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TECHNOLOGICAL DEVELOPMENT: THE U.S. AND JAPAN

by

Kyoo-Man Ha

A DISSERTATION

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Technological Development: The U.S. and Japan

BY

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GRADUATE COLLEGE
UNIVERSITY OF NEBRASKA

TECHNOLOGICAL DEVELOPMENT: THE U.S. AND JAPAN

Kyoo-Man Ha, Ph.D.
University of Nebraska, 1997

Advisor: Robert Miewald

The methodology of comparative public administration, which examines similarities and differences in different systems, is the primary analytical tool used in this dissertation, which focuses on Japanese and U.S. technological development. It examines inter-relationships between technology, economy, and politics, national ideologies, national security, innovation institutions, and instruments of technology policy and strategies.

The research question of the dissertation includes four sub-factors. (1) While both the U.S. and Japan have continued to support technological development, (2) U.S. efforts to support defense technology are far more obvious and tangible than those of Japan, which go on behind the scenes. (3) The U.S. government and Japan's industry have both been major sources of financing technological development for their respective industries. In addition, (4) the U.S. aerospace technology as well as its electrical equipment technology, and Japan's machinery and computer technologies, together with the Japanese electrical equipment technology, have been strategically supported by each country.

This dissertation disconfirms the hypothesis that only the U.S., not Japan, has made efforts to develop defense technology. Japan's development of dual-use technology, which means that a technology can be used for both civilian and military applications, is a major tenet of this dissertation.

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Chapter One
Introduction

Although the U.S. and Japan possess the strongest economies in the world, these two nations have taken different paths to achieve their economic success. The Japanese have concentrated on domestic cooperation to catch up with Western economies, and thus have achieved the second largest economy in the world. Japan's economic growth has been attributed to vital domestic factors including political support, the role of its industry, and its dedicated people; as well as international advantages like the assimilation of foreign technology, benefits from the Korean War, and U.S. military and economic assistance to Japan. In contrast, through winning the World War Two, the U.S. enjoyed many advantages, allowing it to become a leader country in the world market. By exploiting abundant material resources, the U.S. has continued to exercise its huge power over industrial and military rivals.

The U.S. began to direct its attention to the expansion of the Japanese economy at the beginning of the 1980s, because Japan's industry had expanded internationally, through its skillful use of cutting-edge technology. Japan shielded its domestic markets from international pressure as it cultivated its high-technology industry. In spite of a steady and robust economy, the U.S. lost relative its technological edge over Japan during the past twenty years. While the U.S. retains its position as a superpower in nuclear and military industries, some worry that Japan's rise is a major economic and geopolitical challenge (Ferguson, 1989, pp. 123-136).

When examining how a nation becomes industrialized, it is obvious that a number of relevant factors are operative (Gerschenkron, 1966, pp. 5-30). Among them, technological advancement is responsible for an appropriate proportion of each nation's industrialization. The speed of diffusion of new technology, the rate of technological change, the direction of technology, and technology's influence on economic productivity clearly are all important for the improvement of an economy. Therefore, it has become increasingly important to account for technological change, especially for the most economically advanced countries like the U.S. and Japan.

Within the foregoing context, this dissertation will examine how the U.S. and Japan have grown economically by employing high technology. It will focus on similarities and differences in the two countries' technological development. Its research question holds that while the U.S. and Japan have similarly continued to support their technological development under their own peculiar traditional ideologies, they have developed differently in three aspects: (1) the U.S. has relied more heavily on defense technology than Japan has, (2) the U.S. government and Japan's industry have both been major sources for financing the further technological development of their respective industries, and (3) the U.S. aerospace technology as well as its electrical equipment technology and Japan's machinery and computer as well as its electrical equipment technologies have all been strategically supported by each country.

To this end, it is necessary to examine various aspects of the topic. A similarity of the supporting technologies reveals that it is not easy to develop an economy without a corresponding focus on developing technology, thus technological development is pre-

requisite for improving a national economy. It is also helpful to examine differences between economies to understand just how each economic power has supported technology. In doing so, studies on funding patterns are especially relevant. Without knowing how much money has been allocated for both defense and industrial technologies, it is difficult to perceive differences between the two nations. In addition, it is helpful to know who or what provided funding for the two.

A study of this thesis about the two countries' increasing investments in technology with the supports of each national ideology, will include three sets of data: international export shares of technology related products between 1965 and 1989, national research and development (R&D) expenditures between 1981 and 1995, and the number of engineers and scientists in R&D between 1970 and 1993. By examining the huge national R&D expenditures, the export share of technology products, and the number of scientists and engineers, it is possible to show empirically that both the U.S. and Japan have strongly supported technological development.

In order to illustrate how the U.S. has supported defense technology more apparently than Japan has, five kinds of data are included. These are: national budget distribution for R&D by socioeconomic objective in 1992, 1993, or 1994; non-defense R&D expenditure between 1981 and 1995; Japan's basic defense plans; lists of Japan's dual-use technology; and Japan's defense production in 1987. While data like R&D distribution by socioeconomic objective and non-defense R&D expenditure show that the U.S. has invested for defense technology, more substantial data including lists of defense plans, Japan's dual-use technology, and defense production in 1987 suggest that Japan

has also supported defense technology. Nevertheless, these combined data reveal that the U.S. has more directly supported defense technology than has Japan.

To explain the financial support of U.S. government and Japan's industry of technology development in their respective industries, two types of information are pertinent. These include national R&D expenditures by source of funds in 1975, 1986, and 1993, and national R&D expenditures by sector of performance in 1975, 1986, and 1993. According to the data about national R&D expenditures by sector of performance, industry rather than government in both the U.S. and Japan has primarily performed R&D activities. Moreover, national R&D expenditures by source of funds show that those national R&D expenditures have been financed mainly by the U.S. government and by Japan's industry, even though there has been increased expenditure by U.S. industry on national R&D efforts.

To see the U.S. strategic emphasis on aerospace and electrical equipment technologies as well as Japan's strategy on machinery and computer and electrical equipment technologies, two kinds of data will be used to include a U.S. comparison of R&D for manufacturing and non-manufacturing between 1981 and 1992. The second set of data is the proportional allocation of industrial R&D among manufacturing industries in 1986. The U.S. has historically more heavily invested in R&D for manufacturing than for non-manufacturing, according to a U.S. comparison of R&D for manufacturing and non-manufacturing. Meanwhile, the percentage of industrial R&D among manufacturing industries indicates that Japan has strategically supported machinery, computer, and

electrical equipment technologies, as opposed to the U.S. which has supported aerospace and electrical equipment technologies.

Based on one similarity and three differences, a working hypothesis can be formulated to illustrate how a conventional wisdom has been misinterpreted in assessing how each nation has supported its defense technology. Revelations about Japan's covert emphasis on defense technology will surely surprise those who believed that Japanese intentions are not at all militaristic. As a result of these considerations, a logical hypothesis is that just the U.S., not Japan, has supported the development of defense technology. An independent variable is each nation including the U.S. and Japan, and a dependent variable is the amount of defense technology in the two nations. By comparing their expenditures on defense technology through the years, the hypothesis will be tested. Particularly, a careful analysis of funding for U.S. defense technology and the nature of Japan's industrial technology will be emphasized.

Empirical data used in this dissertation come from a book, Science & Engineering Indicators, National Science Board, Washington, D.C., 1996. Secondary sources will be several books such as International Science and Technology Data Update, National Science Foundation, Washington, D.C., 1996 and 1991, The Science and Technology Resources of Japan: A Comparison with the United States, National Science Foundation, 1988, Rich Nation, Strong Army, Richard J. Samuels, Ithaca, 1994, and Competitors in Alliance, Andrew A. Procassini, Connecticut, 1995.

To provide an orderly development, the dissertation will be organized in the following manner. Part I has three chapters to describe the general outline of the

dissertation, before delving into intricate differences between the U.S. and Japan. In so doing, Chapter Two, on comparative public administration, will describe the history of the comparative perspective in the field of public administration, thereby explaining a major methodology of the dissertation. Despite its temporary popularity, Chapter Two will show that a comparative perspective balancing between generalization, which is related to similarity, and separatism, which is related to differences between American and Japanese technological development, is still urgently needed for public administration efforts to compete with other nations, because of internationalization of public administration, professionalism, overcoming localism, distinctiveness of public administration, more research opportunities, public administration coordination for technology by world interdependence, and administrative arrangements for technology invention and diffusion.

Chapter Three will focus on technology, economy, and politics, showing that the two countries have both continued to support high technology in a similar vein by a general review of technology. It has not been easy to demonstrate empirically that technology can improve an economy, because technology, by its very nature, interacts with many factors and developments. Nevertheless, technology becomes visible in an economy through influencing its structure, based on legal patents and their commercialization. Furthermore, technological advancement plays numerous unnoticeable roles in an economy through complementary, accumulated, and inter-industrial effects. However, this does not simply imply that technology alone plays many roles in improving an economy without adjusting to political interests. Because of an

identification with national interests, technology cannot substantially adjust to market changes without a particular policy. Many new technologies cannot be commercialized and thus are useless in the market unless the political situation makes the necessary adjustments in supply and demands for a competitive environment.

Chapter Four will have two small sections on national ideology and technological competitiveness to support two countries' investment for technology. In the first section on Japan, Japanese Confucianism, Buddhism, Shintoism, and the Japanese inferiority complex will be emphasized. Japan's technological development has been heavily influenced by its unique cultural background. Japanese Confucianism has emphasized anti-individualistic and nationalistic cooperation in economic activities as well as normal life. Confucianism has considered all workers as a part of a team as opposed to the American concept of a collection of individuals. With support of religions including Buddhism and Shintoism, the Japanese strong inferiority complex concerning the Western world has also actually been a driving force for catching up with the American technology.

The second section, on the U.S., will include American individualism reflecting a market-oriented competition, a smaller role of government and, in particular, the development of technology. With its individualistic culture, the U.S. has experienced a very different process, and different support for technological development from that of Japan. Between the years 1700 and 1900, the agricultural environment of the U.S. encouraged the people to be independent rather than dependent on others' help, primarily because pioneers were separated, isolated, and well removed from their neighbors. With

Americans' strong beliefs in Calvinistic Puritanism, the influence of John Locke, and the American constitution, individualism became a national ideology. Accordingly, individualism has continued to emphasize market-oriented competition and reduced roles of government to maintain individual property rights. In other words, the chapter will show that American individualism has encouraged the country to develop practical science and technology since the beginning of its history.

In parts II and III, three important differences between the two countries will be tested by comparing one to another. Thus, part II will have three chapters for Japanese technology. Chapter Five will cover the roles of national security, so it examines Japan's support of dual-use technology, to illustrate Japan's emphasis on defense technology empirically. Conventional wisdom holds that while the U.S. has focused on developing defense technology, Japan has made the same efforts for industrial technology based on the MacArthur Constitution. Particularly to test the hypothesis, the chapter will contest this belief by showing that much of Japanese industrial technology, especially electronics, telecommunication, and other part of assembly technology, can be converted into defense technology in emergencies. Historically, the Japanese have never pursued economic growth without considering military security. Thus, the Japanese security dilemma has encouraged the country to develop dual-use technology without seriously violating the Article IX of its Constitution.

Chapter Six will deal with innovation institutions and their relationships, focusing on the role of the Ministry of International Trade and Industry (MITI) and its strong influence over other public technology institutions, defense-related institutions, the

Technopolis, and industry to study that Japan's industry is a major source of financing technology development in its industry. A popular thought is that the MITI plays more important roles in technology, but this chapter will refute that it has exclusive influences over other institutions. Many other public institutions also have interdependent influences over technology. Meanwhile, private industry, including the Keiretsu, should follow initiatives of public institutions concerning technology development, as the research in universities is not so active in Japan's innovation system. Also, because Japan's industry, not its government, finances its industrial R&D, the concept of "technology transfer" deserves attention.

Chapter Seven, on instruments of technology policy and strategies, will be related to technology importation strategy, targeting policy, administrative guidance, and technology management to show that Japan has strategically supported machinery, computer, and electrical equipment technologies. The chapter examines how Japan was able to import and even copy many foreign technologies without permission of foreign governments. Once the MITI has chosen several industries for its targeting policy, Japan's government has comprehensively supported those industries by using tax benefits, subsidies, and other non-tariff barriers. The role of government has grown even more pervasive according to Western critics. In short, the chapter will make efforts to reject the Japanese excuses for their protectionism. Also, Japan has administrative guidance quite uniquely, which is the indirect guidance over industry by the government. Supporting this contention is the argument that a higher percentage of Japanese former technical officials have become important heads in many industries.

Part III examines the U.S. technological development, and it will have an organization parallel to the preceding chapters on Japan for systematic comparison. Chapter Eight, which concerns the roles of national security, will observe the U.S. emphasis on defense technology, protectionism for security-related technology, and economic security in examining the U.S. more direct support of defense technology. Like most countries, the U.S. has been energetically concerned with its national security. Through working on numerous military projects and operations in the World War Two, the U.S. turned its interests toward developing defense technology. Even after the war, the political environment of the Cold War helped the U.S. support development of defense technology, through export controls policy and related laws, protection for growing industry, prevention of foreign association with American universities, and increasing worries about dual-use technology transfer. After the Cold War, the U.S. government has attempted to convert this defense technology to industrial technology for economic security. Thus, this chapter will maintain that the concept of national security has been important in both industrial and defense technologies. Also, this chapter will test the hypothesis by reviewing the U.S. expenditure on defense technology.

Chapter Nine on innovation institutions and their relationships will explore the cooperative relation among the government, industry, and universities, identifying the U.S. government as a major source for financing technology development in industry. While the government finances technology, many public organizations have their own roles in controlling some specific technologies. American universities play more active roles in basic research than those in other countries, and industry cooperates closely with

universities on research. In the meantime, even though the U.S. government strongly supports university research, some technology transfers between government and industry have been limited because of security concerns. Usually, however, American initiative for technology development comes from private industry rather than government, a situation which differs from Japan.

Chapter Ten, on instruments of technology policy and strategies, will speculate on the support for manufacturing technology and sectoral-industrial policy, to determine if the U.S. has strategically supported aerospace and electrical equipment technologies. Many have argued whether the U.S. even has a technology policy or not. Indeed, it is certainly difficult to identify a clear technology policy. The instruments of U.S. technology strategies or policy have been changed according to international relations and domestic politics. Despite unfixed instruments of technology policy, the chapter will argue that the U.S. has supported development of manufacturing technology. Many instruments of U.S. strategies have emphasized the importance of fundamental manufacturing technology to its economy. As another instrument, this chapter will investigate that the U.S. government has recently differentiated its support for declining and growing industries, based on sectoral-industrial policy, rather than equally supporting all industries.

Chapter Eleven, the conclusion, will summarize the technological development in the U.S. and Japan, based on the previous Part I, II, and III. To examine the research question, both the similarity and the differences between two countries will be drawn and reemphasized. Also, the importance of multiple causes and effects will be supported for

two countries' technological development. As one might expect, the conclusion will disconfirm the hypothesis, and thus conclude that not only the U.S. but also Japan has supported defense technology. In particular, Japan's development of dual-use technology will be examined as one of major tenets of this dissertation.

Chapter Two
Comparative Public Administration

Politics and economies have produced many different relationships between the U.S. and Japan. Economically, Japan is the biggest consumer of U.S. goods, while the U.S. is the biggest market for Japan's consumer goods. At the same time, these relationships cause serious and thorny political problems between the two countries. According to one survey in 1991, a majority of Americans responded that Japan is a bigger threat to the U.S. than any other country. In Japan, many politicians have gained votes from their constituents in recent elections by emphasizing their resistance to American trade pressures (Kernell, 1991, pp. 1-6). Economic dependence between the two countries is increasing and, with it, is a sharp increase in political tensions.

Because of this variety of relationships, the problem of each country's industrialization is not isolated in nature, rather it is mutual. Indeed, when a competitive country does not carefully study other advanced countries' precedents, it will not improve its own economic or political circumstances. In other words, when the U.S. ignores the economic problems of Japan, especially involving technology, they can come back to haunt the U.S. In a similar vein, by knowing what has, and has not, worked politically and economically for the U.S., Japan will have less difficulty increasing its productivity in the international market. Thus, it behooves both the U.S. and Japan to examine each other through systematic comparisons.

It follows, then, that this dissertation uses the comparative perspective as a major methodology to study and analyze different administrations. Comparative public administration requires worldwide perspectives from many areas beyond American dominant concerns. In so doing, the perspective evolves from systematic review of case studies. A comparative perspective provides two different functions in public administration theory. First, through comparing many different cases, comparative public administration can generalize administrative knowledge. In other words, by drawing on generalized principles as guidelines, a comparative perspective will help many understand a variety of subjects from different areas. Efforts toward generalization are inspired by the search for a scientifically engineered administration that has general applicability for comparing every political entity.

Besides making generalizations, a comparative perspective can study specific cases and then characterize their unique features. This aspect emphasizes separatism, which is completely different from generalization. It has been an old tradition in public administration that a specific national administration should be carefully examined. In short, public administration has historically given more credit and priority to administrative procedures and structures that are developed domestically through specialization. A number of researches have carefully focused on understanding a specific administration and its behavior. Likewise, most social science research tends to devote more attention to the importance of specific factors than to general factors.

As in any field, comparative studies of public administration can inject fresh energy into the field (Pierre, 1995, pp. 4-5). Considering both generalization and

separatism, public administration should not rely too heavily on either perspective. Rather, it should strike a balance between the two perspectives to understand the reality of transnational administration. In fact, these two perspectives are not separate from each other but are really complementary in nature. If one focuses on one of these perspectives, it tends to discourage mutual interchanges, a situation that is undesirable in both case studies and general principles.

Based on studies using both generalization and separatism, the U.S. and Japan can learn from each other's mistakes and avoid pitfalls. A comparative perspective should thus focus on not only political and economic changes of two countries, but also the unique aspects of those changes. In addition, such balanced studies of advanced systems are applicable for related public and private managers, even in a wide range of other countries, regardless of economic status (Branscomb and Kodama, 1993, p. 1).

After a careful analysis, the U.S. and Japan both share a certain similarity in the realm of technological development, and one can make a generalization to explain this phenomenon. On the other hand, both countries exhibit many subtle differences in dealing with specific types of technology and how its funding patterns are related to separatism of comparative public administration.

By nature, the study of public administration is still far less comparative than in other fields of social science, mainly because the nature of administrative execution is idiosyncratic and requires study in context for understanding. Furthermore, the actions of public administration do not attract many intellectuals, perhaps because it is dry and lackluster (Caiden and Caiden, 1990, p. 363). Also, the comparative perspective has not

become a major stage even in the public administration field. This does not imply, however, that the demise of the comparative perspective is absolutely true.

The use of comparative perspective has been more or less active for public administration through the years (Wart and Cayer, 1990, p. 238). Before World War Two, comparative public administration was at its formative stage and thus not used often. In general, just a few American colleges tried to understand administrative operations in other countries by using the comparative perspective. Usually, they focused on civil services and reforms in some European countries without considering other areas (Dwivedi and Henderson, 1990, p. 10). Meanwhile, some British scholars realized the importance of comparative public administration and expressed sustained interests in other nations, but the U.S. interests remained limited in foreign administration.

At the end of the Second World War, Americans began to actively use a comparative perspective in the public administration field. Throughout the 1950s and 1960s, the comparative perspective was enthusiastically embraced by many researchers. Many factors contributed to this popularity. After many political scientists and politicians, including public administrators, visited foreign countries during the war, they tried to transfer what they had seen and learned to the American system. Thus, patriotic Americans tried to do something for the country by adopting knowledge from foreign nations.

There were yet other reasons for its popularity. Because U.S. technical assistance conducted administrative reforms in other countries, the opportunity for research increased incredibly in public administration. In addition, the contemporary revisionist

movement played many roles. The combination of all these factors increased the popularity of comparative public administration.

After experiencing growing popularity for two decades, in the 1970s, the number of supporters for comparative perspectives began to decline. There were many critical complaints from different sources that mirrored those which made it popular in the first place. The total amount of financial support for public administration technical assistance decreased by half in the U.S. by the beginning of the 1970s. The focus on international and U.S. technical assistance shifted from reforming administration to economic growth, which resulted in comparative public administration research losing many opportunities.

Characteristically, the Comparative Administration Group (CAG), which used to be a central institution for the studies of comparative perspective, went out of existence following merger with another organization, meanwhile the new public administration movement tried to assume the status of comparative public administration (Heady, 1984, pp. 10-31). Although the merger of CAG was not in, and of itself, the main cause of the decline of comparative administration, it nonetheless had a negative effect.

Furthermore, many scholars complained that a comparative perspective could not provide an acceptable range of studies. Generally, they pointed out three potential difficulties of using a comparative perspective (Pierre, 1995, pp. 6-8). First, because many countries used a somewhat peculiar definition and conceptualization of public administration, mainly as a result of varying contexts and different cultures, it was difficult for American scholars to rely on a comparative perspective based on those differences.

Second, without knowing how some foreign cases were organized and operated, many researchers could not develop both independent and dependent variables. Third, users of the comparative perspective continued to experience difficulty testing theory, as well as measuring many variables. Without agreement on measurement of public organization across national boundaries, empirical methodology was not easily applicable to the perspective.

Clearly, the comparative perspective offers both favorable and unfavorable reasons for its use. Even when the comparative perspective is not a general theme in American public administration, recognizing the proposition about administrative behavior that rests within national boundaries is a necessity. Also, by examining the features of a single system, a comparative perspective offers a better understanding of public administration across national boundaries. Thus, political science students should not disdain the use of the comparative perspective in analyzing public administration.

Despite the temporary unpopularity of the comparative perspective, it has a significant aspect that should be considered as we head into the 21st century. Many nations in the world need to improve their standard of living and have other worthy goals for their future. Therefore, some nations need to improve their economic and governmental systems to provide as many people as possible a chance to succeed through hard work. In doing so, their need for relevant knowledge also increases. When a society becomes bigger and more complicated, many changes require wise responses. A good government will correct its actions and policy by applying advanced knowledge. In short, the existing paradigms for resolving anxiety about the future are insufficient.

As for the relationship of economies to the paradigm, many nations have become interdependent through the flow of capital, trade, and even information over the last several decades. The relationship of the U.S. and Japan is a good example of this situation. Moreover, our rapidly changing views of the world are becoming globalized, primarily due to the flow of technology, which has in some respects unified the world. By using transportation, communication, and space-age information technologies, many can talk and interact with one another. Thus, there are few people on the planet who are isolated from globalization.

With the reasons noted above, a comparative perspective can help public administration adjust to ever-changing international politics. A comparative perspective can provide information about many changes in international politics, including administration. Clearly, public administration has been pressured to adapt to changes occurring during the 1980s and 1990s. Because public administrators are part of the integration of the globe, any discussion will be outside the parameters without accepting those global aspects. Objective and uncensored knowledge, which is also the best available, is best obtained by the comparative public administration studies rather than from any other research (Dwivedi and Henderson, 1990, p. 18). By the same token, if a comparative perspective does not provide information about administration and its changes, public administrators would have more difficulty managing those changes.

By providing useful knowledge on the trend of globalization, public administration can be reshaped with international aspects in mind. Internationalization is a term that describes the process of taking part in, and contributing to, the practice and

study of worldwide public administration. Internationalization can be beneficial for participants in many enterprises, since it can neutralize many problems in different areas and then can give important solutions to nations based on each nation's differing experiences. The expansion of the public sector and its tasks as well as developing a competent administration are basic to the internationalization of public administration through communication among nations, the exchange of appropriate information, and widespread research (Henderson, 1990, pp. 333-339).

