.

Also, as will be discussed below, some aspect of environmental quality are better maintained in a democracy than others. Yet, despite the obvious failings of some democratic regimes to protect certain aspects of environmental quality, authoritarian regimes are bound to be worse, as will be discussed in the next section.

2.6 Authoritarianism and Environmental Quality

Further supporting the idea that democratic institutions and conditions can better provide for the protection of environmental quality is the proposition that authoritarian regimes, which lack these institutions and conditions, are worse. A few reasons for this have been alluded to above as the flip-side to some environmentally favorable aspects of democracy. Authoritarian regimes are less likely to have free flowing information (see, for example, Kramer, 1987; Jancar-Webster, 1993b; Hubbell and Selden, 1994), less likely to interact with neighbors and learn from them.(Payne, 1995) and less likely to allow civil litigation. There are additional reasons why authoritarian states are unlikely to protect the environment.

2.6.1 Concentration of Power

Most fundamentally, in contrast to democracies, which are better able to control environmental degradation due, in part, to the balancing of power among different groups in society, authoritarian regimes are worse at protecting the environment because power is concentrated. Due to the needs for resources for coercion and legitimacy, which will be discussed below, the losers from environmental degradation tend to be powerless

while the winners are the decisions makers. A 1989 Bulgarian newsletter called Ecoglasnost summarized this problem:

> A basic fact about our social and economic life is that different social groups participate unequally in the process of taking the decisions that set the path of the overall development of society. Those who make the strategic decisions are not the same people as those who have to face the consequences. This basic social fact unquestionably applies to policy in the ecological sphere. Here we have privileged chiefs and unprivileged consumers. Moreover, the degree of an individual's responsibility in decision making is in inverse proportion to the actual suffering caused him by...environmental pollution. (Cited in Fisher, 1993)

This concentration of power makes it difficult or even impossible for the losers from environmental degradation to control the actions of the winners. The Broad (1994) study cited above found that losers from environmental degradation were not in a position to limit these activities regardless of how intensely they were affected. This is the most basic reason why authoritarian regimes are less likely to protect environmental quality.

2.6.2 Accountability

A second reason why authoritarian regimes are less likely to protect environmental quality is the lack of accountability of leaders. This lack of accountability intersects with environmental quality in a number of ways. To begin with, authoritarian governments are seldom subject to legal and financial accountability and monitoring that typically limits a democratically elected leader's ability to amass a fortune. In most

democracies, financial holdings of elected leaders are public record, which hinders their ability to engage in financial wrongdoing. Authoritarian leaders are therefore much more likely to take advantage of their personal power and amass personal fortunes than are democratic leaders. Often these fortunes arise from the profits of industry and the exploitation of natural resources within the country. Leaders who hope to personally profit from their position are less likely to impose environmental regulations on industries, which might temporarily decrease profits or taxes that can be collected.

Authoritarian regimes also do not need to worry about public opinion related to environmental quality, with some exceptions discussed below. Unlike for elected leaders, the majority's opinion of a leader's ability to protect public health and welfare is irrelevant for dictators.

They are also less likely to worry about the long-term protection of natural resources. In particularly tumultuous regimes, the leader may expect to flee the country at any time so there is no personal reason not to profit as much as possible in the short term. Political insecurity, therefore, can increase the rate of resource depletion. This is clearly antithetical to the goal of sustainable development.(Hubbell and Selden, 1994; Chadwick, 2000)

2.6.3 Public Pressure

Authoritarian regimes are also less likely to concern themselves with environmental problems because the public itself might be less likely to press for improvements in environmental quality. Especially in a country with a former history of democracy, the public may be more concerned with regaining political freedom and civil

liberties than with protecting the environment. In coercive regimes that engage in human rights abuses, the focus of individuals as well as NGOs is more likely to be directed at eliminating these abuses than decreasing levels of pollution or environmental degradation. Also, the public may not have information as to the level of degradation in the country, due to limits on the free flow of information, lack of government efforts to collect information on environmental quality within the country, and restrictions on individuals and groups attempting to collect and disseminate this information.

2.6.4 Coercion, Elites and Legitimacy

Authoritarian regimes are less likely to protect environmental quality because of their continued need for financial resources for coercion. Authoritarian regimes stay in power through a combination of three general approaches: 1) brute force relying on military support and violent oppression of opposition; 2) support by the elite and other power-holders in a society; and 3) some level of legitimacy associated with convincing the populace that they are doing an adequate job of providing for economic growth and/or security, or other socially desirable goals. The populace may accept the limitation of political freedom and civil liberties if their economic welfare is improving. These three approaches all require resources that could otherwise be used for environmental protection.(Hubbell and Selden, 1994)

For regimes that use military force, government stores of financial resources are necessary for the continued support of the military. Even for non-military authoritarian regimes, concern over military coups especially require that they do not neglect wages for military personnel and that they provide acceptable benefits.

Gaining the support of the elites generally involves allowing the elites to profit from the economy or country in some way that would change with a change in power. This often means giving them unhindered access to natural resources or allowing for unregulated industrial activity. So, for example, in the Philippines, Ferdinand Marcos gave to many of his supporters forestry concessions from which they could profit.(Broad, 1994) This assured their continuing support.

For a regime that depends on providing economic growth to increase legitimacy, the government may be less willing to pursue policies that may dampen short-term economic growth, even if these policies are better for the economy in the long run. For example, the level of mining and deforestation increased tremendously during the Pinochet regime in Chile so as to provide capital for investment in other sectors of the economy allowing for periods of strong economic growth. This growth increased the support the regime received from some segments of the society.

The government might also be unwilling to take actions which are unfavorable to the business elite, both to maintain their support and because much of the investment in the economy is through the business elites. Ostracizing the business elites could reduce the stability of the economy, leading to a recession or collapse that could seriously threaten the stability of the regime.

Because authoritarian regimes need to devote so much of their resources to supporting the military to maintain their support, to supporting the elites to maintain their support, and/or promoting economic growth to gain support from the general populace in the form of gaining legitimacy, they can not afford potential short term economic losses

associated with protecting environmental quality. These short term losses are composed of: devoting resources to developing, administering and enforcing environmental policies, temporary restrictions in economic growth while the economy adjusts to regulations, and alienation of the elites who are benefiting from their ability to degrade the environment or extract resources.

It is possible that a regime could receive its legitimacy through the protection of the environment – that a benevolent green dictator could rule. However, this is unlikely for a number of reasons. For one, a leader who acts to implement these sorts of policies risks alienating the elites (who are benefiting from the ability to pollute freely and extract resources) and therefore dampening the economy through discouraging investment, as well as lowering their own government revenues. For example, pre-1989 Polish authorities were loath to challenge the industrial sector regarding increasing levels of environmental contaminants because of their financial dependency on this sector.(Kabala, 1993)

Secondly, many authoritarian leaders have close personal ties to members of the elite, and would be unlikely to impose restrictions on their friends' business practices.

Thirdly, due to the timing of the costs and benefits of environmental improvements, authoritarian leaders are likely to see depending on legitimacy based on environmental quality improvement in the future as a risky venture.

2.6.5 Environmental Degradation and Decreased Legitimacy

The acute degradation of the environment can, and has, threatened the legitimacy of governments, forcing them to make efforts to restrict degrading activities.

Environmental pollution was also an issue in the fall of the Pinochet Regime in Chile, as will be discussed in Chapter 4. Environmental degradation was a threat to the communist Polish government (Kabala, 1993) as well as the pre-1989 Hungarian government (Persanyi, 1993). In regards to East Central Europe in general, Susan Baker and Petr Jehlicka (1998) write:

> ...visible environmental deterioration in many industrial regions of the former East bloc, in particular the correlation between high levels of pollution and below average life expectancy, was eventually to weaken the regimes across ECE. Regime inability to redress environmental problems undermined the legitimizing claim of Communist rule to be the guarantor of human well-being...With the exception of Romania, environmental groups and activists went on to play an active role in bringing down the Communist regime in all countries [of ECE].(p.9)

The environmental agenda can be a compelling one for dissident groups to pursue for a number of reasons. The impacts of environmental degradation are widespread, the solutions often call for significant structural change of the whole economy (logically leading to the need for a new governmental system), and dissident groups may be able to forge ties with the West over these issues and receive funding and other forms of support.(Persanyi, 1993)

So although an authoritarian regime may not be able to gain legitimacy through environmental protection, legitimacy and social stability may be threatened by acute environmental degradation, forcing regimes to control this degradation or face destabilizing forces and events.

2.6.6 Physical Threats

Finally, environmental degradation and resource extraction are also more likely to be defended through imprisonment of individuals who criticize the damaging activities (see, for example, Singleton, 1987) and threats of violence in authoritarian regimes, especially when the resource extraction is being carried out by the government or by elites with government cooperation. This can put a damper on the activities of dissident groups.

2.6.7 Example of Authoritarian Regimes Protecting Environmental Quality

Given the centralized power of authoritarian regimes, they could be very effective in imposing and enforcing environmental regulations – especially with the strength of the military's support backing the regulations. And, indeed, there have been examples of authoritarian governments imposing environmental regulations promptly and efficiently once the problems that needed regulation were brought to light. The most well known example of this occurs in Singapore, where protecting environmental quality was and is a goal of the ruling party.

Other authoritarian regimes have also taken limited actions to protect environmental quality. For example, in 1986, Suharto's government in Indonesia banned the use of fifty-seven types of pesticide and instituted a program of integrated pest management in order to protect rice production. The program was based on scientific evaluation of the rice crop crises that had occurred in 1974, and 1979, and was supported by the United Nations Food and Agriculture Organization (FAO).(Cribb, 1998) The government also took hesitant steps to control industrial pollution.

In contrast to the many other situations in which the government is reluctant to control industrial pollution so as not to lose support from the business elite as well as not dampen economic growth, the Indonesian government favored environmental regulations as a way of curbing the increasing power of the growing private sector.(Cribb, 1998) On the other hand, other environmental problems, such as deforestation, have proceeded largely unchecked in Indonesia.

The former communist regime of East Central Europe also made efforts to counteract environmental damage by both establishing environmental organizations and introducing environmental laws.(Baker and Jehlicka, 1998) However, these efforts were tampered by limitations on information gathering and dissemination, limitations with outside contact for the scientific community, and restrictions on "independent and autonomous activities".(p.9, Baker and Jehlicka, 1998)

2.6.8 Summary

In summary, for a number of reasons authoritarian regimes are unlikely to protect environmental quality: power is likely to be concentrated in the hands of elites who are likely to gain from environmental degradation; leaders are not accountable to the public and may reap personal gains from environmental degradation; there is limited public pressure to protect environmental quality; the resource and political demands for coercion limit environmental protection; and actions to protect environmental quality can be blocked through physical threats. Also, in contrast to democracies, authoritarian regimes

are less likely to have free flowing information, to work with and learn from neighbors, and to have civil litigation, all of which can help environmental causes.

Although severe environmental degradation can threaten authoritarian regimes and although some regimes have taken action to limit environmental degradation, overall, the structure of authoritarian rule is not conducive to protecting environmental quality.

The structure of different forms of decision making and how well these different forms act to protect environmental quality is the topic of John Dryzek's book *Rational Ecology* (1987). Although many of his arguments are similar to those presented above, his analysis is structured differently than the argument presented above, and sheds further light on the topic at hand. In the next section, a summary of John Dryzek's work on the topic of environmental quality and democracy is presented.

2.7 Dryzek's View on Democracy and Environmental Quality

John Dryzek examines a variety of methods for rational ecological decisions making such as administrative rule, law, markets, and moral persuasion. He also considers the pros and cons of polyarchy as a form of social choice. He evaluates each form of social choice based on four criteria: (1) negative feedback, which he defines as the system's ability to receive signals from the human/ecosystem interface regarding activities that are having detrimental ecosystem impacts; (2) coordination within and across collective actions taken to protect the ecosystem; (3) robustness and/or flexibility, which allows the social choice mechanism to perform well in a variety of conditions and

circumstances, and/or adjust decision making parameters as environmental conditions change; and (4) resilience, or the system's ability to return the system to a "normal operating range" in the face of steep ecological challenges.

He finds that polyarchy is a successful system in terms of negative feedback, coordination, and resilience. The negative feedback occurs through the ability of interest groups or individuals to express opinions and promote changes in policy processes, allowing the system to respond better to problems identified by those groups or individuals who are directly affected by problems. Negative feedback also comes from interest groups, such as environmental groups, who stay apprised of potential impacts of policies, or lack of policies, and provide a constant flow of negative feedback to the system.

Dryzek contends that this feedback is a boon to polyarchy because it lessens the need for extensive research and evaluation by the decision-making body: "The information pertinent to any decision is sifted, highlighted, and organized into arguments by the stakeholders involved. In consequence, the burden of cognition suffered at high levels in an administered system is avoided."(p.117) Negative feedback is also better able to reach its target because it is not hampered by hierarchy and bureaucracy as it is in an administered system.

Dryzek sees the system's resilience stemming from the ability of the system to openly evaluate the feedback received:

> If any profound disequilibrium in human systems as they interact with ecosystems is recognized, individuals within or outside government can

> and will investigate and develop possible solutions... Doubtless, many hypotheses will turn out to be blind alleys, but the open society can discard or modify unsuccessful policies. Successful policies will be retained, such that society can move incrementally towards amelioration of ecological problems.(p.118)

Coordination is achieved in polyarchy through the eventual accommodation of actors and choices over time – a "quasi-invisible hand producing politically rational collective outcomes as a byproduct of individual actors pursuing their own interests."(p.119) Although the outcome of the forces of various actors simultaneously influencing policy making is political rationality, it is not necessarily ecological rationality. For this, negative feedbacks regarding ecosystem integrity must be clearly received.

Based on these three criteria, Dryzek argues that polyarchy is a better system for achieving ecological rationality (protecting environmental integrity) than other widespread forms of social choice.

Dryzek considers the failings of polyarchy both in terms of ideal polyarchy and existing polyarchies. The primary failings of existing polyarchies are the ability of a small number of excessively strong interests to control the policy agenda, the types of interests represented (usually counter to environmental protection), and the market system in which polyarchies tend to exist. In brief, the problem created by markets is that the imperative of profits tends to generate positive feedbacks that can override the

negative feedbacks of ecosystem degradation. These are all problems that were discussed above.

For ideal polyarchies, one obstacle to obtaining ecological rationality is that, in the face of crisis, all actors affected will try to gain from the resolution of the conflict. If no one group is more powerful than another, the result will be a solution that strengthens the pre-crisis position of all actors involved, thus enforcing the status quo, rather than moving to what could be a superior state in terms of environmental protection. Another obstacles is the pace and method of interactive problem solving, which is not necessarily well equipped to handle environmental crisis or even fundamental disequilibriums between humans and nature. Dryzek also identifies the problems of public goods and common property resources, which can be exploited in a polyarchy, as was discussed above.

A more entrenched problem is the challenge faced by polyarchy in dealing with the dynamism and complexity of environmental problems. Dryzek argues that as dynamism and complexity increase, so does the interpenetration of the values and concerns of different ecosystems, such that each group's interests will affect another. With enough time, an equilibrium solution can be reached, but sometimes there is not adequate time given the dynamism of the system. Problems can accumulate, demanding further action, and eventually leading to chaos. This is a damning aspect of polyarchy indeed. Dryzek sees the only solution to this problem to be a social consensus on the primacy of ecological values.

So, although Dryzek sees polyarchy as a superior method for environmental decision making than other options such as markets and administered systems, it too has its unfortunate shortcomings. The shortcomings I identified above have more to do with the breakdown of democracy. Dryzek also considers the complexity of the system as a burden as well.

2.8 Democracy and Different Aspects of Environmental Quality

Although there are many reasons to expect that a democratic regime would be more likely to make efforts to protect environmental quality than an authoritarian regime, it is important to note that, just as income level might effect various aspects of environmental quality differently, we would expect democracy to affect various aspects of environmental quality differently. The great number of environmental problems facing the world have different characteristics that result in varying likelihoods that they will be controlled through increases in the level of democracy, or increased income levels, technological innovations, improved education, declining birthrates, or a host of other factors.

The following matrix illustrates how different characteristics associated with environmental problems affect the likelihood that these problems will be controlled in a democratic regime. Despite the different aspects of democracy listed above, the matrices below focus on one aspect of democracies – public participation in decision making. Public participation in decision making is a central component of the argument above.

To consider a collection of aspects of democracy, such as freedom of the press and accountability of leaders, at the same time as the characteristics of various environmental problems, would be too complex. The resulting matrix of interactions would be nearly impossible to lay out and largely unnecessary for illustrating how the two variables in question, democracy and environmental quality, interact. A discussion of the heterogeneous aspects of democracy and how this might effect environmental is included in the conclusion to this chapter.

This matrix and the following one are tools designed to aid in understanding the multiple dimensions of "environmental quality", and how these dimensions complicate the analysis of the interrelations between environmental quality and democracy. They are based on generalizations and certainly there are many exceptions to the tables' listings.

TABLE 2.1 CHARACTERISTICS OF ENVIRONMENTAL PROBLEMS AND LIKELIHOOD OF DEMOCRATIC CONTROL

	Democratic Control				
Characteristics	Less likely	>>>	More likely	>>>	Very Likely
Spatial Scale	Global/ foreign	Regional*	National	Local	Very Local
Level of Complexity/ Uncertainty	High	Moderate	Medium	Low	Very Low
Transparency	Invisible	Somewhat Visible	Medium	Fairly Visible	Obvious
Temporal Scale of Impacts	Distant future	Moderate Future	Near Future	Very Soon	Immediate
Sources	Very many	Many	Moderate	Few	Very Few
Source and Target	Same	Mostly Same	Similar or Mixed	Mostly Differ	Differ
Livelihood Impact	Very Low	Low	Medium	High	Very High
Human Health Impacts	Indirect	Somewhat Indirect	Semi-direct	Somewhat Direct	Direct
Level of Health Impacts	Very Light	Light	Medium	Heavy	Very Heavy

* Depends on country size. For large countries, like the United States or China, "national" might be a larger scale than "regional".

