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JAPAN
Moving Toward a More Advanced Knowledge Economy

Assessment and Lessons




Edited by
Tsutomu Shibata

WORLD BANK INSTITUTE
Promoting knowledge and learning for a better world

WBI DEVELOPMENT STUDIES

Japan, Moving Toward a More Advanced Knowledge Economy

Volume 1: Assessment and Lessons

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Contents

Figures

Tables

Boxes

Foreword

Knowledge has long been recognized as a key source of economic growth and a valuable asset that can be leveraged, especially now in an era of increasing globalization. As a result of deeper integration among economies and fueled by the revolutionary advances in information technology (IT), the supply of and demand for knowledge and its application have led to significant challenges as well as opportunities for both developing and developed countries. To create and sustain an effective knowledge economy, countries and companies worldwide must become more knowledge-competitive. This book analyzes Japan as a knowledge economy, with a view to providing lessons for the developing world.

Japan's rapid economic recovery after World War II, assisted by imported technology, was indeed remarkable. In the mid-1960s, it was the second largest World Bank borrower, while only two decades later it was the second largest contributor. Already in the mid-1960s, Japan's GDP was beginning to catch up with some of the European economies.

In the 1970s and 1980s, Japan was held up as a model of economic growth for developing countries; and in the 1980s, companies in the industrial countries realized that they could also learn a great deal from Japanese firms. Some analysts even believed that Japan would dominate the world economy in most major industries because of its advanced production system. Then, in the 1990s, a long period of economic stagnation, especially relative to the resurgence of IT companies in the United States, led many to dismiss Japan as an important source of ideas.

These polar opposite perceptions, however, do not reflect the real Japanese economy past or present. The earlier positive assessments ignored the existence of a substantial number of uncompetitive industries, while the more recent dismissals ignore some highly competitive companies and industries. This book provides a more balanced account. In particular, it assesses Japan's status as a knowledge-based economy, applying the "four-pillar" analysis developed by the World Bank Institute (WBI), and highlights the success of several knowledge-advanced Japanese companies.

In mid-2006, the Japanese economy appears to be emerging from a lengthy stagnation. Japan has been a source of global best practices in both manufacturing processes and management; and although many of its characteristic large-firm management approaches may seem ill-suited to the evolving global economy, others have been adapted and continue to be on the cutting edge. On a macro level, Japan has become the world's second largest economy and has a very high level of social equity.

At the same time, Japan is facing many challenges as it moves into a more advanced position in the global knowledge economy, including the need for a more flexible labor market, and the provision of risk capital, safety nets, and lifelong learning. Some of these issues are also relevant to developing countries.

Among the achievements that modern Japan can be proud of is its economic growth with equity. Knowledge was a crucial tool in this process. What has worked in the past may not work in the future or in other countries, but it is nevertheless important to understand the underlying factors and dynamics. We hope that readers from advanced knowledge-based economies as well as those aspiring to higher levels of knowledge competitiveness will find the lessons and insights in this book useful.

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Three workshops were held. In addition to the authors, who are listed separately in a list of the contributors, participants were Kazumi Asako, Juro Teranishi, and Seiichiro Yonekura (all of Hitotsubashi University), Yukio Yoshimura (World Bank), Shin Horie (Goldman Sachs), and Carl Dahlman.

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Tsutomu Shibata

Glossary

Currency Equivalents

Exchange rate effective March 31, 2006
Currency unit = yen (JPY)

US$	1.00 = 117.8 JPY
JPY	1.00 = US$0.0085

Fiscal year April 1–March 31

All dollar amounts in this book are U.S. dollars, unless otherwise noted.

Abbreviations

3G	Third-generation [mobile telephony services]
ADSL	Asymmetrical digital subscriber line [for communication services]
AIST	National Institute of Advanced Industrial Science and Technology
AT&T	American Telephone & Telegraph
BOJ	Bank of Japan
BPL	Broadband [Internet access] over electric power lines
BPR	Business process re-engineering
CCD	Charge coupled device
CCE	Central Council for Education [advisory council of MEXT]
CEFP	Council on Economic and Fiscal Policy [cabinet-led group]
CIA	Comparative institutional analysis
CRM	Customer-relationship management
DDI	Daini-Denden Incorporated
DRAM	Dynamic random access memory
DSL	Digital subscriber line [for communication services]
ERP	Enterprise resource planning
FDI	Foreign direct investment
FILP	Fiscal Investment and Loan Program
F.O.B.	Free on board
FOMA	Freedom of mobile multimedia access
FSA	Financial Services Agency
FTA	Free trade agreement
FTTH	Fiber to the home [telecom services]
FY	Fiscal year [in Japan, for the government and most companies, ends in March of the following calendar year]
GDP	Gross domestic product
GFI	Government financial institution
GNE	Gross national expenditure

GRI	Government research institute
GSM	Group Special Mobile
GSM	Global system for mobile communications [telecom standard]
HDTV	High-definition television
HIC	Hybrid integrated circuit
IC	Integrated circuit
ICT	Information and communication technology
IMD	International Institute for Management Development
IMF	International Monetary Fund
IPRs	Intellectual property rights
IRCJ	Industrial Revitalization Corporation of Japan
IS	Information systems
ISDN	Integrated Service of Digital Network [telecom standard]
IT	Information technology
JABEE	Japan Accreditation Board for Engineering Education
JAIA	Japan Automobile Importers Association
JAMA	Japan Automobile Manufacturers Association
JDB	Japan Development Bank
JET	Japan Exchange and Teaching Program
JETRO	Japan External Trade Organization
JFTC	Japan Fair Trade Commission
JIT	Just-in-time
JT	Japan Tabacco
LANs	Local area [communications] networks
LCD	Liquid crystal display
LSI	Large-scale integration
KAM	Knowledge assessment methodology
M&A	Mergers and acquisitions
MAFF	Ministry of Agriculture, Forestry and Fisheries
METI	Ministry of Economics, Trade, and Industry[1]
MEXT	Ministry of Education, Culture, Sports, Science and Technology
MHLW	Ministry of Health, Labor, and Welfare
MITI	Ministry of International Trade and Industry[1]
MPT	Ministry of Post and Telecommunications
NCC	New common carriers [telecom service providers]
NEET	[People who are] not in employment, education or training
Nikkeiren	Japan Federation of Employers' Association
NIH	National Institutes of Health [United States]
NIH	Not invented here
NISTEP	National Institute of Science and Technology Policy
NIV	National innovation system
NPL	Nonperforming loan
NPO	Nonprofit organizations
NTT	Nippon Telephone & Telegraph

1. The Ministry of International Trade and Industry (MITI) was renamed and somewhat restructured effective January 6, 2001. It is currently called the Ministry of Economics, Trade, and Industry (METI).

OECD	Organisation for Economic Co-operation and Development
OJT	On-the-job training
OPT	Open protocol technology
PC	Personal computer
PDC	Personal digital cellular [mobile telephony standard]
POS	Point-of-sales
QC	Quality control
R&D	Research and development
RFID	Radio frequency identification [as a labelling system]
ROA	Return on assets
ROE	Return on equity
SAT	Science and Technology Agency
SBI	Science-based industries
SCM	Supply-chain management
SECI	Socialization, externalization, combination, and internalization
SMEs	Small and medium enterprises
TFP	Total factor productivity
TLO	Technology licensing office [found at many universities]
TPS	Toyota Production System
TQC	Total quality control
TRIPS	Trade-Related Aspects of Intellectual Property Rights [WTO term]
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
UNSD	United Nations Statistics Division
VOIP	Voice-over-Internet [telecom] protocol
WBI	World Bank Institute
WITS	World Integrated Trade Solution
WTO	World Trade Organization

Japanese Terms

Dankai	Japanese born during the 1947–49 baby boom. (Literally, "cluster.")
Denden family	Japan's government-owned monopoly telecom provider and its suppliers, especially prior to deregulation.
Kanban	System used to relay information about the quality and types of parts needed at each point on the production line. (Literally, "card.")
Kaizen	Continuous improvement.
Mekiki	"[A person with] insightful eyes." Said of those with the ability to discern the commercial potential of untested technologies, as well as the ability to translate them into a business model for exploitation.
Ningen ryoku	Comprehensive human capacity. The term refers to the well-rounded skills and knowledge of a person as a constituent of society, as well as the strength of the person to retain well-being as an individual.
Sogo-denki	General [broadly diversified] electronics companies.
Yokonarabi	"Do as others do" approach to business.

1

Introduction

Tsutomu Shibata

Knowledge and its application are recognized as key sources of growth. The importance of knowledge has created challenges and opportunities for both developing and developed countries. To create and sustain an effective knowledge economy, countries and companies must put in place appropriate arrangements to stimulate, encourage, and grow knowledge practices and to become more knowledge-competitive. This book analyzes Japan from this perspective, with a view to providing some lessons for developing countries.

In the 1970s and 1980s, Japan was looked to for lessons developing countries could learn to help them grow. In the 1980s, companies in advanced countries (and their governments) realized Japanese firms had much to teach them. Then, in the 1990s, Japanese stagnation, especially relative to the resurgence of U.S. information technology (IT) companies, led many to dismiss Japan as a source of ideas.

Why Study Japan?

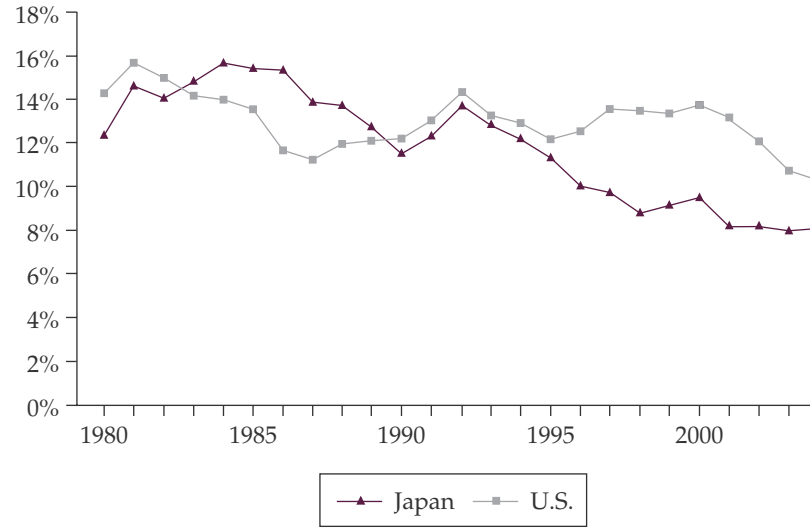
Some may ask why Japan, whose economy in the 1990s is viewed as "a lost decade," should be studied from a knowledge economy point of view. Particularly telling in this regard is Figure 1.1: it shows Japan's share of world trade in manufacturing fell by almost half from its 1984–85 high of almost 16% to its 2001–02 low of just over 8%. From 1983 to 1989, Japan's share exceeded that of the United States. Then, during 1990–95, the two countries had approximately equal shares. Since 1996, the U.S. share has exceeded Japan's, and Japan's share is below 10%.

Car manufacturing has sustained its competitiveness, while electronics—particularly computers and integrated circuits—lost competitiveness during the 1990s, according to research by Ando and Motohashi (2002) using trade specialization indexes. The same methodology is used to compare Japan in 1989 and 2004 to the United States (Figure 1.2) and to East Asia (Figure 1.3). The results are in line with the Ando and Motohashi analysis.

Figure 1.3 testifies to a more drastic change: computers and televisions, which in 1989 Japan had exported to East Asia without any imports from the region in 2004, were being imported into Japan with only a small number being exported from Japan.

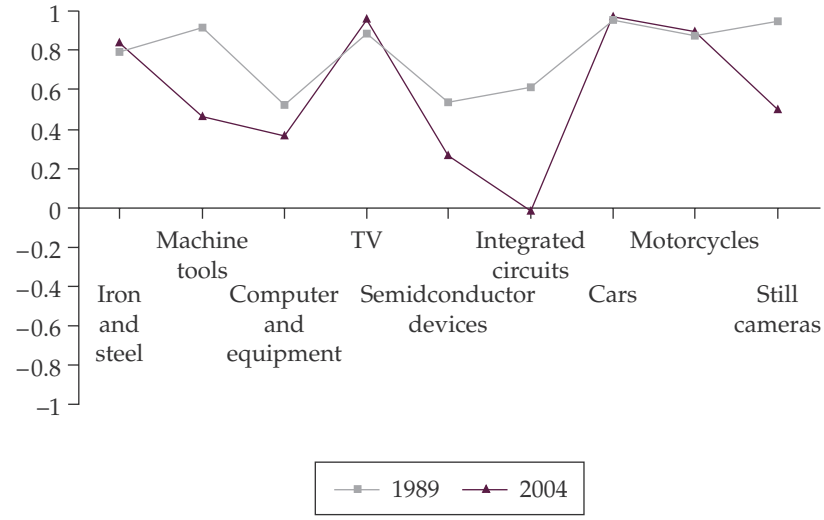
A more subjective measure of competitiveness comes from various rankings. One of them is discussed in Box 1.1. The appendix introduces another way of comparing countries that is broader than economic competitiveness—the Knowledge Assessment Methodology (KAM)—that was developed by the World Bank Institute (WBI).

Figure 1.1. *World Export Share of Manufactures (Japan and U.S.)*



Source: WITS Database, the World Bank, WTO, UNCTAD, UNSD.

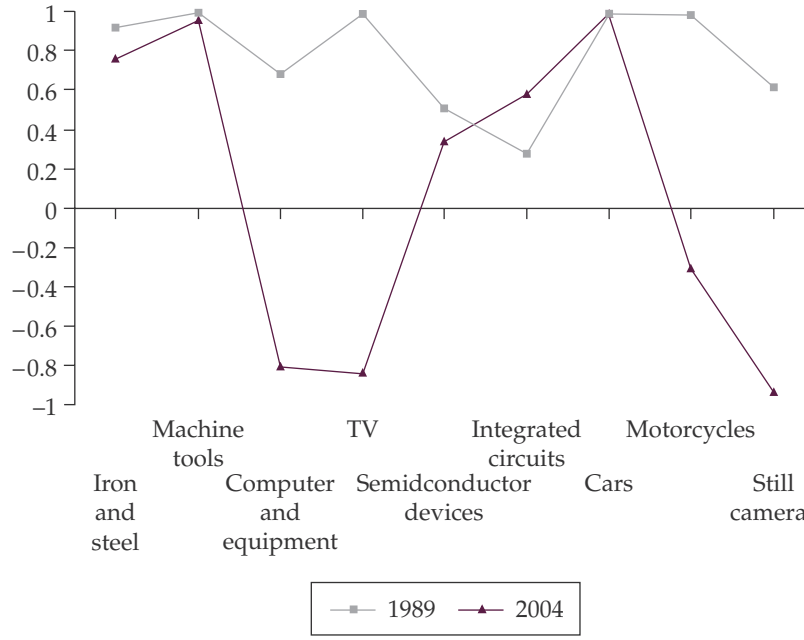
Figure 1.2. *Japan's Trade Specialization Index (vis-à-vis the U.S.)*



Notes: Trade Specialization Index is calculated as *(EX–IM)/(EX+MI)*, where *X* is exports and *M* is imports. For the chart above, Japan's exports F.O.B. to the United States are used for *EX*, and the United States' export F.O.B. to Japan is used for *IM*. Products are named as follows in WITS database. Semiconductor devices: *Diodes/transistors/etc.;* Integrated circuits (ICs): *Electron integ circuits;* Cars: Pass *motor veh exc buses;* TV: *Television receivers*; Motorcycles: *Motorcycles/mopeds*; Machine tools: *Mach-tools remove mtrial.*

Source: WITS Database, the World Bank, WTO, UNCTAD, UNSD.

Figure 1.3. *Japan's Trade Specialization Index (vis-à-vis East Asia and Pacific)*



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Source: WITS Database, the World Bank, WTO, UNCTAD, UNSD.

Box 1.1. *Competitiveness Rankings*

It is generally perceived that the Japanese economy has deteriorated tremendously since the late 1980s. There certainly is no doubt that overall Japanese competitiveness declined in the 1990s, as the economy could not react appropriately to the IT era and new financial tools, hanging onto the sources of their success in the 1980s.

Perceptions of competitiveness are often given to swinging between extremes. The 2005 *World Competitiveness Yearbook* (IMD 2005) ranked Japan 21st of 60 countries (including regions), up somewhat from the low of 23rd in 2004. Every year from 1989 (the year the ranking started) to 1993, Japan was rated number 1. Was the top ranking fully justified objectively? Even during the five years 1989–93, the economy's performance was deteriorating quickly. Take the corporate sector: The average ROE (return on equity) for manufacturing firms listed on the Tokyo Stock Exchange fell steadily during the period, dropping from 8.5% to 1.7%. If the top ranking of Japan in 1993 did not fully reflect the rampant signs of the coming "lost decade" then, by the same token, the 21st ranking in 2005 may not appropriately reflect underlying, ongoing changes and may not explain the sustained competitiveness of some excellent firms.

IMD's 2005 rankings for various criteria that make up the overall index list Japan as 56th for university education, 59th for entrepreneurship, and 59th for cost of living index. These are the lowest category rankings for Japan. But again, these criteria have not changed much for the past decade.

In 2002, Japan was ranked 30th of 49 countries. Ando and Motohashi note that this is a bit of an underestimate because of the influence of macro indexes such as GDP, labor hours, and stock market index performance. These are easily affected by the short-term business cycle. Further, the structure of the IMD inquiry was such that managers might have been affected subjectively by vague, pessimistic views of the Japanese economy (Ando and Motohashi 2002).

Signs of a recovery from the long stagnation after the late 1980s bubble have been seen only in the last few years. The emerging manufacturing power of China and the prompt recovery of the Republic of Korea from the economic crisis in 1997 took the spotlight from Japan. Further, U.S. dominance in IT appears to have also obscured Japan.

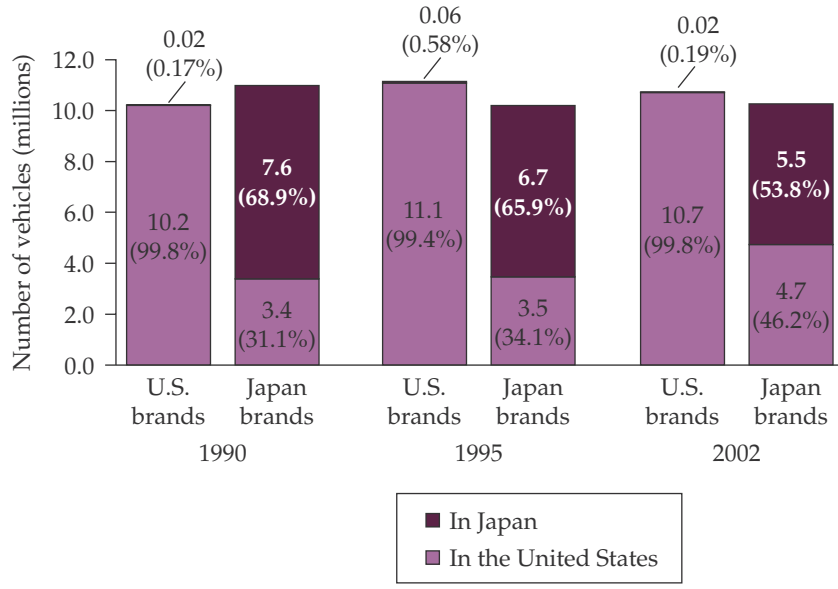
So, what can we learn from Japan? There are at least three reasons. These are 1) the tremendous speed and resilience Japanese industries have shown in catching up with the industrial world and overcoming the oil and yen shocks, 2) the fact that Japan still has many strong leaders in some industries because of their advanced manufacturing processes, and 3) the imbalance between these strong industries and companies and the weak industries.

Many Global Leaders

For consumers around the world, Japan is the home of many top-ranked companies. This is especially true in automobiles, electronics, digital cameras, and game software. For businesses, Japan is a key source for a wide range of products requiring high precision and quality. In short, although a number of major companies and industries have lost ground relative to firms based elsewhere, there are many internationally competitive firms.

Automobiles remain Japan's premier world-class industry. Even as U.S. IT firms have come to dominate that industry, Japanese automakers steadily increased their share of the U.S. auto market beginning in 1995. This is illustrated in Figure 1.4. In

Figure 1.4. *Market Penetration in the Car Market: Sales of U.S. Brands and Japanese Brands in the United States and Japan*



*Includes both light vehicles and commercial-duty vehicles.

**Sales of U.S. brand cars in Japan are substituted by the imports of U.S. brand cars to Japan.

Source: Japan Automobile Manufacturers Association (JAMA, 2003); Japan Automobile Imports Association (JAIA, 2003); Ward's AutoInfoBank (2004).

contrast, imports of U.S. brands into Japan were about the same in 2002 as in 1990. That is, they were almost negligible.

In IT, specific Japanese companies remain leaders. Canon recorded patent revenue of 21.6 billion yen in 2003 and is using its patents strategically to produce and protect its unique products. Canon developed the "print engines" used by Hewlett Packard and others in laser printers.

Among the less widely publicized industries Japan has maintained or achieved leadership in during the last decade or so are robotics, pollution prevention equipment, solar energy, ceramic condensers, small electric motors, optic technology, and bicycle components. Japan has also been a pioneer in mobile phone technology, giving Japanese some of the best-quality service in the world in terms of features.

Speed and Resilience

The economic history of postwar Japan is the story of an amazing rise from devastation to second largest economy in the world, with equity of income. Average GDP growth from 1955 to 1970 was 10%. Catch-up involved more than just adopting foreign technology: there was significant adaptation and improvement. In other words, even before catch-up was completed, Japan was more than a follower.

By the mid-1970s, it was widely recognized that one of the distinctive features of Japan in relation to technological development was "[t]he adroit and extensive use of management, investment, and domestic research and development to capitalize upon imported technology" (Peck 1976).

This innovativeness has given the economy significant resilience. Thus, Japan was phenomenally successful in coming up with substantial energy conservation measures and accelerating the shift to high-tech industries in the wakes of the 1973 and 1979 oil crises. In the 1980s, Japanese manufactures prospered delivering reliable goods—particularly automobiles and consumer electronics. This reflected sophisticated production systems that included total quality control (TQC) and just-in-time inventory practices that have become the basis for global best practice.

The yen shock, starting in September 1985, could not brake the momentum. Japanese firms moved lower value added production abroad and shifted toward higher-end products.

Imbalances

There are two Japans: knowledge-savvy high performers and the rest. Alongside the highly competitive companies and industries are industries and firms that are inefficient and uncompetitive by global standards. In other words, many parts of the Japanese economy face problems similar to those facing firms (and policy makers) in developing economies. In the terms of this study, one can say they need more knowledge to do better. This suggests approaches emerging from the study of Japan have broader applicability.

The Evolution of Japan's Economy

Japan, arguably, was able to catch up in the traditional sense during the 1950s and 1960s because it developed a set of management practices well-suited to the process. These practices also helped Japanese firms during the oil and yen shocks of the 1970s and 1980s.

The Japanese business system most people are familiar with pertains primarily to large firms. It has been widely applauded and emulated by firms in many countries. The underlying principle of the system (often called the J-type firm model) is "coordination based on information sharing among employees." It encourages accumulation of shop-floor-based knowledge and firm-specific skills acquired through in-house training.

Much of the success of Japanese manufacturers in the 1980s has been attributed to their use of tacit knowledge and subcontracting. The overall production system has been termed "integral."

In the 1990s, it was realized that some types of final products, primarily in electronics, can use a different model. In particular, subassemblies and components can be built to common, usually open, standards. This means each part can have multiple suppliers and multiple final assemblers. The idea of interchangeable parts moved beyond screws and capacitors to disk drives and monitors. This is often called modularization. Competition among component makers can lead to more rapid improvement than is usually the case when development is done in-house or by a closely related company. This is often called the Silicon Valley model.

In IT markets since at least the early 1990s, creativity and nimbleness have counted. The open-standards modularization approach of the Silicon Valley model gave many U.S. firms an edge over competitors using proprietary standards and the integral approach. In such an environment, tacit knowledge may be of relatively less importance than before.

Structure

This is the first and main volume of a two-volume study. It deals with knowledge issues that Japan has experienced and is facing. The second volume addresses knowledge at the firm- and industry-levels using case studies.

The analysis here is in terms of the four-pillars framework used by WBI. The pillars can be briefly described.

1. An *economic and institutional regime* that provides incentives for the efficient creation, dissemination, and use of existing knowledge.
2. A dynamic *information infrastructure* that can facilitate the effective communication, dissemination, and processing of information.
3. An *educated and skilled population* that can create and use knowledge.
4. An *innovation system* composed of research centers, universities, think tanks, consultants, firms, and other organizations that can tap into the growing stock of global knowledge, assimilate and adapt it to local needs.

The next two chapters provide context for five chapters that apply the pillars to Japan. (Information infrastructure gets two chapters.) In the concluding chapter, I summarize the salient issues of each chapter and draw lessons and implications, some of which are quite relevant for less developed countries.

Chapter 2 reviews the Japanese growth process after World War II, with emphasis on the role of technology and knowledge. This provides a counter to short-term intellectual overshooting, such as applauding Japan in the mid-1980s as if it would conquer world markets, then regarding it as a useless relic. Total factor productivity (TFP) in subperiods is analyzed to clarify the evolution of the growth process. In particular, the measures adopted by Japanese firms in response to the oil crises are

highlighted, including how these enabled the firms to acquire a competitive edge. Industrial policy, the characteristics of J-type firms, overinvestment in the 1980s, and institutional changes after the bubble are also examined.

Chapter 3 looks at innovation within Japanese companies. One of the clear-cut advantages Japanese companies have had in the knowledge economy is their extraordinary ability to work across disciplines, functions, divisions, and organizational levels *within* a company. This is now being extended to cross-institutional links. The chapter also analyzes two common explanations of what drove Japan's success from the early 1950s into the 1980s. These are a specific set of government policies, and a set of management practices common to Japanese corporations. The business environment has an impact on operational effectiveness that companies can attain. This is directly affected by government policy in such areas as regulation and education.

Chapter 4 analyzes, from the perspective of a knowledge economy, the background and characteristics of a new economic and institutional regime in Japan. This includes the appropriate role for government in a knowledge economy, including the safety nets required and international economic policies. The government's structural reform policies under conditions of a severe fiscal deficit and rapidly aging population are examined. These factors make the role of knowledge and innovation all the more vital for sustainable growth.

The chapter then clarifies the importance and status of risk-money provision for venture businesses, including the emergence of venture capitalists, now that the industrial and financial sectors have almost muddled through their restructurings. The desirability of greater labor mobility and foreign direct investment (FDI) are also stressed.

Chapter 5 is in two parts. The first looks at telecom operators and equipment makers as pillars of the knowledge-based economy. The second looks at Japan's electronics industry, especially its involvement in IT.

The review of the telecommunication industry clarifies the importance of competition policy and the danger of government guidance on advanced technology. As regards competition, the privatization of the government monopoly and subsequent deregulation have yet to create significant competition in traditional telephony. This is because of the cost of providing the "last mile" connection. In cellular and Internet, competition is greater, and Japanese enjoy some of the most sophisticated cellular phone service in the world.

The 1990s is often called the lost decade for Japan, and it was the electronics industry that mostly lost its way. Within electronics, it was information and communication technology that was most affected. How and why this happened, and what the experience means to the business strategies of Japanese firms, are the concern of the second part of Chapter 5. In particular, the reasons for the relative decline of Japan's large, diversified electronics companies in general, and their semiconductor operations in particular, are presented.

Chapter 6 investigates the economic implications of the IT revolution on IT users. The relationship between IT and productivity growth is analyzed in Japan and benchmarked against the United States. In the 1990s, the United States had a stronger growth pattern than Japan's, despite the investment level in IT being similar in both countries. The macro view is supplemented by industry- and firm-level analysis. IT changes business practices and decision-making systems, as well as relationships between suppliers and customers. This means that, without the necessary changes in the systems, IT cannot be effective. This is what happened in Japan.

The implications of the IT revolution are discussed in relation to the "Japanese management system" as an economic institution. Due to the wide diffusion of IT networks, the role of external and explicit information becomes even more important in the knowledge creation process. This shift in the comparative importance of explicit knowledge may benefit U.S. firms more than Japanese firms, which have had an advantage in their handling of implicit knowledge. The chapter argues that the incumbent innovation system, which has relied heavily on in-house R&D, must shift toward a network system utilizing external collaborations.

Chapter 7 deals with providing the ever-changing specific skills a workforce needs in an advanced knowledge-based economy. It provides an overview of the education system that supported Japan's success in the 20th century, with special attention paid to higher education. The chapter then presents the various challenges to the system from globalization and changes in the labor market, and analyzes the policy responses to these challenges, as well as issues of academic quality. Japanese education practices, which emphasize memorization and are geared toward competition for entrance to universities, no longer meet the needs of the society and economy. The various efforts by the government and schools to respond to the new demands are analyzed. At the same time, the locus of job training is changing. Large companies once provided training as an aspect of assumed lifetime employment. As labor mobility increases, so must the options for training.

Chapter 8 is concerned with innovation systems, including the role of government research institutes and universities. It examines how changes in the economic environment in the last decade have necessitated change in the systems. This includes some of the consequences of catching up with the advanced countries, and the emergence of science-based industries as the expected drivers of growth in the 21st century. Government policies to promote science-based industries are taken up, with an emphasis on university-industry collaborations, intellectual property policy, and the promotion of start-ups. The chapter also speculates on whether the requirements of science-based industry are consistent with the traditional Japanese employment and corporate systems.

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Appendix
Knowledge Assessment Methodology (KAM)

As part of its toolkit, WBI uses a *knowledge assessment methodology* (KAM) that benchmarks how an economy compares to others, including those it might wish to emulate. KAM is designed to help understand strengths and weaknesses in making the transition to the knowledge economy. It is thus useful in identifying the challenges and opportunities a country faces, and where it may need to focus policy attention or investment. In so doing, KAM provides a preliminary knowledge-economy assessment of a country, which can form the basis for more detailed, sector-specific work. KAM consists of a set of 80 structural and qualitative variables that serve as proxies for the four pillars that are critical to the development of a knowledge economy.

Comparison Between Japan and the United States

Figures 1.5 and 1.6 are examples of KAM spidergrams allowing a comparison of Japan and the United States using 16 of the 80 possible variables. The shape changes depending on the variables chosen. In this case, the U.S. spidergram has a better shape than that of Japan. The United States is worse than Japan in only two variables: poverty index and total expenditure for R&D as a percentage of GDP. Japan is particularly worse in government deficit, soundness of banks, and public spending on education as a percentage of GDP.