A comparative perspective has several more implications for public administration in the context of globalization. Public administrators need to know what is happening in the world as well as what is happening domestically. By observing foreign organizations, public administration can better learn alternatives for numerous problems and solutions. Public administration can shift to more suitable practices. To do so, the younger generation can be exposed to foreign culture through the comparative perspective and thus consider more options to overcome domestic difficulties by asking similar questions. In short, they can become professionals. The comparative perspective is definitely needed for training young professionals (Caiden and Caiden, 1990, p. 377). Without comparative public administration, young Americans might remain amateur instead of growing into professionals.

By the same token, comparative public administration is very helpful in overcoming the dilemma of localism. Considering that many books show only a local viewpoint, public administration might lack appropriate solutions. The centrality of domestic states limits their public administrators to national boundaries. As long as

public administration focuses on domestic organizations and their behavior, it suffers from the narrow viewpoint of localism. Similarly, while many believe that the U.S. can fulfill the American dream without the rest of world, parochialism limits its public administration. In other words, because public administration is influenced by the parochialism of the dominant nation state, it needs to surpass localism by using the comparative perspective.

Many have recently worried that the field of public administration has become a less distinctive area in social science, mainly because a variety of knowledge has been borrowed from business administration, sociology, psychology, etc. Public administration has become less public. One way to make public administration distinctive is to use the comparative perspective. The distinctiveness of administration cannot easily be achieved by separating domestic administration from foreign administration. By opening dialogues with foreign administrations, students of American administration can transform the nature of public administration to one that is more distinctive and public (Caiden, 1994, pp. 51-53). By emphasizing comparison between domestic public and international public administrations, differences with private organizations will increase.

As indicated by its history, comparative public administration provides more chances and opportunities for scholars and students to research topics. Through studying foreign administrations, research centers stimulate a variety of studies in public policy and other management. Many universities will change their research focus toward

foreign institutions and global aspects. Public administrators also will have training programs and thus get involved in research abroad (Farazmand, 1994, p. 79).

Besides the many advantages of the comparative perspective, the growing interdependence of the nations of the world makes coordination of public administration increasingly crucial for the success of technological development and diffusion. This interdependent global economy has forced national administrations to cooperate with others on technological issues, since many national private and public issues become transnational issues through globalization (Khator, 1994, pp. 83-90). The rise of interdependence also means that public administrators of any nation should be receptive to other administrations to promote technology. Simultaneously, the traditional dichotomy between "rich givers and poor receivers" of technology should be re-engineered to develop more interaction between the two.

Specific examples of successful coordination of public administration to develop technologies include environmental technology, medical technology-especially in fighting AIDS, and crime fighting technology. Such coordination is necessary since these problems do not respect borders, thus they must be solved at an international level. Communication among scientists and researchers as well as public administrators in many countries can yield solutions to these problems (Riggs, 1976, pp. 639-641). As a result, different public administrations have begun to view those problems as a single entity through inventing and diffusing related technologies.

Furthermore, concerning technology, its innovation and diffusion are influenced by many administrative arrangements. Although appropriate roles of public

administration have yet to be resolved (Berman, 1994, pp. 338-339; Lambright, 1976, pp. 4-9), quite a few political scientists have addressed them through budgeting and financial practices, organization, and personnel matters and their decision alternatives in public administration (Rosenthal, 1973, pp. 1-31). How effectively one finances technology and supports its administration are prerequisites to obtain technology. Without finance, it is almost impossible to produce and diffuse cutting-edge technologies. As a result, it is critical that the funding structures for technology be at least partially executed by public administration. In terms of a broader viewpoint, funding patterns and budgets for technology are decided primarily by national security, which includes both economic and military considerations.

Because a network of public organizations plays so many roles in inventing and transferring not only public but also private technologies, organizational administration is closely related to technological development. Thus, R&D demands an efficient organization of public agencies, which also entails which agency conducts or initiates a specific technological program, what relationships are to be developed among them and how much competition is necessary (Bozeman, 1994, pp. 336-337; Hough, 1975, pp. 35-38). All these are worth the effort, since an effective system of R&D not only yields a creative technology but efficiently diffuses it as well.

Not long ago, political scientists began to study the importance of public personnel who administer technology to include administrators, scientists and engineers. Many reported that aspects of personnel administration, such as an individual's technological background, personality, and other behavioral styles, are important in

technological matters. Like financial or organizational administrations, personnel administration can also produce a creative climate for technology (Rahm, Bozeman, and Crow, 1988, pp. 975-976). In particular, the administrators' knowledge of how to use the instruments of technology policy and strategies is definitely correlated to the success of technology.

In an effort to address not only public administration coordination but also administrative arrangements for technology, the advantages of comparative administration should be more carefully considered. Everyone from Max Weber to David Osborne and Ted Gaebler has agreed on the importance of new frameworks for comparison (Fry, 1989, pp. 19-21). Accordingly, this research will use the comparative perspective to consider similarities and differences between the U.S. and Japan's technological development. The efforts made by both nations to pursue R&D reflect similarities under their peculiar national ideologies, while differences can be attributed to factors such as the roles of national security, innovation institutions and their relationships, and the instruments of technology policy and strategies.

In conclusion, comparative public administration was very popular in the 1950s and 1960s, but interest in studying different administrations decreased in the 1970s. Nevertheless, a comparative perspective is definitely needed for public administration, partially to keep up with the globalization of world politics and the global economy. The U.S. and Japan should use a comparative perspective to strike a balance between generalization and separatism rather than rely on either of them. In doing so, several advantages of comparative public administration will accrue including the

internationalization of public administration, an increasing professionalization of young administrators, a reduction in administrative localism, a growing distinction of public administration from private management, and increased opportunities for research available to academia and public administration. Additionally, the interdependence of the nations of the world prompts public administrations to coordinate for technological innovation and diffusion. Indeed, the success of technology partially depends on administrative arrangements, thus the comparative perspective is urgently needed.

Chapter Three
Technology, Economy, and Politics

Human history is replete with instances where technology was a successful catalyst for a thriving economy. Railroads, airplanes, electricity, and other communication media have stimulated economies. Clearly, technology is necessary for economic development, and many scholars have accordingly appreciated its significance. Adam Smith articulated his advocacy of technological development for improving economy in his book The Wealth of Nations.

While Smith's advocacy was successful, it has not been easy measuring the proportional relationship between technological development and economic growth by using empirical data even in academic arenas. The National Science Foundation financed a project studying the relationship between technological contributions and economic productivity in 1972, but many writers have interpreted it differently mainly because of increasingly complicated issues and constant changes in technology. Moreover, the biggest barrier to empirical research has been the various gaps among many industrial sectors due to the differing nature of technological change.

To elaborate, the process of innovation consists of multiple steps including basic research, applied research, manufacturing, transferring, marketing, improving products, and feedback. Because technological innovation results from a collection of continuous, unexpected, complicated, and disorderly events rather than by a simple linear process, it has been difficult to draw clear results about researches. Thus, many have not been able

to produce a complete understanding of the complex technological processes within an economy. The matter of operationalization is not easily solved, and thus a most serious problem in technology fields, not unlike the difficulty of applying the comparative perspective in public administration field.

Despite these difficulties, economists and others have not given up studying the contributions of technology to economic growth during the last several decades. Much time, money, and efforts have been devoted to reduce this deficiency (Smith and Barfield, 1996, pp. 1-4). Additionally, in an effort to obtain better empirical results, many scholars have pointed out the lack of communication between researchers and politicians. They believe that cooperation from policy makers is evidently more helpful in producing quantitative research than ever before. In an increasingly complex modern society, substantial information from policy makers is necessary to clearly see technological processes.

Using more empirical data and cooperation from policy makers, many studies have explained why technological development is important to an economy for both short and long-term growths. Important factors continually change, depending on who emphasizes which focus, but this chapter will study just four common factors supported by political scientists and economists: First, when new technology is developed and commercialized, it significantly improves an economy. This factor is the most noticeable of all, since the commercialization of new technology directly improves the economy through more efficient production. Needless to say, the commercialization of technology

can provide great economic benefits to individuals, small industry, and the macro-economy as a whole.

During the commercialization of technology, the use of patents plays an important role in protecting the property rights of technology developers, when the public enjoys the benefits from the patent. A patent holder can have exclusive rights for producing and selling a specific technology during any given time, thereby achieving economic goals. Because of the similar nature of many technologies, many private companies in the international market must take others to court mainly to clearly establish their own rights of technology (Warshofsky, 1994, pp. 2-7; Megantz, 1996, pp. 11-12).

The invention of technology is always carefully evaluated before ultimately deciding market applicability, primarily because the whole process of obtaining a new technology patent is so expensive. To illustrate this, here is a proportional relationship between R&D expenditure and the possibility of a patent (Horstmann, MacDonald, and Slivinski, 1985, pp. 837-838). However, even though a stunning cutting-edge technology is invented, it does not inherently possess commercial value and thus cannot be applicable to patent. Technological institutions do not want to patent every invention based on their own value, cost-benefit analysis, and other budgets (Carr, 1994, pp. 79-80).

The second factor in technological importance to the economy is the availability of complementary technologies. When a new technology is invented, its effect is not limited to the realm of technology. In other words, the invention of a technology does not take place in an isolated environment, and it complements industries directly or indirectly, since economies consist of many interlocking technologies. This

complementary aspect of technology makes it more difficult to predict what the exact benefit of new technology will be in a broad sense.

The impact of an individual technology on industrial sectors associated with other technologies produces a series of technological changes that stimulate the overall economy, and results in benefits to society. One good example of changes affected by complementary technologies is the invention of the iron steamship; when it went into operation, the transportation cost of railroads was reduced. Social benefits from the iron steamship also increased the productivity of both transportation media. The complementary aspect of technology insures that social benefits of new technology do not disappear but rather mutually stimulate other technologies (Rosenberg, 1982, pp. 56-58). Therefore, the complementary aspect helps people to perceive the technological process through a systematic perspective.

The third factor related to the contribution of technology to an economy is related to an accumulation of minor technological improvements. When inventions provide small contributions to economic growth, this accumulation of new technology cannot be entirely disregarded. Because development of technology is impossible without the prior accumulation of a technological base formed from a variety of technologies, the importance of accumulated technology is widely recognized. Even minor improvements in many of these technologies will produce significant contributions to the macro-economy, particularly in long-term growth. Thus, the accumulation of many technologies contributes to the management for materials, lowered maintenance costs, and convenience in production for industry (Ibid., pp. 63-65).

As new technologies are invented, society itself may be changed due to their influences. Indeed, sudden change does not easily occur, and societal development gradually occurs through the years. In many places, sudden changes are even rarer, and change occurs so gradually it is barely perceptible. Therefore, the accumulative effect of technological development fundamentally, and frequently, causes social change more than any single invention of technology (Stolnikoff, 1993, p. 11).

The fourth factor is technology's benefit to inter-industry. One crucial technology may improve one field of industry, but does not stop there. Because the invention of a technology leads to dynamic specialization in industrial development, the effects of the technology go beyond the limits of industrial boundaries. Benefits of a technology might flow to other fields, while dynamic technologies spread out to many companies and industries. Technology, which in its nature is like capital goods, changes many patterns of the industrial process (Rosenberg, 1982, pp. 70-71). Many technological contributions to economic growth have frequently been captured in related industries rather than simply in the first place where that innovation occurred. Thus, the transmission of technology from one field to another field of industry also fuels increasing productivity for the economy.

The technological evolution across industries often takes a long time, and thus a continuous examination of technology is needed to show the benefits between industries. Over a period of time, technological problems in one industry might be solved by using resources from other related industries, thus an inter-industrial relationship is established. By the same token, this relationship also encourages related industries to be more dependent on each other.

The accumulated, complementary, and inter-industrial effects of technology are the most difficult to assess because these are barely perceptible during a short time period, as opposed to the first commercialization effect which is easily distinguished. Therefore, the latter three effects share a common indirect effect that is very different from the first direct effect. Association with accumulated and complementary technologies and different industries makes it harder to show the impact of technology empirically, despite the fact that these three effects have a beneficial commercialization effect on the overall economy, which many studies support (Rosenberg, 1982, pp. 66-71; Stolnikoff, 1993, p. 12). Prepared from data on both direct and indirect effects, Figure 3.1 shows that about 24 percent of American and Japanese exports have been based on high technology products.

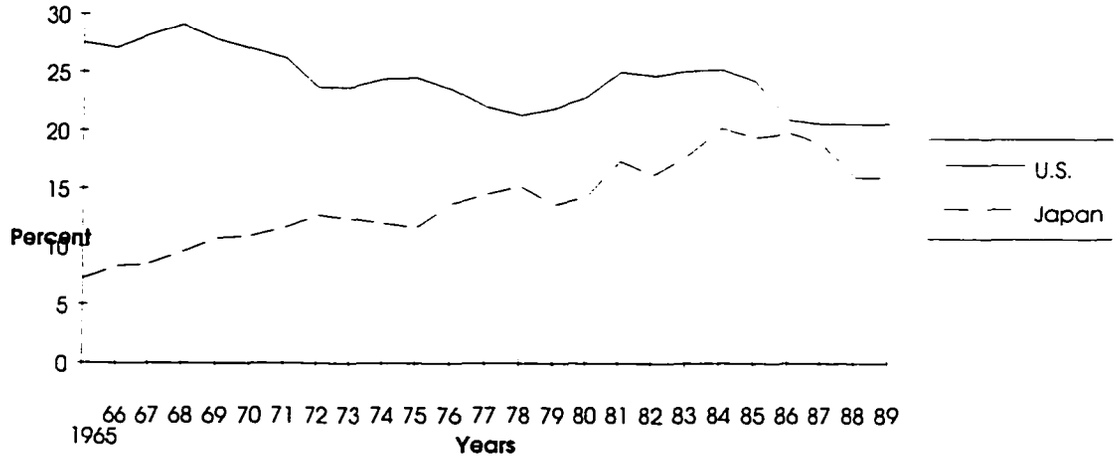

Figure 3.1, International export shares of high technology related products, sources: National Science Foundation, 1991, p. 125 and Andrew A. Procassini, 1995, p. 105.

As just noted, technological improvement can directly or indirectly change the economy. It is difficult to deny that a technological increase in productivity is critical to the wealth of a nation. Technological change has thus been suggested by many supporters as the most important factor for the growth of productivity. However, technology cannot exist in a vacuum. Any one technology may be successful under any given circumstance, but it may fail if market changes do not adjust accordingly. Vice versa, technology becomes increasingly significant when the market and powerful decision makers interact, as they develop interconnections that influence a whole society positively.

Technological development is a strategy shaped by social atmosphere. Particularly, political choices are driven by the need to control technology. Politics thus play many roles in upgrading competitiveness, technology, and productive capability. Conversely, politics can also decrease production, slow the introduction of a new technology, and weaken the distribution of products. Thus, politics can drive policies that change the playing field for industry by encouraging or discouraging technology which in turn affects productivity of industry, causing a technology to be either competitive or less so (Cohen and Zysman, 1987, pp. 81-95; Stolnikoff, 1993, pp. 14-27). Even if science and technology are major factors causing economic changes, they are impotent without politics.

Growing numbers of scholars have argued that machines alone are not enough to achieve industrial growth and economic competitiveness. They have stated that technological development alone cannot achieve industrial growth and will thus often

fail. Because each technology has its own unique operation that limits its possible usage, political leaders select from many technologies to determining which ones to use (Thomas, 1994, pp. 202-245). Thus, some technologies are not seriously considered, but leaders still interact with technology to formulate crucially important economic decisions. Therefore, technology is not an independent from but is dependent on organizational factors.

Many individuals in different sectors of society have emphasized that their fields need support for technology from the government. Businessmen have argued that the supremacy of industrial technology leads their nation to economic prosperity, while military officials have supported the development of defense technology through increasing military research budgets. Many political candidates have tried to be elected by saying that their support for some technologies will improve national economic growth faster than support for other technologies. Considering the wide array of special interests, politicians must choose which technology should be developed and how much of a budget to allocated for technology. As a result, politicians tend to tighten their control over science and technology (Dickson, 1984, pp. 4-8).

In technology transfer, the role of political authority has been shown to be a major factor in governing its particulars (Bozeman and Crow, 1991, pp. 238-241). Technology transfer occurs much more quickly when public organizations support it. On the other hand, when governments do not want to release a technology to what they deem to be inappropriate institutions, technology transfer is impeded or even stopped. For instance,

when the transfer of some specific technologies is closely related to national security, the government authority does not allow private industry to engage in these matters.

Governments in many countries manage their technological development through regulations, subsidies, experimental projects, R&D grants, and other effective instruments of control. While these activities for technology cannot be achieved by the role of private institutions, politics has been integrated with social concerns about technological advance and industrial development (O'Brien and Marchand, 1982, pp. 1-2). In fact, politics has increased its influence in many difficult technology issues such as nuclear weapons, biomedical technology, and other information technology in both domestic and international areas.

On a large scale, an international political outlook embraces a pervasive role of science and technology through enhancing global development. International relations affect technological invention in many ways. When a record of peace is prevalent among nations, they are often willing to focus on industrial technology for their economic growth. After the end of the Cold War, many countries have tried to convert defense technology to industrial technology, a measure called "a fire wall" by some. On the other hand, when many countries are belligerent, they are likely to support developments in defense technology. During World War Two and the Cold War, the U.S., Germany, Japan, and the former Soviet Union made every effort to develop lethal weapons for contingencies.

Technology has global effects, but the international political economy is fundamentally based on domestic politics. Many have argued that international politics is

as important as domestic politics in technological development. It is appropriate to study the influences of both international and domestic politics on technological advances. However, domestic politics are more closely related to each nation's technological process.

A strong national identification can be seen in science and technology, partially because government policy influences the mainstream of technology within each country (Branscomb and Kodama, 1993, p. 1; Lundvall, 1992, pp. 181-182; Nelson, 1992b, pp. 58-62). Because national interests mold high-tech industry to a particular policy, many factors including budget, attitude, and perspectives dealing with science and technology remain predominantly national.

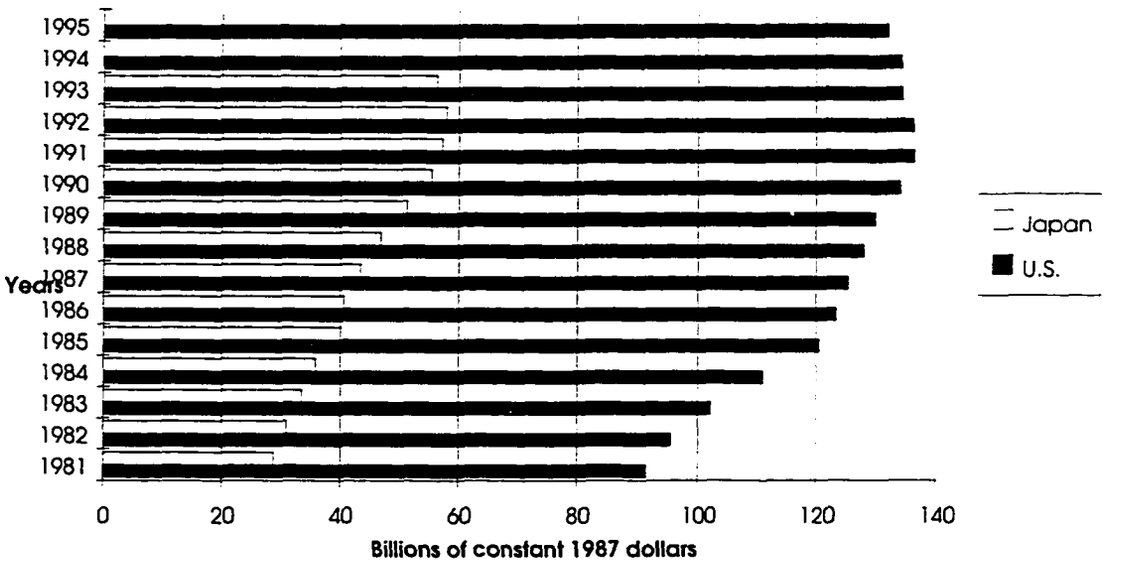

Figure 3.2, National R&D expenditures, source: National Science Board, 1996, p. 154.

There are many examples of national identification of technology. To improve national pride and governmental interests, the U.S. built the Empire State Building and

Hoover Dam, while the huge ocean liners Queen Mary and Elizabeth were built and operated by the British Kingdom. Albeit with the help of German scientists, the USSR launched the world's first satellite, Sputnik (Sanders, 1983, pp. 41-42). In short, the national environment influences the identification of technology by treating technology differently.

Table 3.1, The number of engineers and scientists in R&D, source: National Science Foundation, 1996, p. 33.

Year/countries	The U.S.	Japan
1970	543,800	172,000
1971	523,500	194,300
1972	515,000	198,100
1973	514,600	226,600
1974	520,600	238,200
1975	527,400	253,600
1976	535,200	263,200
1977	560,600	264,800
1978	586,600	272,800
1979	614,500	291,200
1980	651,100	303,200
1981	683,200	311,000
1982	711,600	321,000
1983	751,600	347,400
1984	NA	357,400
1985	801,900	380,300
1986	NA	393,000
1987	877,800	415,600
1988	NA	434,600
1989	924,200	457,500
1990	NA	477,900
1991	960,400	491,100
1992	NA	511,400
1993	962,700	526,500

Recognizing the direct and indirect contribution of technology to an economy, political influence on technology, and the national identification with technology,

Schumpeter's claim that technology is the most important factor in a nation's development is certainly of interest to advanced countries like the U.S. and Japan. Technological change has been one of the most critical variables for improving the economy of those two countries, especially in long term growth. The two countries have continued to increase national R&D expenditures according to Figure 3.2, which reflects the increasing significance of science and technology. Also, the U.S. has devoted about 2.65 percent of its Gross Domestic Product (GDP) on R&D, while Japan has committed 2.58 percent of its GDP on R&D. Table 3.1 goes on to illustrate that the U.S. and Japan have had a large number of engineers and scientist working development of technology. Therefore, the U.S. and Japan have become two of the few industrialized countries that are rated as "R&D oriented nations."

In conclusion, it has not been easy to empirically study the contribution of technology to economic growth, mainly because so many variables interact with the technological processes. Despite the difficulty of operationalization, when technology is commercialized based on legal patents, the rate of economic growth is noticeably increased. At the same time, technology has an indirect effect for improving an economy through an accumulated effect, a complementary effect, and an inter-industry effect, though none are very measurable. In addition, technological development is heavily influenced by politicians and their decisions rather than technology alone to improve an economy. Within the context of politics, technology reflects a national identification in many countries. As a result, the importance of technology to an economy has prompted politicians to support technological development in both the U.S. and Japan.

Chapter Four
National Ideology and Technological Competitiveness

Japan

Ideological influences over a nation are often rooted deep in its past. Thus, Confucianism has been the most important ideology affecting and supporting Japanese technological development. For the greater glory of their country, the Japanese have devoted themselves to assimilating Western technology and have used Confucian precepts when doing so. Confucius, who lived in ancient China, originally advocated attaining the perfection of human nature and supported constant changes of the individual spirit for reaching that perfection. Confucius' method of governing extolled morality and order among people, while he opposed the imposition of law or a constitution, as he deemed these to be artificial constructs. Chinese Confucianism was initiated to regulate relationships between individuals, as it followed their basic beliefs of a harmonious relationship in the universe, which includes nature. In so doing, formal manners among people were more emphasized rather than ethics.