On the left is a list of characteristics associated with different environmental problems. How these characteristics influence the likelihood that the environmental problem will be controlled in a democracy is then rated on a scale from "Less Likely" to "Very Likely". For example, an environmental problem with many sources, such as air pollution from motor vehicles, is less likely to be controlled in a democracy than a problem with few sources, such as industrial emissions. People are less likely to vote for, or press for, policy changes that will potentially be expensive for them, than policy changes that will be expensive for a few big polluters. People are also less likely to pressure their government to control problems that have few health impacts than problems with many direct health impacts. And the public might also be less likely to be concerned with activities whose costs will arise in the distant future, than activities with costs that occur in the present.

Beyond the features of environmental problems that might inspire a greater or smaller response from the public, democracies also have institutional features that may effect the likelihood that different environmental problems will be addressed. For example, in a democracy with frequent elections, activities with present benefits and future costs are less likely to be controlled than activities with present costs. A democracy might also not have the resources to contend with problems that are difficult to monitor or enforce, or ones with many sources.

The matrix below uses the characteristics and scale of the matrix above to see how different environmental problems might respond to democratic control. In each row

is listed an example of an environmental problem. In each column is a characteristic associated with environmental problems followed by the numbers associated with the different ends of the spectrum for this characteristic, following the matrix above. One is associated with a high likelihood of democratic control while five is associated with a low likelihood.

For example, a problem that effects many people is more likely to be controlled by popular mandate than a problem affecting few people. So a problem that affects many people would be given a one and a problem affecting few people would be given a five. A problem affecting a medium number of people would be given a three. A problem that is transparent is more likely to be controlled in a democracy than a hidden problem. So a transparent problem is given a one, and an obscure problem is given a five. A problem with heavy health impacts is more likely to be controlled in a democracy and so is given a one. A problem with light health impacts is given a five.

TABLE 2.2 ENVIRONMENTAL PROBLEMS AND DEMOCRATIC CONTROL

Environmental Problem	Local - 1 Global - 5	Simple, certain - 1 Complex, uncert. - 5	Transparancy Obvious-1 Invisible-5	Timing of Effects Present-1 Future - 5	Sources Few- 1 Many - 5	Source and Target Differ - 1 Same - 5	Livelihood Impact High - 1 Low - 5	Human Health Impact Direct - 1 Indirect – 5	Level of Health Impact Heavy - 1 Light - 5	Total
Local water quality	1	1	2	1	4	1	4	1	1	16
Urban air pollution from industry	2	2	1	1	1	1	5	2	2	17
Toxic dumps	1	2	3	1	1	1	5	1	5	20
Indoor air pollution	1	1	2	1	5	5	4	1	1	21
Local deforestation	2	2	1	1	2	4	2	5	5	24
Acid rain	3	2	3	2	2	2	3	4	4	25
Pesticides	2	3	4	2	2	2	4	2	4	25
Urban air pollution from mobile sources	2	2	1	1	5	5	5	2	2	25
Soil erosion	2	4	2	2	3	4	1	4	4	26
Ocean pollution	5	3	3	2	2	1	3	4	4	27
Global deforestation, loss of biodiversity	5	2	3	2	4	2	4	5	5	32
Resource depletion	4	3	3	4	4	3	1	5	5	32
Ozone depletion	5	4	4	3	4	3	5	4	2	34
Climate change	5	5	4	5	5	3	5	5	3	40

Once each problem is ranked for each characteristic, these scores are totaled to see how the bundle of characteristics for each problem relate to popular control. The lower the total, the greater the likelihood that the problem will be controlled in a democracy. Based on these totals, the list of environmental problems is sorted from most likely to least likely to be controlled.

The rating system is obviously quite imprecise since many problems would score completely differently for certain characteristics depending on what country one is thinking about or even what case study one is considering. Different environmental conditions in different areas can also change the rankings. For example, soil erosion in

some areas might be very visible and a problem in the present while in other areas it could be more subtle and reach its greatest impact in the future. Livelihood impact is particularly variable. Loss of biodiversity or ocean pollution can have no or extreme livelihood impacts depending on where and whom we are thinking of. Also, depending on the severity of the problem, human health impacts can be quite direct or indirect. Urban air pollution, if bad enough, can cause serious health impairment of even death in some individuals but if mild can take its greatest toll over time.

Furthermore, although all rakings range from one to five, arguably some characteristics are more important than others and so they should be weighted more heavily. The timing or location of a problem might be more important than the complexity, for example. In the matrix above, all columns are weighted equally and a simple sum is calculated. The ordering of the environmental problems would be different if the columns were weighted differently.

The table below shows how the ordering would change with two different weighting schemes. In Column 2, spatial and temporal scale rankings are given three times the weight of the other columns under the assumption that these characteristics are more important variables for influencing public input in policy making. In column 3, the rankings for livelihood impacts and human health impacts are given three times the weight of the other columns for calculating the total score. The first column show the original ranking for the sake of comparison.

TABLE 2.3 THE ORDERING OF ENVIRONMENTAL PROBLEMS WITH WEIGHTED CHARACTERISTICS

Column 1 – simple sum	Column 2 – weight on spatial and temporal scale	Column 3 – weight on human impacts
Local water quality	Local water quality	Local water quality
Urban air pollution from industry	Urban air pollution from industry	Indoor air pollution
Toxic dumps	Toxic dumps	Urban air pollution from industry
Indoor air pollution	Indoor air pollution	Toxic dumps
Local deforestation	Local deforestation	Urban air pollution from mobile sources
Acid rain	Urban air pollution from mobile sources	Soil erosion
Pesticides	Pesticides	Pesticides
Urban air pollution from mobile sources	Soil erosion	Acid rain
Soil erosion	Acid rain	Local deforestation
Ocean pollution	Ocean pollution	Ocean pollution
Global deforestation, loss of biodiversity	Global deforestation, loss of biodiversity	Resource depletion
Resource depletion	Resource depletion	Ozone depletion
Ozone depletion	Ozone depletion	Global deforestation, loss of biodiversity
Climate change	Climate change	Climate change

Changing the weights of different characteristics changes the ordering of which environmental problems are more likely to be addressed through public input in policy making. One could make arguments for a variety of weighting schemes. I am not advocating a particular weighting scheme here. These matrices are largely for illustrating how different characteristics of environmental problems affect how they might be controlled in a democracy.

Despite these caveats, the ranking of these problems does roughly correspond to the chronological order in which these problems have been regulated in one democratic regime – the United States. There are clear exceptions to this, such as indoor air pollution, which is a far more significant problem in less developed countries. Certainly,

in the United States, industrial sources of air pollution have been regulated more stringently than mobile sources for many years despite the relative contribution of mobile sources to overall air pollution levels. Although water quality protection ranks high on the characteristics chart, the U.S. Clean Water Act was not passed until 1972. The U.S. Clean Air Act was passed in 1963, nine years earlier.

It is likely that if large numbers of people were becoming sick from drinking municipal water, laws to protect water supplies might have been passed earlier. Providing potable water is the primary environmental goal for a number of poorer nations. Toxic dumps have been controlled through the Superfund, a result of the Comprehensive Environmental Response, Compensation and Liability Act of 1980. The United States has yet to act on climate change.

Again, because of the great variety even within each environmental problem listed, as well as the way in which humans interact with the environment, the rankings of this chart can not be expected to hold in all countries. The matrices above are designed simply to illustrate that different environmental problems might be more or less amenable to regulation by popular pressure. The second matrix also illustrates how different environmental problems have different characteristics making any sort of generalization about what variables are correlated with environmental quality, in general, difficult at best.

One thing that can be said with certainty is that it *is* relevant what problem one is thinking of when discussing the link between democracy and environmental quality, or income and environmental quality for that matter. The different aspects of environmental

quality has not been explored well in the economic growth and environmental quality literature, resulting in blanket statements about changing income being good for environmental quality. It is important to recognize that it is relevant what aspect of environmental quality one is speaking about.

One might go further and consider the characteristics of different *environmental policies* and how these characteristics influence the probability of different policies being adopted in a more or less democratic regime. Are the benefits and costs from an environmental policy concentrated or diffuse? Are the benefits so diffuse as to be nearly invisible? If the benefits are concentrated, do they benefit a powerful group or a less powerful group? Are the costs concentrated and who pays them? Will the benefits from the policy appear in the next few years or in the distant future? As Margaret Keck (1994) points out, policies or programs to improve the environment sometimes benefit powerful member of society, such as with sanitation projects, and sometimes do not, such as with restrictions on development.

These aspects of environmental policies may influence how likely they are to be adopted in countries with different regime types, in countries with high or low levels of corruption, in countries with different income levels, or countries which vary in other civil attributes like education level and distribution of income.

2.9 Level of Decision Making

Although the discussion above has focused on the nation-state level of decision making, it should be noted that the distribution of power occurs on many levels as does

environmental decision making. Local level decision making on environmental issues could be done through consensus or autocratically whether the country is a democracy or dictatorship. Local input in environmental decision making has become an area of increased study.(Agyeman and Evans, 1994; Gould et al., 1996)

For many environmental problems, regime type might be less relevant than the structure of local decision making or custom or culture or a host of other largely local variables. For example, David Potter (1996) compares the enforcement of forestry policies in two regions – one in Indonesia and one in India. The author hypothesized that enforcement would be better in India, the more democratic of the two countries. Instead he found that the relative level of democracy of the central government in the two countries in question was irrelevant. The two regions experienced equal levels of enforcement because of equal levels of local public power.

It may be that a country that is democratic at the national level is not as democratic at local levels. For example, Mexico has had a democratically elected president for years but recently has its first democratically elected mayor of Mexico City, which holds nearly one tenth of Mexico's inhabitants. So environmental problems that are decided and enforced at the national level may receive different treatment than local problems because of varying levels of democracy within the government.

Although many environment related issues are resolved at the local level, often the nature of the national government is still relevant. Government support or lack of support for local attempts to control environmental quality may reflect not just a lack of capacity for environmental policy but also how democratic the national government is. A

national government that does not step in to help promote or enforce a policy that is clearly in the interest of the majority of the public in that area may reflect the limited nature of the penetration of national level democracy, not just limited government resources. Often the government will take the side of the elites in a local resource struggle as a result of the inequality of power in the society.

It may also be the case that formal levels of democracy are irrelevant to some problems – that social norms and direct influence by the public on companies affects environmental quality.(Pargal and Wheeler, 1995) This is true for many areas of the world, especially for poorer countries which have not yet developed the capacity for environmental policy that is evident in many advances industrial countries.

Allen Blackman and Winston Bannister (1998) document the adoption of cleaner technologies in the informal, traditional brickmaking sector in rural Mexico. They find that the adoption of new technology is a result of community pressure rather than any formal regulations. Dara O'Rourke (1999) documents inconsistent levels of enforcement of regulations restricting emissions of industrial contaminants in Vietnam. He finds that this inconsistency results from variations in the level of community pressure in different communities affected by the contaminants.

Although local level power struggles for protection of environmental quality may be far more relevant to overall environmental quality in many countries of the world, the discussion above is focused on an examination of national level democracy and not local or regional participation in environmental decision making.

2.10 Conclusion

This chapter presented a number of arguments supporting the ability of democratic regimes to protect environmental quality. It also presented reasons why authoritarian regimes are less likely to protect environmental quality. It concluded with a examination of how different characteristics of environmental problems will lead to differing likelihoods of these problems being controlled in a democracy, as well as a brief discussion regarding different geographic levels of regulation and control.

Although there are strong theoretical arguments supporting the superiority of democracy for limiting environmental degradation, democracy has its limitations in theory as well as in practice. In response to these limitations, one could argue that where democracy fails (where the power of the elite is not held in check), there fails environmental protection. In democracies around the world there is considerable power in the hands of elites who benefit from economic growth and environmental degradation. According to Norgaard (1994), "many of democracy's widely touted principles of equality have been eroded through an excessive delegation of authority to markets and bureaucracies."(p.153)

Democracy can also fail to protect environmental quality where the citizens are not concerned about or interested in environmental protection. The more that citizens can distance themselves from environmental degradation – in space or time – the less likely they will press their governments to improve environmental quality. This issue brings us back to the concern with international trade. With trade, citizens can move the effects of

their consumption to other countries. Democracy is most likely to help control with certain characteristics such as being local and felt in the present. Environmental quality is not an homogenous good.

Democracy is also not an homogenous good. As was discussed above in regards to the definition of democracy, democracy is made up of many elements. While two countries might be considered to be equally democratic, they might have significantly different attributes. For example, one might have a better developed constitutional and legal system while the other excels in the protection of civil liberties and social equality. This chapter did not examine the importance of different aspects of democracy for protecting environmental quality.

It may be that it is certain characteristics of democracy allow for some democracies to be better at protecting environmental quality than others. A study by Theodore Panayotou (1997) finds that, for countries with income levels between $10,000 and $20,000 in 1985 U.S. dollars, a fifty percent improvement in policies and institutions is correlated with a fifty percent reduction in ambient SO_2 levels. As a proxy for the quality of policy and institutions, they use the level of respect and enforcement of contracts, however they obtained similar results when using the efficacy of bureaucracy, the level of corruption, the risk of appropriation, as well as a composite index, as compiled in the International Country Risk Guide(ICRG).(see Knack and Keefer, 1995)

Further research might establish that it is certain aspects of democracy that are key for environmental protection while others are less relevant. It may be that the enforcement of property rights, bureaucratic efficiency, institutional capacity, the level of

corruption, or other variables that may be correlated with the level of a democracy in a country, are more important to environmental protection than the generalized level of democracy. This could help explain why the countries of North America and Europe, which are considered equally democratic, have different levels of environmental degradation as well as different types.

From my readings of case studies of environmental protection in new democracies, I would hypothesize that both the development of a legal system that allows for citizen redress of environmental degradation, and the level of corruption within a country, are key to a functioning system to protect environmental quality. This would be an interesting area for further empirical research.

In light of the theoretical evidence supporting the superiority of democracies in relationship to environmental quality, the next two chapters focus on empirical evaluations of the relationship between these broad variables. The next chapter considers the empirical relationship using a large N regression analysis with urban air pollution concentrations as the dependent variable. Chapter 4 considers a case study of air pollution regulation in Santiago, Chile.

Chapter 3 Regression Analysis of the Relationship Between Urban Air Pollution and Democracy

3.1 Introduction

This chapter and the following examine the relationship between urban air pollution and democracy using two different methods. The first is a large N, multinational correlation analysis of the relationship between urban air pollution levels, as an example of one type of environmental problem, and "democracy" as measured by two indices, the Freedom House Index and Polity III. The second method is a case study of air pollution regulation in Santiago, Chile during two different regimes – the authoritarian regime pre 1990, and the democratic regime that followed.

The multi-methods approach, using both statistical analysis and a case study, is particularly appropriate for a broad investigation of complex variables such as "democracy" and "environmental quality". This is primarily because the limited quantity and poor quality of international environmental data, and the great number of confounding variables, make it difficult to draw conclusions regarding factors leading to changes in environmental quality. Case studies can be used to explore a relationship while taking into account the complexities inherent in that relationship. Where statistical analysis indicates relationships, case studies can act to determine what these trends might mean.

Russett (1974) provides four arguments supporting the use of both correlational, large N analysis and case studies, for developing understanding of an issue: (1) case studies can generate theories which can later be tested with correlational analysis, (2) case studies can provide verification for or rejection of inferences found through correlational analysis, (3) case studies can establish potential causal relationships between variables found to be correlated and can help eliminate spurious correlation, and (4) case studies can refine hypotheses supported in correlational analysis.

Hypothesis testing using both large N correlational analysis and case studies is supported by the fact that these two methods have complimentary assets and deficits, as discussed by Ragin (1987) and George (1979). Although both methods are limited in their ability to establish cause, which is done in scientific investigation through study design, case studies are better able to consider cause because they allow for causal complexity. Variable focused studies, such as regression analysis, are best at establishing probabilistic relationships over many observations. However, the results of these studies may be vacuous generalizations. Case studies identify patterns that hold true in a small number of cases. The main problem with these results is that they are not generalizable.

Ragin (1987) further argues that both methods are biased: quantitative strategies are biased towards structural explanations of phenomena, and case studies are biases towards the actions of actors and organizations to explain the variable in question. A combined study can help the researcher to identify and perhaps even to avoid these biases because each strategy checks the biases of the other.

In this chapter, I will present the statistical analysis of democracy and urban air pollution. The chapter begins with a review of statistical studies linking democracy and environmental quality. In the following section is a description of the data used for the study as well as of the model. The regression results are then presented, followed by concluding thoughts.

3.2 Literature Review

Although there are compelling reasons to expect democracy to be correlated with better environmental quality, there is little sustained empirical evidence of a connection between democracy and/or economic equity and environmental quality. Potter (1996) writes:

> Given that democracy and environmental sustainability are two prominent values in current international discourse, it is remarkable that the comparative politics literature virtually ignores the environment. Recent comparative analyses of democratization drawing on modernization theories refer to a wide range of more or less propitious economic, political, social and cultural conditions; but environmental variables are not amongst them, nor is there consideration of the possible consequences of democratization for the environment...The growing academic literature on environmental politics likewise has had little to say systematically on the subject of democracy and the environment. (p.9)

A number of authors have explored the relationship between democratic principles, such as public participation, and a variety of aspects of environmental quality

at the local level. As was noted in the previous chapter, often local level decision making is more relevant for certain aspects of environmental quality preservation.