Figure 1.5. *Japan, Normalization Group: All*

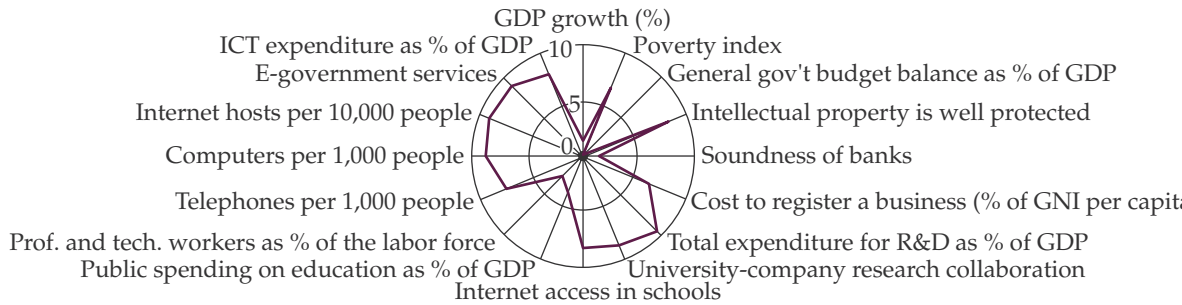
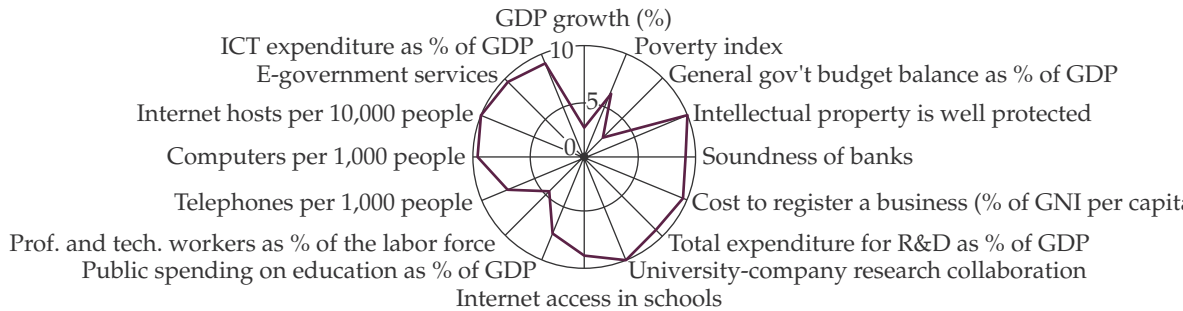


Figure 1.6. *United States, Normalization Group: All*



2

Japan's Development and Growth Process

Hideaki Miyajima

As a context for making an assessment and drawing lessons for the knowledge economy from Japan's experience, this chapter provides an overview of Japan's economic development from 1945 to 2005. Particular emphasis is placed on the years since the second oil crisis (1979) when many Japanese firms began to manifest a competitive edge in world markets.

It is generally agreed that the driving force of postwar development was the high level of private sector investment and constantly increasing productivity. The physical plant and R&D investment that propelled technological innovation was determined not only by expected returns, but also by financial factors and governance structures. Thus, institutional arrangements, corporate governance arrangements, and incentive schemes within firms also played a role, because they affected knowledge creation by employees. That, in turn, made it possible to increase productivity levels through incremental (step-by-step) and breakthrough (leap-frog) innovations.

Large listed firms have been the main drivers of postwar economic development and thus are the focus. Technological innovation in Japan generally has occurred first in such firms and then spread to small and medium enterprises (SMEs).

The chapter is organized as follows. After an overview of Japan's postwar growth patterns, investment and total factor productivity (TFP) are briefly outlined from a macroeconomic perspective in order to pave the way for the qualitative arguments. The characteristics of J-type firms are then summarized. Factors promoting the high-growth era are then explored. Next, the response of Japanese firms to the oil crises is presented, highlighting how the measures adopted enabled them to acquire a competitive edge. Overinvestment in the 1980s is then examined. The penultimate section examines institutional changes that occurred during the bubble and gives some perspectives on the post-bubble economy. In the conclusion, I summarize some lessons from Japan's experience.

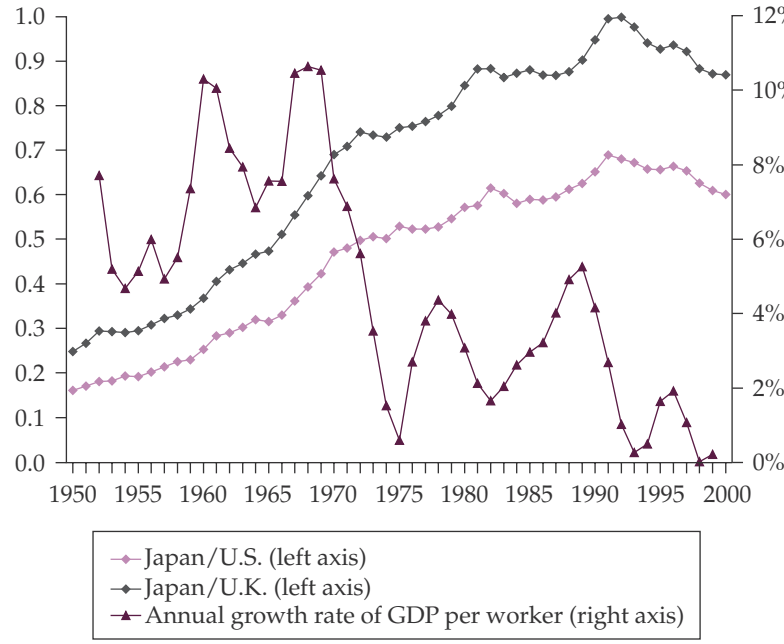
Growth Overview

The analysis begins by assuming per worker GDP in the United States and the United Kingdom represents the technological frontier. Japan's distance from the frontier is shown in Figure 2.1.

In the mid 1950s Japan was a long distance from the frontier. GDP per worker was less than 20% that of U.S. workers in 1950, but by 1970 it had reached almost 50% of the U.S. level and 70% of the U.K. level.

From the early 1970s to the late 1980s, industries such as automobiles and electronics reached the technological frontier. These years are characterized by a mixture of adaptation of foreign technology and development of home-grown technology,

Figure 2.1. *GDP per Worker: Growth Rate and in Comparison to Frontier*



The growth rate of GDP per worker (right axis) is a three-year average of a constant-price series. In particular, as described in the source, it is "a chain index obtained by first applying the component growth rates between each pair of consecutive years . . . to the current price component shares in year t-1 to obtain the DA growth rate for each year. This DA growth rate for each tear t is then applied backwards and forwards from 1996, and summed to the constant price net foreign balance to obtain the Chain GDP series."

GDP per worker in the United States is used as the proxy technological frontier. Thus, Japan's position relative to the frontier is indicated by the percentage Japanese GDP per worker is of U.S. GDP per worker. As an additional indicator, Japan's position relative to the United Kingdom also is indicated.

Source: Based on World Table 6.1 from http://pwt.econ.edu/php_site/pwt61_form.php.

mainly through incremental innovation. GDP per worker continued to increase relative to the U.S. and U.K., but at a slower pace.

A new phase began in the 1990s and coincided with the global IT revolution. Both breakthrough and incremental innovations were sources of growth. Growth of per worker GDP slowed further, and the relative position of Japan vis-à-vis the United States and United Kingdom even declined. This stagnation suggests that the Japanese economy faced serious challenges in the area of innovation in the 1990s.

Overview of Macroeconomic Factors

Table 2.1 presents the composition of gross national expenditure (GNE) growth. These suggest several distinguished features of Japanese economic development, which are taken up in this section first from the demand side, then from the supply. Here, and for the remainder of the period, a four-part periodization is used, as shown in Table 2.2.

Demand Side

The high-growth era was a time when the "investment-begets-investment" mechanism came into play. (This phrase was first used in the 1960 *Economic White Paper.*)

Table 2.1. *Composition of GDE Growth, 1956–95 (percent annually)*

1956 –60	*1961 –65*	*1966 –70*	*1971 –75*	*1976 –80*	*1981 –85*	*1986 –90*	*1991 –95*	
8.9	9.3	11.4	4.6	4.4	3.5	4.7	1.5	GDE
9.2	9.4	11.6	4.5	4.0	2.7	5.3	1.4	Domestic demand
–0.3	–0.1	–0.2	0.1	0.4	0.7	–0.6	0.1	Foreign trade
Decomposition of domestic demand								
5.8	5.6	5.8	3.2	2.4	1.8	2.6	1.1	Private consumption
2.5	2.0	4.1	0.1	0.8	0.7	2.2	–0.6	Private investment
0.5	0.7	0.7	0.6	0.4	0.3	0.2	0.2	Government consumption
0.5	1.1	1.0	0.6	0.4	–0.1	0.2	0.6	Government investment
Decomposition of foreign trade								
0.4	0.6	0.9	0.6	0.8	0.8	0.3	0.5	Exports
0.7	0.7	1.1	0.5	0.4	0.1	1.0	–0.3	Imports

Due to rounding, decompostions may not add to totals.

Source: Hashimoto, Hasegawa, and Miyajima 1998, tables 3.1 (p. 53), 12.1 (p. 158), 18.2 (p. 236–37), and 25.2 (p. 343). The underlying data are from Economic Planning Agency: *Annual Report on National Accounts*, various issues.

Table 2.2. *Features by Period*

Begins	*Period*	*Demand-side*	*Supply-side*
mid 1950s	High-growth	Investment begets investment	Increase in capital stock, TFP growth
1974	Oil crises and aftermath	Changing growth trajectory	TFP surges in manufacturing
1986	Bubble	Resurgence of domestic demand	TFP growth slows
1990	Post-bubble	Stagnation	TFP growth anemic

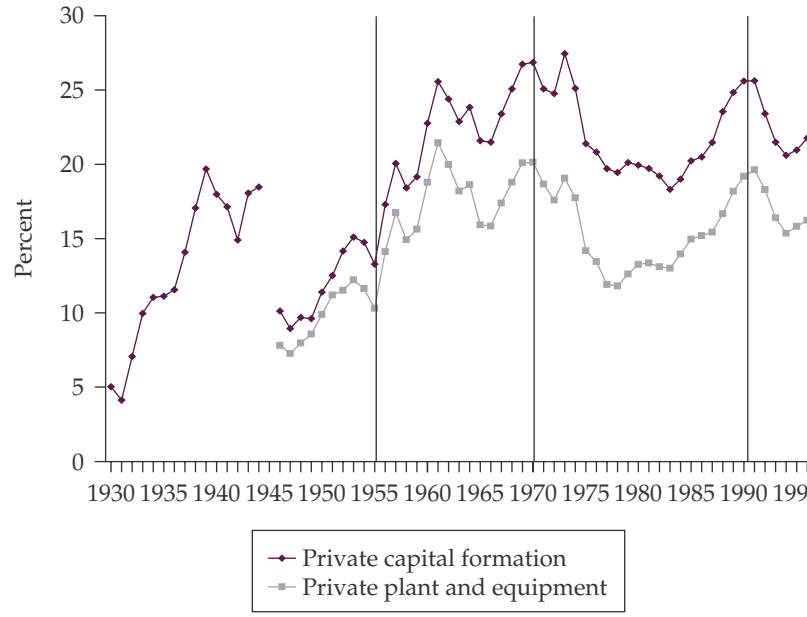
TFP = total factor productivity.

In other words, rapid growth was driven by domestic demand, especially private investment. The investment as a share of GNE rose continually during this period, peaking at over 25% in the late 1960s, as shown in Figure 2.2.

After the oil crises of the 1970s, the trajectory changed to lower levels of GDP growth. However, with a rate around 5%, performance was better than other OECD nations. The driving force of economic growth moved from domestic demand to exports. The contribution of exports was 0.9% in 1975 and reached 2.1% in 1980 after the second oil crisis. In the early 1980s the contribution of exports to GNE growth exceeded that of private investment.

During the bubble period, because of the rapid appreciation of the yen after the Plaza Accord in September 1985 and the Bank of Japan's subsequent low-interest policy, domestic demand again became the main driver of growth. Consumption was pumped up partly by the wealth effect of increasing asset prices. Investment

Figure 2.2. *Investment Ratio in the 20th Century (percent of GDP)*



Source: By 1975, Choki Tokei-soran (long-term statistics), and National Economy Accounts.

also increased, given the low level of interest rates. The investment ratio in the late 1980s was almost at the same level as in the high-growth era.

After stock prices peaked in December 1989, a drastic shift in macroeconomic policy burst the bubble. Land prices began to decline from the middle of 1990. Japan entered a period of prolonged stagnation that has dragged into the early 2000s. Growth declined to less than 1% on average, and domestic demand and private investment sagged throughout the 1990s. Export growth slowed, partly because production facilities moved from Japan to other Asian countries, and partly because most manufacturing sectors lost their competitive edge in world markets.

Supply Side

Table 2.3 presents the contribution of labor, capital, and TFP to GDP growth. During the high-growth era, well over half of growth is attributable to increases in capital stock, which is consistent with the high level of investment at the time. This is particularly so in manufacturing sectors. As the period progressed, the contribution of capital increased, and that of labor decreased. Note that although foreign technology is embedded in the new capital stock, its contribution to growth is partly included in TFP.

For periods beginning with the oil crisis, the pattern of relative contributions becomes much more mixed. Rapid growth in total output in the 1970s and 1980s was realized through large increases in capital accumulation, as well as TFP. TFP increases reflected R&D increases: the ratio of R&D to GDP went from 2.0% in the late 1970s to 2.5% in the early 1980s and 2.8% in the late 1980s (2001 *White Paper on Science and Technology*).

Table 2.3. *Contributors to GDP Growth Rates, 1960–97 (percent annually)*

1960–69	*1970–79*	*1980–89*	*1990–97*	
11.1	4.5	4.2	1.6	GDP growth rate
0.4	0.0	0.4	–0.3	Labor input
6.9	3.8	2.8	1.9	Capital input
3.7	0.7	1.0	0.0	TFP[1]
14.4	5.2	5.1	1.2	Output, manufacturing
1.4	–0.5	0.6	–1.2	Labor input
7.2	2.7	2.1	0.5	Capital input
5.9	3.1	2.4	2.0	TFP[1]
8.8	4.6	4.4	2.1	Output, nonmanufacturing
0.2	0.2	0.3	–0.1	Labor input
6.4	4.5	3.3	2.3	Capital input
2.2	0.0	0.8	–0.1	TFP[1]

Components may not add to sector total due to rounding.

1. Total factor productivity, computed as $\Delta TFP = \Delta Y - \alpha \Delta K - (1 - \alpha) \Delta L$, where ΔY is the growth rate of GDP, α is the ratio of employee income to national income, K is capital stock, and L is labor input. Labor input is measure as number of employees times average labor hours.

TFP estimated as Solow residuals, as is done here, is always associated with some measurement bias, because the growth of value added tends to be overestimated even after carefully adjusting for capacity utilization.

Source: MTI = Ministry of International Trade and Industry, *Tsusho Hakusho (White Paper on Trade)* 1998 (p. 148). Tokyo, Japan.

The contrast in the pattern of relative contributions between the manufacturing and nonmanufacturing sectors is clear. The increase of manufacturing sector TFP in the late 1970s is a remarkable 3.1% annually, accounting for 60% of sectoral growth. Manufacturing growth in the 1980s was fairly steady, with continued substitution of capital for labor and a steady contribution from TFP growth.

In nonmanufacturing, growth is mainly the result of capital accumulation. Innovations such as diffusion of online networks among financial institutions and point-of-sales (POS) systems in the retail sector contributed to rising productivity growth in the late 1980s.

In the 1990s the economy stagnated. There was a decrease in labor input, reflecting a reduction in work hours mandated by regulatory changes (Hayashi and Prescott 2002). TFP contributed less to growth than in previous periods. R&D expenditure growth was steady in the early 1990s (at 2.84%) and somewhat higher in the late 1990s (at 3.08%). This is consistent with the view that the marginal productivity of R&D decreased in the 1990s.

The contrast between the manufacturing and nonmanufacturing sectors in the 1990s is clear. Manufacturing drastically reduced labor input, while maintaining a relatively high level of TFP growth. Growth in nonmanufacturing was supported by increases in capital stock as declines in labor were matched by productivity increases until mid-decade.

The data are consistent with the observation that nonmanufacturing firms kept redundant workers. Consequently, the low TFP may be an artifact of the policy of companies, supported by the government, not to lay off workers.

The weakness of TFP in the nonmanufacturing sector was especially pronounced in finance, construction, and real estate, which have been called the three problem industries since the bubble burst.

Emergence of the J-Type Firm

The high investment levels and steady increase in TFP during the high-growth era were supported by the postwar corporate system, whose main feature is generally considered to be the J-type firm.

The underlying principle of the J-type firm system is "coordination based on information sharing among employees" (Aoki 1988). Information sharing is realized through flexible job descriptions, job rotation among workers, technicians working on the shop floor, and the overlapping of product development functions. The system encourages accumulation of shop-floor-based knowledge and firm-specific skills by employees. This knowledge raises the capacity for employees, and thus firms, to respond to contingencies.

Information sharing is supported by two incentive systems. The first is long-term employment. Firms implicitly guarantee employment until retirement age (originally 55, then 60), which gives employees incentive to accumulate firm-specific skills. The second is seniority-based wages. Wages are determined by age, seniority, and, most importantly, evaluations by superiors. Employees are rewarded for the effort they pour into skill formation with rapid promotion, which raises their wage profiles in the long run (Aoki 1990). It is important to note that these incentive systems applied primarily at the larger firms, and only to some of the employees.

This employment system was supported by unique Japanese corporate governance arrangements. Unlike U.S. firms, which nominally consider maximization of shareholder value to be the managerial objective, Japanese firms were tilted in favor of employees. This is reflected in the make-up of boards, which are usually inbred. Outside directors have been very few until the last decade, and still are a small minority at most firms.

The system was supported by stable shareholders who, through cross-shareholding, supposedly freed top managers from the pressures of external capital markets. (Porter 1992, 1994 emphasized this, but Hall and Weinstein 1996 express skepticism regarding investor patience.)

When managers are freed from external pressure, it is highly possible that their firms will fall into the insider-control trap. However, Japanese main banks, which usually owned equity in firms they lent to, played a role in corporate control that is presumed to have helped overcome the moral hazard problem. In particular, a main bank would, during a time of financial distress, dispatch its own staff or other representatives to a client firm. The incumbent management frequently was removed and, in the extreme, the bank might take over the board and assume the initiative in restructuring efforts. This differs from the Anglo-American reliance on takeovers and bankruptcy, which typically leave management in place. (The definitive study of the stylized main bank system is Aoki and Patrick 1994.)

The internal organization and corporate governance arrangements have been supported by government regulation and the dense networks among firms. Long-term, stable relationships between suppliers and producers are a key feature of Japanese business. They have made it possible for assemblers to acquire constant

supplies of parts and for assemblers and parts makers to cooperate in R&D (Fujimoto 1999; Asanuma 1989).

Postwar Reforms

This uniquely Japanese model emerged from reforms instituted by the U.S.-led occupation after World War II. These included the dissolution of zaibatsu, securities democratization (spreading ownership of stock to a larger group of people), land reform, and support of labor unions. Such reforms played a decisive role in building up Japanese firms, and left postwar Japan with a relatively competitive industrial organization. The dramatic purge of incumbent presidents of business corporations ordered by occupation authorities was a managerial revolution from above that, together with the dissolution of the family-centered ownership structure that characterized the zaibatsu, ceded real authority to young professional managers promoted from within firms (Miyajima 1995, 2004 ch. 8).

Japan had recognized the importance of mass education from the late 19th century, but postwar education reform greatly expanded educational opportunities, contributing to an upgrading of human resources. The surge in enrollment in middle and high schools meant massive numbers of new graduates ready to be trained by business. Establishment of local public universities, as well as private universities, also helped to popularize college education and helped improve the quality of human resources. (For more on education, see ch. 7 by Yonezawa and Kosugi.)

Japanization of the U.S. Model

The immediate postwar institutional regime modeled after U.S. practices had to be modified to fit Japanese conditions. For example, the antitrust law, which was much stricter than U.S. law it was based on, was amended after the end of the occupation. Rather than a capital-markets-based financial system, relational banking emerged as an important force. Cross-shareholding was a natural response to the initial dispersal of firm ownership. A way of shielding managers from shareholder pressure, cross-shareholding evolved during the high-growth era, and was widespread by the late 1960s.

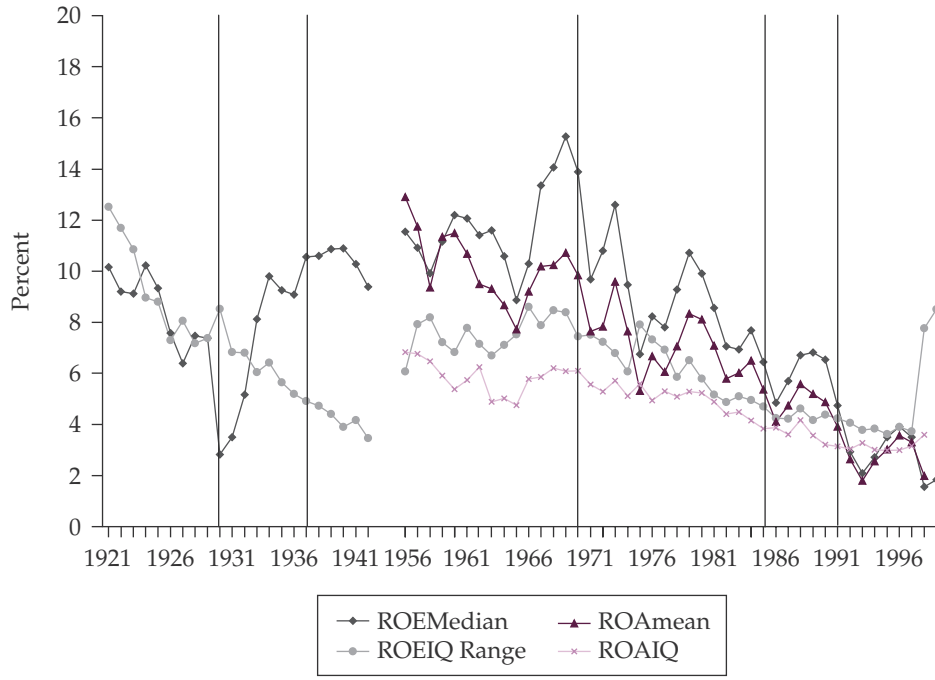
Long-term employment gradually became the standard once the interests of newly organized labor unions and management were reconciled. In particular, the unions traded job security for an implicit no-strike pledge.

Factors Promoting the High-Growth Era

The Japanese economy had recovered from the destruction of defeat by the early 1950s, supported by the windfall of Korean War procurement demand. The high-growth era is dated from 1955, as high levels of private investment sustained annual GDP growth at 10% into the early 1970s. The investment was supported to a large extent by high profitability, measured both as return-on-asset (ROA) (especially as compared to later periods) and profit margins, as illustrated in Figure 2.3.

Along with the high expected returns, several factors promoted high levels of corporate investment during the high-growth era. These are the artificially low interest rate policy, industrial policy, cross-shareholding, and functional complementarities. These are discussed in the following sections. A fifth factor, foreign technology transfer, is then taken up.

Figure 2.3. *Corporate Performance in 20th Century Japan*



Source: Miyajima, Omi and Saitoh (2005), The sample for the prewar period is roughly 170 firms unbalanced, and that of the postwar period is 350 listed firms in manufacturing industries.

Artificially Low Interest Rate Policy

The main bank system played a role in encouraging corporate investment. To fully utilize the advantages of economic backwardness, a country must have, along with a sufficient level of human capital stock (as explained later), an appropriate system for financing foreign technology. During the high-growth era, under the bank-based financial system, the Bank of Japan kept its discount rate at a low level that, in turn, enabled banks to keep interest rates on loans lower than the market equilibrium level (Teranishi 2000).

The artificially low interest rates enabled banks to enjoy rents. Savers had few alternative assets to bank deposits, as the capital market was not developed and they were not allowed to buy foreign assets. Low interest rates to savers subsidized the high investment rate, but also benefited savers who received higher wages as providers of labor.

At the same time, main banks played a significant role in promoting corporate investment. Risk premiums are assumed to be particularly large when capital markets are undeveloped and corporations have yet to establish their reputations. In Japan, main banks, which had private information on client firms, helped to overcome this problem, thus promoting investment.

Thus, even "maverick" companies such as Sony and Honda Motor Co. obtained bank financing. Before they had established reputations, both firms encountered difficulties funding their ambitious investment plans. However, their main banks (Mitsui Bank and Mitsubishi Bank, respectively) stepped in to supply more than half of their total borrowing needs. The loans not only induced other financing but also improved their relationship with the securities market (Miyajima 1995).

Industrial Policy

Industrial policy played a key role in encouraging investment. Government usually turns to industrial policy to promote economic efficiency by intervening in either resource allocation across industries or in the organization of an industry when market failure has occurred or has been perceived to have occurred (Komiya et al. 1988).

The importance of industrial policy in fostering high economic growth in Japan has been controversial. Once generally accepted, later research has led many scholars to assign policy a smaller role in growth. However, our concern is with investment levels, and it is clear that industrial policy influenced the distribution and level of investment—that was its point.[1]

In the mid 1950s, the government designated key "new industries" Including petrochemical, automobile, electronics, and machinery industries. Although justification of targeting varies, the official criteria summarized later were income elasticity and productivity increases (Pekkanen 2003). Many later high-growth industries were not promoted by MITI, consumer electronics being the best-known example. Further, one cannot assume industrial policy based on targeting raised productivity.

The government adopted various policy tools to promote its industrial policy goals, including subsidies and tax concessions. Nominal corporate tax rates were over 40% (including local taxes), and there is no doubt that such things as accelerated depreciation allowances had a substantial effect on investment decisions. Low-interest loans (de facto subsidies) were also supplied to targeted industries by governmental financial institutions such as the Japan Development Bank (JDB) and Japan Finance Corporation for Small and Medium Enterprise, to which funds were funneled from the postal savings system.

The effect of industrial policy was not even across industries. It is widely accepted that it did not have much impact on automobile manufacturers (assemblers) and electric appliance makers. Its effect on the petrochemicals sector is unclear. One success story is revitalization of the machine tool and component sectors (see Box 2.1).

In general, it should be noted that the loans supplied to the new industries were quite limited in amount, and were mainly extended to industries that constituted the core infrastructure of the economy.

Cross-Shareholding

Cross-shareholding also supported corporate investment. In particular, it allowed managers to take a longer-term view than is said to be possible when shareholders are concerned with short-term indicators. Stable shareholders tacitly agreed not to exercise their voice in the running of corporations unless there was a catastrophic deterioration in performance. They did not sell shares, making it difficult for a speculator or other investor seeking to carry out a hostile takeover.

Particularly extensive cross-holding arrangements existed within six major corporate groups (called horizontal keiretsu). The groups are generally identified by

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1. Those demonstrating a more limited role for Ministry of International Trade and Industry (today's METI, Ministry of Economy, Trade, and Industry) and industrial policy include Patrick (1986) and Komiya et al. (1988). The original paean to policy was written by a political scientist, not an economist (Johnson 1982). Also see Johnson (1984), Kosai (1986), Okimoto (1989), and MITI (1990).

Box 2.1. *An Industrial Policy Success: Machine Tools*

From early in the postwar period, MITI targeted machine tool production in order to nurture the automobile industry and to promote machinery manufacturing in general. In 1953, 90% of machinery industry output was produced by SMEs. Product quality was poor, and prices were high by international standards. The 1956 Machinery Industry Promotion Act enabled MITI to establish basic rationalization plans, including financing for designated sectors. At the same time, the government set up the Machinery Industry Council, which included representatives from government, business, finance, and academia. Companies established the Japan Machine Tool Builders' Association in 1957. Information and knowledge creation and sharing among these groups helped to implement the plans effectively.

The most important policy was low-interest loans from the JDB. JDB provided 30% of the financing for investment in facilities. This had a pump-priming effect, encouraging private lenders to lend. Technological screening by MITI and financial screening by JDB helped lower screening costs for private lenders.

Other policy instruments were foreign currency quotas for new machinery imports, which were also exempted from tariffs, special tax incentives.

MITI's policies promoted plant modernization, thus improving productivity and lowering production costs. Raising the technological level of the industry helped sustain subsequent development of the automobile and other industries.

(For more on this case, see MITI 1990, Pekkanen 2003.)

their main bank. However, initially, in the 1950s, the three formed among members of the largest prewar zaibatsu were considered to be grouped around their principal trading company. These three (Mitsubishi, Mitsui, and Sumitomo) had relatively dense shareholding relationships, although the trading companies did not have a significant role in this.

Functional Complementarities

Industrial policy, the main bank system, and cross-shareholding are mutually related and functionally complementary. But industrial policy can have the negative consequence of inducing rent-seeking activities. And cross-shareholding can create a moral hazard to the extent that managers are freed from the pressure of the capital market.

However, domestic interfirm competition was intense enough to prevent most firms from pursuing such rent-seeking activities even without competition from foreign firms. Moreover, the moral hazards of management were disciplined by debt and monitoring by main banks (Miyajima 1999). Overall, the costs associated with industrial policy and cross-shareholding were largely mitigated during the high-growth era by intense competition and financial discipline.

High-Growth-Era Technology Transfer

From 1949 to 1966, 4,135 patents were licensed to Japan. Of these, 60% (2,471) were from the United States and 11% (448) from Germany. Of the total, 21% (856 patents) were transportation-related and 20% (826) related to electrical machinery.

Foreign technology had a great impact on corporate investment. For instance, radio production began with access to a basic patent from RCA. The petrochemical

industry, a completely new industry for Japan in the postwar period, was based on imported technologies. In synthetic fibers, production of nylon used a license from DuPont, while polyester and resin technology came from ICI.

Most foreign technology was acquired through licensing rather than foreign direct investment (FDI). This reflected the fear that FDI might allow foreigners to gain control of Japanese markets. As a result, the government restricted FDI. Moreover, during the 1950s and 1960s foreign owners of technology had little regard for the Japanese market compared to the European market. That meant licenses often could be obtained easily and cheaply.

Japan was extremely successful introducing foreign technology because major industries had sufficiently high levels of technological know-how accumulated over the years, and high-quality human resources, including engineers.

The 1950 Foreign Capital Act played an important coordinating role in facilitating importation of technology. Because foreign exchange was scarce, corporations needed approval to enter licensing agreements. Petitions were approved if they 1) would make a positive contribution to the balance of payments, and 2) were deemed essential to the development of key industries and public industries, or to technical assistance contracts. A contract expected to have a negative impact on the reconstruction of the economy would not be approved.

MITI used administrative guidance to intervene in, and even alter, the content of licensing contracts. MITI played an important role in holding down technology licensing fees by preventing firms from competing against each other.