In 285 AD Chinese Confucianism historically arrived in Japan by way of the Korean peninsula (Nosco, 1984, p. 5). Chinese culture transformed the values of the Japanese by changing their political, economic, social, intellectual, and other aspects of culture. Thus, Confucianism permeates Asian culture, and some maintain that it is a type of Asian religion (Taylor, 1990, pp. 7-22).

Confucianism is actually related much closer to ethics. Confucianism does not discuss the role of a god in society, which alone virtually disqualifies it as a religion. While the debate on the role of Confucianism will go on for a long time to come, a look at the past tells us that the Japanese version of Confucianism has had its highs and lows in the Land of the Rising Sun.

During the Tokugawa period (1603-1868), Confucianism nearly dominated the political realm of the feudal state, as it dealt with many problems. The ancient Japanese turned to a strict version of it to solve many social and ethical problems. The Japanese royal family also supported Confucianism for political purposes during this time, since they wanted their people to support a central government based on harmony between an inferior class of people and a superior class which included royal family. Encountering minimal resistance, Confucianism in the Tokugawa period transplanted the Chinese concept of individuals living in harmony with the environment into the Japanese culture.

This state of affairs could not last forever. During the Meiji period (1868-1912), Western culture contacted Japan in earnest, and the inevitable intermingling occurred. At odds with these foreign values, though literally out-gunned by it, Japanese Confucianism fiercely contested Western ideology, and its position in society waned. Confucianism could no longer play any major role in dealing with social and ethical problems, because Western materialism strongly influenced and contradicted many of the spiritual aspects of Japanese thought. Laden with egalitarianism, Western thought was at loggerheads with traditional Japanese relationships among men.

Another nail in the coffin of Japanese Confucianism was the wholesale embrace of Western ideas by the government of the Meiji period, a situation that prompted the Tokugawa Shogunate to lose credibility, and with it Japanese Confucianism, as it had been a primary tool for ruling the masses. Nevertheless, the new government relied on the principles of Confucianism for the same purpose. When an imperial injunction based on Confucianism was issued to Japanese soldiers, it did not constrict them. Instead, the Meiji government only dismantled the caste system, which made all Japanese eligible for military service in the name of a royal family legitimized by time-honored Confucian precepts. Some individuals realized that the Meiji government used Confucian ideology in a Machiavellian manner, because they tried to revive Confucianism during that time. Their efforts were in vain, as the public did not embrace this reactionary stance.

Some elements of Confucianism were, nevertheless, revived (Smith, 1959, pp. 41-68). In 1918, the Japanese reorganized many Confucian institutions into one single organization, the Shibunkai, which became a watershed in a rise in Confucian activity in Japan. The aims of the Shibunkai stressed that the principles of Confucianism could prevent the deterioration of traditional morality, due to excessive borrowing of Western culture, while it expanded the role of spiritualism in society. Many politicians, businessmen, officials and Confucian scholars rallied around the principles of Confucianism and attended the Shibunkai. They embraced the belief that Confucianism could identify ethical criteria and revive the stability of their society.

This revival of Confucianism helped it regain its influence in Japan in these years around World War Two. Militarists twisted its tenets to justify Japan's aggression in

Asia as early as the 1920s. Citing Confucian ideas, the Japanese government proclaimed that Japan had a mission to protect other Asians' spiritual development. This was the rationale for the government of Japan to invade Korea in 1910, Manchuria in the 1920s, and some parts of China in the 1930s.

Since the World War Two, the Japanese have maintained their traditional Confucianism in almost every aspect of their life. To build their economy in the aftermath of war, they united and cooperated with government policy which was based on the harmony of Confucianism. Nationalism has been the basis by which Japan improved its economy. Still dominated by Confucianism, the Japanese postwar culture continues to stress cooperation and participation within every Japanese societal entity (Patrick, 1986, p. 14).

Japanese culture serves to unite all employees as a cohesive team, as opposed to the American concept of a collection of individuals. The group is a fundamental concept to every Japanese citizen, while the concept of individualism has a commensurate meaning to Western individuals. Individuals do not have social or psychological freedom in Japanese society, rather most are a cog in the wheel. The Japanese put a priority on collective goals and cross functional teams (Branscomb and Kodama, 1993. pp. 13-68; Morishima, 1982, p. 18). The group is the most vital category of political, economic, social and educational activities, and it consists of many social relationships between individuals. Finally, it can be a framework for social participation in both functional and general senses.

The society of Japan is centripetal in orientation rather than centrifugal, primarily because centripetal societal forces keep individuals within a group (Shimahara, 1979, pp. 18-21). Among individuals, mutual reliance is the basis for their activities or organization. Subordination of individuals to a group is thus more important than the protection of individual identity in Japan which is in direct contrast to the centrifugal orientation which is far more common in the U.S.

Clearly, Japanese culture is steeped in the "group," but other aspects of Japanese management styles also display characteristics of Confucianism. First, the emphasis on long term plans allows an ample amount of time to deal with the implementation process, management, and development philosophy. This has been influenced by the Confucian search for human perfection through the ages. Second, the system of lifetime employment supports the eternal development of employee training and their socialization through recruiting employees not based on their technical skills, but on their personal character. This is directly related to the Confucian emphasis on loyalty, family, and diligence. Third, the practice of collective responsibility is more important than that of individual responsibility (Dollinger, 1988, pp. 578-580). In rice cultivation areas, cooperation among people has long been required to grow and harvest a crop, and it has accordingly been in keeping with the Confucian principle of consensus decision making.

Several aspects of Japanese Confucianism have just been examined, but the Japanese do not have a monopoly on this ideology - far from it. China and Korea also have distinctive, though related, variants of Confucianism, and examining them makes it easier to understand Japanese Confucianism. It is inevitable that imported Confucianism

should modify itself under the influence of the differing politics, economic conditions, people, and other cultural factors of the island nation of Japan. The most significant virtues of Chinese Confucianism are benevolence, justice, ceremony, knowledge, and faith. In particular, the Chinese hold benevolence as the heart of humanity (Morishima, 1982, pp. 3-4). Filial duty, harmony, and bravery are emphasized as components of benevolence. In a similar vein, Korean Confucianism emphasizes loyalty, filial duty, faith, benevolence, and bravery. Benevolence is thus emphasized, through to different degrees, by both China and Korea. On the other hand, Japanese Confucianism embraces loyalty, ceremony, bravery, faith, and frugality, but pays little heed to the principle of benevolence. The history of Japan has convincingly shown that the Japanese are aggressively loyal to their country but are anything but benevolent to foreigners.

Confucianism has also emphasized the importance of education in human life. Given that if any farmer or worker in ancient Japan had education, he could be considered a Samurai, one of a warrior class that enjoyed much higher social status than the average Japanese. Education was indeed the essence of a Samurai. The historical emphasis on education for the higher class, with its benefits of prestige, also prompted the warrior class to be ready to study and embrace Western technology. Yet as one might expect, the Japanese education system put a strong emphasis on group effort rather than the individual effort in accordance with the Chinese Confucianism (Herbig, 1995, p. 44). The Japanese believed that education is a process of putting individuals into a group rather than the seeking of individual identities. As a result, one of the main reasons why

Japan has produced good members of its society with cooperative attitudes may be traced back to Confucianism.

College entrance examination, which is held once annually, is one of the most serious educational concerns of not only high school students but also their teachers, parents, and other relatives. The admission of students to good universities is considered an accomplishment of high prestige in line with the Japanese precepts of Confucianism, so almost everyone in high school desperately prepares for the exams. When taking entrance examinations, the pressure for individual achievement becomes highest. As a result, every year a number of high school students commit suicide, mainly due to the pressure of the entrance exam. Furthermore, because many former high school students who failed to pass the exam the first time are challenged to retake it, the competition is much more rigorous than many realize.

The strong Japanese aspirations for higher education are reflected in their educational institutions. The education in elementary, middle, and high schools is known to be more competitive than that of many other countries. As a result, Japan has a less competitive college education than that of the U.S., mostly because high school graduates who have already experienced the competition of college entrance exams involve themselves less in studying in college. Nevertheless, Japanese graduate schools still produce many qualified scientists and engineers for their economy. Japan has a very comprehensive education system to train its workforce in industry, and thereby reducing the gap between blue and white workers (Freeman, 1987, pp. 2-3). Overall, the illiteracy rate is below 1 percent in Japan.

In another vein related to education, Japanese Confucianism has been supported by other religions like Buddhism and Shintoism. Because of very similar principles to Confucianism, Buddhism increased its support for Confucianism. Buddhism came to Japan from India through China and Korea, and initially influenced only the life of the upper class and the capital of ancient dynasties. After several centuries passed, Buddhism trickled down to influence the spiritual and intellectual life of all common people (Reischauer, 1946, pp. 131-138). Both Buddhist monks and artists have contributed to educating many people and have shaped a large part of the Japanese ideological culture. Buddhism has also supported national security and national policy throughout history to the extent that it condoned fighting wars.

Like Buddhism, the principles of Shintoism have maintained the same goal of loyalty as those of Confucianism, albeit with a different end. The forerunner of Shintoism, which is actually Chinese Taoism, emphasized happiness, longevity, and a hermit-like existence. In addition, Shintoism stimulated patriotic worship for nobility in Japan (Morishima, 1982, pp. 5-31; Hearn, 1966, pp. 227-228). Taoism used to be popular in China and Korea, but Shintoism evolved into a national religion in Japan while Taoism did not. Just as Europeans wished to think of royalty as veritable deities, the Japanese believed that imperial ancestors were their gods and heavenly sovereigns. Nobody dared to challenge the authority of the royal family, which the Japanese considered a supreme power. Royal families came from the most powerful clan within a region, so it was only natural that the chief of a royal family would become the ruler of their country. Thus, they considered the ancestors of the royal family as deities.

The Japanese culture has often been described as one that uses shame as an effective tool. Indeed, the Japanese are far more conscious of what others think about them than virtually any other nation on earth (Matsumoto, 1996, p. 10). The society of Japan has enforced that everyone should comply with the judgment from all others. When individuals make mistakes or are guilty of wrongdoing, the Japanese think that they "lose face" in relationship with others. Therefore, the feeling of shame is a social sanction to the Japanese. Because the Japanese worry not only about their family, friends, neighbors, and coworkers but the community at large, this culture of shame oppresses the people and this finding is supported by many psychological studies.

This culture of shame also seems to explain the strong Japanese inferiority complex with respect to the West. The Japanese have long wished to imitate the West, as it is a paragon of modernization. The U.S. has become a role model for Japanese consumers to imitate. Japanese consumers have become Americanized in their tastes especially during the past decade. Any Japanese product which is exported to the U.S. automatically becomes popular in Japan (Ozawa, 1974, pp. 14-32).

The Japanese inferiority complex initially derived from unequal treaties negotiated with the West during the 1850s, when Japan was forced to open its commerce to the West. Since that time, the Japanese have tried to show that they are as civilized as Western peoples, and to show that they can be every bit as much an economic equal to the West through improving their economy (Dale, 1986, pp. 176-200).

Like most people, the Japanese prefer not to be made fools of by Western peoples (Ozawa, 1974, pp. 100-101). The Japanese are very sensitive about what foreigners say

or how they evaluate the Nipponese. When they feel shame, they would like to correct the problems immediately. This sensitivity has manifested itself as a positive response to the problems at the Olympics games, EXPOs, and other international meetings in Japan. The upshot is that the Japanese have shown an eagerness to improve themselves.

The popularity of Japanese high-technology products in foreign countries not only helps to balance the Japanese economy, but it also offers a psychological boost to the Japanese. Seeing their products in foreign markets helps offset their deep-seated inferiority complex. Thus, the Japanese emphasis on export performance has offered a psychological scoreboard for them to reduce their inferiority complex. Exports are still a small portion of Japan's economy, but their psychological impact on its citizens far exceeds what one might expect. As exports increase, many Japanese believe that they are reducing the gap that separates them from their Western role model. In short, the Japanese inferiority complex has played a positive role in Japan's achieving economic parity with the West, and possibly even surpassing it economically.

In conclusion, Confucianism has been the most important national ideology supporting Japanese technological development. In the name of Japan's royalty, Confucianism has encouraged the people to assimilate Western technology for the Land of Rising Sun. The ancient ideology has considered the importance of nationalistic, anti-individualistic, and cooperative individuals in political, economic, social, and other cultural contexts of society. Along with the similar support from Buddhism and Shintoism, the importance of education has been emphasized by Confucianism. Finally,

the Japanese inferiority complex with respect to the West has positively stimulated the Japanese to show that Japan is as civilized as others through their high technology.

The U.S.

While a national ideology is a mainstream of belief in a nation, it does not change quickly without war or evolution. Instead, new elements may alter it in some subtle ways. The traditional American ideology includes a conglomeration of many cultures working together, with emphasis on cooperation among individuals, but its main belief has changed little. Thus, individualism has remained a strength throughout the nation's history, and it has provided flexibility in a changing American environment (Wolfson, 1997, pp. 75-76). Even though some aspects of a communitarian movement have been inserted into government programs, private industry, and other cultural organizations, many informal and official surveys conducted during the last twenty years show that about 70 percent of Americans still believe that individualism is their ideal form of ideology (Lodge and Vogel, 1987, p. 118).

Even in colonial times, Americans based their society on individualism. As a result, individualism, a tradition that has lasted over the last three centuries, has influenced not only many political, economic, and social organizations, but it has also changed the patterns of individual behavior (Arieli, 1991, p. 171). The major principle of individualism is that individuals are the most important elements in a society, whereas a community is just a collection of its individuals. Traditional rights and duties of individuals derive from the fact that a community is a changing group of individuals. By placing human free-will over everything else, a community is at odds with individuals. The value of each individual is supreme, so the nature of the society is therefore atomistic. In short, an American community does not do everything for individuals,

rather individuals fulfill these needs in their life. Each individual separates himself from the community to some degree, and then selects groups within a community.

By the same token, individuals must continue to struggle with the hardships to survive in a society. Otherwise, they become unsatisfactory or unfit members of society, and live off the good will and garbage of a society of plenty. Whatever causes such imperfections in these individuals, they have to overcome it by self-sufficiency, which includes self-dependence, self-respect, and finding one's own way. American individualism holds that individuals should not rely on anybody for their survival.

Besides the stress on individual merits, equality among individuals has been strongly supported by American individualism. This equality before the law means that each individual should have an equal opportunity. While men and women can control politics, economy, and even the environment to some degree, every individual in a community should have an equal opportunity for economic opportunities and equal treatment under the law. For attaining equality of individuals under the law, changes in many areas have been required in U.S. society which include making quality education available to all, an emphasis on collective bargaining, and equal opportunity in gaining employment, among other things. Even with these changes, however, social relationships are still established by contracts, be they written or unwritten. Between employers and employees, relationships are made only through formal or informal contracts. Finally, American individualism holds that every individual must safeguard his or her society on an equal basis (Hoover, 1922, p. 9).

According to Western individualism, a pluralism of individual interests directs the political order, thus every man is subject to the draft in the event of emergencies. This is exemplified by special interest groups that dominate American politics. If individuals cannot influence politics or public policy by themselves, they join interest groups for the same purpose. Based on the significant power of special interest groups, individuals can manage and influence the conflicting interests in a community. Pluralistic individualism has thus been positively augmented by many different interests.

Knowing the origins of U.S. history is important to understand how individualism has shaped in the U.S. Founded on the basis of freedom of religion in the eighteenth century, the American colonies showed their individualistic attitudes in many ways. Calvinistic Puritanism taught that individuals should solve problems for themselves rather than seek God's intervention. Without at least attempting to work out difficult situations for oneself, it was considered immoral to ask others for help. In the pursuit of ultimate goal of piety in every aspect of life, Calvinism taught that hard work, a strong sense of duty and responsibility, and faith as well as self-dependency were vital to both society and religion (Brown, 1996, pp. 87-95). Additionally, the early history of the Puritan colonies reveals that they supported mercantile viewpoints for individuals, including the process of decision making, economic benefits, and other emphases on material factors.

The nascent business relationship with Europe soon grew in importance, primarily because the U.S. colonies had abundant natural resources and could thus make lucrative profits. The free market system made the colonies aggressive and self-reliant, adding a

vigor necessary for their development. When isolated people settled down without a community, they became even more individualistic. Therefore, the people in the colonies became individualistic rather than communitarian. Their economy, which was based on agriculture, did not have a sophisticated division of labor, which therefore encouraged individuals to solve problems without the help of others. Neighbors were several miles away, and each individual had to manage his own land and develop it to be successful in the realm of agriculture. Not all pioneers were farmers, but much of American individualism were derived from the agricultural frontier. In other words, the agricultural environment within the colonies encouraged settlers to embrace individualism and self-reliance (Lodge and Vogel, 1987, pp. 104-106; Hoover, 1921, p. 63).

The seeds for this independent lifestyle were planted before the majority of colonists embarked for the strange shores of America. The political theorist John Locke articulated his ideas in England in the seventeenth century, but the essence of his ideas was most appropriate for North America: for it had endless land, abundant resources, diligent workers, and individual self-reliance. Primarily, as a result of colonial America's economic system, which had a sympathetic outlook on Locke's theory, John Locke's individualism became the principles for North America especially during the next two decades. John Locke's ideology tore down the organic whole that had characterized English society, then put individuals into competition, rather than into relationships between individuals and community. Although many people after John Locke have contributed to the development of individualism, American individualism was basically derived from Locke's theory of natural law.

Locke laid the ground work for self-reliance, but Thomas Jefferson crystallized the concept of American individualism in the colonial, revolutionary, and early U.S. history. Although Jefferson did not write about the national character of individualism, he believed in an individual liberty, equality, and independence. Thus, Jefferson's ideas have influenced American independence since that time (Potter, 1968, pp. 3-20). Individualism also became a core part of the Declaration of Independence in 1776 when it declared that all human beings are created equal. The U.S. Constitution was designed to insure that individual freedom would be enjoyed by those of all political and religious creeds. The Bill of Rights, which is the first ten amendments of the Constitution, further put significance on individual happiness by maintaining that individual rights have legal protection.

Individualism has been reflected in many concepts of American thought. Three aspects of its influence displayed in technological competitiveness. These include: a market-oriented economy, a limited role of government, and in particular the continuous development of technology. These three are directly or indirectly related to U.S. technological competitiveness. These three aspects do not work independently but rather operate interdependently, with technological competitiveness being the key. In other words, to increase national competitiveness, U.S. individualism has supported freer market competition, a smaller role for government, and continuous development of technology, which are not common with many nations.

Free-market competition is based on the individual right of property. Each individual has a right to own his property within a whole community, and he or she can

then freely compete with others in the open market. Because of these property rights, individuals could protect themselves from monarchs. As a means of protection, property fulfilled the economic and political independence of the king. Also, because early colonial governments obtained much of this property from American Indians, they wanted to keep expanding their land holdings, rather than losing it, by emphasizing the individual's right of property. Thus, to support the Westward expansionism, the early Americans built and improved their transportation systems by raising the importance of the property right to pursue money and materialism. Individualism today continues to defend individuals' rights and welfare in a modern society, and thus property rights are considered virtually synonymous to individual rights (Lodge, 1984, pp. 40-42).

Property includes one's body as well as estate, and property rights to both work to ensure that justice, survival, and self-respect in a society prevail. While individuals are classified into buyers and sellers, sellers must try to satisfy buyers' demands. The self-interest of these propertied individuals competes to satisfy consumers' desire in a market. A market can entice a consumers' desire, and a wage is necessary for workers to purchase items in a market economy. The conception of a market, which secures individual economic liberty, does not require community efforts. Instead, it requires individual consumers who have a desire to purchase goods as well as sellers willingness to satisfy this need (Lodge and Vogel, 1987, pp. 10-11). Thus, an individual's right to property is best protected by an open market. American individualism therefore has important ramifications to a healthy economy.

Many Americans of a conservative political bent believe that the free trade system determines the status of nations in the international economy. Furthermore, when some nations have a comparative advantage on certain products, their international status will improve accordingly. This advantage has a similar beneficial effect on the domestic economy, when American national interests are not limited by the strict enforcement of regulation but are fulfilled by natural competition among individual firms. As a result, American individualism embraces a love for free enterprise as well as personal freedom. Also, since the Americans believe that a market oriented economy can offer a wider and better range of options in many sections of the economy and society in general, the free market and free competition results in a progressive American society (Hoover, 1921, pp. 32-33; Curry and Goodheart, 1991, pp. 6-7).

Free market competition is associated with the concept of economic individualism, which has decreased the influence of both church and state by stressing individual economic freedom in the market. Despite the fact that economic individualism gained its support after the mid-eighteenth century, it has become a verifiable doctrine that a competitive market requires freedom of production, contracts, and property rights. Furthermore, the government must increase the standard of living for everyone, not for just a specific group by exploiting the invention of new technology and the equitable distribution of products, just so long as it does not get too pervasive and interfere with the market (Hoover, 1921, pp. 32-33).

Historically, Americans have preferred a government that is both small in size and limited in power, though creeping socialism associated with a growing bureaucracy has

been a favorite target of conservatives for decades. Americans might accept a large government, but they do not want it to become a police state, as incidents at Waco, Texas and Ruby Ridge, Idaho would suggest in happening. Conservative Americans do not want their government to plan for individuals, rather they prefer Americans be self-reliant as they believe that makes for a more vigorous and stronger character (Lodge, 1975, pp. 10-12). Nevertheless, conservatives still want their government to respond to a few limited interests and the more difficult situations that individuals might encounter.

While conservatives insist on a limited government, they still recognize that individual autonomy must be limited by laws and regulations of relationships to authority. Individual freedom must still be balanced with the needs of a government through social contracts. Therefore, conservatives reduce the extent that political authority can be imposed on individual's life, liberty, and property. Conservatives believe that the authority of government is a necessary evil that should be controlled by a system of checks and balances. In other words, the three branches of government, which includes the executive, the legislative, and judiciary branches, should be separated. Accordingly, the government checks and balances itself in a system that is spelled out in the U.S. Constitution.

Another argument for a smaller governmental role is that every political transaction can limit individual autonomy. Individualism is thus devoted to minimizing the influence of political authority over individual prerogatives (Curry and Goodheart, 1991, p. 6). As long as individual rights are developed from a social contract and societal consensus, the nature of individualism is derived from abstract rather than concrete. By

reducing the authority of the government, social contracts largely shape political individualism.

As one might expect, because individualism emphasizes the expansion of invention, science, and technology; it takes a direct interest in the development of technology and technological competitiveness in the U.S., which is, of course, the focus of this paper. Individualism has been an ideological cornerstone prompting the U.S. to continue to support the development of technology. Based on sophisticated technologies, some Americans believe that the truth can be found through science and technology in their individual life, but most still believe in a religious element. Nevertheless, the American ideology pays heed to the concept of technology (Goetzmann, 1992, p. 414).

To maintain individualism in American democracy, new opportunities should continually be offered to individuals for their personal improvement. Technology can provide these new opportunities more efficiently than any other means. In short, the development of technology can create many meaningful opportunities for average individuals (Tobey, 1971, pp. 175-181). Vice versa, those who deal with new technology prefer an individualistic society for their purposes to other political systems, since they recognize that technology develops intellectual abilities, distributes wealth, promotes education, and thus creates free and private resources for education. These preconditions for insuring that citizens learn the scientific method are, of course, the same as those for middle-class members of a society. Technology is considered the best option for their problem solving.