Although there has been little sustained empirical study of the relationship between regime type and environmental quality at the nation-state level, a few authors have examined the empirical relationship between various aspects of environmental quality and social variables, including measures of democracy. Other authors have considered the connection between environmental quality and democracy through case studies.

In addition to their concern with income level which was discussed above, Shafik and Bandyopadhyay (1992) and Shafik (1994) regress a variety of different state characteristics such as level of investment, energy pricing, debt level, and trade policy, against different environmental indicators, holding income constant. They include in their analysis civil liberties and political freedom, as measured by the Freedom House Index (Gastil, 1990), which will be described below. Their only significant results using the Freedom House Index are that dissolved oxygen in rivers improves with political liberties and ambient urban SO_2 levels increase.

As was cited in Chapter 1, Dasgupta et al.(1995) regress measures of environmental quality developed from reports submitted to UNCED against a range of social indicators. They find an insignificant or even inverse relationship between environmental quality and degree of popular representation and freedom of information. This result may be the result of bias in the environmental reports submitted to UNCED based on level of freedom. It could be that more democratic countries tended to be more

honest in their environmental reports while non-democratic regimes either falsified their reports or were unable to write accurate reports due to a lack of freedom of information that may have hindered environmental quality information collection over the years.

Sheoli Pargal and David Wheeler (1995) examine the relationship between environmental quality and other factors through an intra-country comparison. They compare industrial biological oxygen demand (BOD) discharges into rivers in different regions of Indonesia and relate these to a number of variables pertaining to the industrial sector, as well as to community characteristics such as income level, education, and population density. Pollution and income were found to be highly correlated with a 1% increase in income leading to a 4% decrease in pollution. Education was also found to have a separate and significant impact on pollution, even though income and education are strongly correlated.

In response to their results, the authors pose the question of why pollution is greatest in poor, less educated communities: is it a matter of preference, as is generally assumed, or a matter of power, the ability of these communities to realize their preferences? They find that emission controls result largely from community protests and activities, not from federal level regulations or enforcement. In order to test the relative importance of income versus community protests, they look at the variation in the level of pollution within the poorest fifth of the communities, compared to variation between the mean level of pollution in this group and the group of the richest communities. They find that there is more within group variation than between group variation, suggesting, as they say, "a strong role for power."

Manus Midlarsky (1998) regresses three measures of democracy against six measures of environmental degradation: deforestation level, estimated CO_2 emissions per capita, soil erosion by water and by chemicals, freshwater availability, and protected land area. Controlling for a number of variables, including GDP per capita and population growth rates, he finds a statistically significant negative effect of democracy on three of their dependent variables: deforestation, CO_2 emissions, and soil erosion by water. Protected land area was the only variable to show a positive and significant relationship with level of democracy.

Peter Walker (1999) looks at the effects of increasing levels of democracy on environmental quality through three case studies in Africa. He finds mixed results. In some ways, increasing levels of democracy have helped to protect some aspects of environmental quality, but in other ways it has hindered environmental protection. He notes that the democracy in the countries he studies is still quite limited, affecting only some political and social institutions.

Jeff Haynes (1999) considers the effectiveness of environmental movements through case studies in five developing countries. He finds that that the success of environmental campaigns depends, among other things, on the existence of democratic avenues for pursuing environmental quality improvements. He also find, however, that although democratic avenues are essential for the success of environmental movements, they are not sufficient.

Dal O Didia (1997) examines the relationship between rate of tropical deforestation and regime type. He develops his own democracy index for 55 countries

throughout the world and compares this index to average annual deforestation in the four year period of 1981 to 1985. He finds a strong negative correlation between level of democracy and rate of deforestation. So countries that are more democratic have lower deforestation rates. He attributes this to the development of institutions and political processes that work towards forest conservation.

In addition to considering the relationship between income level and deforestation, which was cited in Chapter 1, Bhattarai and Hammig (2001) also examine the relationship between rate of deforestation and regime type. They discuss regime type in terms of the development of particular political institutions. They consider deforestation in 66 countries from 1972 to 1991. As a proxy for these institutions, they use the Freedom House Index, which is also a measure of regime type. They find a statistically significant and negative relationship between the Freedom House Index and deforestation rates in Latin America and Africa, showing that the more democratic a country, the less deforestation. For Asia, the relationship is again statistically significant but here it is positive, suggesting that the more democratic a country, the higher the deforestation rate. They attribute this to the fact that countries such as China and Bhutan have very active reforestation programs, yet rank low for democratic institutions.

They also have thoughts on the EKC. They write: "This study assumes that growth of income is accompanied by improvements in sociopolitical institutions, environmental rules and regulations, and the allocation of environmental resources, which are generally considered public goods. It is therefore hypothesized that underlying institutional and policy conditions affect the relationship between deforestation and

income, and shift the EKC upward or downward accordingly."(p.999) In other words, income level influences deforestation rates through improving institutions for managing environmental problems.

In summary, the limited statistical analysis of the relationship between democracy and various aspects of environmental quality find mixed results. Some studies find positive correlations with some measures of environmental quality, others find negative, and other measures appear uncorrelated.

In the next section I will present my own regression analysis of urban air pollution and democracy.

3.3 Regression Analysis

The statistical analysis method used here follows closely the method used by Grossman and Krueger (1991). This is partly so that the results of their analysis and the following analysis can be compared. Also, random effects and fixed effects models are an appropriate method for analyzing correlations in panel data when no structural relationship is being tested. In other words, this method is appropriate for looking for the correlation between two variables when no causal relationship is being tested, or if the data for testing a causal relationship is not available.

Looking at the relationship between measurements of environmental quality and measurements of democracy in this way is not new. As was cited above, a few authors have included measures of democracy in their analysis of environmental data.

Because of the many difficulties in relying on the results from cross-country statistical analysis, I can not expect statistical results for the relationship between environmental quality and democracy to be more reliable than the existing statistical work on the relationship between income and environmental quality which I critiqued in Chapter 1. But, despite the limitations associated with this type of analysis, I believe that this portion of the research is valuable for three reasons: to highlight the weaknesses of the statistical analysis establishing the income/environmental quality analyses; to establish a foundation for case study work; and to put an alternative to the income/environmental quality hypothesis on the map for those who are interested in statistical approaches.

3.3.1 The Data

Measuring environmental quality.

Many environmental problems can be described numerically, but these numbers are often unreliable. For example, air pollution monitors are famous for poor performance and the readings can be dramatically different depending on the location of the monitor -- is it at street level or on top of the post office? Also, wind patterns that affect ambient pollution levels in one area can hide total emission levels and possible consequences down wind.

For many environmental problems, no international database exists. The best environmental data exists for the advanced industrialized nations. International environmental monitoring has been increasing rapidly over the past few years, which will

facilitate future research on which variables, if any, correspond with improvements in environmental quality.

For the empirical work below, I will look at the same dependent variables used by Grossman and Krueger: urban concentrations of SO_2, suspended particulate matter (SPM) and dark matter or smoke. The foremost reason for this is the availability of data. As was discussed in Chapter 1, the largest international environmental data collection is from the Global Environmental Monitoring System (GEMS), a joint effort of the United Nations Environment Program and the World Health Organization. The GEMS has collected intermittent international data for ambient urban SO_2, SPM and smoke levels, over a number of years.

Additionally, the most commonly cited evidence for a link between economic growth and environmental quality is based on Grossman and Krueger's work with international urban air pollution data, so changes in air pollution regulation deserve further study.

Air pollution is also an environmental problem we might expect to be controlled in a democratic system due to the visibility of the problem, the great number of people it affects, and the immediacy of the health impacts in the form of burning eyes and throats, coughing, and increased respiratory problems (although some of the worst health effects of air pollution, such as cancer, may not be felt for many years).

Air pollution from large fixed site emitters is a classic environmental problem we would expect to be better controlled by a democratic system, assuming that people want to reduce ambient air pollution levels. Many people suffer from the results of the emissions yet few people benefit, primarily the owners of the emitting industries. The

greater the relative power of the many sufferers compared to the few emitters, the more likely these emissions will be reduced.

Air pollution from automobiles and other mobile sources create a more complex problem. In as much as vehicle manufactures can produce vehicles with lower emission levels and not pass that expense on to consumers, mobile source pollution also should respond to democratic control (assuming again a population concerned about air pollution). But if the expense of cleaner vehicles is passed on to the consumer in the form of higher price tags for cars and higher public transit costs, increased public participation in governance may, in theory, impede the reduction of emissions from the vehicle fleet depending on the relative importance of transportation costs compared to air pollution reduction. In other words, even if the majority of the public cares about air quality, they may not push for restrictions on motor vehicle emissions if they perceive that they themselves will be responsible to pay the costs associated with the restriction.

A final reason for using ambient pollution is that the meaning of environmental quality is to some extent culturally determined. Some aspects which many citizens of OECD countries might think are important aspects of environmental quality, such as parks and natural areas, might not be important for other countries. Given the known health impacts of polluted air and water, this measures seems to me to be more neutral than some other measures, although I recognize that this point is debatable.

For my regression analysis, I will use the updated GEMS data available from the United States Environmental Protection Agency (EPA) which provides public access to

the data through its Aerometric Information Retrieval System (AIRS), as was described in Chapter 1.

Measuring Democracy

In order to conduct empirical research related to level of democracy, an acceptable method is needed for measuring democracy, with all of its different aspects. Rather than attempt to develop my own measure of "democracy", I use indexes that have already been developed. Probably the most well known index of democracy is the Comparative Survey of Freedoms, also known as the Freedom House Index, published by the Freedom House since 1973.(Gastil, 1990) This index rates every country of the world on a 1-7 scale for level of political freedom and level of civil liberties. Total ratings therefor range from 2 to 14, 2 being the most democratic and 14 being the least.

Eleven criteria are used to measure political rights (p.30):

1. Chief authority recently elected by a meaningful process
2. Legislature recently elected by a meaningful process
3. Fair election laws, campaigning opportunities, polling and tabulation
4. Fair reflection of voter preferences in distribution of power
5. Multiple political parties
6. Recent shifts in power through election
7. Significant opposition vote
8. Free of military or foreign control
9. Major group or groups denied reasonable self-determination
10. Decentralized political power
11. Informal consensus; de facto opposition power

Fourteen criteria are used for civil liberties (p.36):

1. Media free from government censorship
2. Open public discussion
3. Freedom of assembly and demonstration
4. Freedom of political or quasipolitical organization
5. Nondiscriminatory rule of law in politically relevant cases
6. Freedom from unjustified imprisonment or political terror
7. Free trade unions and other organizations
8. Free businesses and cooperatives
9. Free professional organizations and other private organizations
10. Free religious institutions
11. Personal social rights such as rights to property, travel, choice of residence, marriage
12. Socioeconomic rights such as freedom from dependency on landlords, bosses, union leaders, bureaucrats
13. Freedom from gross socioeconomic inequality
14. Freedom from gross government indifference or corruption

These checklists have changed slightly over the years yet remain more or less similar to the lists given above. Most notably, there appears to be more of a focus on free markets now than political freedom.

In the early years of the survey, the ratings were determined based on the work of one man, Raymond Gastil, who rated each country using a "reference book description". Gastil claims that many of the earlier ratings were superficial, in that he missed the effects that distribution of income or powerful oligarchies could have on the political system. Overtime, he has used more sources to rank the countries and investigators have

been employed to ranks countries on the above criteria.(Gastil, 1990) The rankings are tabulated and countries are then ranked. The shortfall with the Freedom House Index is that many of the criteria are subjective. Although this index is more complete than others are, it is also open to more subjective judgments.

These ratings, as well as essays on each country, are provided in the series *Freedom in the World* by the Freedom House Survey Team published since 1973.(Gastil, 1990) I added this variable to the AIRS database provided to me by William Harbaugh

A second index which I will use for the analysis below is the Polity III index, developed by Keith Jaggers and Ted Robert Gurr.(1995) This index covers 161 countries from 1946 to 1994. Each country is rated annually for level of democracy and level of autocracy. I have only used their democracy scale. The ratings are based on subjective judgements on the level of three fundamental aspects of democracy: 1) the competitiveness and openness of political participation; 2) the competitiveness of executive recruitment; and 3) the constraints on the chief executive. These subjective judgements are based on historical monographs, as well as other "source materials". Countries are rated on an eleven point scale – from zero to ten – zero being least democratic and ten being the most.

Although the authors of the index acknowledge that civil liberties are an important component of democracy, the Polity III index focuses on the institutional aspects of democracies, rather than the social. They argue that, "While serious violations of human rights may occur despite the effective functioning of these (democratic) institutional structures... we contend that when political participation is fully open and

competitive, executive recruitment is elective, and the constraints on the chief executive are substantial, the correlation between democratic institutions and practices will be high."(Jaggers and Gurr, 1995, p. 471)

Jaggers and Gurr test the reliability of the Polity III index by comparing it to a variety of other indices of democracy, including the Freedom House indexes of Civil Liberties and Political Freedom, using the Pearson product-moment correlation coefficient. They find that in all cases the correlation is quite strong. The Pearson product-moment correlation I computed for the years included in the AIRS data base between Polity III and the Freedom House Political Rights index is 0.97, and the Civil Liberties index is 0.94.

Another index for democracy is the Polyarchy Scale developed by Michael Coppedge and Wolfgang Reinicke (1991). They use the requirements for polyarchy given by Dahl, listed in Chapter 2, to develop a scale with which to rank each country. Their scale includes three levels for free and fair elections, four levels for freedom of organization, four levels for media pluralism, and three categories for freedom of expression. They originally also included a variable indicating the right to vote but decided not to use this since the right to vote is irrelevant if there are no elections, for example.

A variety of sources are used to rate each country. More than one source is used for 91% of the ranks they develop, which is important since sources can be erroneous in their claims.

They recognize the limitations of trying to measure on a linear scale all the complexities of different systems. They write:

> We have not developed a finely calibrated instrument suitable for measuring the complex differences among countries at the same level of polyarchy. What we have produced is a coarsely calibrated instrument: an ordered typology with ten to twelve types that apply to many countries at once. This Polyarchy Scale should be very useful for identifying countries that are similar in the degree of polyarchy they possess, and making broad comparisons of dissimilar types.(p.53)

They do not include all of the criteria given by Dahl. For example, they do not include a variable to express how much elected officials control policy decisions. They claim that this is incorporated in free and fair elections but what if the country has free and fair elections for the president only but many decisions are made by lower ranking officials like mayors? Would Mexico score higher when the mayoral position was made an elected position?

The resulting Polyarchy Scale has the greatest number of countries in the top category, which makes sense since they are looking for the minimal requirements for polyarchy. They greatest limitation with their work is the reliability of their ratings, especially for small, less developed countries. Reliability for these scales should improve over time.

Although this index is not useful for the statistical analysis below because it only covers one year, 1985, it is useful for comparing the results of the Freedom House Index

and the Polity III index to see how the ratings compare to Dahl's criteria. If the results for 1985 are similar, this suggests that the two indices used for the statistical analysis below correspond with the definition of democracy used for the analysis in Chapter 2.

Jaggers and Gurr (1995) find the correlation between the Freedom House Index and the Polyarchy Scale is .93. The correlation between Polity III and the Polyarchy Scale is .91. These high levels of correlation suggest that the Freedom House Index and Polity III do not differ significantly in their interpretation of democracy than the interpretation given by Dahl for Polyarchy, as described in the previous chapter.

3.3.2 The Model

I hypothesize that the more democratic a country is, the more likely that it will protect environmental quality. In other words, we would expect a positive linear correlation between level of democracy and level of environmental quality.

I will test this using two linear models which follow from the models used by Grossman and Krueger (1991), and similar to equations (6) and (7) in Chapter 1. The first model is a random effects model:

$$POL = \alpha + \beta_1 DEMO + \beta_2 C + \beta_3 CC + \beta_4 I + \beta_5 R + \beta_6 D + \beta_7 COM + \beta_8 Y + \varepsilon \qquad (8)$$

where the variables are the same as described in Chapter 1. POL is the pollutants studied, α is the constant, DEMO is either the Freedom House Index or the Polity III index, and C is a dummy variable for whether the site is near the coast. CC, I and R are dummies for whether the location of the site is identified as central city, industrial, or

residential, respectively. D is a dummy variable for whether the site is within 50 miles of a major desert. This dummy variable is used for SPM and smoke but not for SO_2. COM is for whether the county is communist or not. Y is for year. The final term is the error term.

The second model is a fixed site effects model, which, again, includes a dummy for each site. As was explained in Chapter 1, the STATA program is able to transform the data such that a dummy for each site does not need to be included in the regression but the regression coefficient results are the same. The R^2, however, does not reflect the influences of the site dummies. This model is better at evaluating change over time rather than cross-country comparisons. It is as follows:

$$POL = \alpha_i + \beta_1 DEMO + \beta_2 Y + \varepsilon \qquad (9)$$

The number of sites used for the analysis depend on which pollutant is being tested and which democracy index is being used as each index is missing values for some countries some years.

3.3.3 The Results

The following table gives results for both the RE and FE models using the three pollutants and the two different measures of democracy described above. A positive coefficient between the Freedom House Index and air pollution suggests a positive correlation between democracy and environmental quality because the lower the Freedom House Index number the higher the level of democracy. With the Polity III data, a

negative coefficient signifies a positive correlations between democracy and environmental quality because the higher the Polity III number, the greater the level of democracy.