The steel industry provides an example. After consultation with Yawata Steel and Nihon Kokan, MITI appointed Nihon Kokan as sole negotiator for a general license for the Linz-Donawitz basic oxygen furnace (BOF) technology, and brokered a gentlemen's agreement stipulating that other steelmakers would be granted sublicenses at a fair price. MITI also established a Basic Oxygen Furnace Commission to disseminate technical information (Nagata 1995). Japan subsequently adopted the technology much more rapidly than U.S. firms (Lynn 1982). BOF spurred major indigenous innovations. In introducing the BOF, a Yawata Steel engineer developed a system for recovering oxygen from exhaust gases that could reduce air pollution and promote recycling resources. This was patented in 1962, attracting attention as the first breakthrough technical innovation of the Japanese steel industry.

From the 1960s many firms were innovating on their own. For example, the large electrical industry firms each established central research institutes almost simultaneously in the early 1960s. This reflected three developments. First, there was less new technology to import. Second, cross-licensing had emerged as an effective means to improve a bargaining position. Third, the intense competition with domestic rivals encouraged each firm to develop its own technology, as the theory of Aghion, Harris, and Howitt (2001) predicts.

The Energy Crises and Competitive Strength

The first oil crisis rocked the Japanese economy as the price of crude oil quadrupled. By 1974, Japan's inflation rate was the highest among the developed countries (see Table 2.4). This was not surprising: even prior to the crisis, the Japanese economy faced inflation caused by excessive money supply, and Japan depended on oil for 78% of its primary energy supplies. Imports accounted for 99.7% of oil consumption, significantly more than for other OECD nations.

Table 2.4. *International Comparison of Major Indicators*

Panel 1: GDP Growth Rate %

	Japan	*U.S.*	*U.K.*	*Germany*	*France*
61–69	10.4	4.3	2.9	4.4	5.6
70–73	7.9	3.2	3.7	4.2	5.1
74–80	3.6	2.2	1.0	2.2	2.6
74	–1.4	–0.5	–1.7	0.2	3.1
75	2.7	–1.3	–0.8	–1.4	–0.3
76	4.8	4.9	2.8	5.6	4.2
77	5.3	4.7	2.3	2.7	3.2
78	5.0	5.3	3.5	3.4	3.4
79	5.6	2.5	2.8	4.0	3.2
80	3.5	–0.2	–1.7	1.0	1.6
81	3.4	1.9	–1.0	0.1	1.2

Panel 2: Changes in GDP Deflater %

	Japan	*U.S.*	*U.K.*	*Germany*	*France*
61–69	5.3	2.9	3.9	3.3	4.2
70–73	7.6	5.6	8.0	6.8	6.9
74–80	7.7	8.2	16.6	4.8	11.0
74	20.8	9.1	14.6	7.1	11.8
75	7.7	9.8	27.3	6.0	13.0
76	7.2	6.4	15.0	3.7	11.1
77	5.8	6.7	14.0	3.8	9.1
78	5.0	7.3	11.2	4.3	10.1
79	2.7	8.9	14.5	3.8	10.2
80	4.5	9.0	19.1	4.9	11.4
81	3.8	9.7	11.3	4.1	11.4

Rapid Adjustment

The oil crises drastically changed the comparative advantage of particular industries, triggering sweeping structural changes. Energy-intensive industries such as iron and steel, cement, pulp and paper, metals, and petrochemicals were at a disadvantage. Soaring wages had a negative impact on labor-intensive industries such as clothing and textiles.

During the high-growth era, Japan had become a high-energy-consumption economy, but from 1973 to 1990 consumption per unit of GDP declined at the fastest rate among OECD nations (Hashimoto et al. 1998). The steel industry is a well-known example. In the cement industry, the new suspension preheater (NSP) kiln enabled shifting to coal. Many energy-saving measures were the result of shop-floor efforts.

Given the drastic changes in factor prices, Japan was relatively successful in carrying out adjustments compared to other countries. Japan took 6.6 years to complete the capital-stock adjustment process. West Germany took 6.2 years, but the United States required 9.5 years (Hashimoto et al. 1998, p. 196).

Led by the steel industry, raw materials industries such as primary metal, ceramics, and paper were able to restore competitiveness through energy-saving measures and rationalization. As a result, their real production in 1980 had increased 34% compared to 1970.

Table 2.4. *Continued*

Panel 3: Wage Increase per Hour					%
	Japan	*U.S.*	*U.K.*	*Germany*	*France*
61–69	10.9	3.9	n.a.	n.a.	n.a.
70–73	16.6	6.4	12.5	13.4	n.a.
74–80	11.6	8.6	10.3	9.0	15.5
74	24.5	8.4	16.8	15.2	18.9
75	15.2	9.1	26.5	11.2	18.6
76	13.0	8.1	16.4	5.9	15.7
77	9.3	8.8	10.6	8.5	12.4
78	9.5	8.7	14.4	6.9	13.4
79	6.4	8.5	15.6	6.9	13.4
80	3.5	8.7	–28.0	8.5	15.9
81	5.8	9.8	13.4	7.1	15.2
Panel 4: Unemployment Rate					%
	Japan	*U.S.*	*U.K.*	*Germany*	*France*
61–69	1.3	4.9	1.7	0.5	1.6
70–73	1.2	5.0	2.6	0.7	2.6
74–80	1.8	6.5	3.9	2.5	4.4
74	1.3	4.9	2.1	0.6	2.7
75	1.4	5.6	2.2	1.3	2.9
76	1.9	8.3	3.6	3.1	4.2
77	2.0	7.7	4.8	3.2	4.5
78	2.0	7.0	5.2	3.3	5.0
79	2.2	6.1	4.9	3.1	5.3
80	2.1	5.8	4.5	2.9	6.0
81	2.0	7.2	6.1	2.5	6.3

Source: Economic Outlook, yearly, OECD.

Table 2.5. *Labor Productivity and Wage Cost (1973–80)*

	U.S.	*Japan*	*Germany*
Wage increase (hourly)	9.3	10.5	9.7
Labor productivity increase	1.7	6.8	4.8
Wage cost increase (based on own currency)	7.5	3.4	4.7
Wage cost increase (based on U.S. dollars)	7.5	8.3	11.2

Institutional Factors

Economic institutions unique to Japanese firms played a positive role in the speed of adjustment. The Japanese economy also succeeded in severing the vicious circle of soaring wages and rising consumer prices that was common to the OECD nations, as shown in Tables 2.4 and 2.5.

The wage hike agreed in the spring labor offensive of 1975 was 13.1%, which was lower than CPI inflation of 13.6%. In 1980, after the second oil shock, the wage increase was 6.7%, compared to an inflation rate of 8%. Japanese unions, unlike those in other OECD nations, responded to the situation by choosing to maintain employment levels and swallowing a relative decline in wages.

However, Japan's more gradual pace of employment adjustment still saddled firms with rising labor costs. In response, labor and management acted together to implement rationalization measures, centering on introduction of increased automation. From the late 1970s to early 1980s, there was a rapid dissemination of numerical control (NC) devices and machining center systems. Japan became the world leader in the industrial use of robots. There was remarkably little resistance to introduction of labor-saving equipment, again unlike labor's response in the United States and Europe. The fact that most Japanese companies coupled long-term employment with regular job rotations facilitated introduction of increased capital intensity.

Employment guarantees not only enabled corporations to maintain their unique, skilled work forces but also stabilized labor-management relations. Under these conditions, manufacturing, which had already begun to adopt quality control methods, began to fully implement total quality control (TQC) systems.

With labor committed to finding ways to eliminate waste in the production process, the "suggestion movement" (known by the Japanese word kaizen, which means improvement) began to spread. Workers were encouraged to suggest ways to reduce energy consumption, such as wrapping insulation around steam pipes. The accumulation of these tiny improvements enabled corporations to adapt to changes in relative prices and other external shocks.

Furthering Industrial Competitiveness

Machinery-related industries, which were not as severely affected by rising energy prices, were able to develop rapidly after the oil crises primarily by process innovation and export expansion.

The share of machinery in Japanese exports increased from 46% in 1970 to 54% in 1975 to 63% in 1980. In particular, the electrical machinery and transportation machinery (primarily automobiles) exhibited remarkable growth. The rapid increase in productivity was the main factor behind the rise in exports, as it enabled Japanese firms to offer competitive pricing and, often, also better quality.

As shown Table 2.5, wage rates increased more rapidly in Japan than in the United States and Germany, but the increase in labor productivity was even higher. Consequently, measured in yen terms, during 1973–80 Japan enjoyed the lowest unit labor costs. However, due to appreciation of the yen in the late 1970s, Japan's unit labor costs in dollar terms were equal to the United States. Then, in the 1980s, the dollar began to strengthen, providing Japanese firms with a clear competitive advantage.

Lean Production and Just-in-Time

Institutional factors summarized above made it possible to increase productivity, and their influence is particularly apparent in automobiles, which led export growth. The first is the lean and flexible production system adopted by Japanese firms—the renowned Toyota Production System (TPS). Lean production is different from the mass-production system invented by Ford. Its basic feature is the ability to adjust the content and volume of production in response to sales results.

TPS has also been defined by just-in-time principles (JIT)—produce only what is needed, only how much is needed, and only when it is needed. To implement JIT

principles, it was necessary to revolutionize the flow of information between sales and production, and within the production process. Part of this is the *kanban* system, used to relay information about the quality and types of parts needed at each point on the production line. (For more on this, see Monden 1993, Fujimoto 1999.)

JIT is particularly useful when producing in small lots and, as in the case of automobiles, a wide range of slightly different items. This is, in part, because of the reduction in inventory costs at all stages (parts, work-in-progress, and final goods).

To set up production lines capable of this flexibility, a manufacturer needs employees capable of performing multiple tasks. Japanese factory workers had been acquiring the ability to perform multiple operations since introduction of job rotation in the late 1950s.

JIT production also drew on the long-term, stable relationships between assemblers and parts makers. After the first oil crisis, Toyota began to transfer its JIT system to the companies with which it did business. The first recipients were firms making parts, because complete implementation of JIT principles requires extensive integration with parts suppliers. Toyota also provided training and instruction on JIT to other companies. Among these was Kawasaki Heavy Industries, for its motorcycle operations. Another was Daikin, a manufacturer of air-conditioning equipment, which had been forced to slash production by half after the first oil crisis. Other auto assemblers, such as Nissan, also made conscious efforts to employ JIT. (For more on this, see Hashimoto et al. 1998, ch. 22; Monden 1993.)

From Physical Investment to Research and Development

From the mid 1970s, electrical manufacturers began to achieve high levels of competitiveness in products ranging from TVs and VCRs to fax machines. By focusing on how Japanese manufacturers assumed world leadership in a single sector—semiconductors, especially DRAM (dynamic random access memory)—during this period, it is possible to illustrate some of the distinctive features of Japanese business.

The story of the DRAM market is one of constant development of ever more powerful chips. When chips ranged in capacity from 1K to 16K, U.S. manufacturers led the market. After Fujitsu successfully developed a 64K DRAM in 1976, Japanese firms assumed the cutting edge, and led the way in each new generation from 256K to 1M to 4M. Taking a preventive approach to quality control played an important role: very low defect rates provided a competitive edge (Okimoto et al. 1984).

Japanese firms reached 53% global market share in 1982 and had 77% in 1986. By 1985, NEC had become the world's largest semiconductor manufacturer. In 1989, NEC, Toshiba, and Hitachi were the world's top 3, and 6 of the world's 10 largest semiconductor firms were Japanese. Domestic demand was generated in part by the government telephone monopoly (now NTT).

The industry was supported by joint R&D projects such as the Very Large-Scale Integrated (VLSI) Circuit Technology Association and government subsidies for R&D. However, some argue that government-led R&D associations were unsuccessful (for example, Goto and Odagiri 1996).

From the latter half of the 1970s, Japanese corporations actively invested in metal oxide semiconductor (MOS) and integrated circuit (IC) production. The semiconductor industry is characterized by the need for massive facilities investment and the rapid obsolescence of these facilities. From 1981, investment by Japanese semiconductor firms surpassed that of their U.S. counterparts. Japanese firms

invested from 10% to 30% of revenues in research and development, and built a technological foundation to deal with technical problems that arose during development. On top of this, the firms earmarked 20% to 50% of revenues for facilities investment in order to automate production.

The large, integrated groups to which the Japanese firms belonged formed the institutional backdrop to the high level of investment. Most Japanese semiconductor manufacturers were involved in the production of a wide variety of products in addition to semiconductors, and were able to channel large amounts of money from other businesses into semiconductors, which was viewed as a strategic sector. There are no clear empirical data, but it is plausible that the internal capital markets that existed within these firms functioned efficiently to finance the semiconductor industry.

From Growth and Innovation to Excessive Investment

After the Plaza Accord of October 1985, the yen appreciated from 240 to the dollar to 150 within a year. Partly to mitigate the effects of the rising yen, and partly to mollify criticism from other developed nations over the rise in Japanese exports, Japan's macroeconomic policy was reoriented toward pent-up domestic demand, and the Bank of Japan implemented a low-interest-rate policy. Under these conditions, asset prices soared, creating a bubble that peaked in 1988 and 1989. Private investment increased, to the same ratio as in the high-growth era (see Figure 2.2), while profitability was much lower than in previous periods (Figure 2.3). This implies that J-type firms changed their orientation away from growth and innovation toward excessive investment behavior.

Combined with favorable macroeconomic conditions, financial deregulation from 1980 on made it possible for firms to raise external funds through measures other than bank borrowing. Large firms with good reputations found it easy to raise money through convertible bonds and warrant bonds in domestic or foreign markets. Thus, firms with higher profitability increasingly depended on bonds for their financial resources, while firms with lower profitability continued to depend on bank borrowing during the 1980s (see Hoshi et al. 1993; Miyajima and Arikawa 2000.)

A distortion was created, however, because firms with low profitability remained clients of the banks, and the banks increased lending to new clients in nonmanufacturing sectors using land as collateral. Although the latter behavior was rational ex ante, it was inevitable ex post that the loan portfolios of banks would be dealt a harsh blow at the end of bubble.

The practice of cross-shareholding also encouraged overinvestment and unproductive investment. Cross-shareholding can facilitate moral hazard among incumbent managers, or lead to the pitfalls of insider control. It is also plausible that bank ownership, the core of cross-shareholding, can play a negative role in corporate governance if banks use their stakes to encourage client firms to take on projects that deviate from value maximization rather than take steps to appropriately monitor the firms' investment projects. (Pioneer work taking this view is Weinstein and Yafeh 1998.)

Assigning the task of corporate governance to banks does not always lead to maximization of firm value because banks as creditors have different objectives from banks as shareholders. Focusing on fiscal 1986, Morck, Nakamura, and Shivdasani (2000) found that the level of equity ownership by the main bank and firm value are inversely related, and suggested that higher bank ownership is associated with relaxed financial constraints, allowing firms to undertake more marginally acceptable investment opportunities.

In the same vein, corporate investment was sensitive to internal funds only among firms with low growth opportunities in the late 1980s, and this relationship was stronger among firms with high ratios of shares held by main banks (Miyajima et al. 2001).

A typical example of overinvestment is the diversification undertaken by firms in mature industries. Facing the low growth of their main business due to the rising exchange rate and catch-up by developing countries, it was almost inevitable that mature firms chose to diversify in order to secure jobs for current employees. The iron and steel industry, for example, expanded not only into related businesses such as engineering, but also into such businesses as semiconductors and real estate. During the bubble period, retail firms pursued foreign investment and resort development.

Internal capital markets tended to function inefficiently, and the new ventures often resulted in the earnings of the main business being cannibalized by less profitable businesses. (Empirical work on this is still scarce. See Miyajima and Inagaki 2003; Kikutani et al. 2005.)

Institutional Changes

In the 1990s, when the world economy experienced the technological changes often called the IT Revolution, the Japanese economy was suffering from the collapse of asset prices. To cope with this situation, the government responded by deregulating four industries (communications, electric power, airlines, and financial services), promoting venture businesses through arranging financial markets, improving higher education, encouraging cooperation between academia and business, and pursuing macroeconomic policies. Chapter 3 and elsewhere in this book address these issues, so the focus here is on how corporate governance arrangements have been challenged by the collapse of the bubble.

First, the economy was saddled with a lingering nonperforming loan (NPL) problem. Initially, and for a long time, it was generally assumed that growth would resume and bail out the loans. Thus, the banks tended to roll over loans, a practice called evergreening. At the same time, the borrowers tended to delay restructuring, instead struggling along with low profitability. NPLs were concentrated in the "three problem industries": finance, construction, and real estate.

Because of capital-adequacy ratio constraints, banks pursuing evergreening compromised their ability to extend new loans to firms with high growth opportunities. These constraints affected primarily SMEs, and new firms, because established firms could still tap the capital markets. (On this, see Arikawa and Miyajima 2005.)

Thus, the soft-budget constraints of the problem industries systematically conspired to create the credit crunch of the 1990s. These constraints led to serious credit misallocations, and help to explain the different performances of the manufacturing and nonmanufacturing sectors, and declining productivity as a whole. Because the functional changes in the main bank system were triggered in part by the declining health of the banking sector as a whole, it is clear that, as many observers have insisted, further restructuring of this sector is of the utmost urgency.

Second, the cross-shareholding and insider boards that characterize traditional J-type corporate governance arrangements are no longer suited to the changing external circumstances brought about by the financial revolution. The rise in the importance of foreign institutional investors and of the capital market for corporate

financing, and thus the importance of bond ratings, has changed what is appropriate. A board structure that is more transparent to outsiders and has more separation between monitoring and management functions is needed. In fact, firms that keep the J-type arrangements are likely to have lower performance (Miyajima 2005). Thus, it is highly important to change governance arrangements by further unwinding of cross-shareholding and reforming corporate boards.

Third, the internal organization of many Japanese firms prevents them from meeting new challenges. The past tendency to increase the number of members who sit on boards was a logical result of policies designed to supply ample work opportunities for employees. However, overly large boards prevent companies from making appropriate strategic decisions speedily (Yermack 1996). And firms with decentralized organizations, which did not cede authority and responsibility to division managers, have been slow to adopt appropriate restructuring measures. Flawed corporate governance arrangements have hampered the performance of firms with diversified business portfolios and industries characterized by modularized segments (for example, finance and general electrical machinery companies). It is imperative that such firms downsize their boards, and revamp their internal organizations in order to promote speedy decision making.

Besides changes in governance, the incentive system of Japanese firms needs to be rethought. The seniority-based system that worked well in an era of incremental innovations is inappropriate to industries where breakthrough innovations are key to competitive advantage. The low productivity of Japanese R&D might be related to the failure to provide engineers with adequate incentives. However, it is also true that the seniority system is complementary to long-term employment practices that have reaped benefits from the accumulation of shop-floor knowledge.

Japanese firms are in the process of searching for solutions that will provide adequate incentives to spur technological innovation while also being compatible with long-term employment. Among other things, stock options were introduced in 1997, and individual inventors are being more richly rewarded than in the past.

Conclusion

It can be argued that Japan, with its mobilization of all workers to contribute to micro knowledge creation, has led one path of the evolution of the knowledge-creating economy—and was doing so before the concept was created. However, with catch-up achieved, and the stagnation of the post-bubble period, there has been a change in what is expected and needed from Japan's economic system. This means the ongoing viability and suitability of the institutions and relationships that defined Japan's past success have been called into question.

The turning point was the 1997 banking crisis. This led to a rethinking and reforming of the traditional corporate governance and incentive models. The government has supported these private sector reforms with regulatory reforms such as a revision of the antitrust law and amendments to the commercial code. As a result, cross-shareholding and a bank-centered financial system, hallmarks of the J-type model, are being discarded.

However, there are definitely aspects of the J-type model that remain valid—most especially its empowering of workers in ways more meaningful than other model's clichés. This is arguably appropriate to future success—not just for Japanese firms, but also for those seeking to emulate Japan's past success.

The historic tendency to look at Japanese firms collectively, and in particular to see the hand of the government, is especially inappropriate as one looks to the future. As in other OECD countries, specific firms and industries are highly competitive and busily adjusting to the continually changing global environment. If one draws no other lesson from Japan's historical growth experience, it should be not to underestimate the resilience and adaptability of the economy and companies.

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3

The Competitiveness of Japanese Industries and Firms

Hirotaka Takeuchi

As the 1990s progressed and stagnation seemed to become the norm in Japan, many questioned whether the country (and its firms) could prosper in the "new" economy. They contended that many of Japan's strengths had become weaknesses. Japan's social and cultural norms were deemed inconsistent with the innovation, entrepreneurship, and risk taking that are the hallmarks of the new economy. Although much of the criticism was, and remains, valid, Japan—and Japanese firms—have in fact been reforming, adapting, and rebounding. Moreover, Japanese firms have continued to innovate.

This chapter outlines the nature of Japanese innovation and its applicability to non-Japanese firms. As context, it begins by examining Japan's success during its early postwar development, and reminds readers that there have in fact been two Japans as regards competitiveness. The material here summarizes the major points regarding innovation and Japanese competitiveness that are made in the case studies in this project's companion volume.

Sources of Success

What drove Japan's success from the early 1950s into the 1980s? Two related explanations are widely held. One has to do with a specific set of government policies, the other with a set of management practices common to Japanese corporations. Both explanations have had a profound impact, not only within Japan, but also on the rest of the world. Within Japan, it has been appealing to believe that Japan had invented a new and intrinsically superior form of capitalism, one more controlled and egalitarian than the Anglo-American version. Outside Japan, policy makers and business leaders have sought to emulate the Japanese model or borrow parts of it.

However, the much-celebrated government model in fact explains Japan's failures more than its successes. Traditional views regarding Japan's corporate success have more merit, but are dangerously incomplete.

The notions of Japan's success come in part from the robust growth of a relatively small number of industries. The same industries—including semiconductors, machine tools, and steel—were examined over and over again. Observers looked at these cases, described what happened, and then made the intellectual leap to generalize about the entire country's success.

A broader array of cases gives a different picture. Thus, Porter, Takeuchi, and Sakakibara (2000) looked beyond Japan's successes to examine its failures. The reality is that Japan has always had many uncompetitive industries, with virtually no

share of international markets. These industries have rarely been given much attention, but it is only by examining such failures that it is possible to distinguish between good and bad policies, at both the government and corporate levels.

Two Japans

Looking at the performance of Japanese industries since the 1970s, it is no exaggeration to say that there have been two Japans. The first has been highly competitive, such as consumer electronics and motor vehicles. These sectors carried the entire economy and drove growth in both exports and productivity. But such industries were relatively few in number, and they have existed alongside a large number of industries that have been a chronic drag on overall productivity.

This uncompetitive Japan has two segments. One is internationally traded industries in which Japan has never achieved a significant export position. This segment includes huge sectors such as agriculture, chemicals, consumer packaged goods, medical products, software, and virtually all services. Trade barriers and other restraints to competition, under the theory that Japanese firms needed to be nurtured until they were strong enough to export, have often protected them in these industries. They have remained uncompetitive, and many are still protected.

The other segment is "domestic" industries such as retailing, wholesaling, truck transportation, construction, energy, health care services, telecommunications, housing, and food preparation. These industries, virtually all highly inefficient, have generated large numbers of jobs and acted as a sort of social welfare system. Consolidation and restructuring have been blocked by a wide array of government policies and intervention.

The rationale behind tolerating the two Japans seemed plausible: while the competitive Japan carried the economy, the uncompetitive Japan provided jobs, stability, self-sufficiency, and a continuation of small family businesses. The cost of the inefficient Japan was borne by Japanese consumers in the form of higher prices.

Policy makers, however, failed to anticipate two devastating consequences of this approach. First, the uncompetitive Japan drives up business costs across the board, weakening the competitiveness of the export industries. Second, it inhibits formation of internationally competitive industries in large parts of the economy. That is, many industries are so idiosyncratic that their operating practices do not work in foreign markets. The net result is an almost total absence of new Japanese export industries.

Activist Role of the Japanese Government

The underlying rationale for the Japanese government's activist role is that no corporation can have the proper perspective and information to guide the economy. Some industries should be targeted because their growth prospects and opportunities to support a higher standard of living are inherently better than others; other industries should be sheltered to gain scale to compete internationally. Intervention, in general, avoids the wasteful and destructive aspects of competition, and allows a country to conserve its resources. At the center of this thinking lies an export-led growth policy promoted by the central government, guided by a stable bureaucracy. Restrictions on trade and foreign investment, which have been

Table 3.1. *The Activist Japanese Government Model*

Activist, central government with a stable bureaucracy (most of all, MITI)[1]
Targeting of priority industries to enhance economic growth
Aggressive promotion of exports
Extensive "guidance," approval requirements, and regulations
Selective protection of the home market
Restrictions on foreign direct investment
Lax antitrust policies and enforcement
Government-led industry restructuring
Official sanctioning of cartels
Intervention in declining industries
Highly regulated financial markets and limited corporate governance
Government-sponsored cooperative research and development (R&D) projects

1. The Ministry of International Trade and Industry (MITI) was renamed and somewhat restructured effective January 6, 2001. It is currently called the Ministry of Economics, Trade, and Industry (METI).

reduced grudgingly, also fit this view, as they allow Japanese companies to gain strength at home in order to penetrate markets abroad. The elements of the activist Japanese government model are summarized in Table 3.1.

The model is derived from actual practices found in the often-studied successful industries: household sewing machines (1940s), steel (1960s), shipbuilding (1970s), and semiconductors (1980s). But a much wider sample revealed that these are not representative. In fact, each decade also gave rise to internationally competitive industries where virtually none of the practices of the government model were employed: motorcycles (1960s), audio equipment (1970s), automobiles (1980s), and game software (1990s). We studied these and more than a dozen other successful industries extensively, ranging from robotics, industrial sewing machines, fax machines, and home air conditioners to carbon fiber and soy sauce. Government intervention was again almost entirely absent. There were no major subsidies and little or no intervention.

One partial exception is sewing machines, which were targeted right after World War II to meet domestic demand for clothing and employment, as well as to promote exports. But Japan became competitive in industrial sewing machines, where government intervention was largely absent, rather than in household machines. (For more discussion, see Porter 1990.)

It is the failures that make the strongest argument against the government model. Our sample covered a wide swath of important sectors, including consumer goods (apparel and detergents), advanced manufacturing (civil aircraft and chemicals), services (financial services and computer software), and prepared foods (chocolate). Particular industries were sometimes chosen to offer a window into a broader sector. Chocolate typifies the uncompetitive prepared food sector, where Japan is internationally successful in just one product, soy sauce, and somewhat successful in another (instant noodles). Similarly, detergents revealed a set of problems common to consumer packaged goods, where Japan has had virtually no international success.

What became clear is that policies at the core of the government model are far more prevalent and pervasive in the failure industries.

In chemicals, a sector targeted by the Ministry of International Trade and Industry (MITI), the government provided price controls, favorable tax incentives, loans, approvals of new entrants, cartels to coordinate the reduction of excess capacity, and subsidized R&D. In civil aircraft, the industry was essentially a single consortium. All the aircraft and engine development projects were cooperative, and there was virtually no competition among the companies. In securities, the government played a heavy hand in blunting competition through a stringent licensing system, fixed commissions, allocation schemes, protection from foreign competitors, and emergency loans to the industry. In computer software, there were extensive subsidies, tax incentives, loan guarantees, and cooperative and joint research projects.

Government policies, once touted as explaining Japan's success—especially practices that limit competition in myriad ways—have inflicted a profound cost on the Japanese economy. Those industries that prospered did so *in spite of* these policies. This view is consistent with what is known about the competitiveness of other countries—vigorous rivalry is the only path to economic vitality.

Human Resources and Education

Japan is often praised for its rigorous basic education and its large pool of well-trained engineers. However, we found that the unsuccessful industries had a shortage of well-trained engineers and professionals. Although Japanese universities produce many graduates in fields such as electrical and production engineering, they are surprisingly weak in fields that are important to such poorly performing industries as chemistry and chemical engineering, finance, software engineering, and aeronautical engineering. Hampered by scarce funds and antiquated facilities, the universities lack strong research programs in many important fields.

Japanese productivity and innovation will not rise unless its population acquires advanced and specialized skills in a full range of academic disciplines. Company training programs are a strength, but they cover only the small fraction of the workforce that is employed in large corporations. Company training cannot substitute for first-rate university education. Moreover, company training tends to produce generalists, while the modern knowledge economy requires more specialists. This practice proved to be problematic in industries such as securities and software, which require highly specialized workers, particularly when the ranks of these industries seem to be rising in an increasingly knowledge-intensive economy.

Part of the problem with Japanese universities is tight control and micromanagement by the government bureaucracies. Although government-run universities and colleges were reclassified as government university corporations in April 2004, this newly acquired status does not give universities the freedom to operate more autonomously.

Furthermore, the current policy debate lacks any sort of strategic framework for how the universities should be operated. The Education Ministry argues that making universities independent will match the U.S. private system, yet it maintains tight regulatory control. On a positive note, the ministry has started over 270 Center of Excellence projects since 2003. This is a system intended to tie funding of university programs to performance and encourage greater competition among universities.

In summary, Japan's basic education system and university system need significant reform. Although the basic education system is anchored in high standards,

Japan must place more emphasis on creative problem solving and move away from a curriculum set by the central government. (Chapter 7 further covers the education system.)

A Role for Government in the Knowledge Economy

The Japanese government once saw its role as guiding, controlling, and constraining competition in the name of improving efficiency and stability. Now, it must work to improve the quality and dynamism of the business environment and the infrastructure that supports the knowledge economy. In addition to overhauling the Japanese university system, which will enable Japanese to acquire more advanced and specialized skills in a full range of academic disciplines, the government must work to facilitate competition and encourage innovation in a number of key areas. The policy agenda to facilitate competition is multifaceted.

Amendments to the Antitrust Law adopted in April 2005 are a move in the right direction, but greater enforcement and meaningful penalties are also needed. Countless other laws, rules, and requirements should be reexamined with a view to reducing the many subtle competitive barriers they represent. Restraints on imports and foreign investment, which have crippled many of the industries they aimed to protect, should be lifted. Statistical evidence shows that openness to trade and foreign investment is strongly associated with economic growth and a rising standard of living.

The government should free market forces so that only the most productive companies remain in the market. Thus, restructuring efforts under way in inefficient and archaic domestic industries such as retailing (Daiei, Matsuyadenki), truck transportation (Kyushu Industrial Transportation), mining (Mitsui Mining), and housing (Misawa Homes) should be expanded. These efforts have been spearheaded by the Industrial Revitalization Corporation of Japan (IRCJ), the government-backed corporate restructuring agency. After starting operations in May 2003, IRCJ selected 41 company groups for restructuring. It has until May 2008 to complete the turnaround of these company groups.

At the same time, the government should build a safety net to ease the effects of restructuring on workers, and mechanisms to facilitate the deployment of freed-up resources to other industries.

The government needs to stop trying to manage the financial markets and acting as the corporate governance system for firms. Instead, it should substitute an effective system of private corporate governance coupled with strict disclosure and securities regulations.