Since that technology has its own languages, values, methods, and other symbols, it can create its own reality like other cultures. Technology encourages critical inquiry while dispelling superstitions, hoaxes, myths, falsehoods, or other such quackery. In some respects, it can be at loggerheads with organized religion, but in general the two have developed a positive working relationship. The positive functions of technology have been supported in the individualistic society of U.S. Individuals and experts see a universal order and, in some respects, they see the whole universe taking care of itself. Newtonian scientific notions and the scientific method have been justified for use by academia, industry, and government to increase technological development. A seemingly incongruous part of this harmony with individualism is specialization, a process of fragmentation inherent in the scientific process (Lodge, 1975, pp. 314-315).

Individualism goes on to emphasize that rational pragmatism works in technology by showing that truth is measured by experiment and practical outcome. Individualism holds that scientific ideology is concerned with objective knowledge rather than subjective knowledge. Based on objective knowledge, only facts lead to paradigms in pragmatism. Similarly, pragmatism puts priority on the importance of the process rather than formal products. Instead of just a final product, how individuals reached the final goal is much more important in American thinking. Therefore, U.S. society considers screening effect of many activities in educational institutions to be more important than Japan's one time entrance exam.

In conclusion, by emphasizing the importance of individuals, which include self-reliance, survival of the fittest, equality, pluralism, and social contracts rather than an

emphasis on the community, the U.S. brand of individualism has been the basis for its technological development. The origins of the individualism include various factors in U.S. history, such as Calvinistic Puritanism, agricultural environment, John Locke's influence, the founding fathers' ideas and their constitutional amendment. American individualism has thus encouraged free-market competition, a smaller role for government, and the continuous development of technology for increasing competitiveness.

Chapter Five
The Roles of National Security

Throughout Japanese history, insecurity and vulnerability have been no strangers. The Japanese have always worried about foreign invasion from all sides of their island nation. Those feelings have accordingly all been incorporated to Japan's national security concerns (Morishima, 1982, pp. 51-155). Partially because of this anxiety for security, Japanese politicians have encouraged their people to sacrifice for their country in fighting their hostile neighbors. To understand the development of defense technology in Japan, it is necessary to know how the Japanese have presented its national security through the years.

Between the 17th century and 1945, Japan lacked a strong base of natural resources, yet it tried to develop defense production for security, and even expansionism. The Meiji Revolution resulted in a rebuilt Japan patterned after a Western model. Key players in the Japanese culture strongly supported a national state based on Japanese spirit and Western technology to increase security and build the economy. In order to expand its territory, the defense-related industries stimulated civilian industry until the end of World War Two. While Japan may have lost the Second World War militarily, the legacy of heavy industry's contribution to Japan's war machine during World War Two proved to be a cornerstone upon which Japan has rebuilt its economy.

After the war, Douglas MacArthur, who was the Supreme Commander of Allied Powers (SCAP) in World War Two, believed that Japan should be prevented from

producing arms, though it could develop industries to encourage foreign exchanges. In 1945, Japan was no longer a threat to world peace. The Japanese forever renounced war as a sovereign right, by establishing Article IX of its new constitution.

A peaceful postwar world was not in the forecast for a beaten Japan, as the threat of communism in Soviet Union and China reared its ugly head. Because the U.S. wanted to mold Japan into a defensive perimeter against communist countries, the U.S. foreign policy for Japan was somewhat reversed at the end of 1940s. Japan could serve as a staging area for allied military operations in the event of war against the Red East. By supplying the U.S. with military components, Japan learned the basics of defense technology. Further, Japan began to recoup a strong economic position by producing materials and finished products for export to European countries. These included ships, heavy machinery, chemicals, steel, and energy.

At the beginning of the 1950s, the Korean War gave Japan a golden chance to produce military products to meet U.S. military needs (Samuels, 1994, pp. 130-133; Ozawa, 1974, p. 24). Almost at the same time, Japan's Self Defense Forces were created, and then they began to increase their influence in Japan. While the Self Defense Forces never fired a shot in anger, its weapons, the way of deploying troops, and its military strategy have been important to preserve Japan's national security.

Partially as a result of the U.S. government allowing an extensive technology transfer to Japan over the last several decades, Japan was able to rapidly improve its national security (Samuels, 1994, p. 151). Moreover, this aid helped Japan to convert

military technology to industrial technology, which in turn resulted in the growth of its export economy. Japan's industry had access to the best U.S. technology for both its economy and military. Indeed, the U.S. was a major supplier of technology to Japan especially from 1950 all the way through the beginning of the seventies (Ozawa, 1974, p. 25). Thus, the U.S. government awarded and supported Japanese defense procurement.

Even at the present time, the foundation and framework of Japan's national security has been carried out with the help of the U.S. government. The U.S. guarantees for Japan's security have been crucial to Japan, partially because the U.S. has allowed Japan to concentrate on building its economy with relatively less concern for its own military defense. Under an agreement between the U.S. and Japan, the U.S. deterred the likelihood of a nuclear attack on Japan, and virtually eliminated the possibility of an invasion of the Japanese islands. Even with this help, Japan's reaction to concern about its national security has been more robust than many expected (Brown, 1994, pp. 432-438). Yet one must consider threats from neighbors such as the former Soviet Union, the unstable political situation on the Korean peninsula exacerbated by North Korea's likely acquisition of nuclear weaponry, and the regional expansion of communist China.

During the Persian Gulf War, Japan's constitution prevented its soldiers from deploying, therefore Japan could not have anything to do with the war militarily. Pressure from the U.S. and other allied countries nevertheless resulted in Japan pledging economic aid of 13 billion dollars for the coalition forces (Fukuyama and Oh, 1993, pp. vii-viii). This economic donation was only made after an extensive debate within its domestic

politics. In short, the U.S. used military force in the conflict, while in contrast Japan contributed economically to the war effort.

Japan has been criticized internationally for its limited role in the Persian Gulf War. In particular, the U.S. wanted Japan to assume more responsibility for international security. However, many have agreed that the U.S. dominated the battle against Iraq, while Japanese technology was a crucial factor helping the U.S. win the war (Romm, 1992, p. 15). In effect, this technology flanked American technology, allowing the U.S. military to devastate the Iraqi military. Many parts of U.S. defense technology were borrowed from the flexible and modern Japanese technology. Thus, as many have continued to comment, Japanese technology was more speedy, shorter, and more efficient than the opponent's technology.

As indicated earlier, the Japanese have never separated national security from economic wealth. Japanese industrialization has been executed under a national slogan advocating a rich nation and a strong army (Samuels, 1994, p. 320; Chinworth, 1992, p. xiii; McIntosh, 1986, p. 7). Only one economy has ever existed in Japan, and it embodies a close connection between the industry and the military. Thus, the Japanese have not perceived defense security as one thing and economic growth as another. Rather, they have linked all civilian consumers, military consumers, industries, regions, and the whole of the nation together. Furthermore, the Japanese believe that technology is the essence of national security. Technology and its production have been considered national interests as well as protecting its territory from other nations. Thus, the Japanese do not

consider technological innovation as being separate from either national security nor economic welfare.

Conventional wisdom holds that while the U.S. has focused on developing, transferring, and diffusing defense-related technology, Japan has concentrated on improving industrial technology. In the U.S., industrial or private research concerning defense technology as well as defense technology from public R&D was abundant during the Cold War, but Japan has not developed defense technology particularly in private industry. As Figure 5.1 illustrates, the proportion of R&D for defense is just 6.0 percent out of the national R&D budget in recent years. It is no secret that since World War Two the Japanese have invested in industrial technology, regardless of the deficiencies of their private or public technology, far more heavily than in their defense technology.

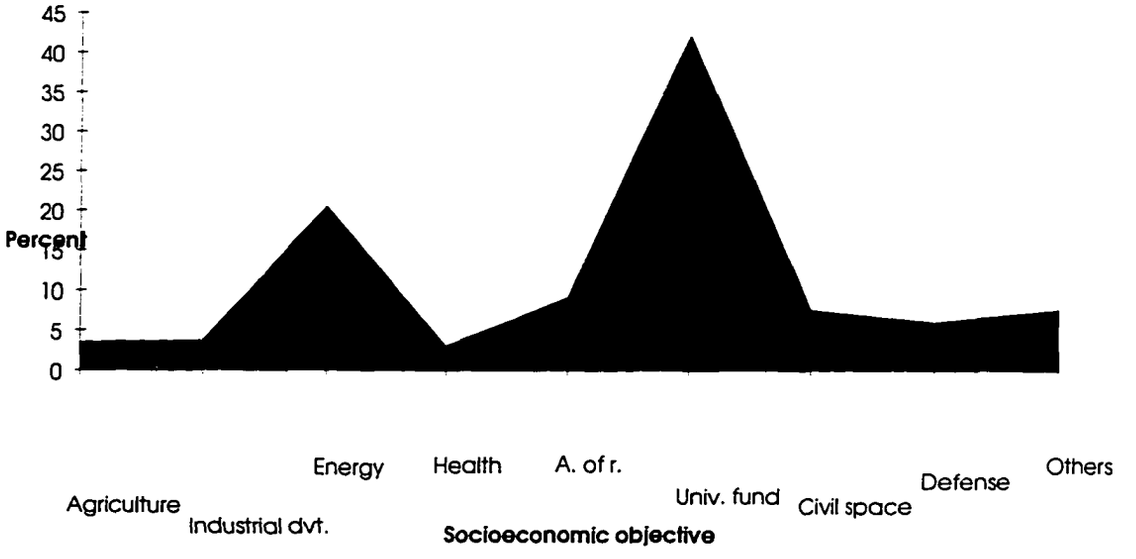

Figure 5.1, Japan's national budget distribution for R&D by socioeconomic objective in 1992, 1993, or 1994, source: National Science Board, 1996, p. 153, note: Agriculture = agriculture, forestry, and fishing, Industrial dvt. = industrial development, A of r.= advancement of research, and Univ. fund = general university funds.

Based on Japan's financial contribution to the UN and humanitarian activities, many continue to believe that Japan has focused on industrial development in keeping with U.S. political and security strategy. At the same time, the end of Cold War has been welcomed by Japanese leaders. Japan's technology is directly related to commercial products by accumulating industrial technology in the industrial labs. Only half a percent of total industrial production is devoted to defense-related production, which is the same amount allocated to the nation's sushi production. These figures can be deceptive, however, since many critics have addressed industrial technology in Japan based on Figure 5.2 without considering that it is closely related to its defense technology. Also, this Japan's non-defense R&D expenditure has been between 2.12 and 2.87 percent, as its percentage of GDP.

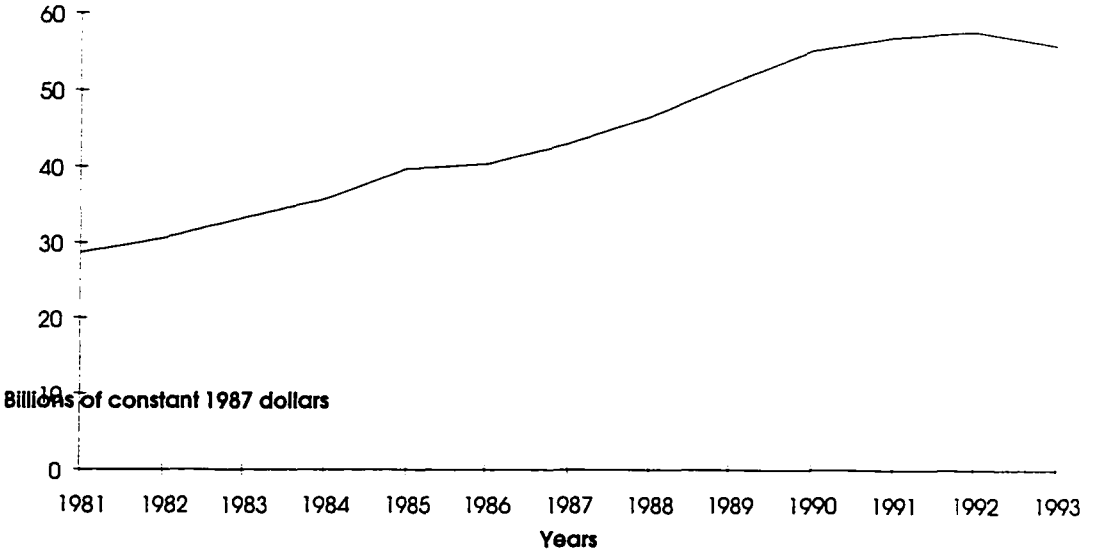

Figure 5.2, Japan's non-defense R&D expenditure, source: National Science Board, 1996, p. 155.

In 1993, Japan allocated about 1 percent of its GNP for its defense budget. This is not comparable in terms of that of the U.S. However, this figure was 46 billion dollars, which was bigger than that of Russia for that same year. In addition, as the second largest defense budget in the world, Japan's budget was bigger than that of the combined North and South Koreas (Maeda, 1995, p. vii). Japan's defense capability, which includes its defense technology, cannot be ignored, just because it is relatively smaller than that of the U.S.

Furthermore, because the government of Japan has not publicly acknowledged its rearmament during the postwar era, the public does not believe in Japan's covert military agenda. The government has not made public maneuvers in the legislative Diet under Article IX, which has concealed Japan's rebuilding of its defense technology. Besides, if a product is part of an assembly rather than a finished one, it is difficult to distinguish between industrial and defense technologies. This kind of Japanese technology thus has no restriction on export, which results in economic benefits to include national security (McIntosh, 1986, p. 55).

In the early 1980s, Japan's industry began to revamp its research organization from commercial one to one with military applications. If necessary, the Japanese want the technology in private industry to be easily converted into defense technology; as this would improve the military performance, reliability, and quality while lowering the costs. Until the end of the 1980s, Japanese defense technology was still not distinguishable from

its industrial technology, therefore, few observers noticed this rapid growth of defense technology. Many recent evaluations of industrial technology of the 1990s underestimated actual moneys spent on Japanese defense R&D. Yet these same studies say that Japan has not achieved its current economic situation by ignoring defense technology, contrary to conventional wisdom.

Arms production has attracted many politicians and leaders. In particular, Japanese military men have focused on defense technology for their country. They have stimulated a diffusion of technology between industrial and military applications rather than focused on developing just industrial technology. Also, they have embedded defense production into the industrial economy. Japanese political power operates through governmental bureaucracy, political parties, and even the relationship between the state and the public. In so doing, politicians friendly to the military have kept the latter's interests in mind. These have helped Japan to have a series of defense plans according to Table 5.1.

Many of Japan's industrial technologies are related to technology needed by defense industries such as data processing, telecommunication, opto-electronic, lightweight materials, electronic parts, ceramic technology, and development of new component materials (Samuels, 1994, pp. 134-154; L'Estrange, 1990, p. 28; Dower, 1989, pp. 18-19; Driffe, 1986, pp. 17-41). In accordance with this rationale, the definition of technology means dual-use technology when applied to Japan. Jan Herring and the Japan Defense Agency identified twelve kinds of dual-use technology as shown in Table 5.2.

Japan had surpassed the U.S. in many of these areas of technology. They continued to emphasize that these technologies will be key factors for industrial and defense manufacturing technology in the next century.

Table 5.1, Japan's basic defense plans, source: Richard J. Samuels, 1994, pp. 154-155.

Years	The names of defense plan
1957	The basic policy for national defense
1958-1960	The first defense buildup plan
1962-1966	The second defense buildup plan
1967-1971	The third defense buildup plan
1972-1976	The fourth defense buildup plan
1976	The national defense plan outline
1980-1984	The 1978 midterm defense program estimate
1983-1987	The 1981 midterm defense program estimate
1986-1991	The midterm defense buildup plan
1991-1996	The midterm defense buildup plan

Many manufacturing industries, like NEC, Kawasaki Heavy Industries. Toshiba. and Mitsubishi Electric Company, have continued to work on defense contracts (Chinworth, 1992, p. 24). Thus, aircraft, ship building, and all manufacturing industries have worked on military technology. As an example, in the 1950s, Mitsubishi Heavy Industries lobbied to assemble F-86 fighter aircraft in Tokyo and Washington D.C. In the 1960s and 1970s, the company also tried to lift the ban on Japanese arms exports. By adjusting to a changing industrial market, Japan's industry has been able to meet the

increasingly sophisticated criteria of the military developing products, all at a lower expense.

Table 5.2, Lists of Japan's dual-use technology, sources: Jan Herring and the Japan Defense Agency, cited in Richard J. Samuels, 1994, p. 30 and 291.

No., Industrial technology	Its defense application
1, Integrated circuits	Command control systems
2, Space-based sensors	Military intelligence
3, LSI, VLSI	Cruise missile guidance
4, Fiber optics	Aircraft, missile controls
5, Electro-optical devices	Intelligence sensors
6, Lasers	Target designation, range measurement
7, Artificial intelligence	Smart weapons
8, Composite materials	Aircraft, guided missiles
9, Projectile core	Tank cannon
10, Ceramics	Armor, engine parts
11, Flat panel displays	Aircraft, tanks
12, Paraglider	Parachute controls

To facilitate the transfer of technology between industrial and defense sectors, Japan has had far fewer legal mandates than in the U.S. Defense contractors in Japan should really report the cost and benefits of technology transfer, but unlike their American counterparts they are not required to account and audit such things. Also, the Japanese Diet has shown more passive attitudes toward defense acquisition than the U.S. Congress. By reducing many regulatory requirements for defense technology and its procurement, Japan's government, with the blessing of the Diet, attempts to reduce the number of barriers for defense contractors. This is facilitated by the relative ease of spin-off, and co-development, of technology between the military and industry which is popular in Japan.

In addition, Japanese defense technology contractors strive to develop or find commercializable defense technologies in domestic and international markets to increase profit margins.

As a consequence of the Japanese making no distinction between defense and industrial technologies, Japan has reduced many of its needs for material resources. A significant portion of the spin away of industrial technology has been attributed to the development of defense technology within the same industry. In addition, Japan has sharply reduced defense spending through intrafirm technology transfers rather than restructuring the whole industry. Thus, the Japanese have made technology indigenous by the acquisition of foreign products, capabilities, and advisors, while changing the Japanese economic strategy of local development, diffusing new technology, and nurturing targeting technology (Samuels, 1994, pp. 33-56).

Table 5.3, Japan's defense production in 1987, source: Mitsubishi Institute Survey, cited in Richard J. Samuels, 1994, p. 186, note: NA = not available.

Product	Its percentage out of total defense production
TANSAM missile	69%
CH-47 helicopter	13.8%
Model 74 tanks	13.8%
Others	3.4%

Despite difficulties in measuring amounts, Table 5.3 shows that Japan produced many more TANSAM missiles than other defense-related products at the end of 1980s. CH-47 helicopter airlifts men and materials, while Model 74 tanks were similarly

designed to Model 90 tanks. The TANSAM missile is a guided missile designed to protect Japan's archipelago from an assault from anyplace including the Korean peninsula, mainland China, and the former Soviet Union. In particular, since the TANSAM missile was made not only by the applied research results in the fields of inertial navigation systems, hybrid integrated circuits and various control technologies as well as by the basic research results of cryptography, artificial intelligence, high-speed processing, and image processing, this missile is a product of Japan's diverse efforts for dual-use technology.

The hypothesis of this paper has focused on how Japan has developed its defense technology. Data about Japan's national budget distribution for R&D by socioeconomic objective and Japan's non-defense R&D expenditure have not shown any significant movement toward defense technology. Nevertheless, the hard evidence points to Japan's pursuit of defense technology. This includes Japan's defense plans, lists of Japan's dual-use technology, and Japan's outright proportion of defense production. In short, Japan, which is an independent variable, has supported defense technology, which is a dependent variable. In other words, this paper disconfirms the hypothesis that Japan has neglected its development of defense technology.

Many policy analysts have analyzed the comprehensive characteristics of Japan's national security (Katzenstein and Okawara, 1993, p. 84). Some claim that this comprehensive doctrine emerged in force in Japan at the end of 1970s (Romm, 1992, p. 101), though it has been actually practiced throughout its history. By increasing high-value added jobs through its dual-use technology, Japan wants to deter both military

threats as well as those to its industrial markets. At any rate, Japan's national security is clearly related to a comprehensive security doctrine, because it includes both industrial and defense technologies.

In conclusion, the government of Japan has not kept economic growth and military strength separate in their quest for national and industrial security. This is not new, as it has been practiced from the Meiji revolution to the post Cold War period. They have always emphasized a comprehensive security policy by developing both industrial and defense technologies, not only to protect the country from enemies, but to improve their economy as well. Finally, however, the Persian Gulf War has made many realize that Japan's technology is dual use in nature, allowing Japan to convert its massive industrial base into one of defense at any time. Under the U.S. conventional and nuclear umbrella, Japan has consistently accumulated industrial technology and made it easier for defense contractors to transfer from industrial technology without violating Article IX of its peace constitution.

Chapter Six
Innovation Institutions and Their Relationships

Japan has a network of public institutions to create technology which is versatile. Among them, the Ministry of International Trade and Industry (MITI) plays many roles in implementing policy concerning technology. As the most widely known institution in Japan, the goal of MITI is to help export industrial products and promote dual-use technology. In so doing, the MITI mainly has jurisdiction over commercial technology in industries without a heavy emphasis on basic research. Therefore, the MITI spends about 13 percent of government provided R&D funds on technological development per year (Herbig, 1995, pp. 32-33). By tapping into this huge fund, the MITI puts a priority on developing technologies for new materials, energy sources, and solutions for social conflicts and problems.

The MITI has taken many unique approaches as the premier institution of technology in Japan. The administration of the MITI in maintaining this role is a crucial reason for its success, mainly because it is so comprehensive in nature. Indeed, many of Japan's public organizations have to follow rigid rules and proceedings under a mandatory system in this authoritative culture. The MITI manages a number of branches categorized by industrial sector, at the same time it fosters competition among them (Freeman, 1987, pp. 31-54). Based on the many sub-institutions under its control, the MITI takes charge of almost every industrial sector and market mechanism ranging from aircraft, energy, and even to the retail distribution of products. As a result, the wide and

comprehensive nature of the MITI is effectively administering the entire national economy.

In pursuing its organizational approach to the economy, the MITI has maintained formal and informal relationships with the private sectors such as the Keiretsu, the banking industry, business federations, and other extensive partners. In short, any entity that plays a significant role in accessing the Japan economy is included. When private support is needed for government policy, the MITI relies on these relationships, and thus can persuade private partners to comply with governmental directives. On the basis of these relationships, Japan has conducted a series of national research projects involving high technology. Without these intimate relationships, it would have been almost impossible for the MITI to establish plans on a national basis. These, in turn, plant the seeds for technology development, increase capital, and encourage long-term planning.

Besides these relationships, the MITI hires some of the most qualified civil servants every year. They bring with them a wealth of experience in technology and the industrial management of it. They are usually legal and economics professionals, and thus are competitive players in the quest for industrial policy (Okimoto, 1986 cited in Patrick, 1986, pp. 40-41). From the perspective of decision-making, the MITI uses a postwar tradition, the "bottom-top approach" among its members. Many aspects of Japan's business and industrial organization are still hierarchical, but the MITI has also addressed the importance of democratic decision making through technological management. Civil servants in the MITI have reached this goal by depending less on vertical decision making.