TABLE 3.1 DEMOCRACY AND AIR POLLUTION USING AIRS DATA

	SO_2 RE	*SO_2 FE*	*SPM RE*	*SPM FE*	*Smoke RE*	*Smoke FE*
Freedom House Index	4.51**	3.27**	6.40**	2.94	7.29**	3.11**
Number of Observations	2401	2401	1080	1080	710	710
Hausman Test Results[a]	.1240		.0006		.0060	
R^{2b}	.098	.087	.402	.048	.357	.176
Polity III	-5.43**	-4.06**	-9.31**	-7.42**	-5.33**	-2.66**
Number of Observations	2322	2322	1063	1063	646	646
Hausman Test Results	.0005		.3484		.0322	
R^2	.078	.102	.417	.058	.351	.177

** Significance greater than .05
* Significance greater than .10
[a] Result gives the probability that the difference in coefficients between two models (RE and FE) is not systematic.
[b] R^2 for the Fixed Effects models reports the R^2 within rather than R^2 overall since this model depends on results from changes within each site.

In all cases, the sign of the coefficient for democracy is as predicted. It is positive for the Freedom House Index and negative for Polity III. In other words, in all cases the hypothesized positive correlation between democracy and environmental quality is supported. All of the results are also significant at the .05 level except for the fixed effects model for SPM and the Freedom House Index.

The Hausman test rejects the hypothesis of unbiased results of the random effects model in favor of the fixed effects model in four of the six RE regressions. The Hausman

test does not reject the RE model for SO_2 concentrations regressed with the Freedom House Index and SPM concentrations regressed against Polity III.

The results for this last model are particularly striking given the high value of the coefficient, -9.31, as well as the R^2 of .417. This particular result gives the strongest support for the hypothesized relationship. None of the twelve regression results contradicts the hypothesized relationship.

Although it is difficult to compare the relative strength of the relationship between income and environmental quality vs. the relationship between democracy and environmental quality because one is cubic and the other linear, the support for the democracy correlation is clearly more consistent than the income correlation. The inverted U-shaped relationship between income and air pollution is only supported with the concentrations of smoke using the AIRS data. But the linear relationship between democracy and environmental quality is supported in all cases except for SPM and the Freedom House Index. Here, the Hausman test rejects the RE model, and the FE model does not give significant results.

It is worth noting that the R^2s in the table above for the FE regression do not reflect the influence of the site dummies, which is not the case in Grossman and Krueger (1991). In their results, the R^2s are higher because they include the influence of site dummies. If we were to include these dummies, the regression coefficient results would be identical but the R^2s would be higher. The following table gives the R^2s for each FE regression including dummies.

TABLE 3.2 R^2S FOR FE REGRESSION RESULTS IN TABLE 3.1 INCLUDING THE INFLUENCE OF SITE DUMMIES

	SO_2 FE	*SPM FE*	*Smoke FE*
Freedom House Index	.823	.915	.797
Polity III	.823	.916	.792

These are comparable to the reported R^2s in Grossman and Krueger for their 50th percentile FE regressions. These were R^2s of .76, .91, and .87 for SO_2, SPM, and smoke respectively.

The results reported in Table 3.1 have many of the same problems that the Grossman and Krueger results have, as outlined in Chapter 1. For example, the models are reduced form so we do not know the causal mechanisms making up this relationship. Nor do we know the direction of the relationship. The data have not been corrected for autocorrelation, which could effect the regression results. Also, FE model results should not be extrapolated to cases outside of the database used.

In the next section, the robustness of these results will be tested through splitting the data.

3.3.4 Data Subsets

As was done with the results presented in Chapter 1, the data can be broken into subsets to see if the regression results still hold. The first test is to create a subset of data by dropping China from the database. There are many data points for China for both SO_2 and SPM. China has 212 out of 2401 data points for SO_2 concentrations and 211 out of 1080 for SPM. There is no China data for smoke but the regressions for SO_2 and SPM

can be recalculated without China data to see if dropping this one countries strongly effects the results. The following table gives the results.

TABLE 3.3 DEMOCRACY AND AIR POLLUTION USING AIRS DATA WITHOUT CHINA DATA

	SO_2 RE	*SO_2 FE*	*SPM RE*	*SPM FE*
Freedom House Index	5.04**	3.53**	9.19**	5.42**
Number of Observations	2189	2189	869	869
Hausman Test Results[a]	.0876		.0038	
R^{2b}	.082	.102	.281	.086
Polity III	-5.37**	-3.98**	-8.90**	-6.42**
Number of Observations	2110	2110	852	852
Hausman Test Results	.0027		.2099	
R^2	.069	.119	.266	.097

** Significance greater than .05
* Significance greater than .10
[a] Result gives the probability that the difference in coefficients between two models (RE and FE) is not systematic.
[b] R^2 for the Fixed Effects models reports the R^2 within rather than R^2 overall since this model depends on results from changes within each site.

The results for SO_2 without the China data are quite similar to the results for the whole data set. The results for SPM find a higher regression coefficient for the Freedom House Index and a slightly lower (absolute value) coefficient for Polity III. The SPM FE results for the Freedom House Index, which were insignificant with the whole data set, are now significant at the .01 level. The RE R^2s are lower which may be in part a result of fewer data points. Overall, this subset of data supports the earlier results with the full data set. In the case of the SPM FE model, the results from this subset are stronger than for the whole data set.

The country with the most data points for SO_2 in the AIRS database is the United States, not China, with 569 data points out of 2401. Another data subset can be made by dropping the United States from the database to see if the results still hold. The following table shows these results for SO_2.

TABLE 3.4 DEMOCRACY AND AIR POLLUTION USING AIRS SO_2 DATA WITHOUT THE UNITED STATES

	SO_2 RE	*SO_2 FE*
Freedom House Index	4.49**	3.38**
Number of Observations	1832	1832
Hausman Test Results[a]	.1643	
R^{2b}	.076	.067
Polity III	-5.54**	-4.28**
Number of Observations	1753	1753
Hausman Test Results	.0019	
R^2	.059	.084

** Significance greater than .05
* Significance greater than .10
[a] Result gives the probability that the difference in coefficients between two models (RE and FE) is not systematic.
[b] R^2 for the Fixed Effects models reports the R^2 within rather than R^2 overall since this model depends on results from changes within each site.

Again, these results are similar to the results with the full data set and therefor support those results.

Breaking the data into groups can create another subset. In Chapter 1 this was done based on GDP and on an alphabetical listing of countries. These splits can be done here as well. The data are split into two groups by GDP, those with a GDP per capita higher than $7000 and those with a GDP per capita below this level. They are also split into two groups alphabetically by country. These are reported in the tables below as

Group 1 for the first half of the alphabet and Group 2 for the second half. The letter chosen for the split varies for each pollutant's data set. It is based on the closest half-way point for the data set so as to keep the two groups as even as possible.

Table 3.5 below reports the results for SO_2. The RE results are not given because in all cases but one, Group 1, they are rejected by the Hausman test in favor of the FE model. The results from the full data set, as given in Table 3.1, are included below for comparison.

TABLE 3.5 DEMOCRACY AND SO_2 DATA SUBSETS

	Full Data Set FE	*GDP>$7000 FE*	*GDP<$7000 FE*	*Group 1 FE*	*Group 2 FE*
Freedom House Index	4.51**	2.66**	2.31**	3.40**	1.38
Number of Observations	2401	1498	903	1104	1297
R^2	.098	.080	.033	.302	.013
Polity III	-5.43**	-7.71**	-3.36**	-2.56**	-6.04**
Number of Observations	2322	1444	878	1092	1230
R^2	.078	.1224	.053	.288	.045

** Significance greater than .05
* Significance greater than .10

The most notable result here is that the relationship between mean SO_2 concentration and the Freedom House Index is no longer significant for the subset of data composed of countries in the second half of the alphabet. Otherwise, all subsets find significant results with the relationship in the appropriate direction suggesting that the original results are robust to splits in the data set based on income level or country name.

The following table gives the results for SPM.

TABLE 3.6 DEMOCRACY AND SPM DATA SUBSETS

	Full Data Set FE	*GDP>$7000 FE*	*GDP<$7000 FE*	*Group 1 FE*	*Group 2 FE*
Freedom House Index	2.94	4.10*	2.60	-3.49	4.65*
Number of Observations	1080	426	654	557	523
R^2	.048	.310	.043	.029	.073
Polity III	-7.42**	Dropped	-6.83**	-3.20	-12.32**
Number of Observations	1063		649	557	506
R^2	.058		.050	.030	.090

** Significance greater than .05
* Significance greater than .10

With SPM, the results from the full data set for the Freedom House Index were not significant. The results become significant at the .10 level for the subsets of data for countries with GDP per capita greater than $7000 and for alphabetical Group 2. For the other subsets the results are still insignificant.

With Polity III and SPM, the initial FE results were significant. The results are similar and remain significant in two subsets but in the other two the results are no longer significant. For the subset of data for countries with GDP greater that $7000 per capita per year the regression is not even viable.

The following table gives the regression results using subsets of data for smoke.

TABLE 3.7 DEMOCRACY AND SMOKE DATA SUBSETS

	Full Data Set FE	*GDP>$7000 FE*	*GDP<$7000 FE*	*Group 1 FE*	*Group 2 FE*
Freedom House Index	3.11**	10.50**	-1.55	9.39**	-1.26
Number of Observations	710	345	365	334	376
R^2	.176	.385	.140	.347	.085
Polity III	-2.66**	-8.45**	-.366	-5.39**	.759
Number of Observations	646	292	354	303	343
R^2	.177	.324	.135	.322	.07

** Significance greater than .05
* Significance greater than .10

For smoke we find mixed results. For the richer half of the countries and for the countries in the first half of the alphabet, the subsets find even stronger results than the full data set. For both the Freedom House Index and for Polity III the coefficients are higher than with the full data set and the results are significant at the .05 level. Also, the R^2s are approximately twice as high in all four regressions as they are in the full data set.

For the other two subsets of data, the results are no longer significant for either the Freedom House Index or Polity III. The strength of the relationship in Group 1 and the weakness in Group 2 is not related to a correlation between income and placement in the alphabet. Mean GDP for Group 1 is 6.45 and for Group 2 is 7.05. So this split is not an artifact of both subsets, based on income and based on alphabet, reflecting GDP levels.

Overall, where regression results for subsets of data find the same result as for the whole data set, as is the case for most of the SO_2 subset regressions, the results appear robust to data divisions. The different results from the subsets of data with SPM and smoke suggest that the regression results for the full set are not very robust. The results for smoke in particular suggest that democracy may be an important variable for smoke concentrations in wealthier countries but not in poorer countries.

3.3.5 Additional Tests

Quadratic Model Form

An additional test that was conducted in Chapter 1 was to consider alternative model forms. A quadratic form was tested as this also fit the theory of the inverted U-shaped relationship and was found to not give significant results. Other model forms could also be tested here although the theory supports a linear model: as level of democracy increases, air quality improves. A quadratic form would suggest that either air quality improves with democracy until a certain level is reached and then it declines or, alternatively, air quality deteriorates with democracy until a particular level is reached and then it improves.

Although we have no theory to support a U-shaped relationship, this form can be tested to see if the regression results are as strong as the linear results as a test of robustness for the linear results. The following table gives the results for a quadratic model. Again, the results are restricted to the fixed effects models.

TABLE 3.8 QUADRATIC MODEL FOR DEMOCRACY AND AIR POLLUTION

	SO_2 FE	*SPM FE*	*Smoke FE*
Freedom House Index	-.250	9.48	22.36**
FHI squared	-.224*	-.346	-1.32**
R^2	.080	.050	.210
Polity III	1.09	-22.65**	2.98
Polity III squared	-.545**	1.55**	-.599**
R^2	.106	.065	.188

** Significance greater than .05
* Significance greater than .10

The only significant results using the quadratic form and a FE model is for smoke and the Freedom House Index and for SPM and Polity III. The rest of the results were not significant. The SPM Polity III results had a very low R^2 but the smoke Freedom House Index has an R^2 of 0.210. What do this model's results suggest about the relationship between democracy and smoke? That smoke concentrations decrease with increasing levels of democracy until the Freedom House Index reaches 8.47 (on a scale of 2-14, 2 being the most democratic, 14 being the least) and then air quality deteriorates with increased democracy.

Although the R^2 is higher for the quadratic model for smoke and the Freedom House Index than for the linear model, .210 compared to .176, a higher R^2 is expected when there are more variable in the regression equation so this level of difference indicates little about the relative strength of the regressions. Also, the quadratic form for smoke and Polity III gives insignificant results, while the linear form gives highly

significant results. Therefor, the existence of a significant quadratic relationship does not overshadow the linear relationship hypothesized.

National Averaged Data

The robustness of the relationship in question can also be tested by calculating an average urban pollution concentration level for each country for each reporting year and then running the regressions using this national average rather than individual reports from each site. An average mean concentration level was calculated for each country year using a simple average as well as a population weighted average using the population levels of each reporting city within a country, as was described in Chapter 1. These averages were then regressed against both the Freedom House Index and Polity III using a fixed country effects model. Year was also included in the model to take into account a time trend.

The table below gives the results. The first column (1) for each pollutant is without population weighted averaging and the second column (2) is averaging using city population weights.

TABLE 3.9 DEMOCRACY AND AIR POLLUTION USING NATIONAL AVERAGED AIRS DATA

	SO_2 (1)	*SO_2 (2)*	*SPM (1)*	*SPM (2)*	*Smoke (1)*	*Smoke (2)*
Freedom House Index	5.89**	5.67**	14.06**	14.50**	6.12**	6.29**
Number of Observations	494	494	290	290	225	225
R^{2a}	.08	.10	.35	.36	.39	.41
Polity III	-5.17**	-5.05**	-5.84**	-5.41*	-3.94**	-4.14**
Number of Observations	465	465	283	283	195	195
R^2	.06	.08	.30	.30	.38	.41

** Significance greater than .05
* Significance greater than .10
[a] R^2 reports the R^2 overall.

As Table 3.9 shows, the linear regression results of nationally averaged pollution level on both measures of democracy give significant results and coefficients in the predicted direction in all cases. This test supports the earlier finding of a relationship between democracy and urban air pollution concentrations.

As was discussed in Chapter 1, since the independent variable I am using (level of democracy in this case) is a national level variable, it makes sense to use the national average pollution level rather than pollution levels for individual cities or cites. For some countries, only measurements from one city are included however, and pollution levels in this city may not be a good reflection of urban ambient pollution levels. Even for countries with multiple cities reporting pollution levels, these levels may not reflect average urban pollution levels. Also, as was discussed in Chapter 1, due to the location of measurement sites as well as the quality of measurement, ambient pollution levels,

whether national average levels or individual site levels may not reflect actual human exposure levels.

Cook-Weisberg test for heteroskedasticity

As was discussed in Chapter 1, an additional test for regression results is the Cook-Weisberg test for heteroskedasticity. This tests the residuals from a regression to see if they are homoskedastic and therefor consistent. This test on all six FE regression results find that we can reject the hypothesis of constant variance with a certainty greater than .0001. Therefor, as we found for Grossman and Krueger's results, the residuals are heteroskedastic and the results may be inconsistent.

3.4 Conclusion

As was discussed above, correlation does not mean causation. There may be intervening variables which create the impression that more democratic countries are more likely to protect environmental quality, when really some other related variable is at work. For example, in the data analyzed above, a correlation between income level and level of democracy exists. The Pearson product-moment correlation coefficient is 0.74 between GDP and Polity III, and 0.77 between GDP and the Freedom House Index. Wealthier countries tend to be more democratic, which can either be used to explain the downward slope of the inverted U-shaped relationship between income and air pollution, or the downward slope of the relationship between level of democracy and air pollution. A study by John Helliwell(1992) of 125 countries over the twenty five year period from

1960 to 1985 finds that there is a positive relationship between income level and level of democracy.

As was discussed in section 2.10, it may be that other important variables are at work that can be employed to explain differences in environmental quality at the nations state level which are correlated to democracy. Variables to consider include literacy levels, population growth rates, level of corruption, military expenditure as a percent of GDP, even percent Protestant.(see Hadenius, 1992) A study by Debabrata Talukdar and Craig Meisner (2001) of industrial carbon dioxide emissions in 44 developing countries finds that the higher the level of private sector investment in the economy, the lower the emission levels. This effect is further enhanced by participation of the government in private sector development.

There are numerous problems with using large-scale statistical studies of this sort to identify global trends. My statistical analysis finds support for the environmental quality, democracy link. However, the robustness of the model did not hold up well to splitting the data into subset in some cases as well as using national average pollution levels. Also, the Cook-Weisberg test finds the results inconsistent. So, although the regression results are suggestive of a relationship, statistical analysis of this type is not proof that there is a causal relationship between the variables in question.

The next chapter sheds more light on the relationship between environmental quality and democracy through a case study of air pollution regulation in Santiago, Chile.

Chapter 4 Urban Air Pollution Regulation in Santiago, Chile: A Case Study of Regime Type and Environmental Protection

4.1 Overview

This chapter considers the relationship between regime type and environmental quality by examining urban air pollution regulation in Santiago, Chile from 1973 to 1993. During this 20-year period, Chile experienced tremendous change. A violent coup in 1973 ushered in 17 years of an oppressive military dictatorship, followed by a return to democratic rule in 1990. The level of trade increased substantially, and GDP per capita grew from approximately $1180 to $3170 as measured in 1995 US$. Environmental quality deteriorated significantly during the military dictatorship and Chile continues to have numerous significant environmental problems.

This period in Chile makes an interesting case study of the relationship between regime type and environment because, despite the dramatic shift in government, the economic system changed little with the new democratically elected government that took power after Pinochet. The new government made few changes to the free market-based economy that had been put in place by the military government.