Encouraging Innovation and Entrepreneurship

To encourage innovation and entrepreneurship, the government has to change the structure through which innovation occurs.

First, the government must remove itself from the role of directing the innovation efforts of companies. It should concentrate instead on improving the incentives for innovation, upgrading the quality of scientific and technical personnel, and strengthening the nation's scientific infrastructure.

Second, intellectual property protection needs to be strengthened, especially in speeding up the process of deciding infringement cases and stiffening the penalties for patent infringement.

Third, there is a pressing need to bring the nation to the forefront of information technology in all parts of society. Unless Japan becomes more productive through the use of IT and utilizes its labor force in new and better ways, the nation's standard of living cannot be sustained.

Fourth, powerful programs to encourage new business formation and entrepreneurship—such as lower long-term capital gains tax rates, liberal policies allowing tax losses to carry forward, and easier access to risk capital—need to be established. At the same time, approvals, reporting requirements, and other regulatory barriers to starting companies must be dramatically reduced.

Competitiveness at the Micro Level

A nation's prosperity ultimately depends on the productivity with which its firms compete. Productivity affects profitability, a measure that includes both the prices that products and services can command (from a buyer's perspective, the willingness to pay) and the efficiency with which they are produced, and reflects company sophistication.

Company sophistication comes about in two ways. The first is *operational effectiveness,* which is the extent to which companies approach world best practices in areas such as production processes, technologies, marketing methods, and management techniques. The other, which is more fundamental to success in an advanced economy, is the degree to which companies have *distinctive strategies.* (For a more detailed discussion, see Porter 1996.)

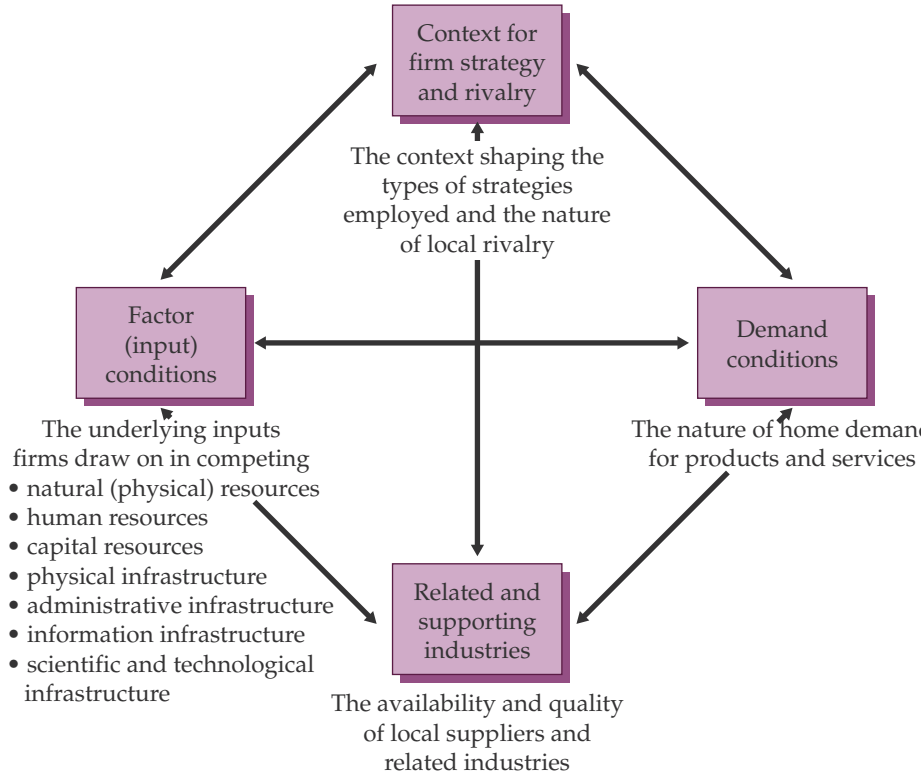
The existence of these two ways of competing is evident in the case studies of competitive and uncompetitive industries in Japan found in Porter, Takeuchi, and Sakakibara (2000). Japanese companies were internationally competitive if they had significant advantages in operational effectiveness. In the 1970s and 1980s, Japanese companies set the world standard for operational effectiveness—that is, for improving quality and lowering cost in ways that were widely applicable to many fields. They taught the world an array of approaches that improve productivity. These approaches included total quality management, just-in-time inventory control, continuous improvement, cycle time reduction, lean production, and close supplier relationships. Starting in the mid- to late 1980s, however, the gap in operational effectiveness between Japanese and Western companies began to narrow, as the latter began to emulate Japanese practices and embrace IT.

The competitiveness of Japanese companies was especially robust if they competed with distinctive strategies, as some companies did in video games, robotics, and automobiles. On the other hand, in uncompetitive industries, Japanese companies faced impediments to operational effectiveness improvement, imitated one another, or competed in ways that created little value in international markets.

The Importance of Business Environment

The sophistication with which companies compete is not solely of their own making. It is strongly influenced by the quality of the national business environment in

Figure 3.1. *Japanese Business Environment: Diamond Framework*



Source: Porter, (1990).

which companies operate. The business environment has an impact on the levels of operational effectiveness that companies can attain, as well as the degree to which distinctive strategies can be realized.

Operational effectiveness is unattainable, for example, if regulatory red tape is onerous, logistics are unreliable, IT infrastructure is undeveloped, or companies cannot receive high-quality services for their production machinery. Similarly, companies have a hard time competing with distinctive strategies if they cannot find well-educated staff, if marketing channels are poorly developed, or if local customers are unsophisticated.

A nation's business environment is shaped by four distinct but related influences listed below and depicted in Figure 3.1. (See Porter 1990 for more detail.)

1. The cost, quality, and specialization of factor inputs (factor conditions)
2. The availability and competitiveness of local suppliers, related industries, and supporting institutions (related and supporting industries)
3. The sophistication of local customers (demand conditions)
4. The intensity of local rivalry (context for firm strategy and rivalry)

The relationship between company performance and the business environment is evident in case studies of competitive and uncompetitive industries in Japan. Competitiveness arose and was sustained when the environment in the industry was dynamic, stimulating, and intensely competitive. Using the terminologies of

Figure 3.1's diamond framework, those industries where Japan flourished had favorable factor conditions, a cluster of competitive related and supporting industries, sophisticated home demand conditions, and intense home rivalry.

In contrast, industries were invariably uncompetitive if human resources, capital resources, physical resources, information infrastructure, and scientific and technological infrastructure were unavailable or of poor quality; critical related and supporting industries were weak or nonexistent; domestic customer needs were misaligned with international needs; or no effective local competition existed.

It is here that the macro and micro levels intersect. Improvements in the national business environment and the upgrading of individual companies are inextricably intertwined. A national business environment with better-quality inputs, improved infrastructure, and more advanced educational institutions fosters more sophisticated company strategies. At the same time, companies can help shape the business environment. Individual firms can take steps such as working with local universities, attracting suppliers, or defining standards that benefit not only themselves, but also the overall competitive context.

In addition to companies, universities, and suppliers, a myriad of institutions and other players contribute to shaping the business environment and play an important role in creating new knowledge at the micro level. These include government, customers, local communities, research centers, consulting firms, information and communications infrastructure providers, standard-setting agencies, trade associations, and chambers of commerce.

Japanese Innovation Within Companies

One of the clear-cut advantages Japanese companies have in the knowledge economy is their extraordinary ability to work across disciplines, functions, divisions, and organizational levels *within* a company. This ability to work together has been at the heart of Japanese companies' ability to trigger both small innovations and breakthroughs. A good illustration of this point is Canon's development of the first mini-copier, which created the personal copier market and propelled Canon's successful migration from the camera business into office automation.

The Canon Mini-Copier Example

Canon's management asked a development team to come up with a copier that could be used by anyone and produced at minimum cost. The 14-member team included 8 from R&D, 3 from production, 2 from marketing, and 1 from product design. The team realized that, to be successful, the copier had to be reliable. On existing models, the source of 90% of all maintenance problems was the copier drum, so the team proposed making it disposable. To be disposable, the drum had to be cheap to make.

Team members engaged in outspoken argument, and invited people from other areas of Canon to discuss how the problem could be solved. In the words of one member, managing the different "rhythms" that existed within the extended team became the key to achieving a creative solution. "When people's rhythms are out of sync, quarrels occur and it's hard to bring people together. Yet, if a group's rhythms are completely in unison from the beginning, it's also difficult to achieve good

results. Creating the rhythms of divergence and convergence is the trick to conducting a successful camp session."

The breakthrough came during a drinking session when the team leader, Hiroshi Tanaka, held up a beer can and wondered aloud, "How much does it cost to manufacture this can?" The question led to speculation whether the process for making aluminum beer cans could be applied to making aluminum copier drums. By exploring how the copier drum is and is not like a beer can, they were able to come up with appropriate low-cost technology.

Having made this breakthrough, Canon decided in 1980 to go ahead with full-scale development. This meant a formal task force, originally with 130 members. Eventually, nearly 200 scientists and engineers in pure research, product development, production engineering, as well as marketing specialists, were involved. (See Nonaka and Takeuchi 1995, ch. 5 for more detail.)

General Lessons

Teams play a central role in creating new knowledge, as the Canon example suggests. They provide a shared context where individuals can interact with each other and engage in the constant dialogue on which effective reflection depends. Team members create new points of view through dialogue and discussion. They pool their information and examine it from various angles. Eventually, they integrate their diverse perspectives into a new collective perspective. This dialogue can involve considerable conflict and disagreement. It is precisely such conflict that pushes employees to question existing premises and make sense of their experience in a new way.

The mini-copier example also suggests that no one department or group of experts has exclusive responsibility for creating new knowledge. Senior executives, middle managers, and front-line employees all play a part. Indeed, the value of any one person's contribution is determined less by location in the organizational hierarchy than by the importance of the information provided to the entire innovation process.

Japanese Innovation: Cross-Institutional Links

One advantage Japanese companies have in the knowledge economy is an extraordinary ability to work *across* institutions. This ability to form linkages with outside constituents, referred to as an "innovation system" (Dahlman 2001, p. 5), is a hallmark of Japanese companies. It is exemplified by how Toyota works with a relatively small and closely linked set of suppliers to constantly improve quality, efficiency, and cost in the auto industry (see Ahmadjian 2004). But a more vivid example of how a company works with someone outside an organization to realize a breakthrough in innovation comes from Matsushita Electric in Osaka.

The Matsushita Bread-Making Example

In 1985, product developers at Matsushita were hard at work on a new home bread-making machine. But they were having trouble getting the machine to knead dough well. Despite their efforts, the crust was overcooked, while the inside was hardly done at all. Members of the pilot team in the Cooking Appliances Division exhaustively analyzed the problem. They even compared x-rays of dough kneaded by the

machine and dough kneaded by professional bakers. But they were unable to obtain any meaningful data.

Finally, software developer Ikuko Tanaka proposed a creative solution. Her idea was to train with a chef at Osaka International Hotel who had the reputation for making the best bread in Osaka. Ms. Tanaka and several engineers from Matsushita apprenticed themselves to the hotel's head baker. One day, after several months on the job, Ms. Tanaka noticed their mentor was both stretching and twisting the dough. This turned out to be the secret for making bread with the correct texture. Ms. Tanaka could not devise mechanical specifications, but was able to transfer her knowledge to other apprentices using the phrase "twisting stretch." She also suggested the strength and speed of the propeller to be used in kneading.

It took another year of trial and error, working closely with project engineers, for Ms. Tanaka to come up with the product specifications—including the addition of special ribs inside the machine—that successfully reproduced the head baker's technique. The result was Matsushita's unique "twist dough" method, and a product that in its first year set a record for sales of a new kitchen appliance in Japan.

Although the general process described here could be replicated by firms outside Japan, there are three organizational aspects that are unique to Matsushita as a Japanese corporation. First, Ms. Tanaka was not what would be called a hardcore member of the product development team, yet she is the person who drove the breakthrough. Second, the company allowed her to apprentice in the hotel for several months. Third, the hotel let her stay as long as she did—after all, it must have been a bother to the chef. That the Osaka International Hotel was willing indicates how well-regarded Matsushita is in its hometown. (The description of the knowledge creation process in this section is adapted from Nonaka 1991.)

The Knowledge Creation Process

Ikuko Tanaka's innovation in bread making illustrates a movement between two different types of knowledge.

The end point of that movement is "explicit" knowledge: the product specification for the bread-making machine. Explicit knowledge is formal and systematic. For this reason, it can be easily communicated and shared in product specifications or a scientific formula or a computer program.

But the starting point is another kind of knowledge that is not so easily expressible: "tacit" knowledge, like that possessed by the head baker. Tacit knowledge is highly personal. It is hard to formalize and, therefore, difficult to communicate. Tacit knowledge is also deeply rooted in action, and in an individual's commitment to a specific context—a craft or profession, a particular technology or product market, or the activities of a work group or team.

Tacit knowledge consists partly of technical skills—the kind of informal, hard-to-pin-down skills captured in the term "know-how." A master craftsperson acts instinctively, almost automatically, and is often unable to articulate the scientific or technical principles behind the skill.

Tacit knowledge also has an important cognitive dimension. It consists of mental models, beliefs, and perspectives so ingrained that we take them for granted, and therefore cannot easily articulate them. For this reason, these implicit models profoundly shape how we perceive the world around us.

Table 3.2. *Basic Patterns for Creating Knowledge*

From tacit to tacit (socialization)
Sometimes, one shares tacit knowledge directly with another. For example, when Ikuko Tanaka apprentices herself to the head baker at the Osaka International Hotel, she learns his tacit skills through day-to-day social interaction. His tacit skills become part of Ms. Tanaka's tacit knowledge base. Put another way, she is "socialized" into the craft.
From tacit to explicit (externalization)
When Ikuko Tanaka is able to articulate the foundations of her tacit knowledge of bread making that she gained apprenticing under the head baker into explicit knowledge—by using the phrase "twisting stretch" to provide a rough image and by suggesting the strength and speed of the propeller to be used in kneading—she has converted tacit knowledge into explicit knowledge. Tacit knowledge is shared with her pilot team members as well as others in Matsushita and becomes the basis of new knowledge such as concepts, images, and written documents.
From explicit to explicit (combination)
Discrete pieces of explicit knowledge are then combined, edited, and processed to form a more complex and systematic set of explicit knowledge. The new explicit knowledge is then disseminated among members of the organization. For example, the pilot team standardizes the explicit knowledge expressed by Ikuko Tanaka—in the form of a phrase (twisting stretch) she used as well as the strength and speed of the propeller she suggested—putting it together into a product concept, a manual, or workbook.
From explicit to tacit (internalization)
Finally, individuals through action, practice, and reflection convert explicit knowledge created and shared throughout an organization into tacit knowledge. For example, the new product concept enriches the tacit knowledge base of Ms. Tanaka and her team members. They come to understand in an extremely intuitive way that a product like the home bread-making machine can provide genuine quality. They use it to broaden, extend, and reframe their own tacit knowledge base in the form of shared mental models or technical know-how.

The distinction between tacit and explicit knowledge suggests four basic patterns for creating knowledge in any organization, as shown in Table 3.2.

Ikuko Tanaka's innovation also provides a good illustration of where knowledge begins and where the knowledge creation process starts.

First, new knowledge always begins with the individual. A software engineer has a hunch to apprentice under the best bread baker in town to develop a revolutionary new product. Similarly, a researcher has an insight that leads to a new patent. A middle manager's intuitive sense of market trends becomes the catalyst for an important new product concept. A shop-floor worker draws on years of experience to come up with a new process innovation. In each case, an individual's personal knowledge is transformed into organizational knowledge valuable to the company as a whole.

In other words, an organization cannot create knowledge on its own. It is very important, therefore, for an organization to support and stimulate the knowledge-creating activities of individuals and to provide the appropriate contexts for them. Organizational knowledge creation should be understood as a process that "organizationally"

Table 3.3. *The SECI Spiral*

Socialization	Sharing and creating tacit knowledge through direct experience
Externalization	Articulating tacit knowledge through dialogue and reflection
Combination	Systematizing and applying explicit knowledge and information
Internalization	Learning and acquiring new tacit knowledge in practice

amplifies the knowledge created by individuals and crystallizes it at the group level through dialogue, discussion, experience sharing, or sense making.

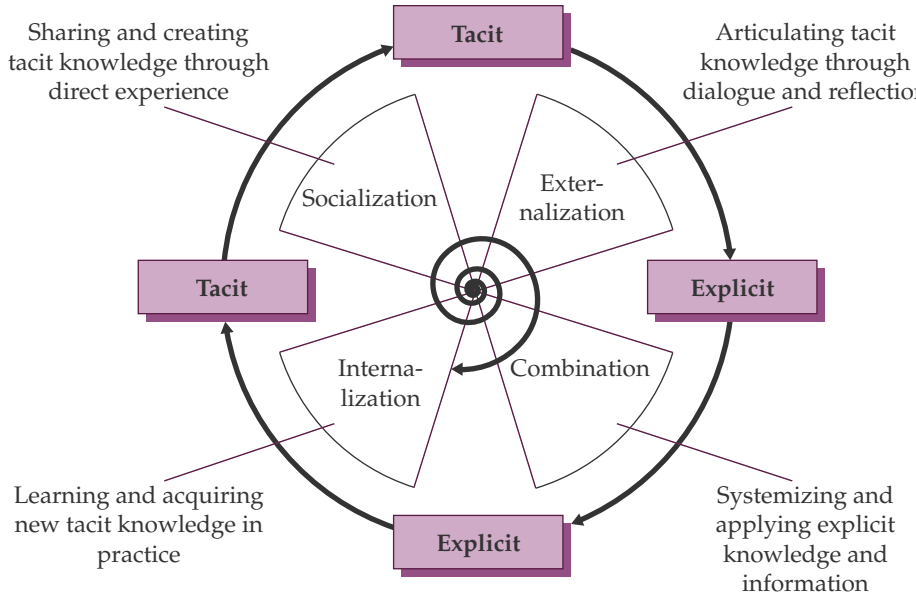
Second, Ms. Tanaka's innovation illustrates that knowledge creation starts with socialization and moves through the four modes of knowledge conversion in a spiral, which has become known as the SECI (socialization, externalization, combination, and internalization) process. This is shown in Table 3.3 and Figure 3.2.

Moving through the spiral, the interaction between tacit and explicit knowledge is amplified. The spiral becomes larger in scale as it moves up the ontological levels (that is, individual, group, organizational, and interorganizational). Knowledge created through the SECI process triggers a new spiral of knowledge creation, expanding horizontally and vertically as it transcends sectional, departmental, divisional, and even organizational boundaries. As the spiral expands beyond organizational boundaries, knowledge created by universities, suppliers, customers, competitors, local communities, government, and others interacts with each other in amplifying the knowledge-creating process.

Conclusion

What can be learned from the experience of Japan and its innovative companies? Perhaps the most important point for policy makers in emerging economies is that

Figure 3.2. *SECI Process of Knowledge Spiral*



Source: Adapted from Nonaka and Takeuchi (1995).

the much celebrated Japanese government model is *not* the cause of Japan's postwar economic success. In fact, it is more closely associated with the nation's failures. The core of the problem rests with government mistrusting competition and, therefore, intervening in ways that harm productivity and prosperity. The government's role in the knowledge economy is clear. It must work to improve the quality and dynamism of the national business environment, facilitating competition and encouraging innovation and entrepreneurship.

Conventional wisdom about Japan's corporate success has more merit, but it is dangerously incomplete. Globally, firms must move beyond competing just on quality and operational effectiveness to competing on distinctive strategies and breakthroughs in innovation.

Innovations are made, not born. Leaving it to serendipity and happenstance may work at times. The real trick is doing it over and over again. This means setting high goals, relentlessly experimenting, and continually hammering away. That is hard work. The contemporary experience of Japanese companies teaches that breakthroughs in innovation are triggered by working together with a diverse group of individuals within the company, as well as across organizational boundaries. Individuals, not companies, create new knowledge.

The organizational knowledge creation at Canon and knowledge creation across organizational boundaries at Matsushita outlined above are classic examples of advantages Japanese companies were able to build to trigger breakthroughs in innovation. They are classic in the sense that they took place some time ago (in the 1980s), were among the first practical illustrations to appear in the knowledge management literature, and have been cited frequently in different publications since then.

But what is important is whether Japanese companies can come up with breakthroughs to be competitive within the knowledge economy. The short answer is that innovation is alive and well in Japan, and the Japanese approach to knowledge has a new dynamism that makes it as relevant as ever—perhaps even more so. The short answer is elaborated in this project's companion volume. It presents the Japanese approach to knowledge management and relates it to actual practice in five case studies. The case-study firms span a wide variety of industry segments: Seven-Eleven Japan (retailing), Lexus Division of Toyota (automobiles), Sharp (television), Keyence (electronic components), Nintendo (home video games), and Shimano (bicycle parts). The experiences of these companies suggest a fresh way of thinking about competitiveness within the knowledge economy.

Thus, history may repeat itself. Much as manufacturers around the world learned from Japanese manufacturing techniques in the past, any company that wants to compete on knowledge must learn from the Japanese approach to knowledge creation.

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4

Elements of a New Economic and Institutional Regime for an Advanced Knowledge Economy

Tatsuji Hayakawa

Recognition of the importance of knowledge to the economy has a long tradition in Japan, and this forms the intellectual and practical foundation of Japan's move toward being an advanced knowledge economy. The public has had firm confidence in the importance of science and technology throughout the course of the country's modernization, militarization, and postwar reconstruction. Such an attitude is compatible in principle with the nature of a knowledge-based economy. However, parts of the current economic and institutional regime have become mismatched with the global environment. Hence it is crucial for Japan to complete an updated framework more fitting for the knowledge-based economy of the future.

From the perspective of a knowledge economy, this chapter analyzes the background and characteristics of a new economic and institutional regime in Japan. Attention is paid to evaluating the achievements of structural reforms already undertaken, including government deregulation. The chapter also explores a number of factors that may affect Japan's transition into a more advanced knowledge economy, and hence may have caused Japanese growth to have slowed in the 1990s.

The chapter is organized as follows. As background, relevant issues regarding the financial and labor markets are reviewed. Then, international economic policies are discussed. The role of government appropriate to a knowledge economy, and the necessary safety nets required, are then taken up. For context, Figure 4.1 shows GDP growth and inflation for the 1970–2003 period.

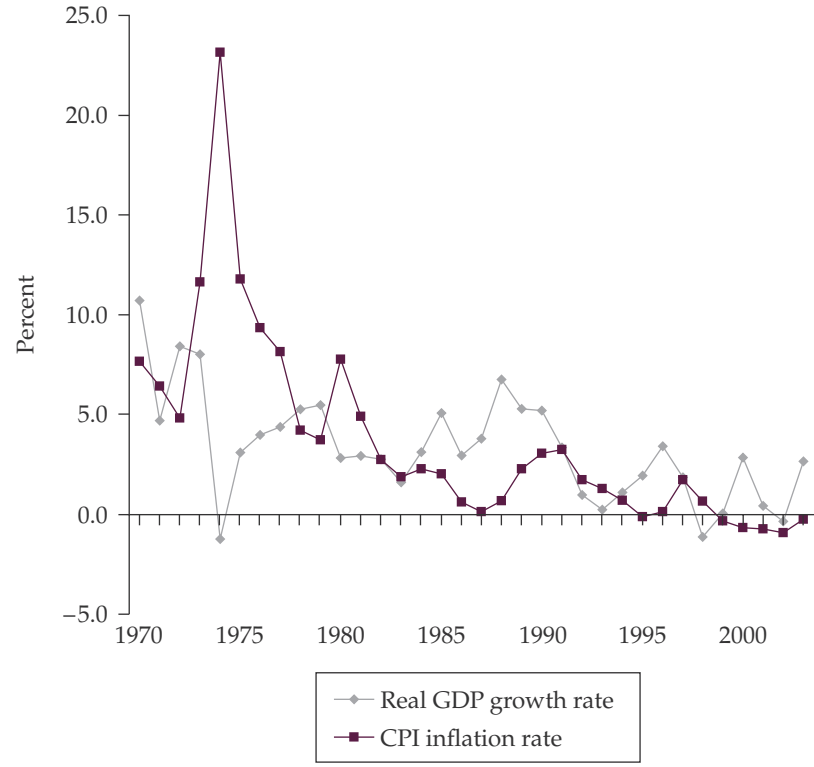
The Doing Business Database

To gain perspective on Japan as a knowledge economy, Table 4.1 summarizes where Japan stood in 2005 in terms of various measures of business regulation and enforcement.

The data suggest Japan needs improvement in starting a business, an important element for a knowledge economy. This includes the minimum amount of capital necessary to start a business. However, in February 2003, the government amended the regulations, so now a new business can maintain any capital amount, even just ¥1, during its first five years, subject to approval by the Ministry of Economy, Trade and Industry (METI). Applications for such exceptions will be accepted until March 2008.

On the other hand, closing a business in Japan is relatively easy, and creditors of failed businesses recover a larger percentage of what they are owed than in other countries.

Figure 4.1. *Growth and Inflation, 1970–2003*



Source: World Bank, World Development Indicators.

Financial Markets

Japan has been overbanked since the 1930s. Banks played the dominant role in financing firms during the high-growth era and into the 1980s. A low-interest policy, and a tax code allowing deduction of interest payments in determining taxable income, have made borrowing costs low. During the high-growth era, strong demand for capital led to excessive leveraging by firms and overloan by banks. Table 4.2 compares the relative size of security markets and borrowed funds during the postwar period.

Japan is the only G-7 country whose stock market capitalization expressed as a percentage of GDP *declined* from 1990 to 2003. This reflects the magnitude of the bubble that collapsed beginning in 1990 (Table 4.3).

A knowledge-based economy requires a financial system that can contribute to an efficient allocation of capital. However, the proper functioning of Japanese financial intermediaries was severely affected by the accumulation of nonperforming loans during the years after the bursting of the stock and real estate market bubbles.

The dependence on financing through the banking system is considered one of the most important causes of Japan's prolonged inability to recover quickly after the collapse of the asset price bubble. In particular, the banks had huge amounts of nonperforming loans. It is possible that continued bank support of extremely underperforming firms—called "zombies"—crowded out lending to potentially profitable firms, thus costing productivity. In short, the stagnation of the 1990s

Table 4.1. *Where Japan Stands in 2005*

Country[1]	*Starting a business*				*Hiring and firing workers*			
	Number of procedures	*Time (days)*	*Cost (% of income per capita)*	*Min. capital (% of income per capita)*	*Difficulty of hiring index*[2]	*Rigidity of hours index*[3]	*Rigidity of employment index*[4]	*Firing costs (weeks of wages)*
Low	10	62	179.7	289.5	45	58	50	52.4
Lower-middle	10	48	40	222.4	35	46	39	58.6
Upper-middle	9	45	21.3	96.1	30	48	35	36.2
High	6	22	7.4	55.7	28	49	34	38.2
Japan	**11**	**31**	**10.7**	**75.3**	**17**	**40**	**19**	**21.2**

Country[1]	*Registering property*			*Getting credit*		*Protecting investors*	
	Number of procedures	*Time (days)*	*Cost (% of property value)*	*Legal rights index*[5]	*Credit information index*[6]	*Private bureau coverage (% adults)*	*Disclosure index*[7]
Low	6	120	10.4	4	1	0.1	5
Lower-middle	6	65	5.4	4	2	10.6	4
Upper-middle	5	103	4	5	4	21.7	5
High	4	47	4.5	6	4	51.5	5
Japan	**6**	**14**	**4**	**6**	**6**	**61.2**	**6**

Country[1]	*Enforcing contracts*			*Closing a business*			*Economy characteristics*	
	Number of procedures	*Time (days)*	*Cost (% of debt)*	*Time (years)*	*Cost (% of estate)*	*Recovery rate (cents on the dollar)*	*GNI per capita (U.S.$)*	*Informal economy (% GNI, 2003)*
Low	36	436	48.1	3.7	19	13.8	445	39.4
Lower-middle	31	414	29.5	3.5	19	24.6	1,985	38.4
Upper-middle	31	415	18.4	3.4	16	34.7	5,958	31.2
High	23	272	11.7	1.8	8	68.9	27,833	17.6
Japan	**16**	**60**	**8.6**	**0.6**	**4**	**92.7**	**37,180**	**11.3**

1. Averages of 52 low-income, 50 lower-middle-income, 22 upper-middle-income, and 31 high-income countries.
2. 3. 4. Higher values indicate more rigid regulation.
5. Higher scores indicate that collateral and bankruptcy laws are better designed to expand access to credit.
6. Higher values indicate that more credit information is available from either a public registry or a private bureau to facilitate lending decisions.
7. Higher values indicate greater disclosure.

Source: World Bank, The Doing Business Database, http://rru.worldbank.org/DoingBusiness.

Table 4.2. *Funding Patterns, Level of Claims Data (percentage distribution)*

	Securities markets				*Borrowed funds*			
Year	*Total*	*Equity*	*Domestic bonds*	*Foreign bonds*	*Commercial paper*	*Total*	*Private lender*	*Public lender*
1955	21.3	17.2	4.1	0.0	0.0	78.7	69.6	9.1
1965	22.5	17.4	4.9	0.2	0.0	77.5	70.2	7.3
1975	13.6	9.0	4.4	0.3	0.0	86.4	78.4	8.0
1985	17.0	9.9	5.1	2.0	0.0	83.0	74.7	8.3
1995	22.2	9.5	8.2	3.1	1.4	77.8	64.6	13.2

Source: Table 4.5 and Table 7.8 of Hoshi and Kashyap (2001).

Table 4.3. *Stock Market and Banking System*

Stock market capitalization (% of GDP)	*1990*	*2003*
Canada	42.1	104.4
France	25.8	77.1
Germany	21.2	44.9
Italy	13.5	41.9
Japan	**96.1**	**70.7**
United Kingdom	85.8	134.4
United States	53.2	130.3

Domestic credit provided by banking sector (% of GDP)	*1990*	*2003*
Canada	82.3	92.3
France	104.4	107.2
Germany	104.4	142.9
Italy	89.4	105.3
Japan	**260.7**	**157.3**
United Kingdom	121.0	150.4
United States	174.5	261.8

Source: World Bank, World Development Indicators.

may well have been caused primarily by a dysfunctional financial system misallocating funds. (See Fukuda and Koibuchi 2004; Bayoumi 2001; Bergoeing et al. 2004.)

Ando et al. (2003) find that the rate of return on assets in the corporate sector is very low in Japan, due mainly to the corporate governance structure allowing low dividend payments. They suspect that the retained earnings of Japanese corporations have not contributed to the value of equities because they have not led to an increase in dividends. Hence, they recommend changes in corporate governance so as to enable equity holders to deal with management more equally. Reforms of the accounting system and of the corporate tax system are also recommended, with a view to increasing household net worth, and thus consumption. It is now recognized that Japanese companies tended to pursue revenue growth and market share, while ignoring profitability. (See, for example, Porter et al. 2000.)