In spite of the major role of MITI in controlling the economy, many other public institutions follow their own agenda for technological innovation. As a former ruling party in Japan, the Liberal Democratic Party (LDP) dominated the MITI after 1947. Though it lost its dominance, it has recently re-gained the position of the ruling party again. Besides political parties, many encourage Japan's rearmament and economic growth. Japan's Council for Science and Technology (JCST) strives to shape a comprehensive national policy. The JCST consists of the prime minister, cabinet ministers, and other technology experts. It was restructured in 1980 mainly to advise the prime minister on technology matters through hearings with experts in many fields.

Meanwhile, the Science and Technology Agency (STA) controls both technological publications and the transfer of technology to industry. By spending about a quarter of the government funds allocated to R&D, the STA coordinates an overall technology policy. The Ministry of Education (MOE) oversees national universities and other affiliated institutions involved with technology, by using about half of the government R&D funds. As one might expect, the MOE supports basic research in the universities. Working on basic research is a unique mission of the MOE in Japan, when compared with other institutions that are involved with applied research and the specialized commercialization connected with it.

As already indicated, many government institutions formally have their own domain, but they also fiercely compete with others to promote science and technology in Japan. For example, the MITI, the MOE, and the STA all get government funds for research. The MITI has attempted to expand its influence over government R&D areas

since the 1980s, because the institution has been pressured to adjust to the changing international market. In short, the MITI intends to meet new requirements for basic research in the international market by turning away from its domain of applied research. In response, the MOE and the STA have confronted the MITI, because they do not want to relinquish a greater share of their traditional funding for government sponsored basic research to the MITI. In particular, the MOE has intensified its struggle with the MITI by emphasizing that basic research in Japan's universities has been its major domain. While the MITI has allowed many universities to participate in its basic research, the MOE has firmly denied the universities under its control permission to participate.

Many agree that the role of MITI is very powerful, but the relationship between the multiple government agencies is still interdependent. The MITI does not have an exclusive role in industry, though its role has changed over time. In fact, Japan has a centralized and cooperative innovation system under the MITI, but Japan's industrial policy is significantly changing recently. The emergence of Japanese technology has shown the existence of a much more complicated and interdependent relationship among public innovation institutions than previous scholars had concluded (Callon, 1995, pp. 1-35).

In managing defense-oriented technology, Japan has multiple institutions that are similar to those for its industrial policy. For instance, the sale of defense products is generally controlled by the MITI (McIntosh, 1986, p. 55). Because the MITI aims at developing dual-use technology, it has an unofficial influence regarding the development of defense technology. The Ministry of Finance (MOF) supports the minimum amount

necessary for the defense policy by defending allocations on defense budget. Meanwhile, the Ministry of Foreign Affairs (MOFA) articulates the security policy with the help of the MITI.

In addition, the Japan Defense Agency (JDA) formulates the defense policies approved by cabinet members of the National Security Council. The director of the JDA oversees defense contracts and procurement from industry, while the Technical Research and Development Institute (TRDI) within the JDA is organized to encourage technology departments in the various industries rather than to develop technology directly. The JDA has conducted several important activities to enhance defense technology by approving military procurement, and assimilating many technologies through sending students overseas (Chinworth, 1992, pp. 1-40). The Director General of the Equipment Bureau, which includes ex-MITI officials, plays the biggest role in the JDA.

In 1980, the MITI created a "Technopolis plan" to build nineteen modern Silicon Valleys in Japan by the year 2000. Through this Technopolis, the MITI wants to inject new vigor into Japan's declining industries while balancing private and public responsibilities (Anchordoguy, 1989, p. 4; Tatsuno, 1986, p. 2). The Technopolis promotes joint research and private capital investment in cutting-edge industry by changing from a reliance on copying technology to innovation. The Technopolis combines industry, universities, and government labs for commercialization, so that applied research may be popular in the Technopolis. Even though the MITI has provided guidance and tax incentives, the Technopolis is still managed at local levels. However, because of fiscal stinginess, the Technopolis has limited funds available.

A predecessor to the Technopolis was the Tsukuba science city, which serves as a national research center. Thus, contrary to a misconception, the science city was not included in the Technopolis plan. Nonetheless, the city followed the role of Silicon Valley like Technopolis, but it was funded by a central government. Private industry plays few roles in Tsukuba city; rather it develops basic research and obtains benefits from large construction budgets.

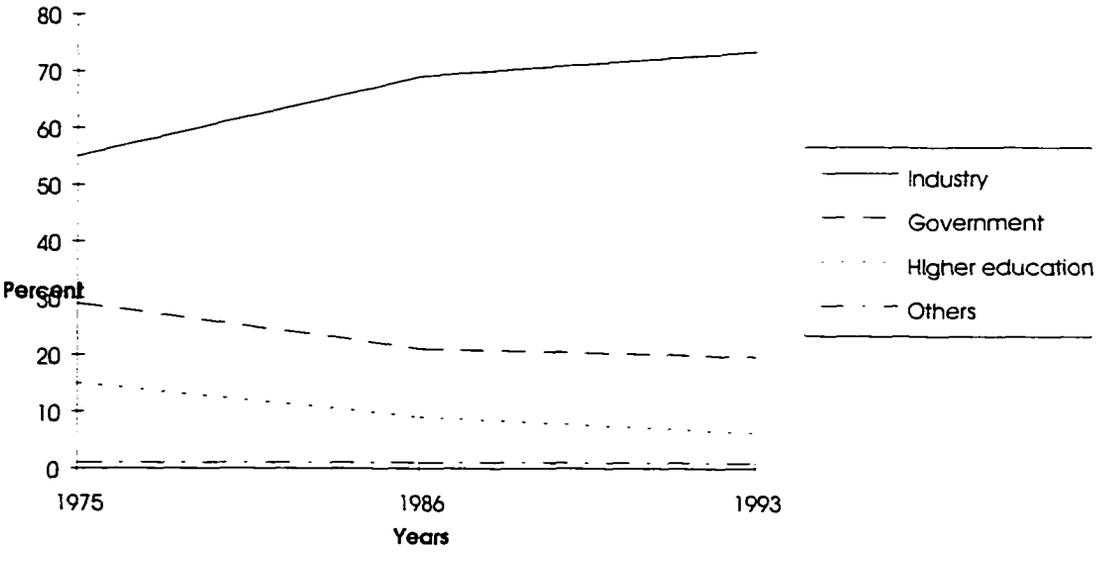

Figure 6.1, Japan's national R&D expenditures by source of funds, sources: National Science Board, 1996, p. 156 and National Science Foundation, 1991, p. 12.

The Keiretsu is a postwar version of the Zaibatsu, a conglomeration of affiliated corporations. In Japan, the majority of industrial corporations belong to the Keiretsu. Moreover, trade companies direct each Keiretsu group by focusing on overseas investment (Ozawa, 1974, p. 60). Many Keiretsu members are involved in heavy industry

and do not pursue self-contained, but mutually exclusive, benefits. In fact, the Keiretsu has financed a large proportion of the R&D expenditure. Figure 6.1 shows that historically 55 to 73.4 percent of the R&D funding has been supported by Japan's industry. This means that industry has been a major financial supporter of R&D in Japan, rather than the government or the institutions of higher learning (Hadfield, 1997, p. 6). Accordingly, government policy has given benefits to large Keiretsu members.

If one considers that a major corporation in each industry belongs to a Keiretsu, each has an extensive market range. Therefore, many different industries are included in the corporate groups that are the Keiretsu. The relationships among the many corporations under the Keiretsu are linked to one another on the basis of reciprocal shareholding. In addition, sharing stockholdings between related corporations facilitates the government's administrative ability to maximize its potentiality. Thus, a major bank lends money to subordinate corporations through a lender and borrower relationship, or a long-term buyer and seller relationship. The relationship among these many corporations is basically that of horizontal intermarket. However, the relationship between a major corporation that belongs to a Keiretsu, and its many subcontractors, which provide parts of the product for the major corporation, is not horizontal in nature but rather vertical (Nakatani, 1990, p. 151). Therefore, two different relationships exist in Japan's industry.

The Keiretsu is classified into three categories. The first literally translates to production Keiretsu, which promotes efficient relationships between major and subordinate corporations through producing products. As a rule, a major company has the power to make decision for subordinate corporations. The second category is distribution

Keiretsu, which aims to control the distribution of manufacturing products from industry such as automobiles, electrical products, and electronic commodities. The third is the finance Keiretsu. Based on stock holdings and the banking industry, a finance Keiretsu finances related corporations and boosts the control of major corporations (Yoshitomi, 1990, pp. 10-14).

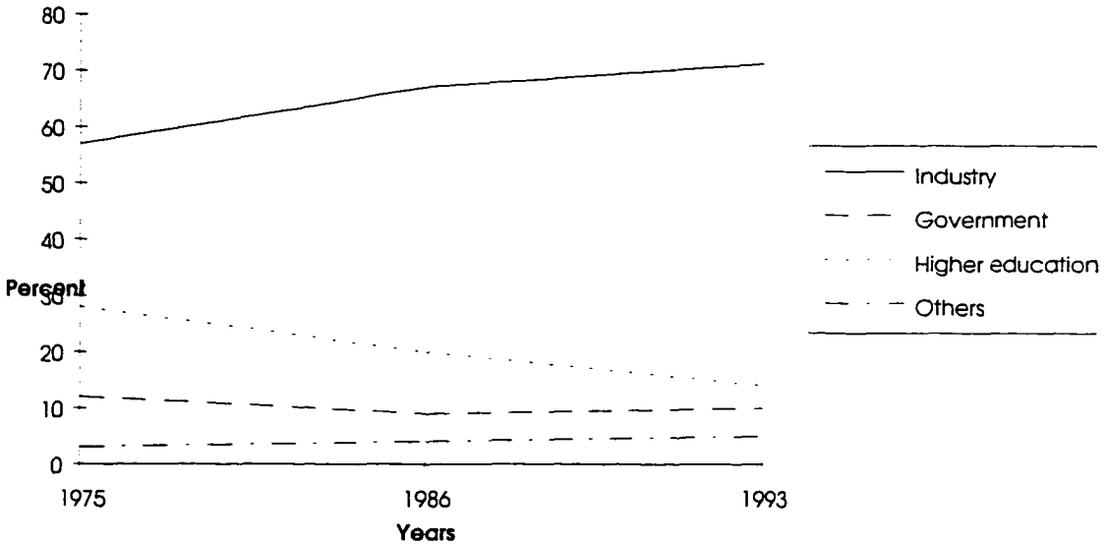

Figure 6.2, Japan's national R&D expenditures by sector of performance, sources: National Science Board, 1996, p. 156 and National Science Foundation, 1991, p. 14.

Figure 6.2 shows that the biggest proportion of R&D expenditure has been spent in Japan's industry between 1975 and 1993. Most of R&D is conducted in industrial labs rather than in government or universities labs. According to both Figures 6.1 and 6.2, Japan's industry has been the biggest financial supporter of technology development in its lab. Technology transfer originally means that technology from government labs transfers to industry, but this is not applicable in Japan. Japan's government has not allocated much of R&D expenditure for industrial performance, according to Figure 6.1.

Therefore, the expression "technology transfer" does not exactly equate to the Japanese version.

Some technological developments have been shared by labs in universities and the industrial sectors in Japan. Yet, because private industry works primarily on the invention of commercial high technology, the responsibility for basic research has been left to university labs. Many universities with research labs have been built as academia has extolled the importance of technology, but they have generally failed to define their research roles. In spite of the efforts of the universities, most research has been conducted by less than three professors and their staffs. Many talented students do not work for doctoral degrees, rather they prefer to work for industrial R&D labs, which are far more prestigious. As a result, research in Japan's universities has been limited.

Many foreigners have also taught advanced technology in Japan, but the Japanese have developed their own learning center which directly and indirectly converts foreign technology into Japanese applications. Nevertheless, foreign engineers and scientists do transfer extensive knowledge such as blue prints, quality control methods, machining techniques, and design methodologies. This, in turn, leads to cost control and manufacturing process improvements.

Based on the public and private institutions just discussed, the initiative for technological concerns has derived mostly from public agencies rather than industry. The government bureaucracy dominates the role of the private sector by directing the Japanese economy, as the government has always maintained the priority. The government of Japan has traditionally extracted compliance from industry, mobilized economic

development, and incorporated industrial interests into its national goal of developing harmony between the society and the economy. After the government researches and decides which technologies are necessary, industry can develop or transfer these accordingly (Boyd, 1987, pp. 62-82). Unless the government selects a specific technology, it is generally difficult for an industry to develop a specific technology alone. The government has considerable latitude to handle industry as a tool of public policy.

The Japanese have experienced a more positive side of governmental role in economic development. The historical record shows that the government has played a leading role in building the army and the market since the 1800s. Thus, a majority of Japanese believe that the government can handle the competitive market more efficiently than any other organization through regulations. They believe that a market economy will not offer solutions to economic problems in many cases. As a result, cooperation between government and industry is stressed. In a sense, Japan's industry helps the government shape industrial policy, and thus the state intervenes in private sectors. By reducing costs, and developing quality and technology, government forms its industrial policies in ways that dominate the market incentives. Vice versa, Japan's industry has encouraged the government to intervene by using technology as a market force. This results in limiting industrial production, better allocation of resources, and the setting of sale prices legally.

In conclusion, Japan has developed its own system of innovation that embodies its unique relationships. In doing so, the role of MITI has been more obtrusive than many other public institutions involved with industrial and defense technologies, yet it does not

have a centralized or exclusive role unlike those suggested in many previous studies of similar nature. Multiple public institutions compete with one another in initiating industrial policy, while research in the universities is not very active when compared to the states. As a passive entity, many of Japan's industries share stockholds through the Keiretsu groups. Further, they finance the largest proportion of R&D funds for their own technology development. As a result, industrial labs play a major role in pursuing Japan's R&D.

Chapter Seven
Instruments of Technology Policy and Strategies

Various theories seek to explain Japan's technological success. Many of these use detailed information to analyze how the Japanese have depended on economic nationalism. In general, several analysts have suggested that nationalism has been instrumental as the primary force behind Japan's technology policy. Japan's government has encouraged nationalism in the Japanese populace from the time that they are in elementary schools through middle and high schools. If any portion of a textbook is anti-nationalistic, it cannot be used for students. Although anyone can publish textbooks, these cannot be used in schools without government approval (McIntosh, 1986, pp. 41-43). Therefore, children are already imbued with nationalistic ideals before they become leaders in politics and business.

After World War Two, Japan realized that its technology lagged far behind Western industry. In the process of catching-up, Japan tried to locate, import, assimilate or even copy foreign technology without the permission of foreign governments. For its importation strategy, Japan relied on diverse channels, and thus they became important instruments of post-war economic growth. Such as, a great deal of the imported machinery, including rolling machines, machine tools, and electrical products, was converted into domestic technology. Meanwhile Japan's industry made agreements concerning technology with both the U.S. and Europe. Japanese industry even purchased blueprints to obtain technology of an experimental nature from foreign labs.

Until the beginning of the 1970s, Japan's government did not usually allow direct foreign investment in Japan, which is contrary to what most other developing countries do, as they depend on direct investment as a major policy of development. The Japanese have, instead, taken a sophisticated approach toward the importation of technology by controlling direct foreign investment in domestic technology. By emphasizing an abundant profit incentive through the successful importing of technology, Japan's government has encouraged many elements of the economy to import foreign technology.

Japan's large industry was especially successful at importing technology, partially because the postwar international environment was favorable to its developing technology. In the 1950s and 1960s, the Americans did not recognize Japan as a competitor, therefore U.S. foreign policy contributed to the free flow of technology into Japan. Accordingly, many companies sought to acquire important technology from Western countries such as automobile manufacturing, electric machinery, steel industry, and textile manufacturing (Goto, 1993, pp. 280-283).

In addition, Japan's government influenced industry's profit motive to import technology, primarily through the Foreign Exchange and Foreign Trade Control Law in 1949 and the Foreign Investment Law in 1950. To purchase foreign technology, Japanese industries needed government approval under those laws. Industries had to submit a statement that shows the benefits for the economy of Japan as well as the benefit for the industry itself. Based on these restrictive laws, the government carefully reviewed and screened application for importing technology.

In 1980, these two laws were combined into the Foreign Exchange and Foreign Trade Law, and Japan's limitation on technology importation was liberalized, except in some designated areas. In short, Japan's government has helped its industry import foreign technology under favorable conditions. For industry, one of its most important strategies is to employ license agreements, contracts, and subsidiary operations under the 1980 law. Thus, industry has been able to quickly apply the best advanced technology from foreign countries to their machinery under the auspices of license control elements of the government agencies, and by following foreign exchange regulations.

Taken alone, importation of technology is not sufficient to develop high technology since foreign nations, including the U.S., no longer want to transfer their technology to Japan for international competition. Fully being aware of this, Japan has often sought different instruments. For the Japanese government, a targeting policy has been another major strategy. This policy entails coordinated government action that directs resources to offer a competitive advantage to selected industries. Once the government selects an industry for special attention, government agencies comprehensively support it.

This targeting policy is formulated, implemented, and justified primarily by the rule of the MITI. By using protective measures, the MITI prevents technology from deviating from its market. The government has given tax credits to R&D-related corporations by permitting them to deduct R&D expenditures from current or the previous years' taxes. In addition, tariff barriers, subsidies, quotas, export facilitation, import duties, restrictions on foreign investment, and non-tariff barriers have contributed

to many R&D programs. Government agencies have encouraged a competitive environment between selected industries (Patrick, 1986, pp. vii-12). This technology policy has been pragmatic, because it has changed its methods and development according to a particular stage of R&D. Furthermore, the choice of means has been selected in cooperation with the scientific community.

Japan's government has heavily subsidized several industries, which has had a commensurate effect on the production of steel, automobiles, communication equipment, machine tools, and semiconductors. Japan's industry has also tried to tailor its input to the targeting policy, because private managers know their market better than government officials, as the government has also kept competitive industries intact (Anchordoguy, 1989, p. 180). Protective measures in private industry have been claimed by foreign competitors, but Japan's industry has effectively denied foreign corporation access to domestic markets based on its strong relationship with the government. Under the slogan of "buy Japanese," many competitive foreign products have been kept out of the territory of Japan's industry.

In terms of research, many studies conclude that Japan's impressive success is rooted mainly in its anti-competitive policies, such as protectionism for its domestic market and its expansion abroad. These studies have accused Japan's industrialization by criticizing negative aspects of its industrial policy. Even though many European and Asian countries have complained about Japan's anti-competitive policy, the U.S. has been one of the biggest critics of Japan's targeting policy and the pervasive role of the Japanese government.

The U.S. advocates fair competition for all players under the same rules in response to Japan's targeting policy. Japan, however, is not interested in fair play, rather it merely wants to win the game. According to the U.S. Trade Representative, Japan is the most serious violator of unfair practices relative to other accused countries. President Clinton has also criticized Japan for increasing its trade surplus through denying market access and decreasing the amount of imports to its major domestic industries. Many of Japan's domestic markets are closed to U.S. products, and foreign industries investing in Japan's domestic markets have faced considerable difficulty.

Japanese politicians, business leaders, and academics as well as some foreign scholars have typically responded to charges of Japan's anti-competitive and unfair trade practices from other nations by using statistics to show Japan's openness to foreign products. By mentioning several examples such as Coca Cola, IBM, and McDonald's, for instance, the Japanese want foreign nations to provide better quality of life for the Japanese populace. Apologies for Japan have maintained that its market is as open as any other market, and it continues to emphasize that foreign markets do not understand the nature of Japan's domestic market. They also emphasize that Japan's tariffs are lower than those of the EC or the U.S.

During the last decade, formal barriers to foreign products have been reduced somewhat in Japan so that not every foreign industry may have had tremendous difficulty penetrating Japan's domestic market. Similarly, the involvement of the government to include the MITI, has been reduced in industrial affairs. However, a bigger barrier is that Japanese politicians and businessmen do not sincerely welcome the decreasing extent of

protectionism in their market, so they denigrate foreign products rather than their anti-competitive practices. Also, the last thirty year experience in a protected market has allowed Japan to gain international competitive advantages in the long-term.

Furthermore, there are yet other invisible bureaucratic barriers within Japan's industrial policy. Japan's government does not want to change from its traditional and incompatible standards for products to those reflecting internationally-accepted criteria. Its regulations, definitions of terms, and classifications are usually not coherent to foreign partners, especially since Japan's government does not adequately protect foreign intellectual property rights (Kotabe and Wheiler, 1996, pp. 4-34).

In addition, the method of calculating accurate statistics about Japan's protected market is often questioned, because of the changing values of currency and a lack of a standard for complicated calculations. Therefore, despite Japanese statistical evidence extolling their low trade barriers, many recent researchers have reported that Japan's policy still shows considerable evidence of barriers to foreign products. In 1986, Balassa found that Japan's import behavior toward manufactured goods differed radically from that of other rich nations. Moreover, in 1988, Balassa and Noland examined Japan's proportion of imported manufactured goods and found that it was much lower than that of competitors. Meanwhile, Lawrence noted that Japan's import of manufactured goods was lower by forty percent than that of other corporate economies. Just two years later, Lincoln maintained that the amount of manufactured goods imported by Japan, as a proportion of domestic output and GDP, were extraordinarily low compared to those of other advanced nations. Finally, in 1993, Prestowitz, et al. showed that imports of

consumer goods and capital goods in Japan were very low relative to those of other developed nations, and Harrigan revealed that Japan's nontariffs on imported manufactured goods were 40 percent higher than those of other developed countries. Clearly, the playing field was not level for Japan's competitors.

As previously alluded to, administrative guidance has also been utilized in Japan. It has been a versatile instrument allowing Japan's technological developments to adapt to an ever-changing environment by suggesting, advising, recommending, directing, and persuading industry to take certain courses of action (Okimoto, 1989, pp. 93-95). If conflicts cause breaks with international trade partners, the Japanese government works with domestic corporations to settle these problems. As industrial protection declines, the government takes active measures to guide it from its morass. Similarly, when mutual interests are threatened between industries, government agencies initiate administrative guidance to solve some temporary problems.

Because Japan's Diet has not passed laws requiring the compliance of industry to government mandates, industries still voluntarily cooperate with administrative guidance. Administrative guidance is thus not a formal unwritten instrument of government policy. Rather than relying on the accumulation of formal regulations that restrict public policy, Japan's government uses flexible administrative guidance to carry out its industrial policy. Because of this informality, few know the whys and wherefores of Japan's government policy on industrial, international, and domestic economic problems. The content of this flexible administrative guidance is not publicized (Miwa, 1996, pp. 179-181). Thus, Americans still have difficulty determining Japan's exact trade barriers.

Despite these informal regulations, administrative guidance is as effective as statutory laws in Japan. The close relationship between government and industry prompts the latter to accept administrative guidance (Okimoto, 1986, pp. 76-77), as long as prior consultations take place before issuing that guidance. Accordingly, some say that administrative guidance is not related to the top-bottom approach (Hsu, 1994, pp. 1-2). Also, this administrative guidance is rarely rejected by industry, because the industry requests for helpful guidelines for government. In another sense, because government has the power of licensing technology for industry, industrial leaders feel an obligation to follow the informal administrative guidance. Therefore, mixed responses from industry are appropriate to administrative guidance.

The managers of Japan's industry have been very entrepreneurial, because they have aggressively sought out foreign technology, and have turned it into their own science and technology in spite of the huge expenditure and risk. Because a very strong relationship exists between the concerns over technology and industrial policy in Japan. Japanese managers decide on the market, products, suppliers, and their relationship with customers to insure the success of technology. Prewar managers also possessed technological knowledge, and built many high-level engineering schools. The managers continue to enjoy more investment to develop their own technology in an international market. By fending off foreign competition, the managers have established new entry possibilities for technology in both the domestic market and abroad.