The situation in Chile can be contrasted with that of Eastern Europe, which also experienced environmental degradation under an authoritarian government during approximately the same period. In Eastern Europe, however, not only did the political

system change when the iron curtain fell but the economic system changed as well, confounding the relationship between regime type and environmental quality. Therefore, a study of the effect of regime change on environmental quality is complicated by the change in economic system.

This case study contrasts the institutions and conditions of democratic regimes to those of authoritarian regimes in terms of how they affect changes in environmental quality. I focus on some of the basic conditions of democracy identified by Dahl (1989): the accountability of leaders resulting from meaningful elections; public involvement in policy making resulting from freedom of expression and organizational freedom; and access to alternative information. I also consider briefly the availability of civil litigation options and international aspects of democracy.

Of central importance to the argument presented below is the idea of the relative ability of different segments of society to influence government policy making and policy implementation. The distribution of power in a society depends both on the institutions listed above as well as civil conditions. This chapter, however, does not discuss the issues of social equity directly.

Although the relationship of interest is that between environmental quality and democracy, this case study focuses solely on urban air pollution, one aspect of environmental quality. As was explained in Chapter 3, I chose to focus on urban air pollution for a number of reasons. The availability of the data is not as important for this case study as for statistical analysis, except that I wanted the case study to use a similar variable as the regression analysis. The other reasons apply here as well. It is the same

variable used by Grossman and Krueger. Also, in terms of the matrix in Chapter 2, this problem is likely to be one subject to democratic control since it is visible, fairly local, fairly simple to understand, and the effects can be felt fairly immediately.

An additional reason for focusing on urban air pollution in Santiago is the importance of the problem for the country as a whole because of the size of Santiago. Almost one third of the Chilean population lives in the Santiago metropolitan region, so air pollution is a relevant concern to the national government, not just the city government. Air pollution in Santiago affects a range of the population, wealthy and poor, so pressure for change will not be restricted to one social class. Also, Santiago is where most of the national TV stations and other media are located, increasing the visibility of the problem.

In addition, although the Chilean Congress is located in Valparaiso, about an hour away from Santiago by car, many government offices are in Santiago, so air pollution is something that government officials are well aware of. This is important because this study is concerned with national level regime type, not the balance of power at the local level.

Finally, I chose to study air pollution because, during the period of study, Santiago had some of the worst air pollution in the world, with levels of many pollutants reaching critical levels many times each year.(Salinas and Vega, 1985; Ostro et al., 1985) Poor air quality has been shown to have detrimental human health effects in Santiago. (Salinas and Vega, 1985: Ostro et al., 1985) Respiratory problems were common in the 1980s and constituted the third leading cause of death in Chile for the general population.

50% of children's visits to hospitals were related to respiratory problems.(Salinas and Vega, 1985) In addition to the health effects from poor air quality, there are welfare losses associated with decreased visibility (the Andes are largely invisible for much of the year) and the physical irritation associated with the poor air quality.

Air pollution levels in Santiago are exacerbated by the geography of the metropolitan area. It is bordered on the east by the Andes Mountains, and on the north by the San Cristobal and Manquehue peaks. The major wind pattern is from the southwest and thermal inversion layers are common, leading to pollution being trapped in the metropolitan region, especially during the winter months.

Ideally, for research of this sort, one would want to focus on changes in environmental quality. However, data on actual environmental conditions are not always available, which has impeded research in this area. It is difficult to measure true changes in ambient pollution levels in the Santiago metropolitan region during the case study period because methods for measurement and monitoring sites changed during the period and some data may not be very accurate due to problems with the equipment and quality control methods.

Existing data show that some ambient pollutant levels and emissions decreased in the 1990s, while others simply stopped increasing. From 1987 to 1997, TSP emissions dropped more than 30%, although this is in part due to the availability of inexpensive natural gas in 1997.(Montero et al., 2002) Ground level ozone levels also decreased during the period from 1988 to 1998.(Jorquera et al., 2000) Most dramatic has been the drop in SO_2 concentrations and ambient carbon monoxide (CO) concentrations. SO_2

concentration monthly averages, which at times approached 150 ug/m3 in1999, dropped to less than 25 by 2000. CO concentrations dropped from monthly average highs in the range of 8-9 ppm in 1990 to less than 3 ppm in 2000. NO_x concentrations remained largely unchanged during the 1990s.(Jorquera, 2002)

Due to the unreliability of the air pollution data, the analysis below focuses on the development and implementation of air pollution regulations, rather than ambient levels themselves, even though the regulations were designed to reduce ambient levels, so that is the primary concern. It is important to note that regulations do not necessarily lead to improvements in environmental quality. The best regulations do nothing if they are not enforced.

In the next section is a brief overview of the history of the military regime followed by an examination of air pollution regulation during this period. This section finishes with an analysis of why the military government did as much as they did do to reduce air pollution and why they did not do more. In the following section is an examination of air pollution regulations during the administration of Patricio Aylwin and why it did as much as it did and not more. In the summary is a discussion of the limitations of this case study, and what this case study does show about the relative merits of the theory supporting a relationship between democracy and environmental quality. A brief discussion of environmental quality improvements in other countries that have undergone regime changes in the recent past follows the summary.

4.2 The Pinochet Period

In 1973, a military coup overthrew the democratically elected, socialist party government of Salvador Allende, thus ending 140 years of almost uninterrupted democratic government. For the next 17 years, Chile was under the authoritarian rule of a military government headed by General Augusto Pinochet. The Senate was suspended, universities were placed under military control, the media were censored, and peasant and labor organizations were broken and banned. Thousands of Chileans were killed and tortured, especially those with ties to the left. Many academics and leftists fled into exile. Political parties were eventually largely banned as well.(Collins and Lear, 1995) There were no longer institutions that provided for the accountability of leaders, public input and decision making, or access to information.

This contraction of civil liberties and political freedom was accompanied by enormous changes in the economic system. Salvador Allende had begun a process of agrarian reform and increased ownership of capital by the state in an effort to reduce uneven development. Unfortunately, many of the policies the government adopted to achieve their goals, such as large wage hikes and price freezes, caused high levels of inflation and economic stagnation, leading to increased unrest.

The military government took an absolutely opposite approach to growth. Starting in 1975, the government began to systematically adopt policies that adhered to a free-market economic model, following the advice of economic advisors primarily trained at the conservative University of Chicago Department of Economics. Most national industries were sold, companies were deregulated, and borders were opened to

trade with minimal impediments. There were many negative consequences associated with this new model including periods of stagnation, higher inflation, higher national debt, increased numbers of people living in poverty, reduced access to health care and depletion of natural resources.(Collins and Lear, 1995)

Among these negative consequences was a deterioration of air quality in Santiago. Increased pollution stemmed in part from overall increased activities. The population in the metropolitan area grew from approximately 1.6 million in 1973 to more than 4 million in 1990. The number and size of industries grew, transport grew, and increased affluence and lower import tariffs allowed vehicle traffic to increase considerably. Unfortunately, this growth occurred with virtually no regulation on industrial or vehicular emissions.

In 1975, the military government deregulated public transport. Buses and taxis were allowed to operate with minimal state involvement. Anyone who wanted to have a bus route simply needed a bus. Many of the "new" buses were second hand buses purchased from other countries and had much higher emission levels than buses in the existing fleet. These buses could operate wherever the drivers desired at whatever price they chose. The same held true for taxi drivers.

Following neoclassical economic theory, the government believed that this would lead to the most efficient number and distribution of buses and taxis at the best price. Unfortunately, a cartel formed, which led to fare increases, and the theory on which the deregulation was based did not take into account externalities such as air pollution. The number of buses operating in Santiago nearly tripled between 1977 and 1987 (Collins and

Lear, 1995) and taxis increased in number as well, many of the new taxis being high polluting, imported cars. Many of the new private cars purchased due to decreased tariffs were used Russian cars or second hand trucks from other nations with high emission levels as well.

This greatly increased ambient air pollution levels in Santiago.(O'Ryan and Escudero, 1997) In the early 1980s, motor vehicles were a major contributor to three key air pollutants in the metropolitan region. They were responsible for approximately 94% of CO emissions, 85% of NO_x, and 69% of volatile organic compound (VOC) emissions.(World Bank, 1994) By 1990, approximately 75% of particulate emissions in downtown Santiago were due to buses.(Collins and Lear, 1995)

In the next section is an overview of urban air pollution regulation during the military regime.

4.3 Air Pollution Regulations Under the Military Government

A variety of rules and regulations were passed under the military regime to respond to the ever increasing levels of urban air pollution:

In 1978, Resolution 1.215 of the Ministry of Health established air quality norms for carbon monoxide (CO), nitrogen oxides (NO_x), sulfur dioxides (SO_2), Ozone (O_3) and total suspended particulate (TSP). It also established the official method of analysis for each pollutant.

In the same period, the Ministry of Health also passed resolutions aimed at controlling vehicle emissions and industrial emissions by establishing norms for emission levels.

In 1980, a new constitution was adopted for the country. Article 19.8 contains a clause that states citizens have the right to live in a pollution free environment and that it is the responsibility of the state to ensure that this right is not violated and that nature is preserved.

In 1982, the Metropolitan Regional Ambient Health Service was created with its own dedicated funding.(Katz, 1993)

In 1983, the responsibility for controlling vehicular emissions was transferred to the Ministry of Transportation, which passed a decree limiting the allowable level of CO emissions in exhaust.

In 1984 the Military Government created a National Commission for Ecology (NCE). Its mandate was to develop environmental plans for the country, to propose ways to coordinate government offices on environmental issues, and to advise the president on environmental matters.

A car inspection system was instituted in the mid 1980s.

Also in the mid 1980s, the Minister of Finance and the Intendencia of Santiago engaged in a coordinated effort to study environmental problems in Santiago and establish a network of automatic air monitoring stations around the city. They created an inventory of emissions, modeled contaminant dispersion, and, through a loan from the

Interamerican Development Bank, funded two studies of the effects of air pollution on children's health.

A number of other studies were also prepared that helped set the stage for future regulations. During the 1980s, the Pinochet government conducted studies of the possibility of using emission taxes or tradable permits to control pollution. However, the government decided that the necessary state apparatus to maintain a system of taxes or tradable permits did not exist, so these studies did not result in any regulations or actions on the State's part.(O'Ryan and Escudero, 1997)

Unfortunately, many of these rules were unenforced or unenforceable. The 1978 Ministry of Health norms were ineffectual since there were no regulations in place to enforce them. The 1980 Constitutional clause was not applicable at the time because the institutions were not set up to carry out environmental monitoring and enforcement. The car inspection system was also a failure. Cars that did not pass inspection would, in general, be superficially adjusted and would be back on the street the next day. It was thus not a successful program for significantly reducing emissions.(Escudero, 1997) Due to lack of political and financial support as well as lack of technical knowledge, the NCE did little more than monitor public agencies.(Arensberg et al, 1989) Lack of coordination was also a problem. Measures passed by some ministries were often contradicted by others, or else enforcement would depend on other ministries and would not occur.

In 1988, due to increasing emissions as well as particular climate conditions that caused the air in the Santiago area to be trapped for longer than usual, air quality was so poor that a number of children died and the hospitals were full beyond capacity. There

were an estimated 300,000 extra cases of bronchial-pneumonia in 1988.(Silva, 1997) Both newspapers and TV stations reported the problem. As a response, the Ministry of Health developed an emergency system to reduce vehicle circulation and shut down the most polluting industries on the worst days. Circulation was controlled based on vehicle license plate numbers. The government monitored industrial emissions and created a list of the companies with the highest concentration of pollutants in their emissions. The higher a company was on the list, the more likely that they would have to be shut down on an emergency day. Companies were motivated to reduce their emission levels to move lower down the list, reducing the chance that they would be shut down on emergency days. The government did enforce these regulations but arguably not to the extent necessary to protect public health, as there were continued cases of pneumonia and asthma. However, these were the first regulations to noticeably improve air quality in the city.

During this period, there was also important activity by environmental scientists and Environmental Non-Governmental Organizations (ENGOs). While there were strict bans on congregating and political organizations of all sorts, as well as on other types of NGOs such as those supporting human rights, these ENGOs were allowed to form. The government did not see the actions of environmentalists as a threat to its stability and so allowed these groups to operate.(Katz, 1997)

The year after the 1973 coup, a group of ecologists created the Instituto de Ecologia which lobbied the government to address the deterioration of environmental quality by developing administrative capacity to regulate environmental problems.(Silva,

1996a) Although they were free to lobby, they were largely unsuccessful in creating any fundamental change in government policy. They were instrumental, however, in the adoption of the environmental clause in the 1980 constitution.(Silva, 1997)

In the early 1980s, an ENGO called the Centro de Investigacion y Planificacion para el Medio Ambiente (CIPMA: The Center for Environmental Research and Planning) was created by a group of environmental scientists and academics who had been associated with the Catholic Universities of Chile, in Santiago, before the coup. In 1983, they organized a conference entitled the First Scientific Congress on the Environment to discuss scientific aspects of environmental problems in Chile. The military government saw this as an apolitical scientific conference and so allowed it to proceed. About 400 participants attended, which was remarkable given the lack of political freedom in Chile at that time.

The conference coalesced interest in the environment in Chile among scientists and also among the general public due to media coverage. This conference was credited with instigating the formation of the National Commission for Ecology by the military government in 1984.(Rojas, 1994) As an outcome of the conference, CIPMA began the publication of the journal *Ambiente y Desarrollo* (Environment and Development) in 1985, currently one of the most important environmental journals in Latin America. They also began publication of an environmental researchers' newsletter.

The conference in 1983 was followed by two more conferences during the military regime that continued to criticize the regime for its lack of attention to environmental quality and to stimulate interest in environmental protection. The

criticisms were moderate though, and the conclusions of many of the studies published were that more research on environmental problems was needed. The participants now included more members from the private sector industries and members of small ENGOs. However, workers, peasants, and natives were not present, so the agenda was fairly centrist in its approach to environmental problems.

In 1989, the Instituto de Ecologia Politica (IEP) was created by a more leftist leaning group of environmentalists who wanted to bring environmental issues into the politics of the left.(Rojas, 1994) They also created an umbrella organization to help coordinate the activities of some 120 environmental NGOs around the country called Renace (Red Nacional de Accion Ecologica, the national network for ecological action). This organization continued to promote public awareness of the pollution in Santiago through publications and organization of meetings. They were largely irrelevant to the Pinochet regime since they became active at the very end of the regime.

The more radical voices of the IEP and Renace had and continue to have a peripheral influence over policy making.

In summary, despite the existence of the rules and regulations mentioned above, as well as others that were scattered in various ministries and various departments within these ministries, no general environmental policy was developed under the Pinochet regime. These regulations were largely not applied due to limitations in resources provided for enforcement, lack of government coordination, pressure exerted by the sectors to be regulated, lack of knowledge of what methods would best reduce pollution levels.(Katz, 1993)

At times, the state did take concrete steps to reduce emissions from individual industries, but this occurred in a reactive rather than proactive manner. Inspectors from the Ministry of Health would respond to complaints about industrial emissions by neighbors of these industries. If the emission levels were clearly having negative impacts on agricultural areas or public health nearby, the inspectors would require the industries in question to reduce emissions. These responses were not part of any regulatory structure but occurred on a case by case basis.(Escudero, 1997; Vergara, 1997)

Despite the various efforts made and studies conducted regarding air pollution levels, the only concrete reductions in air emissions during the Pinochet government resulted from the emergency day regulations in the last two years of the regime, and the sporadic regulations applied to individual industries. Overall, little headway was made in actual air pollution reduction while, at the same time, deregulation and unregulated growth resulting from free market economic policies led to a dramatic increase in air pollution.

4.4 Forces Hindering Air Pollution Regulation

The military government's lack of attention to increasing environmental problems reflects that environmental protection was not a priority of the government. There are a number of factors that may have hindered the development of effective environmental controls. Many of these are broadly relevant to any dictatorship:

(1) There was limited public pressure to reduce pollution during the earlier years of the regime because people were more concerned about human rights and were scared by

the oppression of the government. In the late 1980s the air quality had deteriorated to such an extent that public pressure increased.

(2) Public pressure could be largely ignored until the final years of the dictatorship when the governing party faced democratic elections. In the early years, the government did not need to take into account public pressure for environmental regulations since it did not rely on broad public support to stay in power.

(3) The NGOs that pressure democratic government to implement environmental measures were engaged in fighting for human rights during the military government and were less concerned with pollution, with the exception of CIPMA.

(4) There was a limit to the free flow of information so citizens were limited in their knowledge and understanding of the air pollution problems in Santiago. The press was allowed to print information about air quality but was self-monitoring in terms of the significance they gave the issue.

(5) The fear of government oppression and murders forced abroad many scientists and intellectuals who might have otherwise worked on environmental problems.

(6) There was no dialogue between the government, public health officials, companies and the public, which hindered the development of workable solutions.(Escudero, 1997)

Eduardo Silva (1996a) points out that there were also a number of forces inhibiting environmental protection related more specifically to the case of Chile.

(7) The free market ideology made many problems worse in that it enabled unregulated growth. Free market ideology is not conducive to government intervention.

In many ways the Pinochet years were an experiment in economic growth through free market activities. Economic growth was the paramount objective and environmental regulation was seen as hindering this growth. Although the government studied the possibilities of using free market mechanisms to control pollution, the concern with reducing the size of government insured that the institutional support needed to operate market controls such as tradable permits did not exist. So the government was in a free market bind: wanting to use market mechanisms to control pollution, yet not wanting the bulky institutions necessary to carry out these measures.