Table 4.4. *Japanese Financial System Structure, End-March 2003*

		Total assets			
	Number of institutions	*Trillion yen (% total)*	*% of GDP*	*Deposits outstanding, trillion yen (% total)*	*Loans and discounts outstanding, trillion yen (% total)*
Banks					
City banks	7	407 (21.6)	81.6	248 (22.7)	223 (28.0)
Others	224	382.7 (20.3)	76.6	284.5 (26.1)	227 (28.5)
Cooperative financial institutions	2137	370 (19.6)	74.2	320 (29.3)	136 (17.1)
Non-depository financial institutions					
Life insurance	43	179 (9.5)	35.9	n.a. (n.a.)	47 (5.9)
Nonlife insurance	59	31 (1.6)	6.2	n.a. (n.a.)	4 (0.5)
Securities companies and money market dealers	279	107 (5.7)	21.4	n.a. (n.a)	n.a. (n.a.)
Public financial institutions					
Japan Post	1	242 (12.8)	48.5	239 (21.9)	0.7 (0.1)
Government financial institutions	8	166 (8.8)	33.2	... (...)	159 (19.9)
Total financial system (excluding Bank of Japan)	2758	1884 (100.0)	377.6	1092 (100.0)	797 (100.0)

Source: International Monetary Fund (2003).

According to Hayashi and Prescott (2002), funded projects were receiving a low rate of return in the 1990s, when the growth rate of total factor productivity (TFP) fell significantly, as discussed in Chapter 2 in Volume 1. Analyzing Japanese firm-level survey data for 1994–2001, Fukao and Kwon (2004) conclude that a significant portion of the decline in TFP growth in the manufacturing sector can be attributed to the negative-exit effect. That is, the average TFP level of exiting firms was higher than that of surviving firms.

The keiretsu (industrial group) system was considered efficient in preventing bankruptcy by members, something achieved by a group's main bank participating in rescue operations of inefficient firms. Whether this was desirable in terms of efficient allocation of capital is another question. It definitely often negatively affected bank balance sheets. (See, for example, Hoshi and Kashyap 2001.)

It is worth noting that government financial institutions (GFIs) have been playing an important role in Japan, in terms of total assets, deposits, and loans. Japan Post is the largest deposit-taking institution in the world. As summarized in Table 4.4, as of March 2003 it held 22% of deposits and 13% of total assets in the total financial system.

Loans made by the eight major GFIs accounted for 20% of all loans in March 2003. With a view to creating a level playing field among deposit-taking institutions, one of the major focuses of the ongoing financial reforms is privatization of Japan Post. Historically, Japan Post deposits and life-insurance assets have funded the Fiscal Investment and Loan Program (FILP), which channels resources toward GFIs and agencies, public corporations, local governments, and the central government. As the environment has changed, the performance of GFIs has been mixed. It is possible that making subsidized loans to borrowers that no private bank would lend to will slow growth. Review and reform of the various GFIs are under way.

By mid-2005 the issue of nonperforming loans finally appeared to be under control. The outstanding amount in March 2005 was reported by the Financial Services Agency as ¥17.9 trillion, equal to 3.5% of GDP. Gross public funds of ¥25 trillion (4.9% of GDP) had been injected to rescue Japanese private financial institutions. However, the major banks have repaid much of what they received, leaving an outstanding balance of ¥16.9 trillion (3.3% of GDP).

Taxpayers will eventually bear losses from the financial system's problems, and the burden will be substantial, although the total will be unknown for some time because funds continue to be recovered by the government. Hoshi and Kashyap (2004) estimate the full cost as at least 20% of GDP, including bailing out FILP losses of ¥78 trillion (about 15% of GDP) and life insurance companies, as well as the banks. (Also see Fukao 2003.)

As financial reform progresses, it is expected that the financial system will become more flexible and accommodating to the needs of a knowledge economy, achieving an efficient allocation of capital. Hoshi and Kashyap (2001) see corporate finance depending more on securities markets in the future, attracting savings not only from wealthy families as in the 1920s, but also more widely. Such a shift should be welcome as supportive of a knowledge-based economy. The financial system particularly needs to be capable of providing an ample supply of capital for companies not endowed with traditional collateral such as real estate. When they work properly, securities markets are more convenient and flexible for new companies setting up knowledge-based business activities.

The level of venture capital investment is low in Japan. The 2001 flow amount of ¥280 billion was about 6% of the U.S. level, and the stock amount, ¥1.02 trillion, was just over 3% (METI 2003).

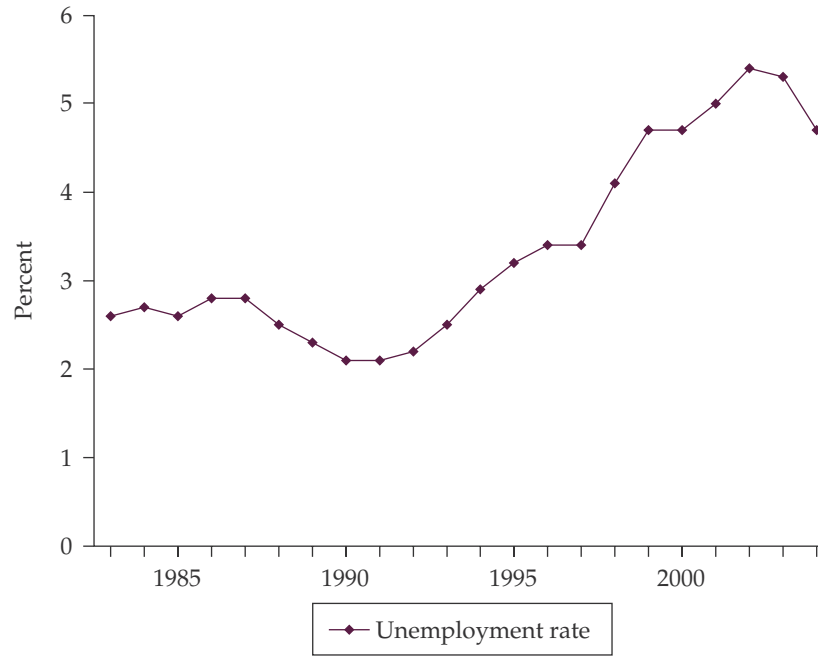
Stock markets and banks contribute to economic growth by providing different kinds of financial services, so they are complementary. Banks in general have tighter limits on the amount of financial risk they can take on. This means an advanced knowledge economy will require a supply of venture capital for Small and Medium Enterprises through channels other than the banking system.

The Labor Force

From the 1950s into the 1990s, Japan's labor market was characterized by lifetime employment and seniority-based wages. However, the situation has been changing as firms find it difficult to maintain such a system. As a result, the unemployment rate started to rise in the mid-1990s. From 2.1% in 1990 and 1991, the rate peaked at 5.4% in 2002 (Figure 4.2).

Moreover, the duration of unemployment has become longer. The percentage of those unemployed for 12 months or more has risen for both men and women since

Figure 4.2. *The Unemployment Rate, 1983–2004*



Source: Statistics Bureau, Ministry of Internal Affairs and Communication.

Table 4.5. *Incidence of Long-Term (12 Months and Over) Unempolyment Rate*

Year	*Total % of total unemployment*	*Men % of male unempoyment*	*Women % of female unemployment*
1990	19.1	26.2	8.8
2001	26.6	32.1	18.3
2002	30.8	36.2	22.4
2003	33.5	38.9	24.6
2004	33.7	40.2	23.1

Source: OECD (2005).

1990. The percentage for women may have peaked in 2003, but the level for males continued to rise in 2004 (Table 4.5).

Although labor market reform is clearly a matter of priority in Japan, it is a difficult structural reform compared to reforms in the financial sector, product markets, and trade. (See IMF 2004a.)

Unemployment is generally considered a near-term issue. In part this is because Japan faces a demographic change. The percentage of the population that is 15 to 64, which is considered working-age, has been falling since 1993. According to the OECD, it decreased from 70% in 1992 to 67% in 2003. It is projected to drop to 57.5% in 2030 (United Nations 2005). To compensate for the reduction, Japan needs to explore policies related to the retirement age, labor force participation, and immigration. These are discussed in the next sections.

Retirement Age

The retirement age has drawn special attention. Japan experienced a baby boom between 1947 and 1949. These boomers are called the *dankai* (cluster) generation. As of October 2004, they numbered 6.8 million, which is 5.3% of the population. (If those born in 1950 are included, their number is 8.9 million, 7% of the population.)

In the last half of the current decade, they reach retirement age. If they all leave the workplace at once, there could be serious problems regarding technology transfers and skill levels within firms. Their retirement could also cause Japan's household saving rates to decline even further, and affect the financial viability of the public pension system. For example, Koga (2004) finds that the decline in the Japanese household saving rate in the 1990s is explained mainly by demographic factors and confirms the implications of the life-cycle model for Japan.

To avoid these negative consequences, government and corporate policies must be implemented to encourage workers over 60—still the usual retirement age—to continue working. This includes increasing the official retirement age at large corporations and in the public sector and developing measures for re-employment for those who do retire. Fortunately, many boomers intend to keep working past 60. Also fortunately, those in their 60s place greater priority on the hours worked, the work environment, and the type of job than on wages (Ohashi 2005). This will help to create the more flexible and innovative compensation schemes needed to keep older workers on the payroll without endangering the financial position of employers because of high labor cost.

The Young

In principle, a knowledge-based economy can be friendlier to younger generations with new knowledge than a more traditional type of economy, where the deterioration or obsolescence of labor skills occurs much more slowly, and each individual accumulates skills through work experience over time. In that sense, the fact that the percentage of young and single people not engaged in productive activities has increased in the last decade is a social and economic concern with adverse effects for the longer run.

Those classed as NEET (not in employment, education or training), numbered about 640,000 (0.75% of the working-age population) in 2004, up from about 400,000 (0.46%) in 1993. In addition, there were around 2.1 million "freeters" (3.2% of the labor force) in 2004. These are young workers, other than students and housewives, who work part-time. Originally, the term referred only to those working part-time by choice, but it has come to include those who would prefer full-time work but cannot find it. The Ministry of Health, Labor, and Welfare (MHLW) reports that from 1989 to 1993, 99% of high school graduates who sought full-time employment received a job offer. In 2002 and 2003 only 90% did. With an improving economy, 94% of March 2005 graduates got offers. Still, many NEETs and freeters are unable to get stable or desirable positions in either education or labor.

Some young people are discouraged by the gap between the sort of work they aspire to do and the actual assignments they are given. The issue is quite complicated, but timely public policies in the labor market to encourage younger generations into productive activities are necessary.

There are also employment mismatches for higher-education graduates. The number of graduate schools has increased, reflecting the intention of the Ministry of Education, Culture, Sports, Science and Technology (MEXT) to increase the number of master's and doctorate degree holders in Japan. However, as an example of the mismatch, many take courses related to international development assistance, even though there is only a limited number of stable jobs in this area. As the number of those completing a doctorate degree increases, so does the number of so-called "over-doctors"—PhDs who do not get a stable position. Not utilizing such human capital means a serious waste of private and public resources devoted to higher-level education. In creating graduate programs, the stakeholders need to give more weight to the relevant job market.

From the viewpoint of employers, it may be appropriate in some cases to change training and mentoring methods. Young workers who quit too soon after being hired might have been excellent employees with a little more time and patience on both their part and the part of their supervisors. More than 25% of high school graduates quit their initial job within one year. Such separation rates were around 15% until the early 1980s. Citing this increase, Ariga (2005) points to a deterioration in the quality of the high school placement system in both rural and urban prefectures. Some leave work thinking there are many other better opportunities, even when that is just wishful thinking.

Women

Increased female participation in the labor force will boost economic growth. The female participation rate has generally risen since 1990, reaching 60% in 2004, which is the OECD average. Further increases are possible: a number of countries have rates over 70%. Ireland increased its female participation rate from 43% to 58% during 1990–2004, contributing to its strong economic growth in the 1990s, and the case was studied by the OECD (2004). Moreover, 65% of Irish women work full-time, compared to 58% in Japan. (The rate for males is much higher than the OECD average of 80%. It has increased some since 1990, but is less than the 85% recorded in 2000.) Data on participation rates are in Table 4.6.

Mothers rearing children tend to be discouraged from participating in the labor force at all. When they do participate, part-time work is often preferred. Infrastructure such as day-care services, together with labor arrangements such as flexible working hours, liberal maternity and sick leave, and the like, can make motherhood and women's labor force participation more compatible, as observed in Scandinavian countries. However, to achieve greater infrastructure allowing more women to work, greater public funding is necessary. Likewise, providing women with more benefits, such as paid maternity leave, implies an increase in labor costs.

Regarding concerns over a negative correlation between female participation and fertility, Jaumotte (2003) points out that Nordic countries have attained high female participation and high fertility relative to the OECD average. In contrast, southern European countries have both relatively low female participation and low fertility.

Work-family reconciliation policies for both women and men are needed in Japan so that women can participate without having to choose to reduce family size. According to regional data published by the MHLW, the fertility rate in Japan seems to correlate positively with the participation rate of women and negatively

Table 4.6. *Labor Force Participation Rate*

Persons aged 15–64 years (percentages)	*1990*	*2004*
Australia	73	73.6
Canada	76.6	78.2
Finland	76.5	73.8
France	67.1	69.5
Germany	67.4	72.7
Ireland	60.1	68.6
Italy	59.5	62.5
Japan	**70.1**	**72.2**
New Zealand	73.2	76.6
Spain	61.7	69.7
Sweden	84.7	78.7
United Kingdom	77.8	76.2
United States	76.5	75.4
OECD	69.3	70.1

Men aged 15–64 years (percentages)	*1990*	*2004*
Australia	84.4	80.8
Canada	84.9	83.0
Finland	79.6	75.5
France	76.5	75.3
Germany	79.0	79.1
Ireland	77.5	79.1
Italy	75.1	74.5
Japan	**83.0**	**84.2**
New Zealand	83.4	83.8
Spain	81.3	81.6
Sweden	86.8	80.7
United Kingdom	88.3	83.1
United States	85.6	81.9
OECD	82.3	80.3

Women Aged 15–64 Years (Percentages)	*1990*	*2004*
Australia	61.5	66.3
Canada	68.3	73.5
Finland	73.4	72.0
France	58.0	63.7
Germany	55.5	66.1
Ireland	42.6	58.0
Italy	44.0	50.6
Japan	**57.1**	**60.2**
New Zealand	63.2	69.6
Spain	42.2	57.7
Sweden	82.5	76.6
United Kingdom	67.3	69.6
United States	67.8	69.2
OECD	56.6	60.1

Source: OECD (2005).

with the average hours worked by men. For Japan to be able to increase its fertility rate, which has been below replacement level for some time, employers need to understand the importance of time and flexibility. This can facilitate parents being able to attain a balance between work and family.

The decline in Japan's fertility rate is rooted in several complex factors. In addition to a lack of supporting infrastructure and labor practices, an obvious factor is the later age of marriage compared to previous generations. It was common among postwar boomers to marry while attending college. Such practice is rare today. Although it is true that the younger generation tends to give priorities to intensive study and work experience before starting a family, it seems that there is a significant issue of matching, just as the young tend to suffer from employment mismatches. In terms of fertility in Japan, marriage is crucial, as 98% of births are to married mothers.

Immigration

Japan depends very little on immigrants. The MHLW estimates there were 568,000 legal foreign workers in Japan in 2003. It will be necessary to provide employment opportunities for foreign workers, especially in occupations for which demand is likely to increase due to Japan's low fertility and aging. These include physicians, nurses, and other health care providers, as well as low-paying and relatively undesirable jobs.

For example, the case of nursing care providers is being discussed as part of the free-trade agreement (FTA) negotiations between Japan and the Philippines. Japan requires such foreign workers to be certified according to the Japanese system, which requires significant Japanese language skill. Although the Japanese language is not easy to master, the pronunciation is not too complicated, so speaking Japanese is achievable with reasonable efforts. Accepting more cooks from Thailand is also under negotiation.

Employers are expected to treat immigrants on an equal basis with Japanese nationals. Regulations will need to be updated in such areas as taxation, benefits, and pensions.

Opening to more immigrants can make Japan more integrated with the rest of the world, resulting in faster mutual spillover of knowledge, as well as a stronger international promotion of Japanese culture and language. However, as in other countries, there exists a restrictive sentiment regarding immigration, so changing regulations will require major political decision making. Such a policy change is compatible with ongoing globalization and Japan's own international interests.

The possibility of immigrants relieving the fiscal burden on future generations in low-fertility countries through their taxes and social security contributions is widely discussed. Germany and New Zealand are particularly cited. However, in the United States, where the degree of population aging is less than that in Japan and Europe, any positive fiscal impact of immigration appears insignificant. As for Japan, immigrants from Brazil, Peru, and the Philippines, for example, are stimulating the economy and strengthening Japan's long-term fiscal position, in addition to contributing to their home countries through remittances.

Labor Mobility

Improving the quality and allocation of the labor force can be as valuable as encouraging wider labor force participation. Although some firms are maintaining the tradition

of lifetime employment, the system has become harder to sustain. Thus, enhancing labor market flexibility, including an increase in pension portability, can facilitate labor mobility and hence the dynamism that a knowledge-based economy requires.

At large, established firms and government agencies, newly hired graduates traditionally tended to pursue lifetime employment, and their employers did not engage in mid-career recruitment. The participation rate in job-related continuing education and training is considered relatively high in Japan, at 32% in 2002 (MHLW data). However, on-the-job training has tended to be firm-specific. Given the expectation of long-term employment, firms have offered formal in-house education and training to both junior and experienced workers. In contrast, in most countries such opportunities tend to increase with the number of years worked.

Given the expectation of seniority-based wages and the limited portability of pensions, the incentive to change employers has been weak. As lifetime employment becomes less certain, it is necessary to provide workers with training opportunities to gain up-to-date skills so they are able to enter the job market as employable candidates. There needs to be more emphasis on equipping workers with widely applicable skills rather than purely in-house know-how. To this end, the government does subsidize individual workers for educational and training programs, as explained in Chapter 7 in Volume 1. As more and more firms find it financially difficult to maintain redundant workers, a payment structure less influenced by age and years is to be expected.

There are experiments with trial employment for a fixed term as an alternative to the almost immediate permanent commitment of the traditional system. As employers move toward more flexibility on who is retained, so will they also need to be more active in hiring mid-career workers. Hiring someone mid-career is often the best way to gain workers who have experience using skills that are new or needed by a firm.

International Economic Policies

The importance of international transactions to G-7 countries is compared in Table 4.7. The share of Japan's exports in GDP is somewhat similar to that of the United States, but smaller than in the other five countries. Nonetheless, exports often have played the role of an important engine of growth in Japan. Japan's level of imports and net foreign direct investment inflow are by far the lowest in the group.

FDI is considered to have positive consequences for innovation because of spillover effects. This is as true for advanced countries as it is for less developed ones. Thus, higher inward FDI would stimulate the dissemination of knowledge and know-how, helping Japan keep abreast of global trends.

Interest in concluding free trade agreements and economic partnership agreements within East Asia has increased. The first FTA, with Singapore, took effect in 2002, followed by one with Mexico effective from 2005. Japan has been negotiating with the Philippines, Malaysia, and Thailand. Beyond such bilateral deals, economic integration in East Asia is a logical defense against economic shocks. (For a positive view of the role of FTAs, see Urata 2005.)

Although it makes sense for Japan to concentrate on the neighboring, booming East Asia region, Japan cannot ignore the rest of the world. This is especially so if it intends to continue active participation in the workings of the globalized economy envisaged by such multilateral systems as the World Trade Organization (WTO).

Table 4.7. *Exports, Imports, and FDI, 1999–2003*

Exports of goods and services (% of GDP)	*1999*	*2000*	*2001*	*2002*	*2003*
Canada	43.7	46.1	44.0	41.6	38.4
France	25.9	28.6	27.9	27.0	25.8
Germany	29.6	33.8	35.3	35.9	36.0
Italy	25.5	28.3	28.4	27.0	25.4
Japan	**10.1**	**10.8**	**10.4**	**11.2**	**11.8**
United Kingdom	26.4	28.1	27.3	26.2	25.1
United States	10.8	11.2	10.3	9.7	9.3
Imports of goods and services (% of GDP)	*1999*	*2000*	*2001*	*2002*	*2003*
Canada	40.0	40.3	38.3	37.2	34.4
France	23.7	27.3	26.3	25.2	24.6
Germany	28.8	33.4	33.3	31.6	31.8
Italy	23.5	27.3	27.0	26.0	24.9
Japan	**8.5**	**9.4**	**9.8**	**9.9**	**10.2**
United Kingdom	28.2	30.1	30.1	29.2	28.1
United States	13.6	15.1	14.0	13.7	13.9
FDI, net inflows (% of GDP)	*1999*	*2000*	*2001*	*2002*	*2003*
Canada	3.8	9.3	3.9	2.9	0.7
France	3.2	3.2	3.8	3.4	2.7
Germany	2.6	11.2	1.1	1.8	0.5
Italy	0.6	1.2	1.4	1.2	1.1
Japan	**0.3**	**0.2**	**0.1**	**0.2**	**0.1**
United Kingdom	6.1	8.5	3.8	1.9	1.2
United States	3.1	3.3	1.7	0.7	0.4

Source: World Bank, World Development Indicators.

Absent progress in WTO negotiations, FTAs with important trading partners—the United State, the European Union, Australia, and Canada—could increase Japan's real GDP and help Japan advance as a knowledge-based economy.

Even if Japan's fiscal position continues to be restricted, the international community expects Japan to continue its relatively high level of official development aid. Fortunately, this usually facilitates trade between developing countries and Japan.

If Japan truly believes in the importance of an open economy to attain mutual gains internationally, it is necessary to proceed with reform of its agricultural sector. The sector has long been protected by restrictive trade measures and government subsidies. Most other countries also protect agriculture, so opening the field requires a coordination of policies with other counties. Such reforms entail great political risks, yet should benefit Japan and its trading partners. One particular factor that has made agricultural reform difficult in Japan is the election system: rural areas are disproportionately represented relative to urban ones. Although this is less true than in the past, it remains an issue.

Redefining the Role of Government

The government plays a key role in an advanced knowledge economy through its policy choices. The problems of the 1990s illustrate the basic importance of proper and timely macroeconomic policies. The government must continue efforts to improve its capacity to deal with macroeconomic adversity, especially in the area of financial supervision.

To keep pace with globalization, the government has to maintain support for higher education and research and development, as these constitute vital parts of a knowledge-based economy. The role of the private sector in research and development leading to innovation is crucial in Japan, so it is expected that the government will act to facilitate it rather than to control it.

The government must also tackle the challenge of providing the necessary general infrastructure, and at a lower cost than currently, by carrying out further reform in public procurement and by establishing a more competitive environment. As part of this, the government needs to increase competition in its purchases.

Competition policy needs to be strengthened. There also is a need for a regulatory framework that is more inducive to start-ups and the growth of SMEs in knowledge-based industries. It is of particular importance to continue encouraging industrial restructuring and revitalization. The Industrial Revitalization Corporation Japan (IRCJ) was established jointly by the public and private sectors in 2003 to provide revitalization assistance to companies with sound business foundations but financial and other difficulties. The IRCJ accepted 41 cases before its statutory deadline for selecting firms to help.

Japan has to strengthen the technical and financial capacity of local governments, which historically have relied on the central government. With the aging of the population, innovation is needed to vitalize rural areas without resorting to public works projects. Doi and Ihori (2004) point out that the productivity of public investment at the local level fell during the 1990s. They attribute the slowdown of GDP growth in the decade to this inefficient public investment. Some prefectures are making efforts to cut unnecessary public investment to improve their budgets, while encouraging projects financed by the private sector.

The central government has been promoting more efficient administrative management at the local level by mergers of municipalities to generate scale economies. While the main objective of this policy is to reduce administrative costs, it is also expected to stimulate economic activities as a by-product.

Even though these tasks by the public sector are crucial, it is inevitable that the government will be smaller in size. This reflects the government's deteriorated fiscal condition and the imminent population decrease. Fiscal sustainability is becoming a serious issue as a result of policies in the 1990s, as particularly pointed out by Ihori et al. (2003). Doi and Ihori (2004) claim that Japan's fiscal deficits are no longer sustainable, and urge the government to reduce its deficit each year to attain an overall budget balance, including debt service, in 2013.

In any case, the services provided by the government ought to be more efficient and effective than they have been. Raising taxes is seriously discussed, and new schemes, such as linking consumption taxes to pension benefits, have been proposed. Still, private resources will be more important in the provision of public goods, including social safety nets, through coordination between the public sector and nonprofit organizations (NPOs). Private sector participation in some activities

usually carried out by the public sector is also desirable in stimulating the economy. Finally, it is always worth remembering that economic growth itself will contribute to a better management of public debt by reducing its size relative to GDP and by increasing tax revenues.

Social Safety Net

As Japan is transformed into an advanced knowledge-based economy, with an emphasis on the market mechanism and greater competition, intrinsic risks related to employment and financial well-being are likely to increase. Thus, it is important to secure new safety nets that can cope with the greater uncertainties. These should include, among others, measures to strengthen the existing scheme related to SME start-ups and closures and to provide displaced workers with opportunities to be trained in new skills. Given the historical importance of SMEs in Japan, the government needs to give priority to METI's efforts to promote entrepreneurship and business start-ups.

The aging population is generating unprecedented challenges. Efforts need to focus on how to deal with intergenerational welfare conflicts in the face of the government's debt-laden fiscal position. Other things being equal, the budget balance will deteriorate as the elderly increase as a percentage of the population. This reflects higher spending on pension benefits and health care and lower tax revenues from a smaller working population. (See IMF 2004b; Faruqee and Mühleisen 2003.)

The current public pension system relies heavily on increases in contribution rates. This puts the burden on younger generations, leading to intergenerational inequity. This can even discourage young people from participating in the public pension scheme. However, implementing pension reform to cut retirement benefits is politically difficult, as older people are very likely to vote their immediate self-interest. A realistic solution is to expand labor force participation and to increase the number of workers actively participating in the pension system. Another possibility is to link consumption taxes to pension benefits.

Conclusion

Japan's postwar economic system worked well until the 1980s. However, it has proven to be a poor fit for an advanced knowledge-based economy, increased globalization, and international competition. Indeed, some even see it as hindering the growth potential. Certainly, the system contributed to the slow response of both the public and private sectors to the changes in environment caused by globalization. That slowness is essentially responsible for prolonging the stagnation of the 1990s. (See, for example, Teranishi 2005.)

Japan thus is examining its current economic and institutional regime. Among the crucial ongoing reforms is improvement of financial markets through strengthened supervisory capacity and review of the roles of government financial institutions, including privatization of Japan Post. A more active discussion, and concrete actions, are expected to make the labor market more efficient and to encourage global competition by industries. Education in its broad sense is seen as indispensable. The government can provide a framework within which lifelong learning opportunities are available so that workers can reskill as job opportunities change.

The government has an important role to play to support Japan's transition into an advanced knowledge economy. In particular, it is urgently important to determine what policy changes allow productivity to grow rapidly, especially in traditionally inefficient sectors. Unless TFP accelerates, output growth will slow as the workforce shrinks. A desirable scenario is for TFP to increase in a sustainable manner through effective structural reforms and constant technological advances. Sustainable economic growth can, in turn, improve public debt management.

Financial factors are linked to productivity and economic growth, so the new system must treat them as an integral part. Although banks are finally overcoming the difficulties caused by nonperforming loans, an important challenge remains for the financial sector as a whole: How to support a knowledge-based economy. Because the role of new firms is crucial, it is necessary to encourage further provision of venture capital.

The traditional lifetime employment system is under critical review. Lifetime employment, together with seniority-based wages, supported the catch-up process completed in the 1980s by providing stability. However, they are not necessarily consistent with the kind of labor market suitable for a dynamic knowledge economy. Instead, Japan needs a labor market characterized by higher mobility and flexibility, based on increased opportunities of lifetime learning and of reentry, especially for women.

In a sense, those employed in inefficient sectors have long been enjoying stability and self-sufficiency at a high cost borne by consumers and more efficient sectors. It is time to change the mentality toward genuine entrepreneurship, and away from looking to the government for protection.

Under strict budget constraints, the government has to seek innovative and cost-efficient ways to invigorate the country, especially rural areas, and to realize Japan's potential as an advanced knowledge-based economy. The government will be smaller in size, so the public services actually provided will have to be even more efficient and effective. To alleviate the fiscal burden, it is expected that the private sector will participate more in the provision of services traditionally offered by the public sector. Such a trend should be welcome both for growth and for progress as a knowledge economy.

Japan has overcome serious crises before, and the spirit of entrepreneurship has certainly existed. But the incumbent system has not been good at supporting risk taking in innovative venture business. The excessively risk-averse attitude must be transformed. This requires systemic change, including a revised incentive scheme. In particular, the system must ensure a legitimate second chance, whether in studies or work. Relieving the public of a general fear of failure can help regain the level of confidence that existed until the 1980s. Then Japan will discover itself as a truly advanced knowledge economy in a dynamic and global environment, overcoming its economic and social challenges.

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5

Information Infrastructure

Risaburo Nezu

Information flows are a key element in a knowledge-based society. Indeed, in the 1990s rapid advances in the Internet and telephony led to talk of an infobahn (information superhighway). For many firms, investors, and policy makers it proved to be a fast track to a crash. Japan, especially Japanese electronic firms, were caught up in this, mostly with varying degrees of nonsuccess.

This chapter is in two parts. The first looks at telecom operators and equipment makers as one of the pillars of the knowledge-based economy. The second looks at Japan's electronics industry, especially its involvement in information technology.

Part A Telecommunications

Telecommunications is an essential part of creating a knowledge-based society. Indeed, it is advances in telecommunications—particularly wireless telephony and the Internet—that are, with personal computers, the most visible aspects of the IT revolution.

This part begins with overviews of the first phases of the deregulation of telecom services and of mobile telephony. The subsequent split-up of Nippon Telegraph and Telephone Corporation is then analyzed. Attention next turns to the Internet, including the spread of Asymmetrical Digital Subscriber Line (ADSL) as the dominant broadband technology in Japan and the rapid spread of broadband in Asia. Access to the Internet by mobile phones and some newer technologies are then explored. Part A concludes with a presentation of lessons of particular importance for government policy makers.

Japan Deregulates

The Japanese telecommunications market was formally opened for new entry under the terms of the Telecommunications Business Act and the NTT Act of April 1985. This means Japan was one of the first countries, along with the United States and the United Kingdom, to privatize and liberalize its telecom industry. Under the NTT Act, the state telecom monopoly was privatized and transformed into NTT (Nippon Telegraph and Telephone Corporation, Nippon Denshin Denwa KK in Japanese). This was just after the United Kingdom's 1984 privatization of British Telecom (now called BT Group plc) and the 1984 break-up in the United States of American Telephone & Telegraph (from 1994, simply AT&T Corporation; being acquired by SBC Communications Inc. in 2005).