More than 90 percent of Japanese chief technical officers belong to the board of directors in industry, as opposed to less than 25 percent of their American counterparts.

Moreover, about 50 to 70 percent of Japanese managers used to work in production and technology areas. They also were involved in marketing or export (Kono, 1984, p. 33). A smaller-scale example is the Hitachi company, which had all eleven directors with engineering backgrounds in 1941 as well as in 1991. Furthermore, 24 out of 35 directors graduated from the engineering departments of their schools (Odagiri and Goto, 1996, pp. 99-100). In other words, many Japanese managers have strong backgrounds in technology.

Technology-oriented managers are increasing in the U.S. at the present, so it may not be wise to overemphasize the percentage of engineering managers in Japan. Nevertheless, a higher proportion of engineering graduates means that Japan emphasizes not only the development of technology but also its management. The success of Japan's development of technology has been strongly influenced by its management through establishing higher technical goals and successful projects by ex-technical office. Their experience in R&D, production, and marketing enables them to acquire a keen understanding of rapidly changing technologies.

From the viewpoint of low level workers, Japan's industry fully trains its new employees to adapt to corporate culture (Branscomb and Kodama, 1993, p. 12). After industry recruits new workers, almost all corporations put their new people into training centers to teach them the basics of the companies and the national economy. One unique thing is that many training programs show similarities to military training to instill courage and discipline, while some programs are related to working for corporations including computer works, management practice, chain of command, etc. Through

experiencing training like military boot camps, new workers understand their missions and responsibilities to their corporations in a manner similar to combat soldiers.

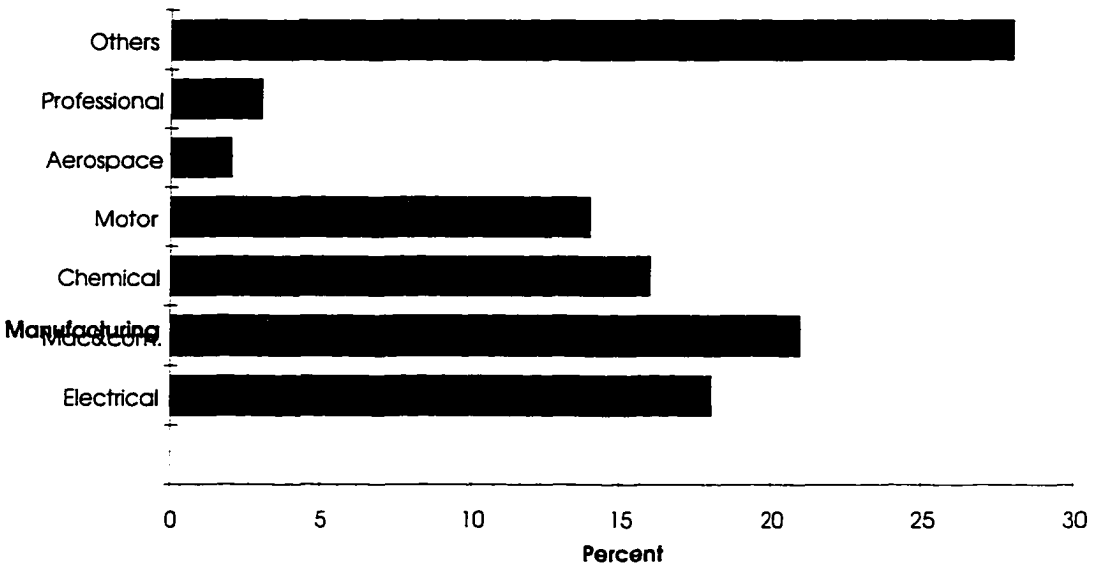

Figure 7.1, Japan's proportional allocation of industrial R&D among manufacturing industries in 1986, source: National Science Foundation, 1991, p. 20, note: Electrical = electrical equipment, Mac&Com. = machinery and computer, Chemical = chemicals and allied products, Motor = motor vehicle, and Professional = professional and scientific instruments.

Japan's government officials and industrial managers have strategically continued to finance some specific manufacturing technologies, which among many other things stimulates economic growth. Figure 7.1 shows how machinery and computer technologies have been financed to a greater degree in Japan than other manufacturing products. This was a wise move, since the demand for computer integrated machinery has rapidly increased in current domestic and international markets. Electrical equipment technology has received a secondary priority in financing as it is considered to be at a higher technological level than textiles or iron. Clearly, imported technology has been a

key factor in Japan's successful R&D efforts, and thus the computer industry has become Japan's most competitive industry with the U.S.

In conclusion, nationalistic instruments of technology policy and strategy have been utilized well by Japan. To catch up with the Western economy, Japan strategically imported and copied many foreign technologies during the postwar. At the same time, Japan's government has relied on protectionism when targeting technology, while its administrative guidance has encouraged industry to cooperate with government policy. A higher proportion of managers in industry has worked in R&D jobs, and training for new workers is similar to training military people. Finally, concerning manufacturing R&D, Japan has historically supported machinery, computing, and electrical equipment technologies.

Chapter Eight
The Roles of National Security

Individualism was closely related to the development of technology, but national security has been a major responsibility of the U.S. government and it has been related to U.S. technology as well (Weida and Gertcher, 1987, pp. 3-4). By utilizing high technology, the U.S. government has protected its territory and its independence, and established a Pax Americana in the world, though it is imperfect. Just as with Japan, national security has crucially influenced the evolution of U.S. technology. As a result, the emphasis on national security has allowed the U.S. to maintain a strong base for its defense industry.

Defense technology dominated U.S. technology policy as early as World War Two. This is epitomized by the Manhattan Project, atomic weaponry that transformed the U.S. into a super power (Ferguson, 1989, p. 128). The Second World War was a turning point for the U.S. in its recognizing the significance of defense technology. Because Americans believed that the best way to maintain national security was to invest in defense technology, they increased federal funding of defense technology.

Soon after World War Two, the Cold War legitimized continued support of defense technology. Emphasis on defense technology was so successful for the U.S. policy during World War Two that the trend continued, thus the U.S. continued to develop defense technology even after the war (Lundvall, 1992, p. 175). More importantly, tensions with the Soviet Union and Red China encouraged the U.S. to place

high priority on defense technology. In particular, a major goal of postwar U.S. national security was to contain the Soviet Union. Other allied countries also pressured the U.S. to develop its military capability for world security and peace.

Another factor supported the U.S. emphasis on defense technology. Many important positions in government were occupied by those who believed in a strong defensive doctrine. The extent of their emphasis on the military varied, but most embraced defense projects as a major concern for the government because of economic benefits as well as national security. Industry was willing to follow government desires for defense technology as this translated to corporate projects. Thus, mutual interests between government and industry have also been important to continued support of defense technology.

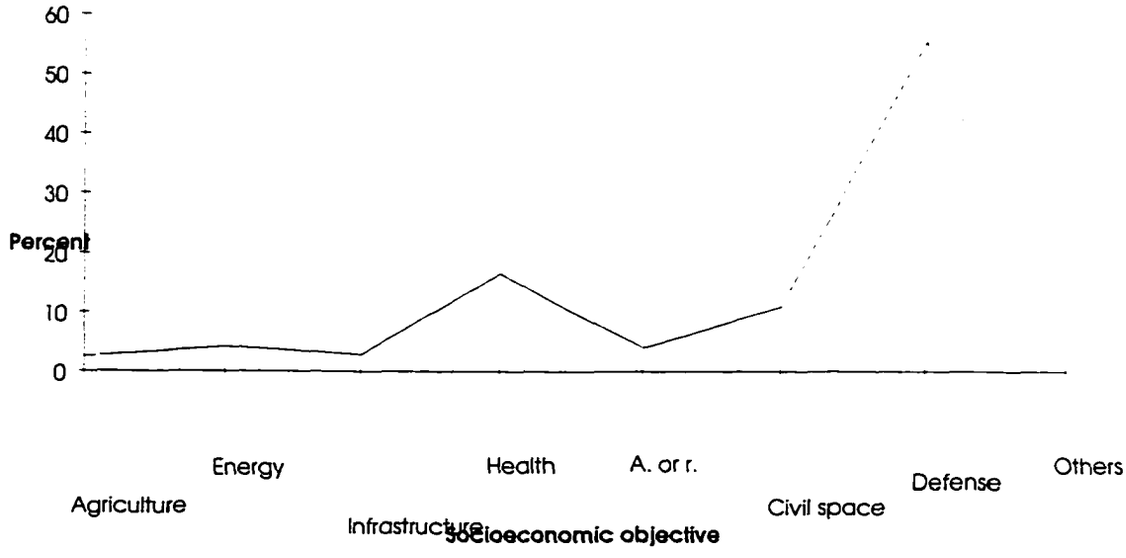

Figure 8.1, U.S. national budget distribution of R&D by socioeconomic objective in 1992, 1993, or 1994, source: National Science Board, 1996, p. 153, note: Agriculture = agriculture, forestry, and fishing, and A of r. = advancement of research.

Clearly, the major share of the federal R&D budget has been spent on defense technology in the postwar era. This R&D budget has emphasized the development of defense technology rather than basic or applied researches, meaning the federal government has bought large amounts of hardware such as aircraft. missiles, and electrical machinery (Mowery and Rosenberg, 1993, pp. 42-43). Figure 8.1 shows that the proportion of funds spent for defense-related R&D has been larger than that of any other socioeconomic objective, while figure 8.2 indirectly shows the U.S. emphasis on defense technology through relative small amount of non-defense R&D. This U.S. non-defense R&D expenditure in Figure 8.2 has been only between 1.77 and 2.17 percent, as a percentage out of GDP.

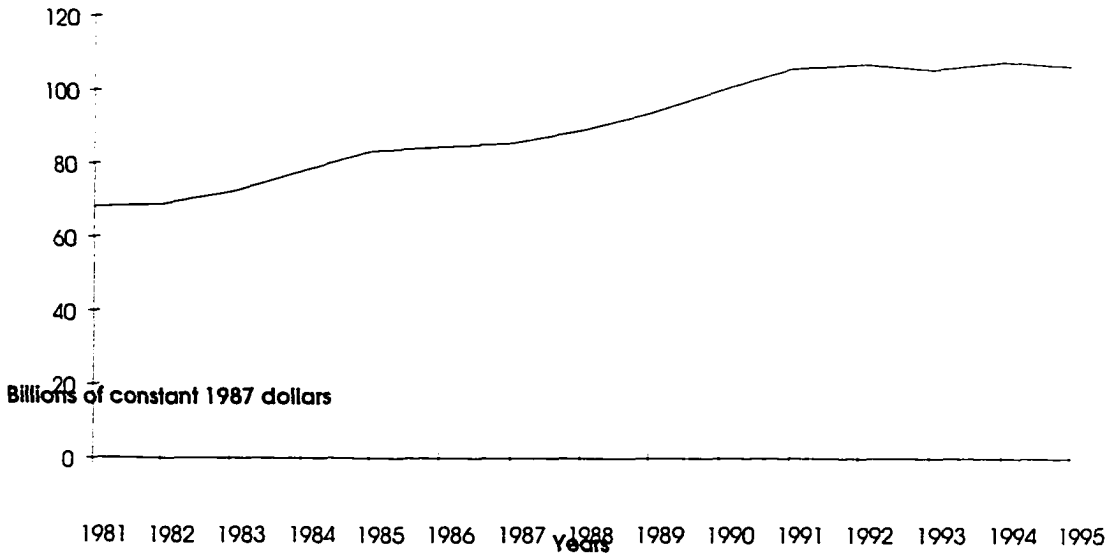

Figure 8.2, U.S. non-defense R&D expenditure, source: National Science Board, 1996, p. 155.

It is noteworthy that some defense-related R&D have been kept secret from the public so that Figures 8.1 and 8.2 may not include the actual sums spent on this R&D.

Several examples illustrate the secret funding of military technology. In 1988, the Department of Defense (DOD) did not reveal how it spent 27 percent of its requested R&D expenditure, which was about $12 billion. Some of the Pentagon's R&D have also been kept secret to include the Stealth bomber. Thus, this black expenditure may increase the actual amount of the U.S. defense-related R&D expenditure. The reason for this security is obvious to anyone remotely familiar with defense matters. If one keeps adversaries unaware of the true nature of the threats that they may soon encounter, they will have few ways to respond effectively.

This paper's hypothesis is associated with how the U.S. has supported defense technology. Data about U.S. non-defense R&D expenditure and explanations about secret defense funds indirectly show the heavy U.S. investment in defense technology. Moreover, data about the national budget distribution of R&D by socioeconomic objective directly shows the U.S. focus on defense technology. In short, the above data confirms that the U.S., which is an independent variable, has supported defense technology, which is a dependent variable.

The U.S. national security just after the Second World War generally kept pace with the increasingly liberal and open economic system. This state of affairs could not last forever, however, mainly because of various challenges to security. To maintain its security base, the U.S. government increased its policy of protectionism when its industries were threatened by other countries. Its emphasis on national security is evident in several cases discussed later in this paper. To block other countries from acquiring

certain defense or industrial technologies from the U.S., the governmental controls on these were tightened (Kohno, 1995, pp. 203-215).

Export controls have been significant to the U.S. overall national security policy. After the U.S. enacted the Export Administration Act (EAA) in 1969, it tried to increase trade with the East. At the same time, the U.S. focused on national security through controlling commercial interests with the East. The U.S. continued to amend the EAA in 1977 and 1985, and it controlled exports to communist countries (Bertsch and McIntyre, 1983, pp. 119-120; McDaniel, 1993, pp. xi-xii). Particularly, the 1979 amendment of EAA gave government authority over export controls, and thus national security was separated from trade policy.

The efforts of the U.S. Congress to change and reform export controls were not completely successful even after a series of EAA amendments, primarily because the executive branch always checked those efforts. Nonetheless, the Bucy Report of 1976 crucially affected national security policy, as it emphasized the significance of revolutionary manufacturing technology and advocated its protection by increased controls and restrictions on defense technology. Despite these export controls, Eastern Bloc nations and other countries obtained defense technology. Ultimately, however, U.S. efforts slowly succeeded in restricting the export of this crucial information.

The goal of the policy on current export controls is to make it difficult for Russia and some former Soviet republics to transfer or use critical defense technology. Many critics have warned that U.S. and Western technology could find its way to Russia and thus assist the nation to build better weapons and threaten world peace. Such warnings

have been promoted the U.S. and other allied countries to cooperate on establishing export controls policy. In the meantime, this export controls policy has helped the U.S. and NATO to keep their qualitative advantages in weapons, communications, information, and control ability (McDaniel, 1993, pp. 97-98).

During the Reagan administration, the DOD educated both the public and allied countries about the costs of transferring defense technology to communist countries. Indeed, the acquisition and the transfer of high-technology have become key elements in national security policies between super-power countries since the Reagan administration. In 1982, Executive Order 12,356 provided for close control of technology transfer to the Soviet Union, a situation quite similar to the export controls law.

Soon thereafter, the Pentagon intervened to prevent Japanese industry from investing in U.S. industries including high technology. NASA followed suit in 1986 when it made a list of foreign companies that were not allowed to access NASA's technological information. According to the Omnibus Trade and Competitiveness Act of 1988, the U.S. president can block mergers, acquisitions, and takeovers to avoid foreign control over entities engaged in interstate commerce. In addition to these restrictive regulations, the Reagan administration accelerated the buildup of arms, thereby reversing a trend of military emasculation begun under the Carter administration. The growth rate of arms during Reagan administration was faster than that of any other country, as defense R&D and weapons procurement increased (Deger and Sen, 1990, p. 42).

The U.S. took active steps to punish those who would transfer technology to America's rivals. In 1988, the U.S. Congress opposed the sale of the Aegis air defense

system to Japan, because a Japanese company had illegally exported submarine propellers to the Soviet Union. Although Japan eventually bought the Aegis system, the incident clearly illustrates the American concern for national security. As if to reinforce this message, U.S. industry blocked a Japanese company's economic activities in the Fujitsu-AT&T case at almost the same time.

National security has also been closely related to policies toward growing industries. Federal and state governments have sharply increased funding for agricultural research, which has been a model for supporting technology adoption and adaptation by government. In addition, the U.S. government has increased defense-related expenditure for highly competitive products such as automobile industries. Aid to the automobile industry has been justified by national security, as it encourages innovation in industry (Magaziner and Reich, 1982, pp. 223-233).

Some have complained that the research conducted in American universities, many of which are supported by American tax payers, has helped foreign nations to outperform American industry. University officials have maintained that commercializing of academic research engenders financial advantages and expands the opportunities of research. Realistic critics retort that the commercialization of academic research is financed by grants, contracts, and other financial package, so it is not truly free. Since a lot of government funded research is frequently licensed not only to U.S. industry but to foreign counterparts as well, many critics have advocated restricting foreign companies from participating in university research.

Compared to many foreign industries, Japan's industry has maintained the most intimate relationship with research in American universities. While U.S. industry has invested $5.9 billion in U.S. universities over the past ten years, Japanese industrial entities have allocated $4.5 billion during the same period (Tolchin and Tolchin, 1992, pp. 217-230). Huge amounts of money from Japan's industry have been aimed at luring American scientists to work on specific research. Ironically, by supporting American think tanks as well as universities, Japan's industry has drawn a sympathetic response from many critics there.

The U.S. government used to respond to foreign encroachment in American universities by claiming equanimity. The government did not express an urgent need to curb foreign access to universities. However, in 1991 U.S. officials began to clearly express their dissatisfaction about foreign access to domestic research. Meanwhile, Japan's industry hoped to enlist many top American scientists in a Japanese computer design project, so the U.S. government tried to disrupt this action by officially criticizing Japan's industrial policy. The U.S. government considered Japan's intrusion into U.S. academia as serious, so it suggested to the MITI that the 1988 science agreement between the U.S. and Japan was inappropriate. Japan's government never obtained permission from the U.S. government for financing research, after U.S. officials told Japan not to do it again.

It has recently been revealed that U.S. telecom systems were transferred to a Chinese company. The telecom system technology can rapidly move a populous state such as China into the information age, and thus spread capitalistic and democratic

principles. However, because this dual-use technology has been controlled by Chinese Army, already infamous for its crackdown at Tianamen Square, many have expressed their concerns that this technology could help China to build its military (Mahnken, 1996, p. 30). Also, considering the 1996 showdown over the Straits of Taiwan, many Americans believe that the Chinese military has improved its application of acquired U.S. technology. Therefore, concerned individuals have tried to influence the U.S. government to take punitive action against China now.

The issue of national security has become more complicated and even more interdependent on other factors since the beginning of the post-Cold War era, mainly because the relevancy of heavy defense technology has been questioned. Whether defense technology increases or decreases profits in the U.S. economy is a very controversial argument (Gregory, 1993, p. 6), because many analysts have different opinions concerning the matter. Therefore, it is clearly difficult to take a firm stand on whether or not it has a positive or negative impact on the U.S. economy.

Be that as it may, economic growth is certainly not completely separate from military security, as indicated earlier. Defense security always includes factors such as economic dimensions, sources of economic power, the supply of important materials, and economic sufficiency, to name a few. The U.S. support for defense-related R&D has not entirely disregarded the economic effect. Defense-related R&D usually includes a huge amount of government expenditures which include government subsidies, contracts, and procurements, and thus private industry finds it lucrative to become involved in defense-related R&D (Difilippo, 1990, pp. 5-7).

By the same token, the relative decline of U.S. economic growth engenders a threat to its national security. Traditionally, economic growth is involved in an economic base of defense technology, as well as in a wide range of industrial production activities. Although economic threats appear less serious than military threats, many believe that a gradual erosion of the economy may have a similar consequence on military security. National security should not be viewed only through military security any longer, as it clearly involves economic security.

The end of the Cold War brought a different world order, because the threat of the former Soviet Union decreased substantially. As a result, U.S. military expenditure has declined in successive years. Thus, as a result of this reduced military confrontation, economic security is certain to increase in importance with regard to national security. Industrial technology has grown more important, in particular, with the rise of Japan (Sarkesian, 1994, pp. 3-21).

In most cases, competitiveness is the main reason for improving industrial technology (Magaziner and Reich, 1982, p. 2; Zysman and Tyson, 1983, p. 7; Nelson, 1992a, p. 129). When many people examine the difficulties of U.S. industry, they concur that competitiveness is increasing in importance. Competitiveness is generally measured by productivity, which is measured by a ratio of inputs to outputs. U.S. productivity has thus far been the highest in the world, even though its growth rate has recently been slower than that of many competitive nations (Green, 1996, pp. 7-24). Because of the relative decline of its hegemony, the U.S. is turning its interests toward industrial technology. This does not mean that military security is less significant. By maintaining

defense security, economic security has increased its importance since the end of Cold War.

In conclusion, the U.S. began to develop defense technology as a result of its experience in the Second World War. During the postwar period, the threat of the Soviet Union continued to cause the U.S. to focus more on defense technology than industrial technology. National security has thus been reflected in many cases by control of exports and related laws, protection for growing industry, prevention of foreign association with American universities, and increased worries over dual-technology transfer. After the end of the Cold War, national security has turned to economic security and thus the U.S. has tried to recover from its relative economic decline that resulted from the rise of Japan's economy.

Chapter Nine
Innovation Institutions and Their Relationships

Historic factors help explain why Americans have a love affair with technology. One might think that these historical precedents would lead to an orderly approach to the development of technology. This is not the case, however. The U.S. government has made direct and indirect efforts to help public and private technology programs, yet it does not have one single comprehensive public agency devoted to technology. Instead, the U.S. has many fragmented and regional institutions, and each has its own role for specific technology. For instance, the U.S. has many uncoordinated organizations such as the Department of Defense (DOD), the Department of Commerce (DOC), the Department of Energy (DOE), the Department of Agriculture (DOA), the Small Business Administration (SBA), the National Aeronautics and Space Administration (NASA), the National Science Foundation (NSF) and several other entities that deal with technology development.

Many factors explain why so many public institutions have access to U.S. technology. These include various regional and functional groups in the electoral system, the decentralized committees in the U.S. Congress, constitutional emphasis on separation of powers, and so forth. The nature of this microeconomic policy-making, which differs considerably from Japan's macroeconomic policy-making, also contributes to the fragmentation of the institution of technology. In addition, because each administration

has changed their support of industrial policy according to bipartisan factors, it is difficult to attain coordinated innovation system (Krauss and Pierre, 1993, pp. 177-183).

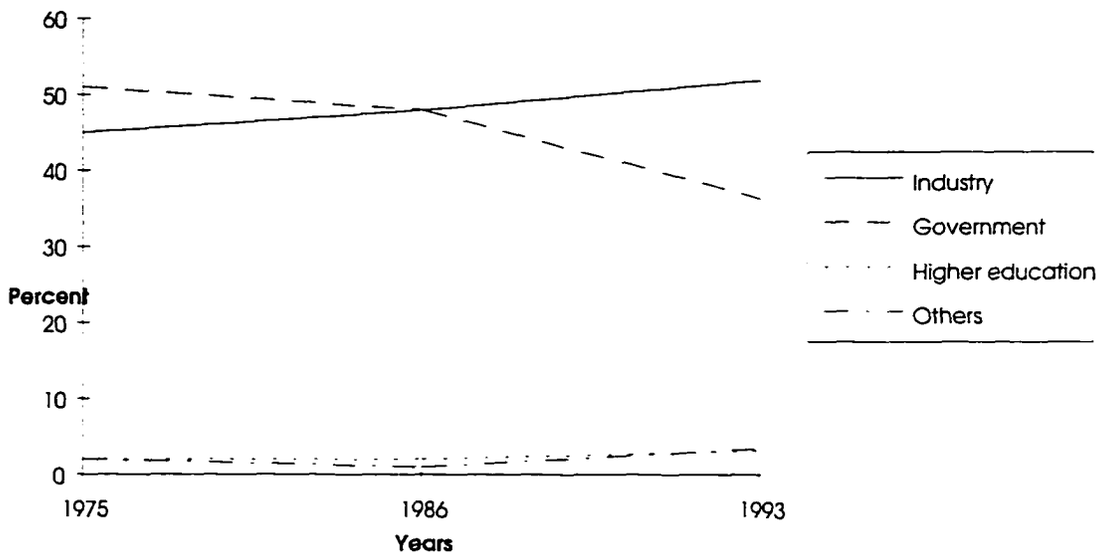

Figure 9.1, U.S. national R&D expenditures by source of funds, sources: National Science Board, 1996, p. 157 and National Science Foundation, 1991, p. 12.