(8) The military government was not accustomed to developing consensus with the public or industries. Its standard operating procedure was much more akin to command and control. However, command and control as a method to control pollution did not fit with the government's ideology. The government made blanket orders to stop polluting, but these orders did nothing without the regulatory structure, enforcement and monitoring necessary to ensure that these orders were followed. The small size of the government also limited its regulatory capacity. Environmental regulations simply did not receive fiscal support.

4.5 Why Dictatorship Took Steps Towards Regulating Air Pollution

Given the thesis presented above, one might ask: *Why would a military dictatorship take any steps to reduce pollution?* In the case of the Pinochet government, there are a number of reasons why they may have done as much as they did:

(1) In some ways the military regime was not a typical dictatorship – especially in the final years when the regime knew that it would face a vote of a approval and then, if they lost that, an election. So efforts made to combat air pollution in the final years can be attributed to the increased accountability of the government.

(2) The regime was also not typical in that it remained a part of the international community more than other dictatorships. The government was under pressure by the World Bank and Interamerican Development Bank to maintain some level of environmental quality, especially for something as visible to the outside world as air pollution in Santiago. Much of the economic growth that the economy experienced during this period, upon which the regime believed their credibility largely depended, stemmed from increased levels of international trade. The military regime did not want to hinder existing trade freedom and so was somewhat motivated to appear benevolent to the world, given the unpleasant fact that the country was, after all, a dictatorship.

(3) Pinochet did not see environmental issues as particularly threatening to the stability of the government as is evidenced by the freedom given to the Institute of Ecology to lobby, to CIPMA to hold conferences, as well as to the press to report on air quality levels. The adoption of the environmental clause in the constitution, as well as the creation of the NCE, suggests that at least some Pinochet officials were sensitive to both environmental lobbies and scientific findings regarding environmental quality, or that at least some members of the administration were concerned about environmental quality.(Katz, 1997) The Minster of Health in particular pushed for regulations.(Escudero, 1997)

4.6 The Return to Democracy

In 1988, a plebiscite was held to determine if the Pinochet regime should stay in office another 8 years. The Pinochet regime lost, which, following the constitution of 1980 written by the military regime, required that it hold presidential and congressional elections in 1989. (Municipal elections were not held until 1992.) The winner of this election would take office in 1990. Patricio Aylwin of the Christian Democratic party was selected to head the coalition representing center to center-left ideologies called the Concertacion de Partidos por la Democracia, or Concertacion for short. He ran against the military-backed candidate Hernan Buchi, who had been Pinochet's Minister of Finance.

Given the increased level of air pollution in Santiago, environmental issues received considerable attention during the campaign. The first debate held between Aylwin and Buchi was at the third CIPMA conference where the problem of air pollution came up. So the environment was an issue early on in the election.

The Concertacion election platform included a chapter about environmental protection calling for increased regulation. This chapter stated that the Aylwin government, once in office, would take the following actions: establish a foundation for environmental law and the necessary legal provisions; develop a national environmental policy that would be the foundation of environmental protection; confront the most important environmental problems, including air pollution in Santiago; and promote environmental research and education.(Quiroga and Van Hauwermeiren, 1996)

The Concertacion won the majority of seats in the senate and Patricio Aylwin became president in 1990. The military government agreed to step down. With the return to a largely democratically elected government, many of the people in exile returned. Civil liberties were reestablished, and increased public participation in policy making was allowed to occur. However, Pinochet remained head of the armed forces and nine senate seats were reserved for members of the dictatorship, including five from the military. The presence of these non-elected members in the senate limited the level of public influence in the new government because these senators could veto new legislation. The authoritarian enclaves in the new government, which resulted from the 1980 constitution, limited the ability of the progressive forces in the new government to challenge the status quo.(Garreton, 1995)

4.7 Air Pollution Regulations Under the Aylwin Government

Within the first weeks of the new administration, the government began a dialogue with industry about air pollution regulation.(O'Ryan and Escudero, 1997) Within the first two months, the new government created institutions to manage the country's growing environmental problems, and passed regulations to stem air emissions. This section outlines the most important of these in terms of genuine progress in reducing air pollution in the metropolitan region.

One of the first measures taken by the new government was the creation of the Special Commission for Pollution Prevention and Reduction in the Metropolitan Region (CEDRM). CEDRM was in charge of promoting public education about air pollution,

performing special studies, air quality monitoring, emergency measures, and coordinating the effort of the various ministries that were required to implement specific actions. In a matter of months after it was created, CEDRM published a plan for the decontamination of the metropolitan region. The plan laid out what needed to be done in the short, medium, and long terms to reduce pollution emissions from different sectors -- transport, construction, urban services, industries, and the residential sector.(Escudero, 1996) It was given a budget of $200 million 1990$US to spend on air pollution control in Santiago.

CEDRM was eventually largely replaced by the National Environment Commission (CONAMA) which was created in June of 1990 as the interminesterial coordinating body for all environmental activities performed by the various ministries of the government. The advisory board for CONAMA is composed of two ENGO representatives, two academics, two representatives from labor, and two representatives from business. Because CONAMA is primarily a coordinating and advisory institution, it is limited by law to only 62 staff members. However, they are allowed to hire more staff on a consulting basis.(Silva, 1997)

In 1991, the government began to regulate public transport. It adopted a policy of purchasing old polluting buses and taking them out of circulation. In six months, 2,380 buses, or about 15% of the fleet, were permanently retired. They also began to regulate bus routes again to limit the number of buses operating in the city center and to promote the use of cleaner vehicles. Bus companies that had new, cleaner buses making up at least 50% of their fleet were rewarded with better routes and a longer permit of operation.

Miles traveled by buses in the metropolitan region decreased 15% from 1990 to 1994. Unfortunately, miles traveled by taxis increased approximately 50% over this same period.(Escudero, 1996)

Interestingly, during the military regime, an Intendente (governor) tried to regulate buses. The bus drivers threatened to strike and the next day this Intendente was fired by General Pinochet. The military government felt that a strike would infuriate the public and hurt the government's credibility. When the Aylwin government started to regulate bus routes, the drivers again threatened to strike but the government would not bend so a strike was called. The public supported the government in this situation because they were aware of and frustrated by the number of excess buses in the city and the related pollution. During the strike, numerous people with vehicles, even trucks, picked up passengers at bus stops to help make up for the lack of buses. As a result of the lack of public support, and the hospitality of other drivers to bus riders, after a couple of weeks the bus drivers gave up their strike and accepted the new regulations imposed by the government. (Vergara, 1997; Escudero, 1997)

Starting in 1992, new cars had to reach emission standards equivalent to the United States' Environmental Protection Agency's 1983 standards for vehicles. Although enforcement of these rules was not perfect, the government also began a program of pulling over cars emitting black smoke and fining the driver as a way to catch the drivers whom skirted the vehicle inspection system. The government also required all imported cars to have catalytic converters, which was easier to enforce than emission

levels, and will have a continuing beneficial impact on air quality, helping to offset the increased emissions from the growing vehicle fleet.

In 1992, Decree No. 4 was passed by the Ministry of Public Health to control emissions from fixed sites. It requires that all industries comply with a maximum total emission level with fines for excess emissions starting in 1996. A tradable permit scheme for SPM was also developed so that companies that reduce more than required could sell emission reduction credits to other companies. An initial distribution of emissions rights was set using 1992 emission levels. New emission sources after 1994 were to be required to compensate for their emissions through a trade.

Also in 1992, the executive submitted the Ley Sobre Bases Generales de Medio Ambiente (Environmental Framework Law) to congress, and it was promulgated in March of 1994. The principal contributions of the Environmental Framework Law are that it provides the administrative basis for environmental protection, and it systematized the procedures for the State to follow to define environmental quality norms, emission norms, and prevention plans for contaminated areas. It also defines the structure of the environmental impact statement system and raised the status of CONAMA by placing it directly under the General Secretariat of the government.

The Framework Law has been largely a disappointment to the environmental community in Chile for a number of reasons. A long time frame is given for industries to meet most of the new requirements of the law so as not to disrupt industrial activity. The regulations necessary for establishing the norms for emission levels, without which the law could not be carried out, were not published until 1995. Also, the law does not cover

the emissions of toxins, only criteria pollutants. This is a serious omission given the potential importance of toxic emission levels for public health. The focus of the law is also on end-of-pipe solutions, not on using cleaner fuels, alternative production techniques or less energy.

The Framework Law was also a disappointment to the environmental community because of limitations it placed on legal means for preventing and seeking compensation for environmental damage. For example, community groups are bared from appealing to the courts if they do not agree with the results of an environmental impact statement. This curtails their ability to have direct influence in the evaluation of projects that may have serious environmental impact in their community. The ability to seek legal retribution for environmental damage ends five years after the damage takes place, which is often not enough time for people to know about the damage. This is especially problematic for toxic pollution, from which health and ecosystem damage may appear after more than five year. Also, showing that a company or individual created environmental impacts is not enough for them to be legal responsible. It must be shown that they caused the damage intentionally.(Quiroga and Van Hauwermeiren, 1996)

The system of environmental impact statements was designed to limit the detrimental effects of new projects on the environment. CONAMA was put in charge of reviewing these assessments and deciding on the suitability of projects. Because CONAMA is directly under the president, the acceptability of the level of environmental degradation associated with a project depends largely on the attitude of the president, rather than the senate. This might limit the effectiveness of the EIS program, since it

reflects primarily the environmental inclination of the president, rather than a broader section of the government.

Also, in coordination with the Ministry of Health's Decree No. 4, tradable permits are a central instrument in the Environmental Framework Law for the control of SPM but it has not yet been successful, largely because the administrative basis for the system is not well intact. Tradable permit schemes need to be well constructed with significant attention paid to the details of the system in order for them to function properly. The Chilean regulatory system had not yet established the institutions or capability to maintain a successful tradable permit program. By 1995, not a single trade had been made, except within companies. The goal of allowing the fluid entry of new industries without increasing air pollution was not met.(O'Ryan and Escudero, 1997) The tradable permit scheme for SPM has continued to be unsuccessful, although significant reductions in SPM emissions occurred by 1997. This was not a result of the tradable permits, but due to the availability of inexpensive natural gas from Argentina via a pipeline that was opened in 1997, as well as efforts from firms to switch to cleaner fuels in order to avoid being shut down during emergency days.(Montero et al., 2002)

A World Bank report notes that, "This system of tradable permits has the potential to achieve a desirable level of pollution reduction at the least possible cost. However, attention needs to be paid to the implementation details of the system... For a permit trading system to work, a stable institutional framework is required. As long as enforcement is weak and there is still uncertainty about the exact definition of emissions

from different processes, the system is unlikely to work effectively." (World Bank, 1994, p.17)

Another problem with the Framework Law is that a long time frame is given for industries to meet most of the new requirements of the law so as not to disrupt industrial activity. The law does not cover the emissions of toxins, only criteria pollutants, and sets no standards for toxins. This is potentially a serious omission given the possible impact of toxic emission on public health. The focus of the law is also on end-of-pipe solutions, not on cleaner fuel use, alternative production techniques or energy conservation.

Some companies did reduce their emissions to meet the standards required. The requirements were not overly onerous and had been drafted through a coordinated effort by the government and the industrial consortium, SOFOFA, so industry felt beholden to comply. Also, the emergency measures put in place by the Military Government were still in effect so companies were motivated to be removed from the list of the most polluting industries in order to avoid being shut down. By 1993, there had been a 90% turnover on the list.(Escudero, 1996)

Regarding Santiago's air pollution specifically, CONAMA was placed in charge of developing a plan for reducing air pollution in the Metropolitan Region. It did not release this plan for public comment until April, 1997. The plan includes a great variety of measures, from land-use planning controls to improved public transport. It is yet to be seen how effectively these proposals will be implemented and enforced.

In summary, the government was able to operate efficiently in the early 1990s and made some rapid progress on some of the most pressing problems—namely mobile

source pollution. These initial measures taken by the government had some immediate positive effects on ambient pollution levels. The daily ambient air quality standard for PM-10 of 260μg/m3 was violated fewer days each year, from 100 days in 1990, to 69 days in 1991 and then 60 days in 1992.(World Bank, 1994) The number of emergency days, which are defined by the surpassing of an index of a collection of pollutants, declined from eleven in 1990 to only three in 1995.(Quiroga and Van Hauwermeiren, 1996) The emergency day shut down, instituted during the Pinochet Regime, has continued to have an effect on reducing emissions from industry. The decrease in SPM emissions in the Metropolitan region is largely a result of decreases in emissions from industrial processes as industrial respond to the fear of being shut-down as well as the availability of natural gas.(Montero et al., 2002)

Although the 1990s saw decreases in many criteria pollutants, Santiago continues to have severe air quality problems. The effectiveness of environmental regulation under the democratic governments in the 1990s has been hindered by the structure that has been given to environmental policy making and enforcement. Although there are thousands of laws and regulations in Chile relating to the environment, enforcement of these are scattered in nine different ministries and 28 public service offices, often with few means to coordinate application. CONAMA is responsible for coordinating the environmental activities of each Ministry, an arrangement that is bureaucratically cumbersome because none takes final responsibility.(Quiroga and Van Hauwermeiren, 1996) Rather than having a separate ministry of the environment, all ten Ministries have environmental branches. Often, the work of these branches goes against the primary goals of the

Ministries so the environmental agenda is overruled.(Quiroga and Van Hauwermeiren, 1996; O'Ryan and Escudero, 1997)

This fragmented structure of environmental regulations resulted from heated debate between different factions of the Aylwin government. The winning faction was concerned about disrupting industry and worked closely with industry to develop the design of environmental policy making in Chile. The losing faction, whose members were largely drawn not from the Christian Democrats but from the other, more leftist parties that made up the coalition that took power, wanted a separate ministry of the environment with more power and responsibility and less beholden to the presidents office.(Silva, 1995; Silva, 1996a)

Unfortunately, continued improvements in environmental quality will most likely be hindered both by the structure of the environmental branches of the new government and the weakness of the laws passed thus far. Fiscal capacity has also not been well developed, although the Aylwin government spent four times more than the military government on environmental protection.(Silva, 1995) CONAMA's budget increased considerably in 1994, allowing it to increase its staff and capabilities. In 1993 the budget was approximately $1.6 million US but this increased to almost $10 million in 1994.(Quiroga and Van Hauwermeiren, 1996)

Researchers from the Institute of Political Ecology in Santiago wrote in 1996: "Of all the policy initiatives of the first Government of the Concertacion, without doubt the most significant were the creation of CONAMA and the promulgation of the Environmental Framework Law. However, the operating rules allowing this law to be

implemented remain to be defined... This prolonged delay calls into question the Government's real commitment to the environment."(Quiroga and Van Hauwermeiren, 1996. pg.23) Among the greater goals of the new government, the environment, after the initial flurry of activity, has not proven to be a priority.

4.8 Why Aylwin Regime Took Steps Towards Regulating Air Pollution

Although efforts to improve air quality in the metropolitan area have been limited, they were significantly greater than what was done during the Military Regime. The question is can these efforts be attributed to the return to democracy or are other factors involved? Certainly the accountability of leaders increased with the new government as did public involvement in policy making and access to information.

The initial burst of activity can be explained in a number of ways:

(1) The new government needed to distinguish itself from the military government. By promising to do more to reduce air pollution it could both highlight how much air quality had declined under Pinochet, thus damaging the image of the candidate from his party, Hernan Buchi. They could also show that they were the party that cared about public health. Socialists especially were looking for new ideas. They identified environmental destruction with dictatorships.

(2) There was public pressure on the government to reduce air pollution. The winters of 1988 and 1989 had the worst air quality ever experienced in Santiago. The news media, particularly the conservative newspaper, *El Mercurio*, had latched onto this topic and the public was very aware of and concerned about air quality. In fact, during the pre-

election campaigns in 1989, *El Mercurio*, the most popular newspaper in the metropolitan area, published a column in which both candidates, Aylwin and Hernan Buchi, could advertise their platforms. For a three month period, the right-wing candidate, Buchi, dropped out of the race because of a disagreement within the party. The newspaper used the area reserved for the right wing candidate to report about pollution problems. This helped air pollution become a bigger issue in the election.(Escudero, 1997) The importance of reducing air emissions in particular, therefore, increased dramatically at the time that the new government was taking office.

Survey data also suggests that Chileans care about environmental quality more than nationals of many other countries.(Inglehart, 1995) A 1990 survey of attitudes towards a variety of issues was conducted by the World Values Survey. Chile scored high on two scales that rank environmental values. 77% of the Chileans surveyed said that they "strongly approve" or the ecology movement which ranked them 7th out of 43 nations surveyed, the range going from 83% for Moscow, to 28% for Finland. Just for comparison, in the US and Mexico 47% and 70% respond that they strongly approved, respectively. (Inglehart, 1995)

In this study, 76% of Chileans surveyed said that they were willing to pay higher taxes to prevent environmental pollution, ranking them 4th out of 43 nations surveyed, the range going from 78% for China and 35% for Hungary. The United States had 64% stating a willingness to pay higher taxes, and Mexico, 67%. Surveys of this sort are notoriously flawed as many people will claim a willingness to pay more when they don't need to actually hand over any money. Chileans appeared less environmentally

concerned when asked if they agreed that "the government has to reduce environmental pollution but it should not cost me any more money". Chile fell in the middle of the range in percentage of respondents who agree, at 57%, with the US at 54% and Mexico at 40%.(Inglehart, 1995)

A telling sign of Chileans' concern for environmental quality is that, in the 1994 elections, the Chilean Green Party won 5.5% of the vote in the general elections. This was an extremely important election for the Concertation government which needed to show it's continued support over the candidates associated with the previous dictatorship. Yet 5.5% of the population still chose to vote Green, which suggests a high level of concern for the environment in some percentage of the population.(Mumme and Korzetz, 1997)

Once in office the new government was compelled to follow through on its very visible pledge to reduce air pollution by making immediate steps towards this goal.