Privatization was part of a larger process of government administrative reform begun in 1980. A special commission was established in January 1981, chaired by Toshi Doko, at the time head of Japan's most important business organization, Keidanren. The commission, Rinji Gyosei Chosakai, issued a series of reports beginning in July

Box 5.1. *Telecom Terminology*

The connection between switching offices and individual users historically is termed the "local loop" or "subscriber loop" by the industry. It has also come to be called the "last mile" (or, from the users' perspective, the "first mile"). The connection can be by wire or wireless. A local loop that is a fixed line is also called a local line.

"Fixed line" refers to a telephone line that is physical—such as a copper wire or fiber-optic cable. Mobile phones use wireless connections.

Spectrum refers to the range electromagnetic wavelengths used in wireless communications. To avoid interference between users, the right to use specific wavelengths is usually subject to government license and regulation.

1981. The July 1982 report raised the possibility of not just privatizing but also splitting up NTT (a topic discussed later).

NTT shares were not sold by the government until April 1987. After a series of sales, including sales to NTT, the government owned 33.7% of the stock as of September 2005. The original intention had been for the government to sell its shares more quickly, but the collapse of the Japanese stock market in the early 1990s led to a hiatus.

Deregulation had important effects in Japan. In 1985, three companies, called New Common Carriers (NCCs), entered the long distance telephone business, and began service in 1987. These were Daini Denden In (DDI), Japan Telecom (JT), and Nihon Kosoku Tsuhin (Teleway). They concentrated on routes with heavy traffic, for example, between Tokyo and Osaka. Competition led to the cost of using trunk (long-distance) lines falling dramatically—as much as 80% between Tokyo and Osaka from 1985 to 2000.

However, it was impractical to build local networks paralleling the existing NTT lines, so the NCCs had to rely on NTT's local loop to reach users. As a result, the cost of access to the network did not fall to any significant degree. On the contrary, it went up at one point, from 7 yen to 10 yen per three minutes. In an environment with little competitive pressure, NTT had little incentive to reduce prices. Inadequate competition in local service is not unique to Japan. Similar situations existed in many other Organization for Economic Co-operation and Development (OECD) countries. Even in the United States, established companies have continued to control the last mile between the switches and fixed-line telephone subscribers.

Mobile Phones

In the 1980s, equipment suppliers and operating companies in the larger countries were developing mobile phone standards for their domestic markets. NTT's mobile phone subsidiary, NTT DoCoMo Inc., led development of a digital standard for Japan called PDC (personal digital cellular).

DoCoMo was, and still is, the dominant mobile phone service provider in Japan. After deregulation, two firms sought to compete with it. One, IDO (Nihon Ido Tsushin, Ltd.), chose to use the DoCoMo technology, but the other, DDI chose a technology from the U.S. company Motorola Inc.

Equipment Supplier Relationships

During the postwar period and through the 1980s there was a close relationship between NTT and certain Japanese telecom equipment makers. Six in particular

Box 5.2. *Mobile Telecom Providers in Japan*

There are four mobile telecom providers in Japan. As data for March 2005 show, the dominant provider is a subsidiary of NTT.

Million subscribers	% share	Company
48.8	56	NTT DoCoMo
19.5	22	KDDI
15.0	17	Vodafone
3.6	4	Tsuka

DoCoMo is, in its own words, "the world's leading mobile communications company." It was formed in 1991 as an NTT subsidiary to combine NTT's various mobile operations, including maritime and paging. "The company offers a wide variety of leading-edge mobile multimedia services, including i-mode, [introduced in 1999], which provides e-mail and Internet access to over 44 million subscribers as the world's most popular mobile Internet service, and FOMA [Freedom of Mobile Multimedia Access], launched in 2001 as the world's first 3G [third-generation] mobile service based on W-CDMA [Wideband Code Division Multiple Access]." The company has wholly owned subsidiaries in Europe and North America, but most of its customers are in Japan. (Quotes are from the "About NTT DoCoMo" section of the company's English press releases in the first half of 2005.)

KDDI is the result of the October 2000 merger of KDD, DDI, and IDO (Nihon Ido Tsushin, Ltd.). KDD (Kokusai Denshin Denwa) was the government-owned, monopoly international telecom provider before deregulation. DDI established a subsidiary, Kansai Cellular, to provide mobile telecom service in western Japan (the Osaka-Kobe-Kyoto region) in June 1987. In 1992 Nissan Motor Co. Ltd. joined DDI in the mobile telecom business.

Vodafone (Japan) is 97.7% owned by London-based Vodafone Group plc. Vodafone entered the Japanese mobile phone market in 1990 by partnering with JT in the J-Phone group. By 2001 Vodafone had a 67% ownership interest in, and thus control of, JT. In August 2003 JT announced the sale of its fixed-line business to an affiliate of Ripplewood Holdings LLC. The fixed-line business, and the name Japan Telecom, was acquired by Softbank in 2004.

Tsuka provides only PDC service and is not engaged in 3G.

were called the "*denden* family." These were Fujitsu Ltd., Hitachi Ltd., Mitsubishi Electric Corp., NEC Corp., Oki Electric Industry Co. Ltd., and Toshiba Corp.

Development of telephony technology and standards was under the leadership of NTT, with its world-class laboratory. Once the technology was established, it was up to the manufactures that participated in the joint effort to produce the equipment. Because of the influence of the government, and NTT's desire to promote its own standards, the firms concentrated on the large domestic market. Although they were interested in expanding into foreign markets, the burden of pursuing two different technology standards at the same time was considered too great.

The same sorts of relationships were found in the United States and Europe at the time: each telephone operating company (state-owned except in the United States) had a stable of primarily domestic suppliers. In the United States, the near-monopoly phone company (American Telephone & Telegraph Inc.) even owned its principal equipment maker (Western Electric) until 1984.

However, especially in the United States after the 1984 break-up of AT&T, equipment markets became more open, except in Japan. There, the *denden* family remained largely closed to outsiders. Even other Japanese firms, such as Sony Corp., were unable to compete in the domestic market because of NTT's (including DoCoMo's) relationships with its long-standing principal suppliers.

A New Approach

European countries took a new approach with respect to second-generation mobile phones. Realizing that Europe would be at a disadvantage because of fragmented markets, in the late 1980s the European Commission for Post and Telecommunications created the Group Special Mobile (GSM) with the authority to establish a common standard and thus create a unified market in Europe. A key decision was to make it a digital standard, the same decision made by NTT in developing its PDC standard. This leap-frogged the United States, which was using an analog standard. The result was also called GSM (for global system for mobile communications). This is a very clear example of the important role governments can play.

Two Scandinavian companies particularly profited from this because of their ability first to influence the GSM standard and then to promote it in other countries. These were Nokia Corp. and Telefon AB LM Ericsson. By the end of 1996, GSM was used in 105 countries by over 200 telephone companies. Japanese makers of both handsets and network equipment were largely left out. Motorola remained committed to its technology and also lost ground in global markets.

It should be noted that it is not clear that the results for Japanese firms and Motorola could have been different. The tradition in advanced countries was for national champions to supply the domestic market. Europe's innovation was to unify its market so European companies could achieve greater economies of scale and mobile phone users would have a larger roaming area.

Splitting Up NTT

The 1996 Telecommunication Act in the United States had a sweeping effect on the telecom policies of OECD members, particularly regarding local-loop unbundling. Very quickly, OECD countries, including Japan, followed suit. However, actual unbundling proved more difficult to implement than writing the laws. Incumbent companies had many ways to procrastinate, frustrate, and even refuse in spite of efforts by regulators.

The other important provision that was included in Japan's 1997 revision of its telecom law was splitting NTT operations into NTT West and NTT East (regional local-service fixed-line operators) and NTT Communications (long distance). The division became effective in July 1999. This was not a true break-up, because all three companies remained in one group under a newly established NTT holding company. This outcome was a political compromise.

NTT of course wanted to remain an integrated company. The advisory body to the Ministry of Post and Telecommunications (MPT) was split regarding a break-up, and the Social Democratic Party (SDP), part of the ruling coalition at the time, was publicly opposed. Moreover, the MPT minister was a member of the SDP. Thus, those favoring substantive reforms faced powerful opposition. Those opposing a split argued it would result in overall inefficiency, an inability to provide uniform service, and a weakening of research and development (R&D) capacity.

From the viewpoint of competition policy, it is unclear if the division achieved any meaningful purpose. NTT operating companies are required to get approval from the holding company on strategic decisions such as their annual business plans, large investments, appointments of senior managers, mergers, acquisitions, and R&D.

Each operating company formed a small empire in one segment of the telecom market, and competition did not follow. There is no incentive for the holding company to encourage competition among the operating companies. The telephone tariff and interconnection fees are the same for both NTT West and NTT East, in spite of the difference in their financial performances.

Another Attempt at Local-Loop Competition

As of mid-2005, the dual structure of Japanese IT infrastructure tariffs, namely expensive access to the telephone network and cheap Internet, is being challenged by another bold attempt by Softbank Corp. to break into fixed-line service. In November 2004, Softbank announced it would apply for approval to commence fixed-line service at a discounted tariff. The monopoly control of fixed lines has been the source of power for the entire NTT group.

In December 2004, JT, now owned by Softbank, started a service called "*otoku* line," which means bonus line. This is meant to pose a direct challenge to the monthly, fixed base price, and NTT countered by reducing the base rate. In other words, within seven years of mandatory opening of the local loop, the telecom sector will have moved from pure monopoly to full-scale competition.

The role of the government policy to ensure effective competition has never been as crucial as it is now in the telecom sector. Softbank has not built its own local loop, but instead leases lines from NTT.

Connecting to the Internet

The value of information technology is fully exploited when individual computers are connected and information can be exchanged on a large scale. In the early years, such connections were made largely through the public telephone network. Large firms often leased telephone lines from telecom operators as part of private networks, but these were not physically distinct from the public network. Within buildings or on campuses, an organization might have its own switches and phone lines. Satellites and microwaves offered opportunities for large firms with geographically dispersed operations an opportunity to bypass the telephone company to transmit data, although microwaves are limited to line-of-sight situations.

In the first few years after the Internet became available for commercial use, most customers used the public network to reach an Internet access point. This is called a "dial-up" connection because users dialed the telephone number of the access point. Using telephone lines to access the Internet has two important implications.

First, an issue in all countries is speed. Initially, dial-up could provide speeds of only a few thousand bits per second. Eventually this increased to about 55 thousand as a theoretical maximum, but actual speeds are slower, especially for "uploads"—sending data from an individual computer into the system.

Second, an issue in Japan and Europe, but less so in the United States, is cost. In Japan and continental European countries, local calls are metered, that is, charged by their duration. In the United States and Australia, they generally are not. Thus, in those two places, once connected, it did not matter how long the user stayed connected. This flat rate was very conducive to the use of the Internet, as many users preferred to be "always on" (that is, continually connected).

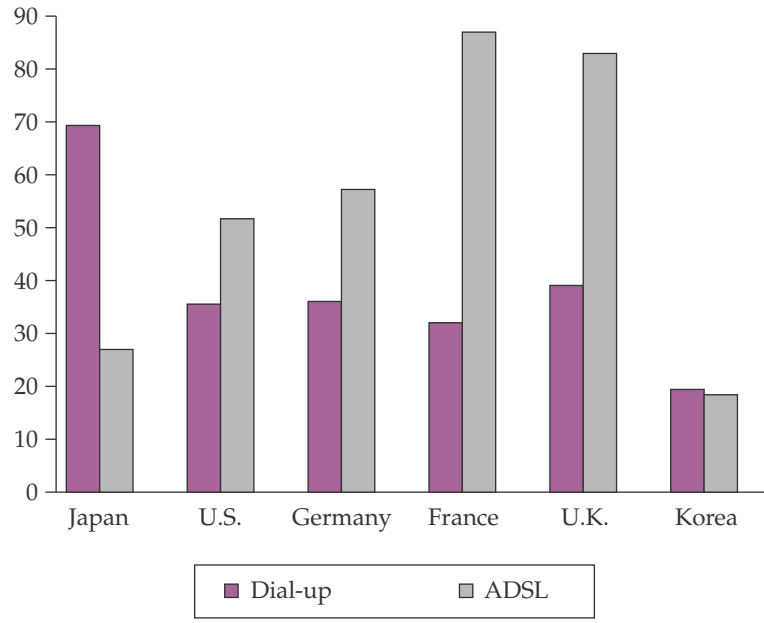
Box 5.3. *ADSL, ISDN, and Other Telecom Acronyms*

ADSL is a transmission system that uses the copper twisted-pair access network used by voice telephones. As the name implies, it is digital. The data rate from the network to the subscriber is faster than from the subscriber to the network. Note that ADSL is a specific type of DSL, and what is commonly referred to as DSL in the United States is not ADSL.

FTTH is "fiber to the home." Although most trunk lines already are optical fiber, the local loop is largely copper cable. FTTH means to make the last mile fiber.

ISDN (Integrated Service of Digital Network) is an early digital telecom technology. NTT's experience with ISDN is analyzed in Box 5.4.

Figure 5.1. *Comparison of Prices Between Dial-Up and ADSL*



Note: ADSL prices are adjusted for 1 Mb/s.
Source: OECD, Telecommunication Outlook (2003).

In Japan, not only are local calls billed by length, but the per minute cost has been the most expensive among OECD countries. According to an OECD survey, as illustrated in Figure 5.1, in August 2002 the cost of using the Internet for 40 hours, including telephone and ISP (Internet service provider) charges, was almost twice as high in Japan as in New York City and in Germany. The cost of a dedicated (leased) line in Japan was even higher relative to other countries. The high cost of using the existing telephone infrastructure translated into high costs for using IT, as was often pointed out.

ADSL Provides Broadband

The story of ADSL in Japan is full of policy implications. NTT did not favor the technology, as it wanted to first establish a nationwide ISDN network, then move

Box 5.4. *ISDN: An Almost Forgotten Story*

From an early stage of Internet development, NTT knew that dial-up access would be inadequate in speed and that Japan would eventually need an entirely different network. NTT decided to first deploy a nationwide digital network, commonly referred to as ISDN, using technology developed by NTT. Then, by 2010, it planned to lay fiber-optic cable connecting all households and offices.

The strategy was ill-timed and unfortunate. The service came to market in 1988, but by 1995 it had only 510,000 subscribers. By the time the service was ready for dynamic take-up in the second half of the 1990s, there was a far more competitive service. This was ADSL. Although ISDN was initially marketed as broadband, it is in fact narrow band, with a transmission speed of only 64 Kb per second, more or less the same as analog dial-up. ADSL was capable of several hundred thousand bits per second, even at the time of its launching in 2000, and it improved quickly to a level of several million bits. Because ADSL could use the existing network, it was much less costly than ISDN, which had to be built from scratch.

Among OECD countries, only Japan and Germany pursued ISDN as a basic infrastructure for the Internet age. Subscribers have been shifting to ADSL, and at some point ISDN will quietly disappear.

Aware of the diversity of technology and its unpredictable nature, the OECD was critical of any government attempt to choose one technology out of many alternatives. The case of Japanese ISDN is a classical example that points to the danger of government involvement in selecting technology.

to fiber optics (see Box 5.4). To NTT, ADSL was nothing more than a distraction. In fact, it refused to cooperate with the new ventures trying to provide ADSL service using NTT's unbundled local loop.

The new entrants were, first, Tokyo Metallic then, later, Yahoo Broadband, a subsidiary of Softbank (run by Son Masayoshi). NTT used delaying tactics to prevent co-location until the end of 2000. (Co-location refers to placing equipment in a relay station, which is necessary for a telecom provider to use the local loop to reach users.) At that point Japan's Fair Trade Commission (JFTC) intervened and publicly warned that NTT risked violating the antimonopoly law. JFTC also warned NTT East and NTT West in December 2001 and in December 2003 regarding their ADSL practices.

Yahoo Broadband proceeded to introduce ADSL service in June 2001, and was spectacularly successful, adding 300 thousand new subscribers every month. NTT East and NTT West had begun offering ADSL earlier in the year, at ¥6,000 a month and a speed of 1.5 megabits/second (Mb/s). Yahoo charged ¥3,000 for a speed of 8 Mb/s. By 2002 the price was down to ¥2,400 ($20) plus ¥1,900 ($16) to NTT for use of the local loop. This is one of the lowest prices in the world, as shown in Figure 5.1.

Thus, for the first time in Japan, there was full-fledged competition in a telecom service. Although the Japanese government has had a reputation for a limited commitment to promoting competition, its action regarding ADSL is a thing to be admired. Today, this is widely referred to by Japanese telecom policy makers as a clear case of success.

Yahoo Broadband has been particularly aggressive in seeking market share. In early 2005 it had about 40%, followed by NTT with 35%. Smaller, but aggressive, newcomers such eAccess and Acca Networks are also advancing into the growing

market. This is a unique development: an entrenched near-monopoly has failed to control an important market niche. In contrast, in the United States and Europe, many attempts to get into ADSL by new entrants have been aborted by established telecoms.

Not only is the price of ADSL in Japan the lowest, the speed of connection is now well above 1 million bits per second. Some services promise more than 10 million, sufficient for high-definition television (HDTV) images. This is far speedier than connections in Europe, which are, for the most part, less than 1 million bits per second.

The appeal of ADSL to consumers is overwhelming. With the price so low, the speed so high, and the ability to be always on, subscription figures exploded in 2002 and 2003. They reached more than 14 million in June 2005. Combined with other broadband connections such as cable modem and optical fiber, broadband uptake relative to population is now higher in Japan than in the United States. Over 15% of Japanese have broadband access.

Effects of Competition

One consequence of the fierce competition is a low level of profitability for service providers. The broadband services are unprofitable or barely profitable. NTT does not release specific data, but Yahoo BB lost ¥97 billion in fiscal 2004. This raises some concern about whether the competitive environment is sustainable. Indeed, in August 2005 Yahoo BB was reported to be stopping its aggressive sales promotions and placing more emphasis on long-term profitability.

There is some question as to whether the high-speed Internet infrastructure is fully utilized. One good way to measure the level of broadband usage is to note that 330,000 pieces of music were downloaded in Japan in December 2004. This is about 1% of the global total of music downloads from iTunes. Although Japan boasts of being one the front-runners in broadband, its use is still very limited: most people use it only for sending e-mails and surfing the Web.

This reflects a lack of consensus on the right balance between protecting the intellectual property rights (IPRs) of content owners and encouraging dissemination. Copyright owners have been quite inflexible about allowing material to be sold at what most people feel is a reasonable price. The key is what is "reasonable": few consumers seem prepared to pay much, if anything. The peer-to-peer file transfer programs available make control of distribution almost impossible for IPR owners. This is a contentious legal issue in the United States as well.

The FTTH Alternative

It is noteworthy to take a look at the situation of FTTH. While ADSL spread far more quickly than any had foreseen, FTTH showed only modest growth until 2005. As of June 2005 the number of subscribers was almost 3.4 million, up from just 1 million in September 2004. Still, there were 14.1 million ADSL users. It is thus likely that FTTH uptake will substantially undershoot the original target set by the government, which was to connect 10 million households by March 2006. NTT's target as of mid-2005 is 30 million subscribers by 2010. Tokyo Electric Power Co. (Tepco) is another major provider.

The speed of ADSL, now up to 40 million bits per second, has diminished the advantage of fiber optics over ADSL. All the services that can be provided by FTTH can also be provided by ADSL, except access for areas remote from ADSL relay stations. However, FTTH is more convenient than ADSL for voice-over-Internet protocol (VOIP). This, combined with a marketing campaigns by providers, has contributed to the jump in acceptance.

Outside Japan, FTTH is considered too expensive to be a viable option. Globally, companies that invested massively in fiber-optic capacity have suffered serious losses. But, among some Japanese, the mentality of placing priority on technology and building physical infrastructure over providing good service at a reasonable price still persists.

The Rapid Spread of Broadband in Asia

While its policy makers are excited to see that broadband uptake is higher in Japan than any other major OECD countries, Japan still pales in comparison to the Republic of Korea; Taiwan, China; Hong Kong, China; and Singapore. Korea, in particular, has attracted a lot of attention, as it appears to have moved faster toward an information society than any other industrialized country. Telecommunications is one of the few areas in which relatively less developed countries have moved to the forefront of installing innovations ahead of more advanced countries. Partly this is because there is no large installed equipment base that has to be scrapped. It also reflects policy decisions and national self-images.

A close analysis of the Korean experience leads to the conclusion that it has been made possible through unique conditions, and it cannot be seen as a model for other countries. The following factors can explain the successful deployment of ADSL in Korea and other Asian countries.

First, all of them have very densely populated urban areas with many high-rise apartment buildings. This physical proximity provides an ideal condition for ADSL, the speed of which diminishes significantly beyond three kilometers from a relay station. If the population is sparsely spread, reaching homes becomes very costly. This is the case in virtually all of the United States and even most of Europe.

Second, the content is largely games, movies, and television programs, which are often circulated in infringement of copyrights. In some Asian countries, the government filters the news, and only an edited version is allowed on the air. This drives people to seek unfiltered versions over the Internet. In most OECD countries, by contrast, it is hard to create such widely popular uses: news is not censored and copyrights are more aggressively enforced.

Third, in many Asian countries, there has been government support for building broadband connections. A high broadband uptake is a matter of national pride rather than commercial concern. In fact, many of the firms that operate broadband networks are running deficits. Korea is subsidizing its film industry to advance Korean culture. Such content is first disseminated on broadband networks.

In light of all this, it is clear that the Asian countries leading in broadband uptake have supportive characteristics and backgrounds that do not necessarily apply or exist in other countries. Other than urban population density, Japan has few of the characteristics.

The Internet and Mobile Communications

Using mobile handsets for connecting to the Internet became possible when NTT DoCoMo introduced its i-mode service in 1999. Despite its overwhelming success in Japan, i-mode has made only modest inroads in Europe and the United States. In those markets, mobile phones are still used primarily for voice communication, with some text messaging. Japanese carriers and equipment vendors are making headway toward 3G offerings, which allows transmission of moving images.

Mobile phones have had profound effects, both economic and social. According to the OECD's *Communications Outlook,* in 2001, nearly $100 billion in revenue was generated from mobile phones in the United States and Japan, making it those countries' largest utility industry. In Japan, the number of mobile subscribers in August 2005 reached 88 million, a 6% increase over 2004. It is now generally believed the domestic market is close to saturation and future demand for handsets will be largely replacement. Globally, more than half of the population of OECD countries had mobile phones. In many developing countries with inadequate fixed-line telephone infrastructure, wireless systems can provide more cost-effective access to the modern information society.

New Telecom Technology

More or less simultaneously in the United States, Europe, and Japan, wireless local area networks (wireless LANs) began to attract attention as an option that is inexpensive and easy to use. The technology uses the existing copper or fiber network to reach connection points (stations), which are usually a small box or short stick. These stations use radio waves to connect with devices, usually computers, that have the appropriate card, thereby providing Internet access. By definition of being local, stations serve a radius of 100 meters or less, but this can be enough for a hotel, office, or coffee shop. This service is sometimes made available free to customers. For the provider of the station, the cost typically is about what a standard broadband connection costs an individual.

Finding appropriate spectrum is a major issue for wireless LANs. At the moment, one such technology, called WiFi, is using the spectrum also used by microwave ovens, 2.4 GHz. A much stronger signal, called WiMax, which has a range of up to 50 km, also is being tested. If the right frequency can be assigned, this technology has the potential to replace mobile phones entirely. In fact, in the United States, where mobile phones have been slower to penetrate than in Europe and Japan, wireless LAN is being far more seriously pursued.

Broadband over electric power lines (BPL) also is being developed. Tokyo Electric Power Co. (Tepco) is conducting a pilot test in a residential area of Tokyo. Equipment makers such as Mitsubishi Electric, Sony, and Matsushita are working together to create a common standard for Japan. It is expected that the government will approve the technology in 2006 if interference problems are resolved. Field tests are also under way in the United States, and BPL has been put to commercial use in Spain. The U.S. Federal Communications Commission is backing the technology, and in July 2005 International Business Machines Inc. (IBM) announced a partnership with a Houston, Texas, utility to develop broadband services.

All this points to the wide range of competing technologies and enormous magnitude of uncertainty that faces the telecom sector.

Conclusions

A review of the Japanese experience in telecommunications policy leads to a number of conclusions.

1. It is important to keep government policy technology-neutral. With such a wide range of technologies, both wired and wireless, it is impossible for the government to determine the most promising one. IT is unpredictable. Any attempt by a government to boost indigenous IT endangers interoperability and could isolate the domestic market from the rest of the world.

   This is not the same as abrogating regulatory responsibility in such areas as allocation of spectrum (wireless capacity), but this should be conducted in a manner neutral to any individual technology. In other words, governments should strive to create an environment where different approaches, both in terms of technology and business models, are encouraged.
2. Removing regulations does not automatically generate a healthy competitive environment. Incumbent players that own the infrastructure needed by newcomers can abuse their power, especially if they are monopolies or near-monopolies. Competition policy must play a role in ensuring a level playing field.

   In Japan, local fixed-line service remains in the grip of NTT. In contrast, although NTT's subsidiary DoCoMo dominates mobile communications, a competitive environment is emerging. For ADSL, newcomers created a new market with a new technology, with NTT playing aggressive catch-up. This suggests that the newer the field, and the less its infrastructure relies on the entrenched incumbent, the more likely there is to be competition in general, and successful newcomers in particular.

   Japanese consumers have reaped huge benefits from privatization and competition. In contrast, "success" for new service providers does not yet necessarily include profitability. The old monopoly has deeper pockets and thus greater staying power than virtually all of its would-be competitors, and is well-versed in the bureaucratic, regulatory games of simply outlasting the upstarts. Even with a sincere government policy to promote competition, the final outcome is in doubt. Thus, policy makers and regulators must remain vigilant, particularly regarding the last mile.
3. IPRs play a crucial role in advancing the information society. Digital content is easy to copy and duplicate. As telecommunications and broadcasting converge, content is expected to have greater influence over the nature of telecommunications. New IT infrastructure has been constructed with a speed unmatched by the tempo of content. Thus, Japan's infobahn looks like an empty highway.

   The copyright protection of music and video is not flexible and efficient enough to allow their liberal movement in Japan. This is a global problem. In developed countries, IPR often are in conflict with technologies that make disseminating music, games, and movies easy. Napster is an example. In 2004, a similar case was raised in Japan. At present, the legal risks associated with distributing video, software, and TV programs on demand are the biggest deterrents to the use of broadband. There is a need for a global consensus on the right balance between protecting IPRs and using and disseminating digital content.

4. The management of spectrum is a politically thorny issue for regulators. With more people using wireless services, spectrum is a scarce resource. There will be even more demand if radio frequency identification (RFID), which attaches a small IC to commodities, comes into widespread use. This is so even though RFID is being developed to use the limited frequencies more intensely. In October 2004, Softbank filed a lawsuit against the ministry in charge of spectrum allocation. The suit claims a right to acquire new spectrum for mobile telephones.

   It is essential that regulators distribute frequencies in the maximum interest of the public. The present allocation of spectrum use should be reviewed to see if control of some portions should be redistributed. The first step is to make publicly transparent the information as to who uses what spectrum and for what purpose. Many users were granted authorizations decades ago when capacity was abundant. Often it is politically difficult to take control back from them, but some mechanism for redistribution should be put in place.

   A revised law managing distribution and use of spectrum passed the Diet in July 2005. How it is implemented should be monitored closely. Policy makers must be aware that new technologies are being developed that allow many users to use the same frequency simultaneously without causing interference. Sooner or later, the existing regime of assigning specific frequencies to specific users for specific use will become unnecessary. Government handling of spectrum should not interfere with the development of such technology.
5. Effective corporate governance must be applied to government-controlled telecom providers. The government is, and always will be, NTT's largest shareholder. It is unclear how the government has played this role. The Ministry of Finance sends representative to the stockholders meetings, but apparently has remained reticent on management issues.

   In 2002 and 2003, after the IT bubble burst, NTT DoCoMo recorded nearly ¥1.5 trillion ($13.4 billion) in losses on investments in overseas mobile phone service companies. And, in 2001, NTT wrote off $4.5 billion related to the purchase of U.S. Web-hosting firm Verio. It still remains unclear who took responsibility for the losses.
6. Effective regulatory oversight must be applied to government-controlled telecom providers. With just under 34% of the stock, the Japanese government is by far NTT's largest holder. Under legal obligation to own more than a third of the company, the government will continue as the largest shareholder.

   This suggests there is a conflict of interest regarding the government's regulation of NTT, something the OECD pointed out in its review of Japan's regulator reforms in 2000. The Japanese government responded that it was the Ministry of Finance that was the shareholder, while the MPT was the regulator and policy maker. Thus, there is no conflict of interest.

   A good corporate governance system and an effective government regulatory system are particularly important because NTT has a very complex structure. Five subsidiaries operate under NTT Holdings. Cross-subsidization within and among them is highly probable, creating an unfair competitive advantage when NTT is confronted by competition. Arguably, the high fixed-line tariffs charged by NTT East and NTT West subsidize the lowest ADSL price in the world as NTT battles Yahoo Broadband.

NTT DoCoMo generates about two-thirds of NTT's profits, although its contribution fell to 63% for fiscal 2004. Much of this is plowed back into the development of 3G service. Consumer advocates argue that the profits should be returned to consumers by reducing tariffs, as they are obliged to pay increasingly expensive monthly bills to DoCoMo. But under the existing governance regime, there is no place for such voices to be heard.

Part B Losing Its Way: The Japanese Electronics Industry in the 1990s

The 1990s is understood to be the lost decade for Japan, and it was the electronics industry that most lost its way. Within electronics, it was information and communication technology that was most affected. How and why this happened, and what the experience means to the business strategies of Japanese firms, are the concern of Part B.

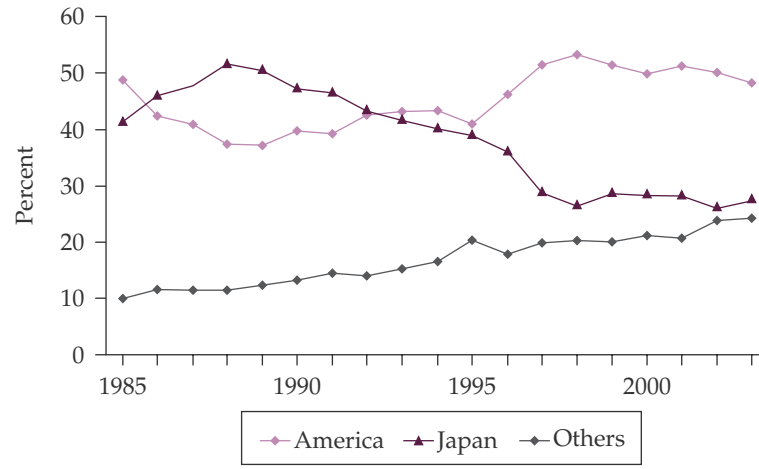
Japan's economy, one of the fastest growers during the 1980s, began to slow in the 1990s and, by the latter half of the decade, it had the lowest level of growth among G7 nations. This was due largely to the fact that key manufacturing sectors stopped growing.