While some public agencies share specific technologies or cooperate on programs once in a while, the operation of these decentralized innovative institutions generally works well within the pluralistic culture of the U.S. According to Figure 9.1, most of national R&D expenditures have been supported by the government even though industry has recently increased its support for this R&D, and in so doing have outstripped government expenditures by far. In particular, compared to Japan, the support of the U.S. government has been much larger than Japan's government of the tune of 23 percent. Also, the U.S. system has much specialized expertise in various technological specialties. Moreover, these institutions are of a politically horizontal nature, involving political leaders and career specialists. While both federal and state governments influence the

evolution of technology, the federal government has redirected its program for education. training, fellowships, and financial aids. Meanwhile, the state governments have focused on regional technologies.

Once again, the history of government involvement with R&D is well worth considering. The federal government expanded its power over R&D during World War Two. After that, it usually allowed the market to handle the civilian development of technology by supporting basic research for commercialization without government intervention. Before the 1980s, cooperation in R&D by the federal government was no more prevalent than fostering some research parks, funding for agriculture technology, supporting land grant universities, and investment in a few national labs (Mowery and Rosenberg, 1989a, pp. 108-109). It was a clear case of the right hand not knowing what the left hand was doing. Since the middle of the 1980s, the government has expanded its role of initiating support for commercialization of basic research. In so doing, the federal government helped U.S. industry benefit from the commercialization of technology. In contrast, foreign industries do not have a faster cycle of commercialization.

As a testament to U.S. reliance on R&D, some estimates hold the U.S. has 16.597 R&D labs, though others reckon a smaller number (Bozeman and Crow, 1990, pp. 25-26). Needless to say, this number varies according to differences in criteria. Regardless of the exact number, the U.S. has developed large numbers of labs since World War Two. Federal departments and agencies have had their own labs to support many kinds of research. Also, many federal labs in various agencies have greatly expanded their efforts for the commercialization of defense technology and other federally-funded innovations.

Besides federally funded labs, American universities have greatly contributed to U.S. research productivity. Universities have produced many internationally known scientists and engineers, and thus have engendered an excellence in research. Even when industry has had difficulties in competing with other nations, research in universities has sometimes resulted in Nobel Prizes after the essence of their intensive research is publicized. Scientists in American universities have been particularly creative, because they enjoy a strong relationship between teaching and research, thus they develop the habit of independent study before their prime. As a result, competition for research funds becomes increasingly intense (Smith, 1990, pp. 171-178).

More than half of basic research funds in the U.S. have been spent by university labs, and this basic research accounts for over two thirds of research conducted in American universities. This means that university research is basic in nature rather than applied or developmental. Basic research increases fundamental knowledge, though it lacks an immediate application. In contrast, applied research gains knowledge through necessity, and development clearly involves a systematic use of research. Most basic research is conducted by specified universities rather than spread out both small and large universities, thus a degree of specialization is present. About 200 research and development universities have spent most of the basic research funds allocated to them (Matkin, 1990, pp. 9-10). Also, universities' research has been used in many other related areas. One of the unidentified spin-offs or benefit from the universities is their methodologies and instrumentation. This by-product of observation and measurement in

basic research has provided a very versatile asset for many other fields to develop technology (Rosenberg, 1994, pp. 250-251).

For better or worse, universities have recently responded to many internal and external changes, and thus they have actively promoted economic development. This goal not withstanding, some changes have threatened the role of universities through the reduction of research funds. Yet, others do provide new research opportunities. Thus, to adjust to a variety of changes, universities transfer technology to appropriate institutions. This technology transfer has two important implications. First, universities can expand their relevant relationships with partners through technology transfer. The partners may include either commercial industry or other non-profit patrons outside the collegiate community. Another implication is directly related to the profits for universities through intellectual property rights. This is more directly related to economic growth than the expanding relationship with other institutions. Moreover, institutions of higher education traditionally are not set up to make profits, unlike other economic entities in the U.S.

Private industry plays many roles in fostering competitiveness in the U.S. It allocates employees, natural resources and capital. At the same time, it provides low-cost and high quality products to U.S. consumers, in so doing implementing decisions about resources. Many U.S. industries have their own in-house labs, and thus they develop cutting-edge technology to help the national economy. To illustrate this, figure 9.2 shows that about 70 percent of national R&D expenditures have been spent by industry. This means that industry rather than government or universities has been a major performer for R&D in the U.S.

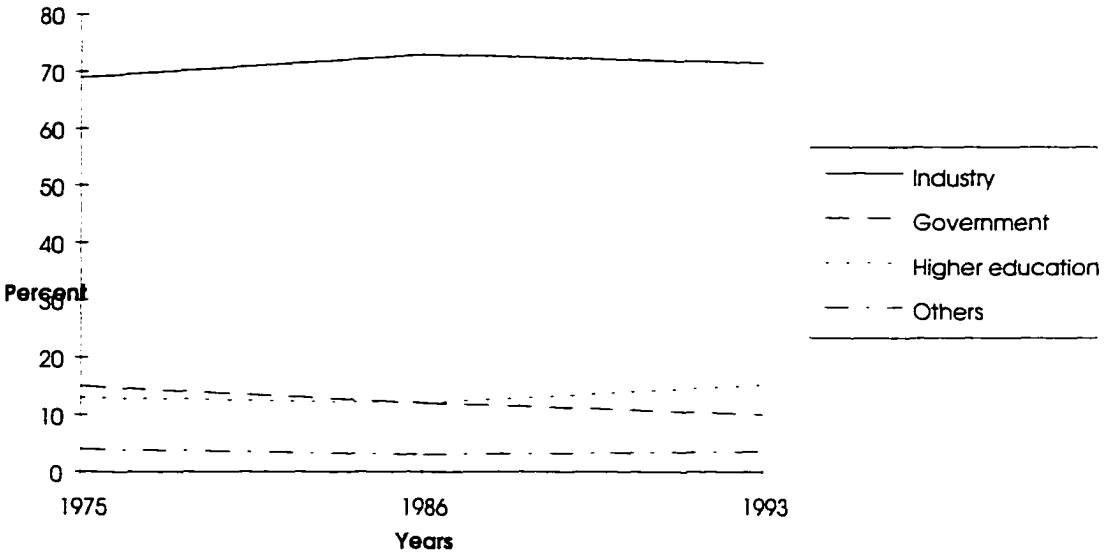

Figure 9.2, U.S. national R&D expenditures by sector of performance, sources: National Science Board, 1996, p. 157 and National Science Foundation, 1991, p. 14.

Within these industries, scientists and engineers have shown a peculiar tendency to solve problems provided by their colleagues in the same field before working on their own technological problems. One might guess that happenstance and serendipity account for this, but they usually work on both basic and interdisciplinary researches for commercialization. In general, however, research in interdisciplinary and applied science is emphasized more than basic research for immediate financial benefits. Researchers exchange information and interact with those who work for production and marketing.

Many different types of industries have performed R&D in the U.S. Particularly, small businesses involved in high technology have noticeably increased cooperation with researchers and developers of large businesses (Horwitch, 1986, pp. 39-64). As a result of antitrust policy and the concept of fairness, especially small and medium sized businesses have been noteworthy in technology development and diffusion in the U.S.,

especially areas such as robotics, computer, microelectronics, and biotechnology. In contrast, Japan's large industry, including the Keiretsu, plays a major role in technology.

As one might expect, various cooperative programs have been established among industrial labs (Nelson, 1992a, pp. 129-130). In general, this cooperative research has occurred between private companies since 1980. Several factors explaining this development include cost reductions, long-term strategies, search for new markets, reduction of time for innovation, the aspect of partners' technological-complementary, monitoring for technological opportunities, and various other reasons (Hagedoorn and Schakenraad, 1990, pp. 3-28). Research consortia have begun under the National Cooperative Research Act in 1984, since it allows many companies to pool their efforts toward technology (Cleland and Bursic, 1992, pp. 108-113). In joint ventures, companies share each other's markets and technology. In short, active collaboration sometimes even with competitors has recently become more commonplace.

The relationships among the three institutions just noted have developed along different paths. The U.S. federal government increased support for university research at the beginning of World War Two. It has been the biggest source of financing university research by purchasing expensive technology equipment and facilities, as well as by enlarging the scientific staffs for universities. The U.S. government has collaborated directly with universities conducting research by allocating different rates of funding to each major university. The government has encouraged a strong linkage between college teaching and research, in the meantime helping its own status as an assessor and shareholder of technology. This expanding support has transformed American

universities into an important source of technology. Also, when the National Science Foundation opened research centers on many campuses, state governments have further funded education at these active universities.

An examination of figures 9.1 and 9.2, shows that the U.S. government has allocated much of the national R&D expenditures, while industry has primarily conducted these R&D expenditures. Compared with Japan, whose industry has been a major financier and conductor of national R&D expenditures, the term technology transfer is nevertheless most applicable to the U.S., since its government has transferred technology from federal labs to industry for several decades. In short, there has been a long history of cooperation between government labs and industrial labs in the U.S. (Fusfeld, 1994, p. 234). This cooperation is exemplified by technology exchange agreements, joint R&D agreements, direct investments, joint ventures, and one-directional technology flows. Cooperative Research and Development Agreements (CRDAs) have continued to provide equipment, intellectual property rights, and personnel familiar with technology to private industry.

However, compared to the many technological products invented from federal labs, technology transfer between federal labs and industry has not been as successful (Berman, 1994, pp. 338-348; Bozeman, 1994, pp. 322-337). Security concerning defense technology has been emphasized more by the government than its transfer. In other words, since technology in federal labs is related to defense technology, engineers in industry have difficulty accessing it. There are many additional reasons for the difficulties of technology transfer that include legal problems, a lack of publicizing

federal technology development, and the differences of scientific attitudes as opposed to business attitudes.

Collaboration between industry and universities was established before the 1940s. Since that time, U.S. industry has frequently decreased its financial support of universities up to 1985. Also, the amount that industry spent to support university research was relatively small when compared to that allocated by the government, though it is still growing. Moreover, cooperation has raised several questions over who should take credit for certain research results. Because industry provides R&D fund to universities, it claims that research should result in exclusive profits. However, universities want to publicize their research results in as many publications as possible to increase their academic prestige (Noori, 1990, pp. 311-331).

For the last decade, industry in the U.S. has opted to cooperate on research with universities. U.S. industry has begun to build research facilities at universities with the goal of achieving lucrative profits. This has been a two-way street, since universities have increased their efforts in conducting basic research (Mowery and Rosenberg, 1993, pp. 47-48). Furthermore, universities can train people and direct them to industrial occupations. To access and employ new graduates, industry offers research fellowships and grants to graduate students and faculty members. Industrial authorities have frequently visited university labs, and thus university scientists have consulted with many companies on the mundane.

In spite of reduced industrial support for universities as opposed to governmental agencies, a close relationship between industry and universities is evident in the U.S., as

opposed to Japan whose industry belatedly began to increase its cooperative relationships with universities in the 1980s. Many U.S. industrial labs are associated with famous universities, such as Bell Labs, DuPont, IBM, General Electric, and Eastman Kodak. As one crucial and powerful component of the unique American innovation, the cooperation between government and private sectors has mobilized industrial innovation and resources for economic growth.

Cooperative research between universities and industry has been increased through the financial help of government. For this purpose, the federal government has relied on its many alternatives such as loosening restrictions on patents and licensing at the expense of the taxpayer as well as managing national coordination efforts. These policies also encourage cooperation between related firms (Rahm, 1989, p. 90). Government also increase information or personnel exchange between industry and universities by emphasizing national interests. On a larger scale, the government supports significant social goals that are opposite to private economic benefits.

By and large, the U.S. government does not define and implement policies for private industry to a greater extent than other countries. The government can assess the potential market for different industries and encourage them to adopt a new technology. Nonetheless, the U.S. government plays more indirect roles for industry than any other country by recognizing less direct government support and more deregulation for private industry. The initiative for a technology has been initiated more often from industry than from government (Vogel, 1987, pp. 91-114). This differs drastically from Japan's innovation relationship.

In conclusion, the U.S. does not have a single public agency to comprehensively direct technology. Rather, it has many uncoordinated innovation institutions that play their own roles. While universities have mainly focused on basic research, industry has spent the lion's share of national R&D expenditures. In those three sectors, many kinds of cooperative research have been conducted, especially since the beginning of the 1980s. The cooperative relationship between universities and industry has been more noticeable in the U.S. than in many other countries. Industry wants to use the basic research conducted by universities to acquire profits. Finally, the initiative for technology comes from private industry rather than public agencies.

Chapter Ten
Instruments of Technology Policy and Strategies

Technology policy means different things to different people. In this chapter, technology policy, which is widely known as industrial policy, is the extent that the government intervenes in allocating technological resources. In this allocation of resources, considerable political activity is involved, and even more so than economic factors. The issues of technology policy have been controversial since the beginning of U.S. history, since it has reflected many controversial matters such as government activism, free trade, protectionism, and various political and economic issues.

Technology policy has been driven by the Department of Defense (DOD) for decades, mainly because of the importance of defense technology throughout the history of U.S. industry. During the post-Cold War era, technology policy from the Department of Commerce (DOC) has gained more latitude to oversee civilian technology rather than defense technology. This does not mean that the policy of DOD has lost its authority, however, since neither are under the authority of agencies (Schafer and Hyland, 1994, pp. 597-599). As a result, the U.S. has not followed a single patterned and comprehensive technology policy, rather the innovative system is used. Thus, U.S. policy has been inconsistent as a result of domestic and international politics.

The U.S. has entirely dominated the realm of technology after World War Two, therefore it could promote a free and liberal strategy concerning technology or its transfer. Even though the U.S. helped other countries by providing them with technological

information, the Americans believed that U.S. products would not suffer competition from foreign industrialization. The U.S. had confidence in its superior research facilities and strong interfirm competition, thus it did not hesitate about releasing its advanced technology to Japan. Furthermore, because the U.S. considered technology to be secondary to military policy at that time, it tolerated the use of its high technology by other countries, to include European nations as well as Japan. Even though some people, including businessmen and labor workers, did not completely agree with this liberal policy, the U.S. generally kept technology policy open and liberal until the beginning of the 1960s.

Questions concerning U.S. technology supremacy began to be raised and its leadership has eroded somewhat since the middle of the 1960s. A flood of changes in both the international market and the domestic technological environment allowed the U.S. to adjust to an ever changing global environment. Because the economic activities of other foreign countries became more intense, the performance of the U.S. economy decreased in a relative sense. Congressional policy soon reflected pressures for protectionism, and it also pushed the president, who, of course, has considerable political authority, to manage various domestic interests.

Since the end of the 1970s, increasing international pressures have put every nation into an economic transition, and the importance of technology has loomed ever larger. The U.S. has faced intense foreign challenges in various sectors such as automotive, steel, textiles, electronics, and apparel, while the international market has caused considerable worry and anxiety for U.S. public and private authorities. Growing

numbers of U.S. industries have recently lost their pre-eminence in the global market, as foreign technology has grown increasingly sophisticated.

In response to competition from other countries, protectionism has appeared as a solution at the first glance, if one recognizes that all industrialized countries influence the pattern of technological investment through tariffs, quotas, and various taxes or subsidies. Foreign governments have used unfair competition in the belief that protectionism is the only relief available to them (Reich, 1991, p. 5). In particular, since Japan has used a broad range of protectionism policies to secure its economy, lobbying for protectionism has greatly increased in the U.S. Many Americans have witnessed the Japanese government's intervention, all encompassing to include forging close relationships between government and industry, long-term technology policy, and other protectionism means. This program resulted in significant technological advances.

Many American liberals including Democratic Congressmen and academics have advocated a comprehensive industrial policy like that of Japan. In 1984, former vice president Fritz Mondale, who was then a Democratic presidential candidate, also embraced the idea of comprehensive industrial policy. Similarly, Dukakis tried to revive elements of industrial policy in 1988. However, some studies also showed that government's intervention decreased technology development in Japan, mainly because it does not have lasting effects (Anchordoguy, 1989, pp. 13-14). Moreover, it would be difficult for the U.S. to follow the Japanese style of targeting policy. Thus, the Reagan administration rejected industrial policy as unnecessary, because it believed that many changes in Japan's policy were simply not realistic, especially in the American context.

While the Reagan administration shunned a comprehensive technology policy, others have advocated it, including Pat Buchanan as recently as 1996 during the presidential race.

Not only is there controversy over the need for a comprehensive technology policy, but some experts even argue as to whether or not the U.S. has ever had a technology policy worthy of the name, mainly because the U.S. government, unlike Japan, does not control technology comprehensively. A majority of Americans show negative responses concerning the term industrial or technology policy, since they believe that government policy entails too much government meddling in private sectors. Their criteria for industrial policy include a systematic involvement of government in industrial affairs. Thus, the majority of Americans agree that U.S. government has no policy on the whole.

On the other hand, others support the existence of U.S. industrial policy, because the government always influences industry, at least on a small scale. Even though it is not cohesive, disjointed, and barely visible, the government still influences technological concerns by using minimal measures. Despite the fact that this technology policy has no grand design, they believe that every collection of small and temporary policy measures actively impact technology. Many aspects of technology policy do not rely on the extent of direct government involvement as much as those of other governments, but the U.S. has clearly borrowed ideas from other successful nations (Teske and Johnson, 1994, pp. 296-297). Their criteria for industrial policy are more precise and include a smaller range than those who oppose technology policy. Besides, others believe that the U.S. is

evolving toward use of a more explicit technology policy by using federal funding for R&D, converting efforts from defense to industrial technologies, and making other coherent efforts as compared to those of previous years.

Since 1980, the federal government has increasingly taken the initiative for technological competition. Some consider this a version of a federal policy (Berman, 1991/1992, p. 28). Particularly, many scholars have recently proven that the policies of state governments in the U.S. are much larger and more extensive than that of the federal government (Eisinger, 1990, pp. 509-513; Teske and Johnson, 1994, 306-307). Since many states use different measures to varying degrees to implement technology policy, they influence the economic growth of the market. During the last decade, many state governments have relied on intervention to help private industry. They have frequently specified economic goals, time limits, and other strategies that are non-coercive, as they claim.

Be that as it may, the different criteria of industrial policy make it harder to determine if the U.S. has a technology policy. If the pressure for an industrial policy has truly increased, the U.S. is still progressing in that direction. Because of that complexity, rather than determining if the U.S. has an industrial policy, this chapter describes the realities of the process of forging an industrial policy in the U.S.

Despite an ambivalent and flexible technology policy or strategies, the importance of manufacturing technology, which of course is closely related to the former, has continued to be emphasized by both politics and economy. The U.S. manufacturing system originally started in federal armories in the middle of the 1840s, as it received

support from military and federal governments. Epitomizing the latest in advanced modern technology, interchangeable firearms were made everywhere in the U.S. during that time. Through armory mechanics and engineers, the U.S. government transferred and spread a manufacturing technology to private industry, even though its distribution was hardly equal in the private sector.

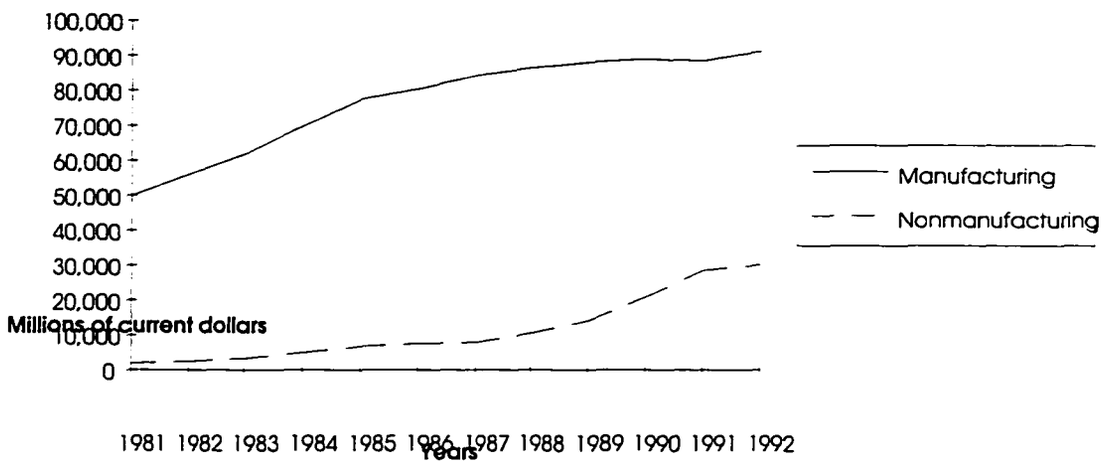

Figure 10.1, U.S. comparison of R&D for manufacturing and non-manufacturing, source: National Science Board, 1996, p. 268.

Private industry continued to improve that manufacturing technology not only through the technology itself but also through a receptive U.S. military (Hoke, 1990, pp. 4-8). Around the Civil War, the U.S. supported manufacturing technology much more so than it did non-manufacturing technology. Especially during the 19th century, because the U.S. had rich natural resources, a large market, and high wage rates, experts considered manufacturing technology vital for mass production industries. By 1900, most U.S. manufacturing industries were based on large scale operations (Nelson and Wright,

1992, p. 1939). Since that time, the U.S. has led high technology industries on a global basis by heavily investing in education for manufacturing as well as manufacturing R&D. Figure 10.1 illustrates the vast extent of American support for manufacturing technology in the 1980s and 1990s.

Manufacturing technology has provided a variety of benefits. Because of its timely reaction and good products, manufacturing technology offers many advantages to industry. By lessening the costs of product design, product development, collecting data, and production equipment, manufacturing technology has reduced the price of other industrial products. Manufacturing technology also has a considerable capacity for improving the quality of products and production processes. Therefore, manufacturing technology has been a basis of integrating other industries and their manufacturing capability.

In addition to the benefits just mentioned, manufacturing technology can increase employees' skills, primarily because a manufacturing technology cannot be used by uneducated employees. Only educated and trained engineers or scientists are able to deal with manufacturing technology effectively, so the mere use of manufacturing technology improves workers' skills. Also, suppliers of manufacturing technology play an important role in designing it, whereas customers are served through both favorite technologies and after-sale service. Clearly, a manufacturing technology affects many people, and it expands the wide range of knowledge.