(3) It had the advantage that, in some ways, the path to create these institutions was paved by the studies conducted under the Pinochet regime. The groundwork had been laid. (Escudero, 1997)

(4) Although the Christian Democrats were not a party with a strong environmental base, Aylwin was supported by a multi-party coalition, including the socialists and the PPD. These two parties were quite green and pushed for environmental improvements. The Christian Democrats needed to respond, at least partially, to the most pressing concerns of these other groups. Democracy relies on consensus building as well as public opinion.

(5) Industry was somewhat open to being regulated and was willing to participate in the development of new regulations, because of the favorable state-business relations in the Concertacion government. Industry was aware of the severity of the pollution in the city and the consequences this had for human health as well as for economic growth. There was general agreement that contamination would hurt development and there was pressure from the United States to clean up the air quality if Chile wanted to sign onto the North American Free Trade Agreement (NAFTA).(O'Ryan and Escudero, 1997) Signing onto NAFTA was a priority for the Aylwin administration.(Larrain, 1997) The government, as well, was aware of the importance of improving the environment, especially in light of the environmental side agreements that had to be made before Mexico could enter NAFTA.(Silva, 1995)

(6) Liberalization and democratization allowed for increased development and enforcement of environmental regulations in a variety of ways. Freedom of assembly was restored along with increased freedom of the press, greater access to policy makers for lobbying and pressuring officials, and greater sensitivity of government officials to clients—businesses as well as others. Academic freedom in universities increased and many exiled academics returned. All of this allowed for an upsurge in the attention given to environmental problems. Also, elections themselves tend to stimulate increased public debate of the issues. The groundswell of support for air pollution regulation probably would not have occurred had Aylwin and Buchi not been campaigning for office.

4.9 Why the Government Did Not Do More?

Given the public pressure to improve air quality and the increased level of public accountability, one might ask: *Why didn't the government do more given the attention to the issue by the public?* Silva (1996a, 1997) makes two arguments for why the Aylwin government did not attempt any serious reforms, such as substantial air pollution regulations:

(1) The 1980 constitution constrained the Aylwin government since it has clauses that are designed to protect the conservatives' interests. The political institutions that were put into place after the Pinochet regime was voted out of office are not fully democratic. For example, nine seats in the senate are reserved for appointed senators, four of which come from the military. All senators have the right to veto new legislation as well as constitutional amendments. Also, the military maintains some level of autonomy so the civilian government needs to consider the military's reaction to policies.

(2) The system of consensus policy making between the government and the private sector was adopted to dispel investors' fears of arbitrary policies that could reduce the returns to their investments. This allows capitalists to have considerable access to policy makers and assure that they can promote policies in their interest. Policy making formally includes labor but, according to Silva(1996b), the process is biased in favor of capital. He writes, "After the transition to democracy, the political institutions of the Constitution of 1980, coupled with the durability of the pragmatic capitalist coalition and the expansion of the international economy, forced center-left administrators to permit ample participation by business elites in policy formation and participation."(p.23)

Chilean scholar Alejandro Rojas writes:

> Although there is broad criticism concerning the environmental effects resulting from the style of development pursued by President Aylwin's coalition government in continuance with the development policy of the military regime, even the most radical environmental organizations have expressed awareness of the vulnerable situation of Chilean democracy. They acknowledge the serious limitations the transition conducted from within the institutionalization created by the military places on any significant departures from the current pattern of development.(p.110)

There are a number of other factors that effected policy making in the Aylwin government:

(1) Maintaining the high growth rate started under Pinochet's regime was considered key for government legitimacy and maintaining social stability. The economy was experiencing annual growth rates approaching 7% at the end of the 1980s and unemployment levels decreasing from 12% in 1987 to 6% in 1989.(Meller et al., 1996) The Aylwin government did not want to disrupt economic growth by imposing restrictions on industry that industry claimed would lower productivity.

The government also did not want to threaten the status quo by burdening certain segments of society. They did not want to adopt any policies that would alienate the business class as this class was responsible for most of the investment being made in the economy. They wanted to assure the elite that they could invest in the Chilean economy without risk, which compelled them to stick to the neo-liberal model that largely

benefited the existing power structure. Rather than make more radical changes in the economic structure, the government focused on incremental changes to increase the welfare of the poorest members of society in an attempt to somewhat rebalance the high levels of inequity that developed during the military regime. The government did this through changes in the tax structure and through government benefits such as health care.

(2) Furthermore, the size of the government had been greatly reduced under Pinochet. The Aylwin government, in an effort to minimize the disruption of the economy by the new government and stick with the free-market model, also kept the size of government limited, which reduced its ability to develop and enforce regulations. Consequently, although the government has required air pollution regulations to be passed, they are still now being discussed and actual implementation and enforcement of many aspects of the new clean air plan are still months if not years away.

(3) The structure of the environmental branch of the administration limits its effectiveness. Because CONAMA is under the Secretary General of the Presidency, its ability to write and enforce policies depends completely on the will of the president. And although I hypothesize that a democratically elected president is more likely to want cleaner air than a dictator is, a president may feel more beholden to business interests than to environmental NGOs or low level concerns of the population at large. The government has continued to work closely with the business community in developing policies and, although this can be helpful for developing regulations that can be enforced, this cooperation between government and business can also temper the stringency of the regulations.

(4) It is also likely the case that after 17 years of social and political oppression, the public was less likely to gear up to voice their concerns about air pollution than had they been in a democratic regime the whole time. The "culture of fear" can lead to apathy. A democratic society emerging from years of oppression may not be fully prepared to make demands, or even recognize the possibilities of what it could demand.

(5) The strength of the political pressure for environmental protection was tempered by the perception of the limitations to the level of democracy in the country. A 1996 survey of attitudes in 17 Latin American countries found that Chile ranked below average for attitudes towards politics and perceptions of democracy.(Lagos, 1997) For example, less than half the Chileans surveyed agreed that "the way you vote can change the way things will be in the future." Only 54% of respondents agreed that democracy is preferable to other forms of government and only 10% thought that democracy is fully established in Chile. The population is aware of the holdovers from the Pinochet regime in the form of institutions and appointed senators, and this leads to a skepticism about the effectiveness of public input.(Lagos, 1997) Marta Lagos(1997), a Chilean, writes:

> Chileans perceive power to be in the hands of unelected actors (large entrepreneurs, the military). Disenchantment with politics rose from 20 to 45 percent within 18 months after the restoration of democracy in 1990, and has increased steadily since then, albeit at a more moderate pace. Furthermore, a large majority of citizens perceive the existence of authoritarian institutional holdovers, and can identify particular examples, such as the continued presence of appointed senators...Faced with this

situation, Chileans are expressing their frustration by adoption an attitude of skepticism about the system.(p.135)

Consequently, many people may accept the continuing high level of air pollution in Santiago because they feel that there is nothing that they can do about it.

4.10 Conclusion to Case Study

This chapter provides empirical support, albeit a single case, for a link between democracy and environmental quality. Although the great variety in types of environmental problems as well as the variety in natural and cultural settings around the world makes it unlikely that there exists one explanatory variable for environmental quality, there are strong reasons to believe that regime type is an important explanatory variable. These reasons were presented in Chapter 2.

This chapter considers air pollution regulation in Santiago to see what changing regulations with changing regimes tells us about the relative merits of the hypothesised link between regime type and environmental quality. What this case study shows is that the increased level of attention paid to reducing air pollution in the 1990s appears to be a result of a democratically elected government taking office. More specifically, effort to reduce air pollution levels resulted from environmentally concerned factions gaining a voice in the new government, in combination with the government's need to respond to public outrage over the pollution levels in Santiago.

There are a number of limitations with this study that the reader must bear in mind when considering the implications of this case study for the relevance of regime type to environmental protection. For one, there are difficulties in comparing two periods of such different lengths of time: seventeen years and four years. There were also different phases in the Pinochet regime. The government behaved differently in the 1980s than in the 1970s, due to increased public unrest as well as the upcoming plebiscite. Although the regime was oppressive and human rights were dismissed, in the final years, the government knew that it would face an election, and so needed to appease the public in at least some limited ways. Much of the work done to reduce emissions occurred during the final years of the regime, which may reflect preparations for the upcoming elections, giving support to the relevance of democracy to environmental quality.

Furthermore, although there is no doubt that the Aylwin government was more democratic than the Pinochet regime, there were structural limits to the level of democracy resulting from the design of the new government set out in the Constitution of 1980, which limited public input in policy making.

To fully understand policy making and outcomes in Chile during the period in question, one needs to deconstruct the power alliances and their resources in the context of the structure of the relevant government institutions to understand why one set of competing policies won out over others.(See Silva, 1996b) This is true of all government decision making.

In addition to the structural impediments to public input, public pressure for improvements in environmental quality might also have been tempered in a society emerging from 17 years of civil oppression, as was stated above. It is unlikely that the voices calling for improved environmental regulation were as loud and organized as they would have been in a society that had enjoyed a sustained period of civil liberties and political freedom.

On the other hand, as was stated above, Chileans have a tradition of caring about environmental quality.

Another point to consider is that there is a lag period in the development of any policies that respond to problems. Since air pollution was the worst in the years 1988 and 1989, it is hard to know what would have happened had the military regime continued for five more years. The lag is also relevant in terms of the international environmental community. Many developing countries were just starting to think about air pollution regulation in the late 1980s, so the timing was right for the Aylwin administration to begin working on these problems.

The evaluation of the importance of regime type is also muddled by the existence of international pressure. It has been argued by Sarah Larrain, the director of Renace, that most of what the democratic governments have done to reduce emissions has been with an eye towards NAFTA.(Larrain, 1997) Although Chapter 2 argues that democratic regimes are more responsive to international pressure, the desire for foreign investment and the recognition of environmentally contingent loans impressed both governments with the need to reduce pollution levels.

Despite these caveats, this case study clearly shows that a change from a dictatorship to a democracy led to a dramatic shift in efforts to reduce air pollution emissions in Santiago and led to improvements in air quality. The Pinochet regime had allowed air quality to deteriorate significantly during its tenure and real efforts to combat this were only made when a democratically elected government took office. During the 1990s, the levels of most criteria air pollutants did appear to decrease. While the Aylwin government did not do as much as it could to reduce pollution, significant gains were made on some fronts.

Although air pollution regulation in Santiago is only one case study of the relationship between democracy and environmental quality, Chile does not appear to be a unique case. We see similar correlations in other countries. As I wrote in the introduction to this chapter, Chile provides an *ideal* case for studying the relationship between regime type and environmental quality because the economic system did not change with the change in government. This is not the case for the Former Soviet Republics, which also experiences democratization in the same time period as Chile. However, it is instructive to consider what efforts were made to improve environmental quality with the change in regime type in this area of the world, as well as in other Latin American countries.

4.11 Regime Change and Environmental Quality in Other Nations

East Central Europe

Much like Chile, environmental quality deteriorated considerable during the authoritarian regimes in the Former Soviet Republics. As was discussed in Chapter 2, in the face of this deteriorization, environmental groups played a role in the collapse of the communist regime in a number of countries in East Central Europe(ECE). The level of improvements in environmental quality in these countries since the regime change varies, although most have seen clear improvements.

In both Slovakia and the Czech Republic, the initial period after the political transition saw bold efforts to improve environmental quality. In Slovakia, green activists played an important role in the transition to a new government and gained acceptance and leadership roles in the new government. With new access to media outlets and policy-making, they ensured the creation of environmental institutions and regulations. An environmental ministry was established in each republic in 1990, which brought together environmental scientists and activists. Much like Chile, after this initial enthusiasm, the focus of subsequent government has been more economic and democratic reform, and the establishment of separate governments after the republics were separated in 1993, with less attention to and activity on the environmental front.(Albrecht, 1998; Podoba, 1998; Fagin and Jehlicka, 1998)

In the Czech republic, the initial activities and enthusiasm related to environmental quality decreased after the separation from Slovakia and the election of a right-wing governing coalition in 1992. Since this time, much of the focus on environmental quality has not been generated domestically but is focus on compliance with EU standards.(Fagin and Jehlicka, 1998) The EU has ended up playing a central

role in environmental improvements in the Czech republic as well as other countries of the region.(Baker and Jehlicka, 1998) Interaction with the EU has not only helped establish environmental regulations but has facilitated the transfer of technologies which allow for improved energy efficiency and cleaner production processes.(Sutherlin, 1999) In 1994, an estimated 2.73 per cent of the Czech Republic's GDP was spend on environmental investments.(Slocock, 1999)

One of the countries that attained the most improvement in environmental quality during the post communist period is Poland. Poland has experienced high levels of economic growth since 1994 yet many indicators of pollution have shown continual improvements since 1992.(Sutherlin, 1999; Cole and Clark, 1998) While some of the improvements were the result of industrial restructuring and economic recession, the pollution intensity of industry also declined considerably, averaging about 30% for SO_x, NO_x, and dust, in the period 1990 to 1994.(Slocock, 1999) Regulatory changes, primarily the use of fees and fines, have led to reductions in pollution levels through the purchase of pollution reducing equipment and other methods. An estimated one per cent of Poland's GDP went towards environmental improvements in 1994.(Slocock, 1999) Poland's fees and fines for environmental pollution are some of the highest in the world and have been effectively designed such that they are supported by broad segments of the economy, making it difficult for other segments to push back the fee levels.(Cole and Clark, 1998) Most importantly, most of the fees and fined assessed are actually collected.(Sutherlin, 1999)

The environmental law enforcement agency created in 1991 has also been a powerful and effective force in protecting environmental quality.(Cole, 1998; Jendroska, 1998) While the impetus for much of these improvement have been to join the EU, environmental improvements are real.(Millard, 1998) Following the EU standards also provides the advantage of avoiding becoming dumping grounds for dirty industries from other European nations.(Sutherlin, 1999)

Like Chile, some of Poland success in improving environmental quality, compared to other ECE nations, may be a result of the structures that were put in place during the 1980s, before the political transition. In 1980, the Environmental Protection and Development Act (EPDA) was enacted by the communist authorities and there was increased government openness about Poland's environmental problems. Unfortunately, the EPDA depended largely on market-based incentives to improve environmental quality. Since there were no real competitive markets in the economy, the EPDA was not successful.(Cole and Clark, 1998)

The EPDA also granted rights to environmental organizations to exist as well as participate in legal actions and government hearings. While these rights accomplished little under the communist regime, they created a foundation for the development of successful environmental policies in the 1990s.(Jendroska, 1998) In the summary of their overview of improvements in Poland's environmental regulations after the political transition, Daniel Cole and John Clark (1998) credit both democracy and markets. They write:

> Poland's experience generally supports claims of a positive correlation between environmental performance and democratic capitalism. Certainly, Poland's embrace of democratic institutions, markets, civil society and international community has brought substantial environmental awards... Post-communist Polish governments have responded to democratically articulated pressures to clean up pollution and protect natural resources... The communist system simply lacked the markets, the commitment to the rule of law, and the respect for civil society that successful environmental policies appear to require.(p.14)

Poland still has a long way to go. Certain powerful segments of industry, primarily mining, have found ways to avoid fines and avoid other regulatory demands for reducing pollution, yet remain in operation. Also, 75 percent of the firms on the list of the most polluting in 1990 were still on the list in 1998.(Slocock, 1999) But more progress towards environmental improvements were made in the 1990's than in the previous decade.

A study by Simina Dragomirescu, Cristina Muica and David Turnock(1998) of environmental quality and regulations since the regime change in Romania also found improvements in environmental quality in the post-communist period. Much of these improvements occurred as a result of inputs of foreign capital and technology transfer.

Lawrence O'Toole and Kenneth Hanf (1998) find that, in Hungary, the transition to democracy did not lead to a dramatic increase in efforts to improve environmental quality. The change in regime type did remove some of the obstacles to environmental

regulation, but the overall approach to environmental quality has not changed much with the new government.

With notable exceptions such as Hungary, most countries of the region have seen improvement in environmental quality, which, in part, has resulted from increased access to information within the country and internationally, increased public involvement in decision making, governments responding to public pressure for environmental quality improvements, and interaction with other democratic nations, most markedly those of the European Union. Jancar-Webster (1993a) and Jendroska (1998) also argue that the environmentalism of the 1980s helped with the building of environmental regulatory structures in the 1990s, and that the environmental movements in many of these countries still play an important role in policy development and implementation.

Some authors are not as enthusiastic as others about the role that public pressure for environmental quality has played in improving environmental regulations.(See Jancar-Webster 1993b) They suggest that much of the enthusiasm for environmental improvements during the 1980s, which helped to bring down the regime, was a result of the fact that the environment was an area that could be discussed openly in many countries, while discussion other social and economic issues was banned. After the transition to new governments, much of the enthusiasm for environmental issues waned.

A number of reasons have been given for this perceived decease in interest in environmental quality. Two primary reasons are the intense focus on material and economic interests that occurred after the transition, and the weakness of civil societies' efforts to influence policy inherited from years under communist rule.

Another hurdle that these newly democratized countries faced is limited capacity of institutions to implement environmental policies. (Baker and Jehlicka, 1998; O'Toole and Hanf, 1998) As was discussed above, it may be that institutional capacity and bureaucratic efficiency may be as important for environmental protection as regime type.