The reasons were different for each sector. The steel industry, for example, managed to survive three difficult decades, beginning with the 1970s, by retaining quality advantages over new competitors and continuously slashing its workforce. Automobile companies expanded abroad to meet foreign demand, so production did not increase at home. These two sectors were, and have remained, the most competitive in the world. However, they did not contribute to the growth of the Japanese economy. Japanese consumer electronic brands, especially in audio-visual equipment and computer games, are still globally important, even dominant. But it is very rare to find a Japanese desktop computer outside Japan. The same is true for mobile telephone handsets. Less visible but no less important is the lack of a single operating system of Japanese make.

The rise and fall of the Japanese IT industry is encapsulated in the story of semiconductors, the basic building block of the sector.

Figure 5.2 shows how the market share for Japan peaked in 1988 at just over 50%, and then began to decline, falling below 30% in 1997. In contrast, the United

Figure 5.2. *Semiconductor Share in the World Market*



Source: Semiconductor Industry Association (SIA) statistics.

States began to recover share that had been lost to Japan in the 1980s. Although U.S. firms came back, it does not necessarily mean that all the chips (semiconductors) were produced in the United States. As a matter of fact, many were made by Asian manufacturers under U.S. labels.

Japan's experience in the 1990s stands in sharp contrast to the 1980s, when Japanese consumer electronic manufacturers overwhelmingly dominated the global markets in videotape recorders and color television sets. But these were analog technologies. In the United States, Motorola initially remained committed to an analog standard for mobile telephony and thus lost out to companies that successfully promoted the digital GSM standard.

But it was not simply being slow in shifting from analog to digital that caused the Japanese electronics industry to move off the technological frontier and fall from global leadership. Another reason was a lack of strategy. In particular, a lack of concentration and selection in the markets they contested, a lack of strategy regarding technical standards, and an overreliance on integrated design and manufacturing processes.

It is instructive to compare the automotive and electronics industries. Automobiles have undergone continuous but generally gradual improvement. This is the type of competition in which Japanese firms have excelled. But such an approach will not work in the IT sector. The innovations that have occurred in IT since the mid-1990s are of quite a different nature. They are more discontinuous and disruptive. As such, they are less amenable to the kaizen (continuous improvement) approach. They also are less compatible with the integrated design and manufacturing processes typical of large Japanese enterprises. These topics are developed more fully later.

Industry Structure and Strategy

To understand what has happened to the electronics and IT industries in Japan, it is necessary to understand their structure and strategy. Electronics and IT have been dominated by firms called *sogo-denki,* which translates as general electronics companies. These are listed in Table 5.1.

What characterizes these companies, even relatively small ones, is that they have had very broad ranges of products. This is the result of a "do as others do" (*yokonarabi* in Japanese) approach to business. Thus Hitachi, Toshiba, and Mitsubishi Electric produce practically everything that runs on electricity, ranging from refrigerators, washing machines, and air conditioners to atomic power generators and computers. Matsushita (Panasonic brand) and Sony are champions of home electronics. NEC and Fujitsu are somewhat more specialized in computers and communication equipment.

A "do as others do" strategy is not entirely without reason. If company A embarks on a project and B does not follow suit, then if the project is a success, B will find itself in an embarrassingly inferior position. If, on the other hand, B follows A, it remains equal relative to A. If the project fails, both A and B suffer, which B may find acceptable. So under a competitive environment where avoiding crushing defeat is more important than outperforming others, there is an advantage to "do as others do." This was in fact the case in Japan in the postwar period. But from a national viewpoint, this is not optimal. No firm can reach the critical mass necessary to command leadership in the global market.

Table 5.1. *Japan's* Sogo-Denki, *by Revenue, 2004 (in billions of yen)*

Parent 1985	*Company 2004*	*Consolidated 2004*	
3,026 (2)	2,597	9,027	Hitachi Ltd.[1]
3,424 (1)	4,146	8,713	Matsushita Electric Industrial Co. Ltd.
2,526 (3)	2,816	5,836	Toshiba Corp.
1,889 (4)	2,427	4,855	NEC Corp. (Nippon Denki)
1,292 (6)	2,846	4,763	Fujitsu Ltd.
1,858 (5)	2,022	3,411	Mitsubishi Electric Corp.
1,048 (7)	1,459	2,484	Sanyo Electric Co. Ltd.
Other major companies in electronics[2]			
1,071	2,895	7,496	Sony Corp.
n.a.	n.a.	3,468	Canon Inc.[3]
908	n.a.	2,800	Denso Corp.[4]
910	2,085	2,540	Sharp Corp.

Data are for fiscal years ending in March of the following calendar year.

Numbers in parentheses are 1985 ranking for parent companies. Hitachi, Toshiba, and Mitsubishi are the most diversified; NEC and Fujitsu are less diversified than the others.

1. Hitachi's parent company decrease reflects a policy of creating legally independent subsidiaries to operate various businesses.
2. As identified by NEEDS (Nikkei Electonic Economic Databank System) in its grouping of companies by industry. NEEDS is a primary supplier of data on Japanese companies operated by Nikkei Shinbun-sha.
3. Canon was not considered an electronics company in 1985.
4. Denso makes automobile electronics and is closely associated with Toyota.

Someone asked to name a Japanese IT or computer company will most likely name one of the *sogo-denki.* This is reasonable: the IT operations of the largest of these firms are as large or larger than many independent IT companies. But "pure" IT companies of great size are not common. Fujitsu Ltd., the parent firm of one of the largest computer groups in the world, is perhaps the closest to an exception.

Japanese IT companies have had a long-standing tradition of doing all of the activities in the value chain (Table 5.2) in an integrated and continuous manner. This is because they believe in the synergetic effect of a seamless operation. That is, firms sought to produce all key parts and components either themselves or through subcontractors and affiliated companies with which they had long-term working relations. Each activity was meticulously coordinated with other activities through constant communication and feedback. The firms' view was that good communications and the steady flow of information throughout the different stages of operations were of crucial importance to efficient production. Japanese companies were generally believed to be particularly adept at this type of coordination, and this integrated approach was considered to be at the root of the efficiency and high production quality of Japanese manufacturers.

Modular Production

Within the manufacturing links of the value chain (Table 5.2), a production model has emerged called modular production. It treats the components of the finished product

Table 5.2. *The Value Chain*

Typically, a production process consists of the following activities, in sequence. Each can be said to form a link in a chain that adds value in some way.

1	R&D, design and development
2	Key parts and components
3	Manufacturing and assembly
4	Logistics (distribution)
5	Marketing
6	Customer service, after-sales service.

as modules. As long as a module meets price and specifications—including an agreed interface—an assembler does not care about the specifics of what goes on inside it.

Modularity gives authority to the company's first-line suppliers—that is, the companies providing the modules—to innovate in their areas of expertise. The assembler thereby gains access to specialized R&D capabilities beyond what it has in-house.

Modularity also allows adapting products to specific markets. Thus, Nokia Corp. uses a module containing software to adapt otherwise similar mobile phones to the requirements of each telephone company.

Agile, Focused Firms

Even as the world-famous integrated Japanese electronics firms faltered, there have been a number of companies below the top 10 that have done relatively well.

In particular, quite a few Japanese companies have succeeded in establishing dominant positions as suppliers of essential parts in global value chains. That is, they have focused on niches. Examples include Nihon Densan (small motors for hard-disk drives), Nitto Denko Corp. (fine chemicals, including IC sealing resins), Rohm Co. Ltd. (custom large-scale integrated (LSI) semiconductors), and Murata Manufacturing Co. Ltd. (world's largest maker of ceramic capacitors). Many of the successful niche players were newcomers, but others were established firms that adapted. Having a very dynamic and decisive chief executive was a key factor in success.

Canon Inc., Ricoh Co. Ltd., and Sharp Corp. are examples of mid-sized, somewhat diversified companies that have adapted. All were founded in the 1920s or 1930s. However, they have transformed their strategies to meet global competition. Canon, for example shifted its focus from cameras to printing equipment to digital cameras, and dropped personal computers (PCs) to avoid dilution of resources. Ricoh, once also primarily a camera company, competes with Canon but is more focused on the printing equipment market, which it entered in the 1950s. For two decades, Sharp nurtured liquid crystal display (LCD) technology, and is now the global leader in flat television sets. (Sharp is a case study in volume 2.)

The Role of Asian Producers

The strategy of contracting out the manufacturing link in the value chain makes a lot of sense. There are many Asian firms well-suited to the task.

Take semiconductors. The plants, called "foundries," are extremely expensive to build and operate. For example, an Intel plant announced in July 2005 will cost some $3 billion to construct in the United States. As a result, many firms have become "fabless." That is, they do not own fabrication facilities. Instead, they draw

blueprints and design sheets and hand them to "dedicated foundries," as contract maker of semiconductors are called. One of the largest companies in the business is Taiwan Semiconductor Manufacturing Co. (TSMC). TSMC, which pioneered the industry in 1987, had $7.7 in revenue in 2004, and planned $2.7 billion in capital expenditures in 2005, according to the company. United Microelectronics Corp. (UMC), also Taiwan-based, is another major foundry. However, the field is not exclusively Taiwanese: IBM provides foundry services from plants in the United States, as do Toshiba and Fujitsu in Japan, albeit much later.

Many electronics products are assembled in Asia. Subcontracting assembly is a long-standing practice: the largest firm in the field, Silicon Valley's Solectron Corp., was founded in 1977. Two of the next three major firms are based in North America: Sanmina-SCI Corp. and Celestica Inc., a 1996 spinoff from IBM based in Canada. The fourth, Flextronics Intl. Ltd., is based in Singapore, but is the successor of a U.S.-based company. All four operate plants in Asia. Thus, small U.S. companies can work with another U.S. company to access Asian manufacturing facilities.

Taiwan is the center of assembly activity. In 2002, the island's factories, coupled with subsidiaries on mainland China, produced 75% of the world's PC motherboards, and 60% of notebook PCs and LCD monitors. During the 1990s, PC-related industries in Taiwan grew 21% annually, going from $7 billion in 1990 to $47 billion in 2000. The bulk of this production went to the United States: $28 billion in 2000. Since 2000, Taiwanese companies have been moving assembly plants to mainland China. As a result, by 2003 some 90% of their PCs were assembled in China (Japan External Trade Organization estimate).

Open Innovation

IT companies in the United States have benefited from close relationships with universities. The role of the Massachusetts Institute of Technology (MIT) in populating Route 128 with high-tech firms and of Stanford University in turning the Santa Clara valley into Silicon Valley are well known. This was a movement of both people and ideas in both directions. Such close working relationships did not happen in Japan. This is not to say that in Japan university researchers and industry people did not interact. On the contrary, there were many contacts. However, due to government regulations imposed on the universities, they remained informal and of a personal nature.

Until the 1980s, faculty at most universities, even in the United States, did not commonly interact with the business community in ways that would encourage the transfer of ideas in either direction. There were attitudes on both sides hindering such cooperation.

Similarly, successful large firms, with their elite groups of engineers and scientists, historically were, like university faculties, somewhat dismissive of work done elsewhere. This was reflected in a not-invented-here (NIH) mentality that disregarded technologies developed outside the company. This was especially true in Japan, where rivalries with other *sogo-denki* and IT companies gave openness an aura of disloyalty to the firm.

The new paradigm is called "open innovation." This refers in part to the availability and use of external resources—especially technology provided from outside the firm. The key point here is that most successful firms in the global IT sector, including even the larger ones, have moved away from an NIH attitude and instead seek technology where and how they can find it.

Obtaining Technology

In an era in which technology need not be indigenous to the firm, how does a company acquire it?

Merger and acquisition is one way. Cisco Systems Inc., the world's top router manufacturer, acquired 70 high-tech ventures during the five years to 2000. Even well-established IBM was buying software companies and integrating them into a core business as it shifted from being a maker of big boxes to a service provider.

Joint R&D is another way. Some technologies are extremely expensive to develop. Several firms, even ultimate competitors, joining to fund the early, pre-commercialization stages of R&D can benefit everyone. This was the idea behind Japan's government-led collaborations. The privately organized ventures in the United States suffered some of the same problems of trust as the Japanese. But, in the United States, participants were self-selected and thus presumably not as reluctant as the Japanese firms had been. Moreover, joint R&D was often done as part of a joint venture that would market the product. This further reduced parent company concerns.

In short, there has been a market for technology in the United States that has contributed directly to the speed, breadth, and depth of creativity. The absence of such a market in Japan is arguably a shortcoming of the Japanese innovation system, and has resulted in overall inefficiency.

Merely increasing R&D spending without addressing this question will not improve the situation. Adopting the forms also is not enough if the underlying substance of a creative and risk-taking culture is lacking.

Strengthening the relationship between university and industry is a central concern for Japan. In this regard, an encouraging trend is now in sight. In 2002 Ministry of Economy, Trade, and Industries (METI) set a target of 1,000 university-spawned venture businesses by March 2005. Practically nonexistent in the 1990s, their number reached 900 in August 2004 and 1,112 as of March 2005. This is discussed further in Chapter 7.

Exits and Entries as a Source of Dynamism

Exits and entries are a key source of economic dynamism. In the United States, they occur when new technologies emerge. For example, when computers shifted from an emphasis on mainframes to minicomputers, names once high on the Fortune 500 list were replaced by new firms. Those firms have also been displaced as the IT revolution of the second half of the 1990s was driven by yet another wave of companies. A decade later, once again many of those technological pioneers have been pushed aside.

The key point here is that, in the United States, the emergence of new technologies has also meant the appearance of new business models and new management to capitalize on the new technology. This has not been the case in Japan. Thus, only 4 names on the list of 10 largest U.S. computer hardware firms by revenue in 1985 are on the 2004 list: IBM, Hewlett-Packard, NCR Corp., and Apple Computer Inc. (Hewlett-Packard absorbed the remains of Digital Equipment when H-P bought Compaq in 2002.) In contrast, there was only one change among Japan's top 10 electronics companies between the two years, although the relative rankings changed somewhat (see Table 5.1).

This ongoing large-scale replacement of old firms with new ones has made it possible for the United States to come back to the fore in the technology race. Why is this rapid turnover of players so important?

The IT revolution in the United States has been driven by the advent of what are called "disruptive innovations." These are innovations that make the technology of the installed base obsolete. Established companies, historically, have seen little benefit from such innovations. Consequently, it is generally new companies that first pursue them. If the innovation does indeed prove useful and successful, the new companies can supplant firms still wedded to the old ways. Even established firms can adapt, however, as IBM has shown.

For Japan, the incumbents, in general, have been more interested in maintaining existing businesses, so long as they are generating revenue, than in trying something new and untested. As a result, the Japanese IT industry moved too slowly to take on the new challenges. There is no doubt that the large Japanese firms were in a more disadvantageous situation than the U.S. newcomers, which did not have to worry about existing business. But it can be argued that the Japanese firms spent too much time and energy discussing whether or not they should move into the new businesses and, more importantly, how they should transform their organization to do this.

The example of routers, which are used to direct the flow of data on the Internet, is illuminating. The business is dominated by two companies—Cisco Systems, with a 60% global market share, and Juniper Networks, with a 30% share. Despite the sophistication of their switching technology, Japanese firms are not a major factor in routers even in their domestic market. Japanese switch makers such as Fujitsu, NEC, and Hitachi could have produced routers, but none dared to do so for fear of destroying their existing business with NTT.

Hard Lessons

Japanese IT companies have learned some lessons that are clearly discerned from their behavior. The more important ones are discussed here. These are narrowing focus, increasing protection of their intellectual property, and utilizing more external resources.

Narrowing Focus

In the face of fierce global competition, Japanese companies have realized they must discontinue the "do as others do" strategy. This means a narrower focus on areas where the company has some competitive advantage.

Thus, in semiconductors, there has been a shift from memory dynamic random access memory (DRAM) to more sophisticated chips. Elpeda, a joint venture of Hitachi and NEC formed in December 1999, is now the only Japanese company producing DRAM. In LSI, too, there are drives for strategic alliances among Japanese firms and with foreign companies. Renesas Technology, one of the largest semiconductor companies in the world, is a joint venture of Hitachi and Mitsubishi Electric formed in April 2003.

Protecting Intellectual Property

Japanese companies have become determined to protect their intellectual property. Japanese firms now feel that their failure to protect their production technology for

DRAM was a major factor in Korean and Taiwanese firms capturing the market. While previously Japanese firms were more likely to be defendants in intellectual property cases brought by U.S. and European companies, now Japanese are initiating litigation. Companies are strengthening their legal staff to deal with the increasing number of cases.

A number of companies have moved some operations back to Japan. They have weighed the advantage of using cheap labor against the risk of leakage of technologies from their plants. Perhaps remembering how much Japanese learned touring U.S. and European factories in the past, Japanese firms are closing their factories and research facilities to visitors. Some experts describe these movements as "black-boxing," which is now regarded as a very effective approach to protecting technologies and know-how.

Behind these new attitudes is a Japanese government policy of vigorously defending Japanese IPRs. In particular, the 2003 revision of the Custom Tariff law made it easier to take prompt action to stop imports of products deemed to violate Japanese IPRs. There is a determination to fight breaches of Japanese patents and other IPRs. This is particularly seen in digital consumer electronics, especially flat-panel displays, DVDs, and digital cameras. All of these were originally commercialized by Japanese firms, but Korean and Taiwanese companies have caught up quickly.

Utilizing More External Resources

Use of external resources to remain competitive is more widespread. For standardized parts, there is more willingness to buy from Taiwan and other Asian countries rather than producing in-house. Contracting out to foundries and assemblers is far more widespread than before. At the same time, Toshiba and Fujitsu each entered the foundry business in 2004, producing the most advanced LSIs designed by U.S. firms. In this way, cross-border value chains are being established with Japanese companies as important links.

The use of external technology resources can make it possible for companies to shorten the time to market, as well as to diffuse the risk associated with R&D. This kind of activity, namely, finding promising technologies out of the myriad of newly developed ones, requires the insight to discern the commercial potential of untested technologies, as well as the ability to translate them into a business model for exploitation. Such a talent (*mekiki* in Japanese, meaning "a person with insightful eyes") appears to have been very rare in Japan, making it difficult to nurture venture businesses.

Conclusion

What made the 1990s different from the 1970s and 1980s is the large number of disruptive innovations, particularly in the IT sector. Unlike in the United States, there were few market entrants in Japan to inject dynamism into the economy. New technology was not effectively exploited by established firms, which maintained old management practices and outmoded business models.

What has become clear as a result of the difficult experience of the 1990s is that it is incumbent on a national economy to nurture an entrepreneurial spirit and foster new business models if it is to benefit from new innovations. This is what happened in the United States and what did not happen in Japan.

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6

The IT Revolution's Implications for the Japanese Economy

Kazuyuki Motohashi

Why hasn't the Japanese economy benefited from the information technology (IT) revolution? Japanese firms were dominant suppliers of semiconductors and other electronic goods into the 1980s. But during the IT revolution of the 1990s, when IT was being hailed as the proximate cause of dramatic changes in business models, processes, and activities in user industries, Japan was in an economic downturn. Moreover, Japan's electronics industry was losing competitiveness relative to firms in the Republic of Korea; Taiwan, China; and elsewhere in East Asia. Aided by investment by foreign enterprises, China now commands the top share in production of many consumer electronic items.

The economic implications of the IT revolution on IT users are investigated in this chapter. First, the relationship between IT and productivity growth is analyzed in Japan and benchmarked against the United States. In the 1990s, a strong growth pattern can be found in the United States, in contrast to Japan's situation.

A growth-accounting exercise comparing Japan and the United States from 1975 to 2000 is provided to show the impact of IT on economic growth and productivity at the macro level. A substantial portion of the growth resurgence of the U.S. economy after 1995 can be attributed to advances in IT (Jorgenson 2002). Moreover, the rapid growth in U.S. labor productivity during the economic slowdown that began in 2001 suggests that prospects for potential growth of the U.S. economy have been considerably enhanced (Jorgenson, Ho, and Stiroh 2002).

The macro view is supplemented by industry and firm-level analysis. IT is a typical general purpose technology, which means it diffuses widely into an economy and has heterogeneous effects on the various aspects of firm activities. IT changes business practices and decision-making systems, as well as relationships between suppliers and customers. Thus, it is important to look at what is going on at the firm level to achieve deeper understanding of the economic impact of the IT revolution.

The implications of IT and digital revolutions are then discussed in relation to the "Japanese management system" or "Japanese model" as an economic institution. Due to the wide diffusion of IT networks, the role of external and explicit information becomes important in the knowledge creation process. This shift in the comparative importance of explicit knowledge may benefits U.S. firms more than Japanese firms, which have had an advantage in their handling of implicit knowledge. In addition, modularization of product architecture, particularly found in the electronics industry, raises innovation speeds. This means quick business decisions and adjustments using external markets are required more than was the case.

The policy implications of this context are then provided. In short, it is imperative that Japanese firms focus on quality rather than price for their competitiveness.

This means that building a national innovation system capable of maximizing knowledge creation in Japan as a whole has become a priority policy item. Effective use of IT is a critical component in such an economy. The incumbent innovation system, which has relied heavily on in-house research and development (R&D), must shift toward a network system using external collaborations.

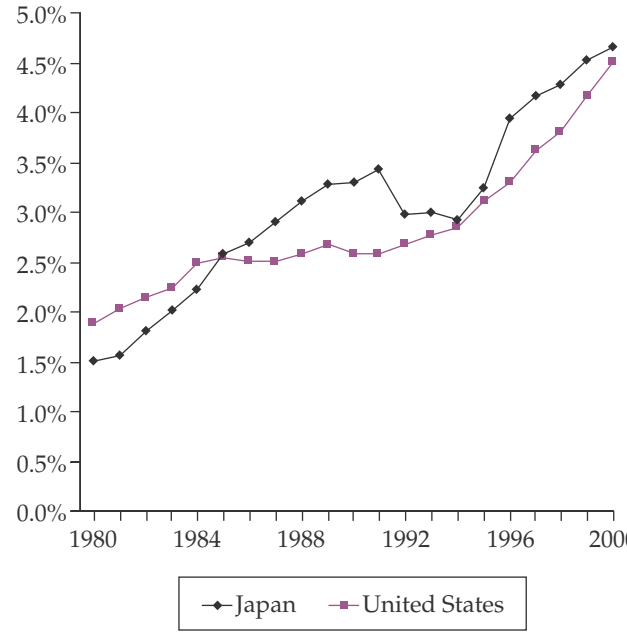
IT and Economic Growth at the Macro Level

As a determinant of productivity, use of IT has been extensively examined. An IT revolution, with rapid technological progress in computers and the spread of the Internet in the 1990s, coincides with a kink in the trend line of U.S. labor productivity. That is, after a slowdown in the 1980s, it regained speed in the late 1990s. Oliner and Sichel (2000) show that about two-thirds of the 1.5% annual productivity revival after 1995 can be attributed to the growth in IT investment. Even after the so-called IT bubble burst in 2001, U.S. labor productivity as measured by the U.S. Bureau of Labor Statistics (BLS) shows strong performance. Thus, it is fair to say that the IT investment surge can explain a significant portion of the U.S. productivity revival after the mid-1990s (Bailiy 2002).

Jorgenson and Motohashi (2005) extend such analysis to Japan and compare the role of IT in economic growth in the two countries. The growth rate can be decomposed into contributions from factor inputs: labor, capital, and total factor productivity (TFP). Capital inputs can be decomposed into IT capital and non-IT capital.

Figure 6.1 shows the ratio of IT investment to gross domestic product (GDP) in Japan and the United States. Due to active IT investment in the 1980s, the IT ratio in Japan surpassed that of the United States in the mid-1980s. After the resurgence of

Figure 6.1. *IT Investment as a Percentage of Nominal GDP, Japan and United States, 1980–2000*



IT investment includes computer, software, and communications equipment.

Source: Author's calculations using various statistical sources.

the U.S. economy in the 1990s, U.S. firms accelerated IT investment and caught up with Japan in 2000. The basic message from this graph is that the IT investment boom is not a phenomenon special to the United States: Japanese firms also invested heavily in IT.

In this sense, the result in Table 6.1, the growth decomposition computed by Jorgenson and Motohashi (2005), is not strange. A major source of Japanese economic growth in the late 1990s is the surge in the contribution of capital services from IT equipment and software. (Capital services refers to services from capital stock, as a contribution to value added growth.)

In Japan, the contribution of IT capital services declined during the first half of the 1990s, then rebounded strongly after 1995. However, the increase is not as large as for the United States. The IT contribution in the United States rose steadily between 1973 and 2003.

Until the mid-1990s, relative to United States, TPF grew faster in Japan, but progressively less so, and the share of GDP growth attributable to TFP was greater.

Table 6.1. *IT's Contribution to Growth in Japan and the United States, 1973–2003 (percent annually)*

1973–90	*1990–95*	*1995–2003*	
Japan			
4.03	1.64	1.28	GDP
Contribution of:			
0.36	0.29	0.54	IT capital services
1.01	0.77	0.62	Non-IT capital services
1.09	–0.22	–0.32	Labor services
1.57	0.80	0.45	TFP
IT capital services composed of:			
0.18	0.13	0.22	Computers
0.12	0.12	0.20	Software
0.07	0.04	0.11	Communications equipment
United States			
2.98	2.44	3.55	GDP
Contribution of:			
0.38	0.49	0.88	IT capital services
1.11	0.71	1.01	Non-IT capital services
1.18	0.93	0.67	Labor services
0.31	0.31	0.99	TFP
IT capital services composed of:			
0.20	0.22	0.49	Computers
0.07	0.16	0.22	Software
0.11	0.10	0.17	Communications equipment

These results are based on adjusted deflators of IT investments for Japan. The same calculation based on national deflators is also conducted, and the contribution of IT capital drops from 0.54% to 0.40% from 1995 to 2005. However, the TFP growth rate does not change, 0.45% for both estimates (Jorgenson and Motohashi 2005). Because of the price adjustment differences, the Japanese GDP growth rate here is different from that in official statistics. Detail may not add to totals because of rounding.

Source: Jorgenson and Motohashi (2005).

This reversed during the 1995–2003 period. The share of TFP in GDP growth has increased in the United States, from 10% in 1973–90, to 13% in 1990–95, to 28% in 1995–2003.

What explains the difference in growth rates between the two countries? Labor input made almost no contribution to growth in Japan throughout the 1990s. Production was becoming more efficient, but demand was not rising fast enough to absorb the available supply. By contrast, labor input growth in the United States far outstripped labor force growth, resulting in a decline in the unemployment rate and a rise in participation rates.

Another indication of slack demand in Japan is the anemic growth of non-IT capital input relative to the United States. The decline in per capita hours worked throughout the 1990s distinguishes Japan from other industrialized countries. This has been analyzed in detail by Hayashi and Prescott (2002) and can be attributed to the widespread adoption of a five-day work week and an increase in the number of national holidays. Demand-side factors in the labor market, such as the historically high unemployment rate, also are relevant.

Revival of TFP growth in the late 1990s can be attributed to acceleration of the IT revolution in terms of the relentless drop in the prices of processors and storage devices. Each successive generation of processors and storage devices was more powerful than the previous one, yet was the same or even less expensive. This meant not only that the constant quality price of hardware dropped, but that users could get a system that was both better and less expensive than the one it replaced. The staggering rate of technical progress in the IT-producing industries—semiconductors, computers, and telecommunications equipment—has led to substantial TFP growth in this sector. This, in turn, pushes up TFP at the macro level. Jorgenson and Motohashi (2005) estimated that the TFP growth rate from the IT sector explains about 80% of the overall Japanese rate.

TFP growth may come from various other factors, such as R&D investment and increasing market efficiency. Thus, growth decomposition by industry shows that a major portion in the 1990s was in service sectors (Fukao and Miyagawa 2003). Productivity growth in services during this period can be attributed to series of regulatory reforms conducted after 1990. A positive relationship between regulatory reform and productivity growth can be observed in industry-level studies in communication, retail, and financial services (CAO 2001). If one takes out contributions from all non-IT factors, a pure effect of IT on productivity in IT user sectors may become very small.

An Industry- and Firm-Level Look at IT and Productivity

The relationship between IT and productivity in user sectors is investigated in this section at the industry and firm levels. It is found that IT is not a sector-specific technology, and it diffuses widely across industries. The Ministry of Economy, Trade, and Industry (METI) IT survey conducted every year provides the amount of IT expenditure by industry. Note that IT expenditure and IT investment are different. For example, hardware rental costs are an IT expenditure, not an IT investment. Most computers are rented, so expenditure provides a more accurate picture of IT use on the user side. Table 6.2 shows the share of IT expenditure by industry in 2000.

In term of IT intensity, measured by the ratio of IT expenditure to total sales, the financial services sector scores (2.1%) much higher than manufacturing (0.9%).

Table 6.2. *Distribution of IT Expenditure by Industry, Japan, 2000 (percent)*

1	Primary industries
2	Construction
31	Manufacturing
6	Utilities
2	Transportation and communications
9	Retail and wholesale trade
20	Financial services
26	IT services
3	Other services

Total IT expenditure was 4.41 trillion yen (about $38 billion at 115 yen/dollar). Data are for fiscal years that ended during 2000. For large firms (and thus, most of the expenditure), this means years ending in March 2000. For small firms, data are mostly calendar year 2000.

The IT services industry includes software and information providing and processing services.

Source: METI, ICT Workplace Survey.

However, higher IT intensity does not always lead to higher productivity growth. Nishimura and Minetaki (2004) analyze the relationship between TFP growth and IT intensity, measured by the ratio of IT capital stock to total capital stock by industry. They cannot find any statistically significant effect on productivity from IT in a cross-industry regression. The same result is found for the United States (Stiroh 2002).

High IT intensity does not always suggest a higher degree of IT capital deepening at constant prices. Cross-industry analysis of the speed of computer downsizing shows that mainframe systems still dominate Japanese commercial banks, while client-server systems are diffused widely in other industries (Motohashi 2005). In general, the speed of technological progress and price decline is faster for smaller computers. Thus, high IT intensity in the financial services sector may simply reflect higher-priced systems.

Cross-industry differences in TFP growth comes from various factors other than IT investments. For example, market competition affects productivity growth (Nickel 1996). R&D is another driver of TFP.