A byproduct of large-scale manufacturing is employment for many people, be it in manufacturing or service industries. Many service jobs are not merely substitutes, but

rather they are complementary to the manufacturing industry (Cohen and Zysman, 1987, pp. 7-8; Milgrom and Roberts, 1990, pp. 511-527). In short, manufacturing technology creates many jobs, to include service industries. Vice versa, when the manufacturing industries experience difficulty, many lucrative service jobs suffer and thus the wealth of people declines. A strong manufacturing industry is essential to the welfare of the U.S. and international competitiveness, since a direct linkage exists between manufacturing businesses and services.

Similarly, when an industry cannot manufacture a certain product, it is certain that it cannot control the product. This problem with production logically leads to a weak competitive situation. Manufacturing technology is closely related to improving competitiveness within the U.S. economy. To increase competitiveness, U.S. manufacturing industry has achieved shorter product cycles, good quality, reliance on independent contractors and suppliers, and flexible organizations. Rather than effecting small adjustments to industrial changes, manufacturing industries have tried to achieve substantial, coordinated, and wide-ranging changes to improve competitiveness.

While the U.S. government has historically supported manufacturing technology, its economy has recently begun to depend primarily on specific sectors of the economy. Recent studies reveal that specific factors explain the change in the competition of certain sectors of U.S. in the context of domestic politics as well as international partners (Zysman and Tyson, 1983, p. 8). To target specific sectors of the economy, the U.S. government can change patterns of investment by using tariffs, quotas, special tax laws, loan guarantees, patents, export promotion program, and other measures.

For this purpose, a policy focusing on sectors is needed rather than a policy with aggregate objectives that addresses all economic sectors such as environmental protection and economic stability to compete with other foreign technologies. A sectoral policy emphasizes that each individual sector should have more appropriate and timed policies that would of course differ from one another. The U.S. government has already monitored different policies among growing as well as ailing sectors of a whole industry.

For ailing industries, the U.S. government has protected them by using tariffs, quotas, voluntary export agreements, and other subsidies. This policy primarily protects business from experiencing diminishing returns in imports to include textiles, apparel, footwear, television, steel, and others. When a particular sector of an industry is in decline, the U.S. government decides on a policy to improve it. Were it not for the government to help maintain competitiveness for decreasing industries, those industries would have considerable difficulty improving. This does not mean that government controls industry. Rather, it means that coherent policies are helpful in maintaining competitive productivity.

In the meantime, politically powerful regions of the U.S. and certain fields of technology have promoted industry. The U.S. government, including a group of separate agencies, has purchased emerging products and thus promoted growing businesses. The government has also supported R&D laboratories for growing industries (Magaziner and Reich, 1982, pp. 197-224). In short, this policy for growing industry has required subsidies, tax expenditures, government procurements and other measures. Also, many

programs including sectoral policy have resulted in benefits to agriculture and many defense-related industries (Cohen, 1991, p. 102).

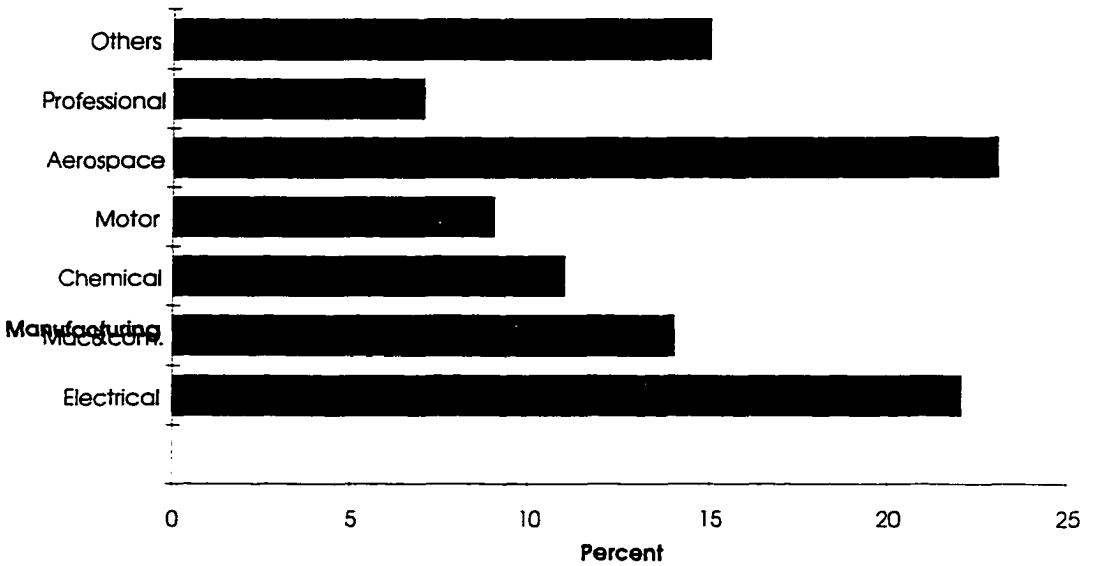

Figure 10.2, U.S. proportional allocation of industrial R&D among manufacturing industries in 1986, source: National Science Foundation, 1991, p. 20, note: Electrical = electrical equipment, Mac&com. = machinery and computer, Chemical = chemicals and allied products, Motor = motor vehicles, and Professional = professional and scientific instrument.

Among many important technologies, Figure 10.2 shows that the U.S. has supported both aerospace technology and electrical equipment technology, primarily by emphasizing manufacturing technology and sectoral policy. Stimulated by the competition with the former Soviet Union and discouraged by the tragedy of the space shuttle "Challenger," the NASA has mainly wielded its influence over aerospace industry. For decades, the Americans have felt compelled to explore space, while military security has driven the efforts in the aerospace industry (Handberg, 1995, pp. 1-3). No less important, but seemingly more mundane in comparison, electrical equipment technology has also received considerable attention for more than a century. The technology has

been the vanguard for increasing national competitiveness, in particular during the 1980s. Thus, it received considerable attention by the U.S. (Aspray, 1993, pp. ix-xiv).

In conclusion, there is considerable debate over whether the U.S. ever has a technology policy or not. Because the U.S. has kept a liberal economic order for a long time, a majority of Americans believe that a technology policy does not exist in this country. However, because some of the more systematic aspects of a technology policy have been practiced since the end of Cold War, to include federal funding for national R&D and other government efforts for cooperative research, it is hard to deny the existence of a technology policy of sorts. In spite of unclear definitions and criteria of technology policy, the U.S. has developed manufacturing technologies, most notably in the realms of aerospace and electrical equipment R&D since the Civil War. Moreover, it has recently taken variegated policies toward declining and growing industries as a sectoral policy.

Chapter Eleven
Conclusion

Japan has made every effort to catch up with the Western technology by capitalizing on cooperation among government agencies, private industry, and its people. This cooperation has been extraordinary noticeable throughout history, and in particular concerning the political support of government policy. Thus, pundits have often given "the Land of the Rising Sun" another moniker, Japan Inc. Across the pacific, the U.S. also realized the significance of technology to an economy from a point early in its history. Carrying out the goals of a super power, political entities in the U.S. have supported the development of high technology mainly by following private initiatives.

An examination of technology policy matters based on comparative public administration reveals both similarities and differences between American and Japanese technological development. As a result, the research question emerges that reflects two important principles of the comparative perspective by balancing between generalization and separatism. In short, the similarity between the two countries has been based on generalization, while the differences have been drawn from a unique separatism or specialization of comparative public administration.

A clear similarity between the U.S. and Japan concerning technology policy is that both actively support technological development through an emphasis on R&D. Moreover, both countries have eagerly invested in technology under their unique national ideologies. Japanese Confucianism and American individualism have resulted in

supporting the development and production of technology. About 24 percent of their total exports involve high technology related products. Furthermore, Figure 11.1 shows that the U.S. has spent about 125 billion dollars in each year, while Japan spent 49 billion dollars on national R&D expenditures as an average. The percentage out of the total GDP spent on R&D has been about 2.6 percent in each country. In addition, the U.S. has employed 962,700 scientists and engineers, while Japan employed 526,000 in 1993. Clearly, the two countries have supported R&D through huge monetary investments and committing great numbers of personnel to the crusade of R&D.

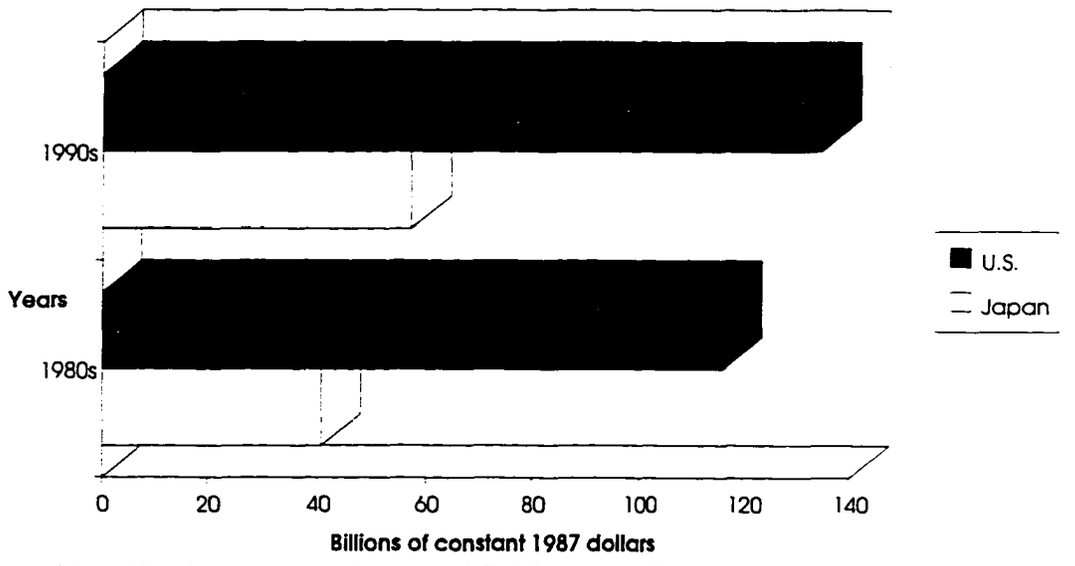

Figure 11.1, Yearly average of national R&D expenditures, source: National Science Board, 1996, p. 154.

It is no surprise that such huge efforts directed at R&D have prompted considerable attention. Three research sub-questions have been formulated and demonstrated for determining differences of technological development. All three examine the topic by examining innovation institutions and their relationships and

instruments of technology policy and strategies as well as the role of national security. Each research sub-question has challenged conventional wisdom to some degree. The first research sub-question has directly challenged the popularly held belief that Japan has focused mainly on industrial technology, while the second research sub-question has differentiated the applicability of term "technology transfer" between the two countries. Finally, the third research sub-question has addressed the American efforts toward developing a technology policy.

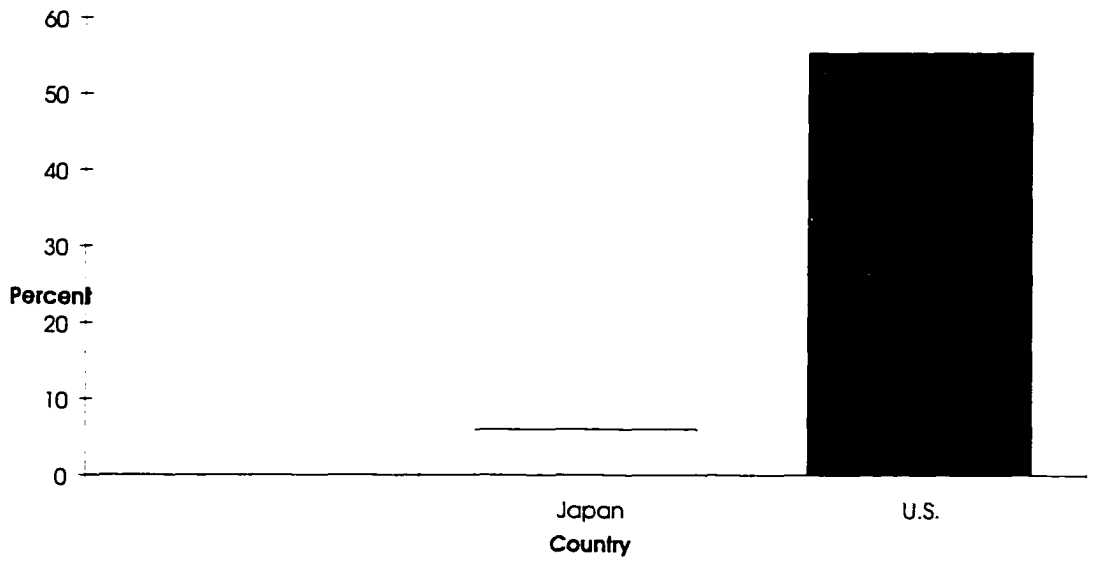

Figure 11.2, Defense proportion out of national R&D budget in 1992, 1993, or 1994, source: National Science Board, 1996, p. 153.

The first research sub-question holds that the U.S. has supported defense technology more directly than Japan has according to Figure 11.2. Meanwhile, Japan has not attempted to keep up with the U.S. in producing conventional weapons, rather it has focused on dual-use technology so that it could rapidly gear up its heavy industry in the event of military contingencies. As a result, official data concerning Japan's defense

R&D can be misleading. On the other hand, the U.S. has continued to invest in defense-related R&D much more heavily, and it accounts for about 55.3 percent of the national R&D budget. Industrial R&D thus takes second place. Clearly, a look at defense-related R&D in the two countries shows that the U.S. has directly supported defense R&D far more than Japan has, probably because Article IX of the latter's constitution has prompted it to focus on dual-use technology.

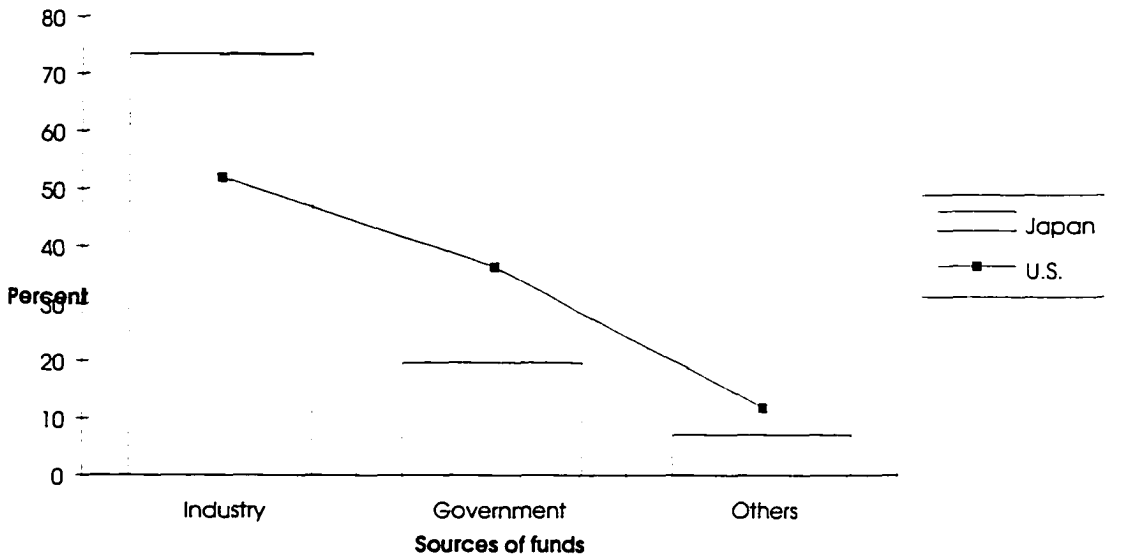

Figure 11.3, National R&D expenditures by source of funds in 1993, source: National Science Board, 1996, pp. 156-157, note: Others = higher education and other nonprofit institutions.

While both countries take different approaches to defense-related technology, Figures 11.3 and 11.4 show that the U.S. government and Japan's industry have been major sources of financing technological development for their respective industries. Private industry has spent about 71 percent of Japan's national R&D expenditures. At the same time, Japan's industry has been a major financier for these funds by allocating about 73 percent of national R&D expenditures. As for the U.S., its industry has consumed

about 71 percent of national R&D expenditures. Government and industry have both funded this research by providing about 44 percent (51.9 percent for industry and 36.3 percent for government) of the national R&D expenditures. Thus, the percentage of financing R&D by the U.S. government exceeds that of the Japanese government by about 24 percent (44 percent minus 19.6 percent). The term "technology transfer" is more applicable to the U.S. than to Japan, even though the role of Japan's government has been much greater through technology policy and strategies than that of the U.S. government. In short, the second research sub-question centers on the differences in government funds to finance R&D.

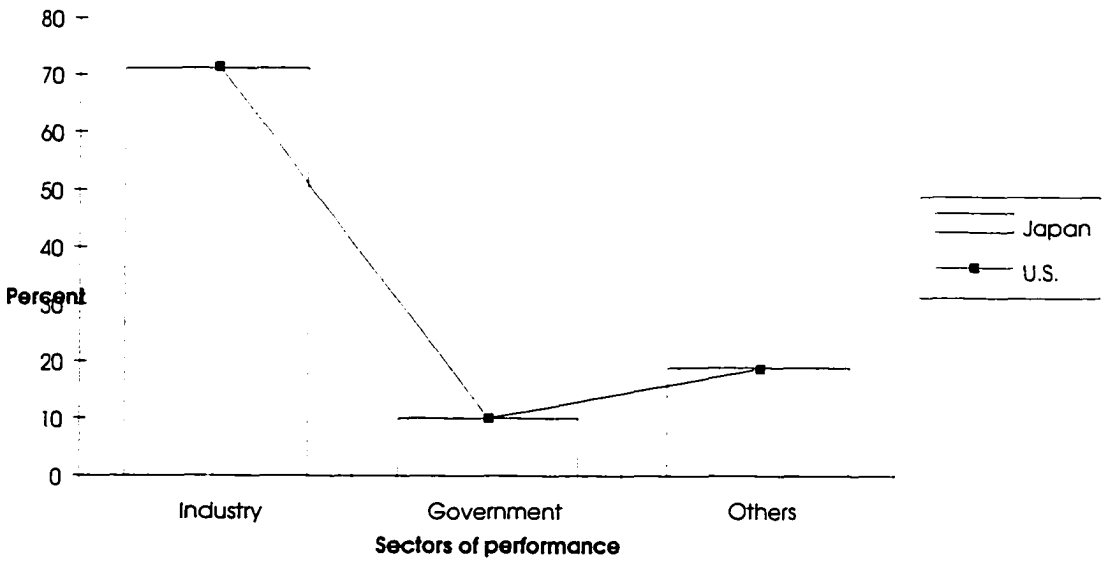

Figure 11.4, National R&D expenditures by sector of performance in 1993, source: National Science Board, 1996, pp. 156-157, note: Others = higher education and other nonprofit institutions.

The third research sub-question looks at specific economic areas that both countries supported. Based on Figure 11.5, the final research sub-question holds that the U.S. has closely supported aerospace technology as well as electrical equipment

technology, while Japan has strategically supported machinery and computer technologies as well as electrical equipment technology. Japan's targeting of electrical equipment technology accounted for about 18 percent of its industrial R&D expenditure, while R&D for machinery and computer made up about 22 percent of the industrial R&D expenditure. Meanwhile, the U.S. strategically invested in electrical equipment technology to the tune of 22 percent of its industrial R&D expenditure, as its aerospace R&D accounted for 23 percent of its industrial R&D expenditure, which totaled more than any other category.

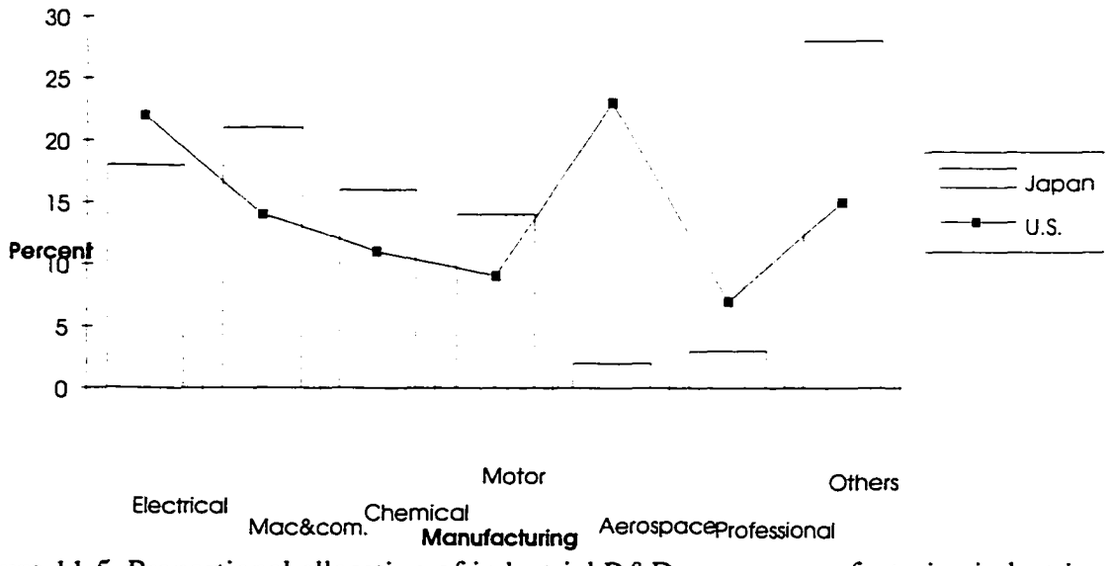

Figure 11.5, Proportional allocation of industrial R&D among manufacturing industries in 1986, source: National Science Foundation, 1990, p. 20, note: Electrical = electrical equipment, Mac&Com. = machinery and computer, Chemical = chemicals and allied products, Motor = motor vehicle, and Professional = professional and scientific instruments.

These total four research sub-questions, including one similarity and three differences, reveal that both countries have increased their support for technology, but the methods they took to develop technology are dissimilar. Moreover, no single factor can

explain how the U.S. and Japan have achieved their technological development. Many factors, such as the political support of R&D based on national ideology, the roles of national security, innovation institutions and their relationships, and the instruments of technology policy and strategies, have interacted to drive development in each country. The unique nature of each country is related to previous political, economic, and cultural factors as well as the flow of history. These combined factors shed lights on the success of Japanese assimilation of Western technology and the ascendancy of American economy, which is the most advanced in the world.

Among those many factors and research results, many observers of Japan have not detected a sinister new development in its economy, dual-use technology, which would allow Japan to rapidly produce offensive weapons. Rather than focusing strictly on the development of industrial technology, Japan has arranged to give this same technology the capability to quickly modify its factories to produce weapons, such as the TANSAM missile. This has been occurring much to the consternation of its Asian neighbors, who remember all too well the unspeakable atrocities committed by Imperial Japanese forces scarcely five decades ago. Survivors of Japanese brutalities and their offspring do not believe that the Japanese have changed their stripes. Unlike the Germans, who have owned up to their transgressions during the Second World War, the Japanese show little, if any, guilt over the conflagration which they set in the Pacific during the 1940s.

This paper's hypothesis holds that the U.S. and not Japan has supported the development of defense technology. With the above reason, the test result disconfirms the hypothesis that Japan has neglected defense technology. Rather, the data confirm that

both the U.S. and Japan, which are independent variables, have supported defense technology, which is a dependent variable. The major intent of this dissertation has been to provide an understanding of Japan's equal emphasis on both economic and defense sectors over past decades. They consider the development of dual-use technology as necessary for its security. It is noteworthy that Americans continue to worry about Russia's military, yet its defense budget was smaller than that of Japan in 1993. Clearly, paying heed to Japan's defense technology is something that is long overdue.

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