Baker and Jehlicka (1998) write that policy implementation was also hindered by, "passing of a large amount of new legislation in a short period of time, lack of funding, weak environmental ministries, fragmentation of administrative responsibilities, poor quality of expertise and the siphoning off of the most experienced into more lucrative private-sector posts, corruption, conflicting goals, and problems in monitoring."(p.15)

Arguably, expectation for improvements in environmental quality in this region due to democratic institutions need to be tempered because the democratic transitions in these countries are not complete.(Jancar-Webster, 1998) As was discussed above, both the lack of civil involvement in policy making, as result of years under communist rule, as well as limited institutional capacity, proscribe the extent to which the governments pursue and are successful at environmental regulation.

It is also important to recognize that the transitions to democracy were accompanied by transitions to market economies to a lesser or greater extent. This complicates the relationship between democracy and environmental quality. While some authors (such as Sutherlin, 1999, and Cole and Clark, 1998) have attempted to separate the effect of market from the effects of democracy on environmental quality, it may well be that it is the combination of the two that allowed for improvements in environmental quality.

Latin America

A number of Latin American countries also underwent democratic transitions in the 1980s, although, in most cases, they were not abrupt transitions as occurred in Chile, but more continuous transitions to increased democracy. Unlike Eastern European nations, the environmental movement did not play an important role in bringing down oppressive regimes and increasing political and civil liberalization in Latin America, with the exception perhaps of Brazil, where the environmental movement was questioning existing government actions, and arguably in Chile, where air pollution was of increasing concern.(Mumme and Korzetz, 1997) Yet this increases civil and political liberalization has allowed environmental issues to enter the policy debate and, in some instances, be substantially addressed.

A paper by Maria Lemos(1998) examines the successful program to improve environmental quality by reducing industrial pollution in the city of Cubatao, Brazil. She attributes the success of the regulatory program to Brazil's transition to democracy. She points to three major features of the transition. First, it reduced the dominance of traditional elites in policy making. Second, liberalization allowed for increased influence of interest groups in policy-making. Third, the issue could now be framed by the popular movement which enabled other influential groups in Brazilian society to be attracted to the issue of pollution in Cubatao.(p.78) This forging of new alliances reduced the co-optation of policy makers by the traditional elite.

A study by Eduardo Viola (1997) of the environmental movement in Brazil concludes that the effectiveness of the environmental movement, which has evolved due to increasing liberalization, is still constrained by the "crisis of governance in Brazil". The Brazilian government needs to successfully deal with social crisis as well as political corruption and inefficiency before environmental concerns will play a key role in policy framing.

In their overview of democratization and environmental reform in Latin America, Mumme and Korzetz (1997) find that increased democratization in Latin America is associated with improvements in environmental quality. They suggest that democratization allows for improvements in environmental quality through changes at a number of levels. To paraphrase the authors, at the formal level, the restitution of democratic institutions as well as the establishment of environmental agencies helped to bring environmental concerns into policy-making as well as legitimize these concerns. At the political level, the relaxation of restrictions on government parities and civil group formation, the relaxation of restrictions on political debate, and the state sponsorship of NGOs also helped bring environmental issues to the forefront of issues. At the policy level, political liberalization encouraged public participation in policy making. At the societal level the liberalized social climate allowed for grater interaction with international environmental NGOs and increased public awareness of environmental issues through media campaign on domestic NGOs.(p.46)

Mumme and Korzetz conclude:

> Environmental mobilization and the political prospects of organized environmental interests have certainly benefited from the climate of political liberalization in the hemisphere. The rapid growth in the number and variety of groups, the appearance of ecology parties, the growth of public environmental concerns, and the placement of environmental concerns on national policy agendas all point to more than a coincidental relationship between political liberalization and environmental mobilization.(1997, p.55)

They note, however, that the mobilization around environmental issues remain handicapped due to formal limitations on interest group activities and electoral freedom, such as standards for voter eligibility, press censorship, as well as "policy biases" inherited from the previous authoritarian regimes.(p.55)

Clearly there are other case studies of the politics of environmental change in Latin American countries other than Brazil that one could draw from here (see, for example, Jurado and Southgate, 1999). There are also other countries that one could look at such as Indonesia (see Cribb, 1990, 1998; Petrich and Smith-Sinclare, 1977), or Nigeria (see Areola, 1998). This survey is not meant to be an exhaustive study of environmental change in the face of regime change. Rather, the cases studies of environmental policy changes in ECE and Brazil are presented to show that Chile is not an isolated case of environmental quality improvement with increased democracy.

Chile may present the clearest example in Latin America of the relationship between regime change and environmental quality improvements. However, the examples given above of improvements in environmental regulations in other nations, as

well as the conclusions of other authors' reviews of these improvements, suggest that this correlation is not a mere coincident, but that political liberalization and environmental quality are indeed correlated.

Conclusion

This dissertation examines two different relationships. The first is the relationship between environmental quality and income level. The second is the relationship between environmental quality and democracy.

In Chapter 1, I demonstrate that there is little existing empirical evidence supporting an inverted U-shaped relationship between income level and environmental quality, known as the Environmental Kuznets Curve (EKC). The strongest support for an EKC can be found using urban SO_2 concentrations as a measure of environmental quality. Even with this variable, the results from existing studies are mixed.

Although economic growth can be associated with the use of cleaner technologies, a change in the composition of GDP from dirty to cleaner industries, and with increased spending on environmental regulation, it is also associated with increased use and degradation of resources, and increased wastes being put back into the environment. There is no compelling evidence at this point to suggest that these pollution-reducing effects of wealth will outweigh these latter pollution-raising effects above a certain income level – certainly not automatically

If evidence is lacking, why then does the existence of an EKC continue to be cited as a truism? One reason is that the belief that growth is good for environmental quality

serves the agenda of those who benefit from unfettered economic growth. If it is believed that economic growth leads to environmental quality improvements, then care need not be taken of the environment in the meantime – care which is perceived to hinder profit levels. For groups such as the World Bank, the EKC validates an entire approach to development theory and practice.

An EKC for some aspects of environmental quality may well exist, or have existed previously in some countries. For other aspects of environmental quality, we might expect either a U-shaped relationship between income and environmental quality, as opposed to the inverted U-shaped relationship of the EKC, or a linear relationship, or no relationship whatsoever. Where an EKC does exist, is this a matter of technological improvements being available only to wealthier countries? If so, this is a problem that needs to be remedied with improvements in technological transfer and the directing of poorer countries to the most environmentally friendly technologies. And where an EKC exists as an artifact of dirty industries moving from richer to poorer nations, then the benefits of an EKC are illusory. This suggests a need to address trade policies as well as consumption patterns in more developed countries.

To the extent that an EKC may exist for certain aspects of environmental quality due to changing demand for environmental quality, then here we need to think about how these preferences are formed and how these preferences are translated onto action. As Desai (1998b) notes, if a certain income level must be achieved before an individual cares about environmental protection and before a society acts to prevent environmental degradation, and if this income level is associated itself with environmental degradation

and unsustainable resource use, we are doomed. Similarly, Brian Czech (2001) claims that if a sustainable ideology does not develop until a certain standard of living is reached, yet that standard of living is associated with a level of economic growth that leads to a decrease in the standard of living due to environmental degradation, we may not be able to achieve sustainability.

Even if an EKC relationship appears true in the past for a certain set of circumstances, this does not mean that this relationship is set in stone, i.e. that it is the result of immutable natural principles. Like other transition theories – e.g., demographic, epidemiologic, risk – people tend to confuse history with inevitability. Development paths for countries now are not the same as they were for countries in the past.

The existence of an EKC is not simply an academic debate. It has wide policy implications. Ignoring the environment in the name of growth can have dire consequences for ecological sustainability as well as future growth levels. Unfortunately, the broad array of empirical challenges to the EKC theory has not been able to unseat this proposition. This only demonstrates how persistent an idea can be if it supports the self-interests of powerful groups and individuals. We can hope that the weight of evidence will become so overwhelming that institutions that publish the theory of the EKC as fact will have to retract this unfounded idea.

The remainder of the dissertation focuses on the second relationship: between environmental quality and democracy. Given that environmental quality is a public good, the protection of environmental quality depends on organized efforts by some level of centralized governing body. As Richard Norgaard points out, "Environmental problems

are problems of social organization."(1994, p.15) So, the question really is, what form of social organization is best able to protect environmental quality? While there are many aspects of social organization that may affect the level of environmental quality in a country, such as size of government, or level of corruption, and there are many social features that may be important as well, such as level of education, and distribution of income, this dissertation focuses on the level of democracy in a country. The scale for analysis is the nation state level. However, democratic decision making at the local, regional or international level might also be found to be an important determinant of environmental quality.

Chapter 2 outlines a number of reasons why a democracy is more likely than an authoritarian regime to protect environmental quality. The kernel of the argument is that many forms of environmental degradation benefit the few and harm the many. Inasmuch as elites tend to benefit from environmental degradation, while the costs are spread throughout the population, the sharing of power that occurs in democratic regimes can act to curb the degrading activities of the few. Other reasons for the positive relationship between environmental quality and democracy are also given. These include: the accountability of leaders; public involvement in policy making; access to information; the presence of non-governmental organizations that can work to help to inform the public about environmental problems, can act as watchdogs on public agencies, and can directly lobby members of government; the availability of civil litigation as a tool to enforce environmental protection; and international aspects of democracy such as the interaction of democratic nations in sharing information regarding environmental problems and

regulatory techniques, and the development of international treaties for global environmental problems. Overall, there are compelling reasons to expect the level of a democracy in a country, or at any geographic level, to be positively correlated with environmental quality.

In contrast, authoritarian regimes are less likely to protect environmental quality. Some of the explanations given for this are: the lack of accountability for leaders; the concentration of power; restrictions on the free flow of information; and the need for coercion and/or legitimacy, which limits long term investments in environmental quality. This is not to say that authoritarian regimes will never take steps to improve environmental quality. There are examples of authoritarian regimes working to improve environmental quality. But overall, authoritarian regimes have much worse records on environmental protection than democratic regimes.

In Chapters 3 and 4, I present empirical evidence to support the relationship between democracy and one aspect of environmental quality, urban air pollution. In Chapter 3, the relationship between environmental quality and democracy is explored empirically using a regression analysis of urban air pollution concentrations of three pollutants, SO_2, SPM, and smoke, and two measures of democracy, the Freedom House Index and Polity III. The results suggest a significant and robust negative linear relationship between these pollutant concentrations and democracy level: the higher the level of democracy, the lower the ambient pollution level.

Chapter 4 presents a case study of air pollution regulation in Santiago, Chile. This case study was chosen because there was a sharp change in regime type in 1990,

when the dictator Augusto Pinochet relinquished power to the democratically elected government of Patricio Aylwin. However, the economic system did not change at this time, so it does not confound the relationship. The study found that very little was done by the Pinochet regime to control air pollution until the final years of the dictatorship, when they were facing a plebiscite. Air quality deteriorated considerably during the 1980s. Once in office, the Aylwin regime took immediate, although limited, steps to reduce air pollution emissions.

This case study suggests a strong correlation between regime type and efforts to control pollution. However, the study is hampered by the blurring of the line between dictatorship and democracy in Chile due to the plebiscite during the Pinochet regime, which "democratized" the dictatorship, and the continued presence of members from the previous unelected regime in the congress of the otherwise democratically elected Aylwin government, which limited the democracy.

At the end of Chapter 4, I overview other cases where a changing of regime from dictatorship to democracy is correlated with increased attention to environmental problems. Chile is not a unique case. There are other nations that seem to follow the form of the Chile case study.

My empirical work only considered one aspect of environmental quality. Environmental quality is not an homogenous good, however, and not all aspects of environmental quality are expected to respond equally to the sharing of power associated with democratic regimes. Due to their different characteristics, some environmental problems are more likely than others to be controlled in a democracy. Problems that have

immediate and clear effects on the health or livelihood of many people, yet that are created by few, such as industrial pollution, are more likely to be controlled. Problems with distant, unclear, or uncertain impacts, or that affect fewer people, are less likely to be controlled in a democracy.

Just as environmental quality is not a homogenous good, neither is democracy. It may be that certain characteristics that help determine the level of democracy in a nation, such as the free flow of information, or the level of corruption, are also important determinants of how successfully a democratic government can and will control environmental degradation. Two countries that are considered equally democratic may have strengths in different aspects of democracy, leading to differing levels of environmental protection. Even different administrations in democratic countries can vary tremendously in their willingness to take steps to protect environmental quality. A particular level of democracy can lead to somewhat different outcomes in different nations or under different administrations.

It is no small irony to me that I am writing about the benefits of democracy to environmental quality in early 2002 while the President of the United States, George W. Bush, and many of his democratically elected colleagues, are busily trying to weaken some existing environmental regulations, or reduce enforcement levels. This demonstrates how much influence industry has been able to wield in policy making. Our democratic system has unfortunately been corrupted by, among other things, lack of rules on campaign contributions, and the high costs of being elected. The effectiveness of

democratic decision making has also declined due to the increasing power of markets and bureaucracies.(Norgaard,1994)

Certainly, democracy is no panacea for protecting the environment. Even the most democratic of nations exhibit severe environmental problems – problems that are worsening annually. The failure of democracies to protect environmental quality more fully does not necessarily suggest that democracy, as a regime type, is unable to protect environmental quality. Rather, it may be that certain aspects of democracy essential to protecting and improving environmental quality are failing. As was conjectured in Chapter 2, it may be that where environmental protection breaks down, we also see a breakdown in these essential processes and functions of democracy. While my research does not shed light on this issue, it is clear that even the most democratic of countries suffer from power inequities. Where the elite maintain a hold on power, environmental agendas are subverted for the needs of profit making. Some democratic regimes seem to be less interested in public welfare and more in corporate welfare, yet they have the resources to hide this preference from the public and to appear to be responsive regimes.

The excessive power of elites ties together the two relationships studied in this dissertation. In the first relationship, the concern is with the effect of economic growth on environmental quality. In the second relationship, the concern is with the effect of excessive power in the hands of the elite on environmental quality. Although economic growth can be beneficial to all members of society, it can also lead to increased levels of wealth and power in the hands of elites. Elites can then use this power and wealth to further their agenda regarding unconstrained economic growth and unrestricted

environmental exploitation. As Paehlke (1988) points out, it is the elites that "pursue economic growth to the detriment of the environment."(p.305)

The problem of the power of elites has become increasingly evident in relation to globalization. As markets have evolved from local to regional to national to global, the ability to concentrate wealth and power has increased. This not only undermines democracy on the national level but also creates powerful international groups, such as multinational corporations, whose actions can be beyond democratic control. There is limited global democracy. Citizens in one country have little say over public policy formation in another. While some world bodies, such as the United Nations (UN) and the World Trade Organization (WTO), are designed to represent many, or all, nations, they tend to be dominated by the influence of a few powerful countries and/or global elites.(Chatterjee and Finger, 1994)

One of the strongest objections to the activities of the WTO is that it is not a democratic organization. Its activities are not transparent and many of the groups who are affected by its decisions have no input in decision making. Why is it that people who are against free trade are relegated to protesting in the street to have their voices heard? Wolfgang Sachs (1990) refers to the global marketplace as the new "closet dictator". Democratically developed national laws and regulations can be overridden by international trade rules.(Nader, 1993) GATT allows for national laws to be challenged as non-tariff barriers. Laws that have been identified as barriers include limitations on lead in consumer products, the asbestos ban and driftnet fishing restrictions in the U.S., Danish bottle recycling laws, Malaysian limits on exports of raw logs, as well as

Canadian requirements for reforestation.(Nader and Wallach, 1996) As globalization and the imperative of free-trade expand, the effectiveness of democratically developed national laws are eroded.

The global market not only decreases the democratic control of decision making regarding the use of resources and the protection of environmental quality. The global market also allows for countries to trade their way out of limits to growth and to distance themselves from the degrading impact of consumption patterns. A recently publicized example of this is the exportation of waste consumer electronics, with their toxic lead, mercury, and PCB contents, to Asia for disposal.(Silicon Valley Toxics Coalition, 2002) If the U.S. were responsible for disposal and recycling of this waste, legislation might be passed to ensure that this would happen properly – legislation that could increase the price of these electronics to include disposal costs. International exportation of waste allows countries to externalize disposal costs.

International environmental problems also can escape democratic control because there is no effective international governing body. Although international treaties are designed to reduce these problems, they are often not enforceable and therefor are often ineffective. This problem is especially poignant in relation to global climate change, not only because of the severity of the potential impacts, but also because the effects are likely to be most profoundly felt in poorer nations while the wealthier nations are the largest contributors to the problem.

So, inasmuch as democracy can act to curb the environmentally degrading activities of the few, increasingly globalized markets can eclipse some of this curbing

effect due to the increased concentration of wealth and power in the hands of elites, and the lack of a global democracy.

In conclusion, economic growth alone can not be expected to spontaneously improve environmental quality in a nation, regardless of where and how this growth occurs and the type of regime governing the nation. Growth can provide resources needed for environmental protection, but too often growth is not focused in areas which lead to benefits for environmental quality. Instead, growth may lead to increasing environmental degradation.

There are good reasons to have faith in the ability of democratic decision making to protect environmental quality. As Dryzek writes, "the kind of values that survive authentic democratic debate are those oriented to the interests of the community as a whole, rather than selfish interests within the community (or outside it). Foremost among the community interests is the integrity of the ecological base upon which the community depends."(1997, p.200)

Unfortunately, existing democracies are constrained in their ability to promote these values due to the excessive influence of powerful elites for which environmental protection is an anathema rather than an asset. Economic growth can increase existing social inequalities, and the power of elites. In a democracy, these inequalities may further subvert the ability of the democratic process to develop and implement regulations to protect environmental quality. We can only guess how a true democracy would respond to environmental problems. Also, as more environmental problems are being exported through increasingly globalized markets, and as international

environmental problems grow in significance, the ability of democratic decision making to address these problems decreases.

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