In this context, Motohashi (2003) conducted a firm-level analysis of IT network use and productivity for the manufacturing and trade (retail and wholesale) sectors to separate IT from other contributors to TFP growth. A rich firm-level dataset for IT and performance collected by METI allows investigation of the nature of general purpose technology and its economic consequences. (A general purpose technology is one that can be used differently in different industries, and in various ways within an industry, as is shown in Motohashi 1997). For example, flexible manufacturing systems and Internet banking are totally different applications of IT. Even within a firm, various IT applications—from financial accounting systems to inventory control systems—can be found.

METI's firm-level dataset includes information on the use of information networks by type of application. Comparing the economic impact by type of IT

Table 6.3. *Effect of Information Network Use on TFP Growth, Japan, 1997–2000 (percent annually)*

	1991–94	*1994–97*	*1997–2000*	
Intrafirm network				
	1.0	0.1	2.2	Manufacturing
	–0.6	3.7	4.3	Trade[1]
Interfirm network				
	3.1	0.7	1.8	Manufacturing
	–0.3	2.1	0.5	Trade[1]

Entries are the difference between a firm using the specified type of IT network and a firm not using IT. For example, the TFP growth rate between 1991 and 1994 of a manufacturing firm using an intrafirm network is 1.0% higher than that of a firm not using it. This productivity growth premium varies over periods, types of IT network, and industry.

Data are from Motohashi (2003). They are the results of estimating a production function including labor, IT capital, and non-IT capital as inputs.

1. Includes both retail and wholesale trade.

application provides useful information for understanding the relationship between IT and firm-level performance.

Table 6.3 shows the difference in the TFP growth rate of a firm using each type of IT network as compared to a non-IT user. The results of this sort of analysis suffer from errors in variables and model specifications. Still, it is possible to conclude that positive effects of network use on productivity are found in general.

The size of the productivity premium is very small. It is also found that variances in TFP growth within the network-use group and non-network-use group are very large. Statistical tests for the regression models show that only 1 of 12 coefficients is positive (different from zero) at a 10% significance level. Therefore, although a positive relationship can be found on average, it is only to a mild degree.

The same analysis is conducted for network use by type of business process, such as ordering, production, inventory, customer relations, human resource management, and the like, in Motohashi (2003). The results are almost the same, showing only small effects, and no particular patterns over type of process can be found. There are no comparable studies for the United States or European countries, but an effort to put together similar types of studies has been conducted by the OECD (2003).

Comparing Japan and the United States, increases in two measures of labor productivity related to network use have been calculated by Atrostic et al. (2004). They found that sales per employee in Japan were 12% higher with network use than without in 1997, and value added per employee was 5% higher. The 1999 differences for the United States were 28% for sales and 29% for value added.

Organizational Considerations

Underperformance of IT network users in Japanese firms can be explained by underinvestment in organizational capital complementary to IT. At the firm level, IT investment is not simply buying computers and software. Success requires co-invention by suppliers and users, including organizational innovation (Bresnahan and Greenstein 1997).

There are a significant number of studies addressing the importance of particular organization forms and work practices to make the most of IT investments. For example, innovative practices are captured by a firm-level survey, and their relationship with firm performance is tested, by Ichiniowski et al. (1996). Practices included work teams (quality circles, for example), employee stock ownership (ESOPs), and flexible job assignment. Their study shows that "high-performance work systems" lead to better performance.

The complementarity of IT and organizational assets is also shown by Bresnahan, Brynjolfsson, and Hitt (2002) using firm-level quantitative analysis. They stress that increased productivity requires both IT investment and innovative work practices. The value of intangible assets is addressed directly by Brynjolfsson, Hitt, and Yang (2002). They looked at the relationship between innovative work practices and the stock market valuation of firms and found a positive association between them.

Complementary assets of interfirm networks include a firm's ability to handle relationships with suppliers and customers. SCM (supply-chain management) and CRM (customer-relationship management) are straightforward examples for IT applications in this area. However, simply applying an SCM system does not automatically improve performance. If it did, Dell Inc.'s effective SCM could be imitated by others, and Dell would loose its competitive edge instantly. There must be some firm-specific and sticky intangible assets to explain the excellent performance of Dell's SCM.

All these studies suggest that introducing a new IT system should be paralleled by changes in internal work practices, incentive systems, supplier and customer relationships, and the like. As IT system prices have dropped dramatically, the cost of the organizational changes (investment in organizational capital) has become relatively large. However, there is a general agreement that without proper investment in organizational capital, the introduction of a new IT system does not work well, and it is difficult to achieve expected performance improvements.

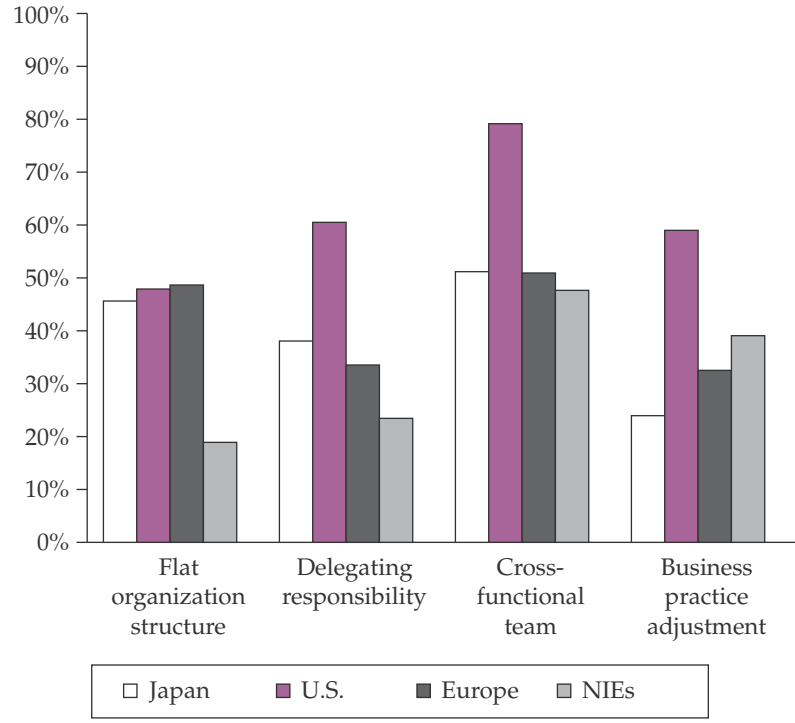
Japanese firms make fewer organizational changes when they introduce new IT systems. Figure 6.2 indicates the share of firms that conducted each type of organizational change in processes related to IT system adoption.

Labor Constraints

There is no evidence that Japanese firms underinvest in IT systems as compared to U.S. ones but, due to employment constraints, they cannot achieve the same level of performance. It is very difficult for firms to fire employees. A major reorganization of a firm's structure typically is accompanied by a reallocation of workers, which sometimes requires cuts in the total number. In Japan, organizational changes such as flattening the organization, integrating divisions, reduction of back-office staff, and the like, were indeed done when new IT systems were introduced. However, workforce redundancy associated with such changes was absorbed mainly within the firm by transferring staff, instead of using more part-time and temporary workers. (Motohashi 1999), using data are from a firm-level survey on technology adoption and organizational changes from 1991 to 1994 conducted by the Japan Productivity Center for Socio-Economic Development).

TFP growth in the late 1990s at the macro level can be—and was—achieved at the expense of labor inputs. In this process, large Japanese companies have conducted substantial restructuring of labor forces. However, reducing the labor force

Figure 6.2. *Organizational Change and IT Adoption*



Data are for 2000. NIEs new industrialized economies.
Source: METI, *White Paper on International Trade*, 2001.

has been done mainly by early retirement rather than terminating underperforming employees. Due to the lack of an active external labor market, the resource reallocation necessary to deal with the rapid shift in labor demand driven by the IT revolution cannot be expected. Sluggish economic performance after the burst of the economic bubble exacerbates this rigidity.

IT Management Style

Another factor in the underperformance of Japanese IT users is rooted in IT management style. In most cases it is fragmented by department or division, rather than an integrated system throughout the whole company. This reflects how enterprise IT systems were developed historically. In the past, systems addressed specific business needs, such as financial accounting, inventory control, and customer relations. Now, however, Enterprise Resource Planning (ERP) systems integrate various application into one package. ERP unifies all information in each division throughout a whole firm, and managers can access it for day-to-day decision making. Efficiency gains in individual sections of a company do not always lead to productivity increases in the whole, but ERP is a system enabling total optimization and timely information availability across a firm.

ERP is used extensively by U.S. firms, while diffusion in Japan has been relatively slow. Even when it is introduced, proper modifications of business practices are not conducted, and it does not contribute to business performance at all. Orga-

nizational rigidity regarding changes in work practices again hampers effective use of an IT system.

METI conducted a survey of about 500 listed companies regarding IT management and business performance (METI 2003). It found 66% of firms use information systems (IS) by department, while 19% had integrated IS.

METI also found that companies introducing firm-wide IT systems achieved better business performance in terms of managerial decision speed, business process re-engineering (BPR), differentiation of products and services, and response to globalization. The problem is the share of firms with firm-wide IS is only 19%, which indicates that, in general, Japanese companies are operated in a decentralized way, without strong top-down leadership.

The Japanese Model and IT User Performance

The foregoing discussion leads to the relationship between IT systems and the "Japanese model" as an economic institution. The term "Japanese model" is a comprehensive reference to a unique management style that has been practiced by Japanese corporations as the country's economy developed in the postwar period. With regard to business practices, it refers to the maintenance of long-term business relationships; with regard to human resources management, it refers to lifetime employment and reliance on seniority; in the financial sphere, it refers to a heavy reliance on indirect finance; and in corporate governance, it refers to the influence exercised by main banks. These institutions and business practices fly in the face of classical economic thinking, with its emphasis on the allocation of resources by labor markets, capital markets, product markets, and other such mechanisms. Of course, Western enterprises do not operate entirely on market principles either, but it remains true that Japanese enterprises rely more than their Western counterparts on nonmarket mechanisms.

Comparative institutional analysis (CIA) provides a useful tool for the analysis of the Japanese model (Aoki 2001). In neoclassical economics, a corporation is treated as a black box, but to analyze the Japanese model, there must be a framework that delves into the organizational structure of corporations. For example, a model has been put forward for decision making processes in managerial and operational divisions, and for coordination mechanisms between different operational divisions (Aoki and Okuno 1996). According to this model, where different operational divisions are highly complementary, the most advantageous institution is one in which the different divisions engage extensively in information sharing while devolving decision-making powers to the level of the shop floor. Where different operational divisions are *not* highly complementary, the most advantageous institution features centralized, top-down decision-making. It is said that lifetime employment, which is one feature of the Japanese model, tends to increase sharing of information within a firm, and that Japanese enterprises tend to stress decision-making at the shop-floor level.

Comparison of firm behavior and organizational structure is conducted in Kagono et al. (1983). Based on a firm-level survey, it is shown that Japanese firms are organized in a decentralized fashion in terms of their decision-making system and allocation of responsibility as compared to U.S. firms. In this sense, cross-functional coordination of Japanese firms is more active at the shop-floor level. In addition, such a bottom-up system, with team-based management, does not require a detailed job description for each employee. This is compatible with the long-term employer-employee relationship at Japanese firms. Fragmented IT systems, as

found in Japanese firms, are consistent with bottom-up decision making, without top-down initiatives for IT investments.

IT systems are an effective communication tool throughout a firm, but their benefit to Japanese firms is relatively small. The first reason is that effective cross-functional communications had already been achieved before the IT revolution. In this sense, the marginal gain from IT systems is smaller for Japanese firms. Second, it is difficult to codify the business processes of Japanese firms in digital format. This is because they are not clearly articulated, and day-to-day decision making is done in a subtle and flexible way. Third, Japanese firms are strong in using tacit knowledge for innovation as compared to explicit knowledge (Nonaka and Takeuchi 1995). Explicit knowledge can be more easily handled by a computer than tacit knowledge. This point is investigated in more detail in the next chapter.

Table 6.4 summarizes the contrasts in management practices between stylized Japanese and U.S. firms, as well as the implications for IT use. Together, the points suggest that the firm-wide application of IT does not fit comfortably into the Japanese model.

Strengths and Weaknesses of Japanese Enterprises

Use of IT in the knowledge creation process is analyzed in this section, and the results of a survey on "organizational IQ" conducted by Research Institute of Economy, Trade, and Industries (RIETI; 2001) comparing Japanese and U.S. firms are presented.

Organizational IQ focuses on providing an overall measurement of a firm's sensitivity to external information, its ability to efficiently process in-house information, and the quality of its decision-making processes. The concept was introduced by Mendelson and Ziegler (1999). They conducted a questionnaire survey of firms in Silicon Valley and used the results to analyze the relationship between organizational IQ and corporate performance.

RIETI conducted a similar survey for Japanese firms. The organizational IQ of each firm was based for the most part on the following elements.

1. Grasp of external information: frequency of contact with customers; intake of information on competitors and technologies.
2. Flow of in-house information: access to information regarding competitors and markets, use of lateral teamwork.
3. Decision-making processes: degree of delegation (flat organization), internal flow of information.

Table 6.4. *U.S. Firms versus Japanese Firms*

	U.S. firms	*Japanese firms*	Implications for IT use
Cross-functional coordination	Inactive	Active	Comparative disadvantage in using IT tools
Job description and responsibility	Clear	Unclear	Dificulty in business process reengineering
Decision-making process	Top-down	Bottom-up	Fragmentation of IT system
Knowledge creation process	Explicit knowledge	Tacit knowledge	Ineffective use of digitalized information

4. Organizational focus: clarity of development processes, operational objectives, and evaluation criteria.
5. Creativity: activities aimed at creation of tacit knowledge, ability to carry through on ideas.

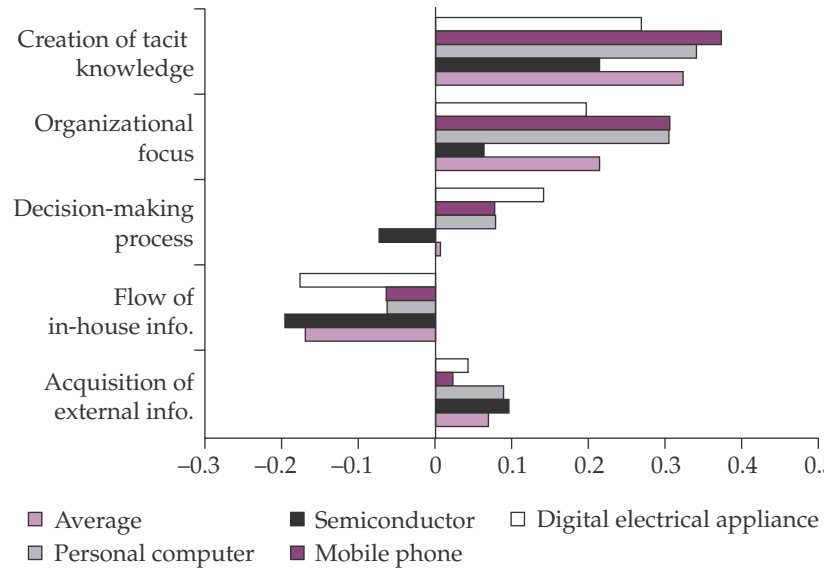
Figure 6.3 shows scores of Japanese firms compared to the U.S. firms in Mendelson and Ziegler. Positive values mean higher score for Japanese firms, and negative mean lower. The results must be interpreted with caution, as the questionnaire deals with subjective material.

Japanese firms scored higher than their Silicon Valley counterparts in many categories. However, Silicon Valley respondents on the whole gave more pessimistic responses, which lowered their overall score. Accordingly, any comparison should not treat the results as absolute scores. However, the U.S. scores can be used as a baseline for determining the categories in which Japanese firms were relatively strong or weak. Also, the results can be used to observe trends in relative scores.

Japanese firms in all sectors scored highest in "creation of tacit knowledge" and lowest in "flow of in-house information." To better understand these results it is helpful to use the Socialization Externalization Combination and Internalization (SECI) model of Nonaka and Takeuchi (1995). The model divides knowledge in a corporation into two types: tacit and formal. These serve as the basis for knowledge creation through the following four processes (the first letters of which are used to form the name of the model).

1. Socialization (creation of tacit knowledge from tacit knowledge);
2. Externalization (creation of formal knowledge from tacit knowledge);
3. Combination (creation of formal knowledge from formal knowledge); and
4. Internalization (creation of tacit knowledge from formal knowledge).

Figure 6.3. *Organizational IQ of Japanese Firms Relative to U.S. Firms*



Entries are the 2001 Japanese score from RIETI (2001) minus the U.S. score from Mendelson and Ziegler (1999).

The creation of tacit knowledge is a process of formalization whereby individual employees turn their tacit knowledge into concrete concepts and new products. Japanese firms can be said to be relatively good in the area of externalization.

The flow of in-house information, by contrast, involves internal circulation within the firm of tacit and formal knowledge. In other words, it involves socialization and combination. Looking at the individual items under the category "flow of in-house information," one finds that Japanese firms got low scores for access to information regarding competitors and markets, and for internal sharing of product specifications, both of which are concerned with formal knowledge. Accordingly, it could be said that Japanese firms are especially weak in the area of combination.

Progress in the field of IT has made it easier for corporate management to make use of external information, and an open-network model of management that focuses on collaboration with outside organizations has come to offer comparative advantage. This is a model that makes active use of formal knowledge. Japanese firms do not make effective use of formal knowledge from outside the company.

Japanese firms got extremely low scores for "management of product development in cooperation with outside organizations" and "selection of strategic development partners." Particularly in the electronics industry, where the pace of technological progress is quick and the business climate undergoes rapid change, a firm must stay well-informed of external developments. Exclusive reliance on in-house resources, such as personnel and information, is unlikely to be sufficient. Rather, as the firm seeks to correctly position itself within its business domain, it must aggressively pursue tie-ups with other entities.

The relative weakness of Japanese firms in handling explicit knowledge may weaken their competitive position, particularly in areas of rapid technological progress.

The IT Revolution and Modularization: Challenges to the Japanese Model

Thanks to decades of improvements in integrated circuit (IC) technology, computers have become of faster and smaller, and build-out of the Internet and other telecommunications infrastructure continues apace. These advances are prompting enterprises to invest in IS and are triggering changes in the structure of the economy. This IT revolution is being fueled by the vertiginous pace of progress in electrical engineering and material science.

Even after several decades, Moore's Law on increases in the capacity of computer chips and the level of integration of ICs continues to apply. In telecommunications, the fear of capacity constraints was shattered by fiber optics and digitalization. IT systems combining computing power and telecommunications have penetrated into the very fabric of society, to the point where economic activities can grind to a halt without them.

To understand the impact of the IT revolution on the economy, it is important to bear in mind the ongoing digitalization of information relating to business operations, products, and technology. In the form of the Internet, this has had particular impact on distribution, both between businesses and with final consumers.

The flow of publicly available information via the Internet is growing much faster than the flow of internal company information. (That is, information relating to unannounced products and technologies, for example, and know-how related to a company's unique management techniques.) The efficiency of exchange of confi-

Box 6.1. *Modular Architecture*

Modular architecture refers to the design of a product (mostly physical, but also some software) using standardized interfaces to allow interchangeability of various specific varieties of a component, and the combining of components into what can be complex systems. The PC is the most obvious illustration: many vendors supply many varieties of, for example, hard-disk drives, but any can be plugged into the computer.

With such an architecture, development of the separate modules can occur in parallel. Because competition takes place among the makers of each module, innovation in the product as a whole can proceed rapidly.

Modularization of product architecture leads to unbundling the supply chain, and dividing it among various kinds of players. Competitive advantage comes from innovative capacity in key components and the capability of maintaining supply-chain networks. This is a fundamental threat to the Japanese model, which is based on stable supplier-customer relationships and manufacturing technology and skills at the plant level, which cannot be codified and managed by IT systems.

dential information between enterprises is also notably higher thanks to improved information networks. This qualitative change in the nature of information makes it easier for corporate management to make use of external information, and it also encourages enterprises to exchange more information with specific outside entities. The result is a network-based model of management that creates win-win situations and offers comparative advantage.

Organization IQ tests show that Japanese firms are relatively weak in handing explicit knowledge, the importance of which has become greater because of IT. On the other hand, The Japanese model is effective in sectors where complementarity among divisions is strong and coordination is required. Therefore, the impact of the IT revolution varies across industries.

The electronics industry is in a particularly serious condition, because of the storm of modularization in product architecture (Ando and Motohashi 2002). In electronics, integrated manufacturers, producing final products as well as their components, have been losing competitive edge to overspecialized component companies due to the unbundling of production and supply-chain systems. This relates to the rise of "modular architecture," as explained in Box 6.1.

Conclusion

In this chapter, the impact of IT innovation in the Japanese economy is investigated using macro-level statistics, as well as micro findings at firms in terms of productivity and organizational effects. TFP growth in Japan has been comparable to that of the United States, and about half of it can be explained by the IT sector. A firm-level analysis suggests that the use and productivity of IT at IT-using firms is not so strong, and its impact is relativey smaller, in Japan than in the United States. New technology adoption always requires changes in work practices and management systems. There is no doubt that IT advancement leads to significant productivity growth in the IT industry, but organizational rigidity in user industries may hinder effective use of new IT systems.

In addition, the Japanese model is in a process of substantial changes, in part because of the digital revolution. In the fierce innovation competition due to the

revolution, speed and collaboration are particularly important in managerial decision making. To achieve speed, a firm must rely on its core competencies and carefully consider its many options before choosing what is best, concentrating its resources in those areas. A strategic approach and leadership are needed. Western firms are aggressively pursuing cross-border merger and acquisition deals and tie-ups, and it has become accepted wisdom that firms with complementary core competencies must collaborate in order to achieve accelerated innovation and greater rates of return. The bottom-up approach to management and the "go-it-alone" business practice that afforded Japan competitive advantage for so many years will no longer meet the challenge of international competition.

To compete successfully in the ongoing IT revolution, it is necessary to formulate a corporate strategy that stresses speed and collaboration. Toward that end, it is important to reform entire systems, including their constituent institutions. As part of this, working within the analytical framework of a national innovation system, Japan needs to develop a "doctor's prescription" to strengthen complementarities between the mesh of institutions that support innovation, for example, product markets, intellectual property rights, financial markets, and labor markets.

Japan's innovation system is anchored by major corporations, and for many reasons the industrial community has not had strong linkages to universities or public research institutes. Based on the U.S. experience, it seems appropriate to create greater linkages with universities and research institutes to help spur corporate innovation.

National innovation systems evolve in each country on the basis of historic and institutional background, and it is not possible to make across-the-board statements about which type of system is best. Japan was able to achieve outstanding economic performance in the postwar years because its enterprises made effective use of in-house tacit knowledge, companies churned out new products on the strength of bottom-up initiatives, and new production systems, such as Toyota Motor Corp.'s, were developed.

Japan's innovation system appears to have worked quite well through the 1980s. Subsequently, amidst the wave of global competition that has erupted as a result of the IT revolution, comparative advantage in many industries has shifted to the U.S.-style network-based innovation system, especially in the electronics industry. Therefore, it is important to facilitate a shift in the Japanese innovation system toward a network-based, dynamic one. In a world of global competition for speed in innovation, in-house innovation systems do not work.

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7

Education, Training, and Human Resources: Meeting Skill Requirements

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Reiko Kosugi

The specific skills a work force needs in a knowledge-based economy with rapid technological change and globalization are ever-changing. This suggests that human resource formation requires lifelong learning systems to help workers acquire new skills. Thus, more than ever, education and training play a significant role in the success and failure of a national economy. The Japanese government recognizes the critical challenge of skill and human resource formation in a global context and is creating a vision to meet it.

The chapter is organized as follows. An overview is provided of the education system that supported Japan's success in the 20th century, with special attention paid to higher education. With this background, challenges to the system from globalization and changes in the labor market are presented. Policy responses to these challenges, as well as issues of academic quality, are then analyzed.

Acquisition of vocational skills and the role of traditional employment practices extend the discussion to the role played by the private sector. As with the educational system, globalization and labor market changes are affecting employment practices and training policies, and these topics are developed. Particular attention is paid to the effects of the rise of a knowledge economy. Specific policy recommendations are made.

Needed changes in Japan's labor market are presented in the penultimate section. Many of these have relevance for developing economies. The chapter concludes with some additional policy recommendations.

Overview of the Education System

The simplified and basically meritocratic competition within the school system since the 1950s has succeeded in involving the majority of students in a competition for academic achievement (Nakamura 2003).

Japan achieved high levels of school attendance in the early stages of its transition to being a modern society. Even before then, by the mid-19th century, there was a basic and higher education system, which was used mainly by the governing elite and business people. During the Meiji period (1868–1912), the new government put great importance on the diffusion of basic education. By the mid-1940s Japan offered six years of basic education to all its citizens, as well as relatively highly developed vocational and general secondary education and a higher and postsecondary education system that included seven imperial universities, flagship research institutions distinguished from other universities and colleges.

Although only the 9 years through lower secondary school are compulsory, in 2004 87.5% of 18-year-olds graduated from full-time upper secondary schools, having completed 12 years of education. Moreover, it is estimated that 76% of 18-year-olds went on to higher or postsecondary education; only 15% got full-time regular jobs. (Data are from the Ministry of Education, Culture, Sports, Science and Technology, MEXT 2004.) In comparison, 39% continued schooling in 1975, 52% in 1985, and 65% in 1995.

Structure

Under the U.S. military government of 1945–51, Japan transformed its education system from a European-type system into a U.S.-type one.

Universities basically provide four-year undergraduate education, two-year master's programs, and three-year doctoral education. The rapid development of postgraduate professional education is adding variety to the length and content of postgraduate education. Junior colleges provide two-year programs that lead to an associate's degree; most of the students are women.

In addition, there are specialized training colleges that issue diplomas on completion of two-year vocational postsecondary programs. Colleges of technology provide unique, vocational-oriented five-year programs as a combination of three-year senior secondary education and two-year, short-cycle higher education. They issue associate's degrees and function quite well as an advantageous career path for both technicians and for transfer to prestigious universities. The number of graduates is quite small, however. In 2005 about 41% proceeded to an undergraduate university, mainly transferring in the third year. Miscellaneous schools offer various types of vocational nondegree programs.

Those who are neither in school nor in education are called "NEET" (not in employment, education, or training) (see Genda and Maganuma 2004, Kosugi 2004, 2005). NEETs are around 2% of the young, and the group's share is increasing. Those who work part-time and are not also students or housewives are called "freeters." Many NEETs and freeters are not able to get stable or desirable positions in either education or labor.

The Role of Public Schools

Japanese children for a long time have been sharing an exceedingly standardized education experience. The important role of the central government has meant equalized learning conditions, as well as a highly controlled national curriculum.[1]

The current, ongoing policy shift toward decentralization and deregulation may increase the differences in financial condition among regions. And some areas have introduced school choice for elementary schools. However, almost all elementary school students are in the public sector, and it is still exceptional not to go to a neighborhood public school. Nationally, the share of primary education students in the private sector was only 0.9% in 2005. Even in Tokyo, the largest and richest city, the share was only 4.6% in 2004. However, the percentage has been increasing.

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1. A useful analysis of Japan's education system through high school in the mid-1990s is NISACA (1998), which includes a bibliography. This is a U.S. government report written at a time when the United States was looking at ways of improving its own education system, especially in science and mathematics, and considered Japan as a source of possible lessons.

In 2005, 94% of lower secondary school students were studying at public schools, generally within the school districts of their families. Senior secondary education is not compulsory, and 29% of the students are in the private sector. Each public and private upper secondary school has a selection process based on grade point average (GPA) and entrance examinations. The student bodies are highly stratified according to academic achievement among the different schools. This tracking leads to different probabilities for entrance to prestigious higher education institutions.

Kariya and Rosenbaum (1987) argued that upper secondary school students had to care about learning achievement within the school even if they did not intend to continue study. This is because allocation to full-time work after upper secondary school has been the responsibility of teachers within the Japanese legal system. Therefore, grades had significant meaning even for the lower half of high school students.

Historically, the universal involvement of students in a competition based on meritocracy lasting through the end of secondary education has ensured high academic achievement on average.

Higher Education

The emergence of mass higher education in the 1960s led to active debate on a perceived crisis of the quality of university education, in terms of staff number and financial resources per student. Especially in the private sector, increases in staff did not keep pace with the rapid increase in student number. To protect the quality of education, the government set up a higher education plan that was implemented in 1976. It controls the number of students at each school, including those in the private sector.

The limitation on numbers was especially rigid in the 1980s. This led to a substantial improvement in the student-teacher ratio, but meant competition for entry became more severe. At that time, almost all four-year universities, including the less prestigious private ones, had a selection procedure based on this excess demand. Therefore, most lower and high school students did indeed have to study hard for survival in what was called a "diploma disease" society (Dore 1997).

Table 7.1 provides data on the number of higher education institutions and students in 2004.

Table 7.1. *Institutions and Students in Higher Education, Japan (2004)*

	Total	*National*	*Local public*	*Private*
Institutions				
Universities	709	87	80	542
Junior colleges	508	12	45	451
Colleges of technology	63	55	5	3
Specialized training colleges	3,443	15	200	3,228
Students				
Universities	2,809,323	624,394	122,864	2,062,065
Junior colleges	233,749	2,975	16,510	214,264
Colleges of technology	58,681	51,729	4,656	2,296
Specialized training colleges	791,540	1,124	28,663	761,753

Source: MEXT (2004).

Quality in Higher Education

Higher education has been regarded as a screening device. That is, it used to be said that the general ability of Japanese higher education graduates was ensured on entrance because of the severe competition for school places. Further, Japanese universities are viewed hierarchically, so graduation from the most selective institutions was seen as a signal of particularly high general ability. This meant employers, including the government, looked primarily at the schools: little attention was paid to what was learned while at university. As a result, students tended to concentrate only on test preparation: acquisition of more substantive learning and enhancing creativity or communicative skills tended to be ignored. Still, when the number of university places was limited, this sort of screening was probably fairly effective. However, the increase in student number and participation rate changed that.

A survey by the Promotion and Mutual Aid Corporation for Private Schools of Japan in 2004 revealed that 29% of four-year private universities faced difficulty enrolling enough students. This suggests a significant number of schools are very easy to enter.

The completion rate for those enrolled in higher education was 94% in 2000, highest among OECD countries (OECD 2004). Japanese students are almost assured graduation whether or not they get added value while enrolled. The custom of companies recruiting students before graduation, and high family demands for graduation based on expensive tuition fees, pressures institutions, especially private ones, to allow students to graduate even if they are not academically well prepared.

A survey on employability of youth by the Ministry of Health, Labor, and Welfare in 2004 suggests that employers are not satisfied with all aspects of the competencies of graduates of higher and secondary education. Concerning higher education graduates, employers were especially unhappy regarding willingness to take initiative, and the abilities to identify problems, collect information, and achieve goals.

Investment in Higher Education

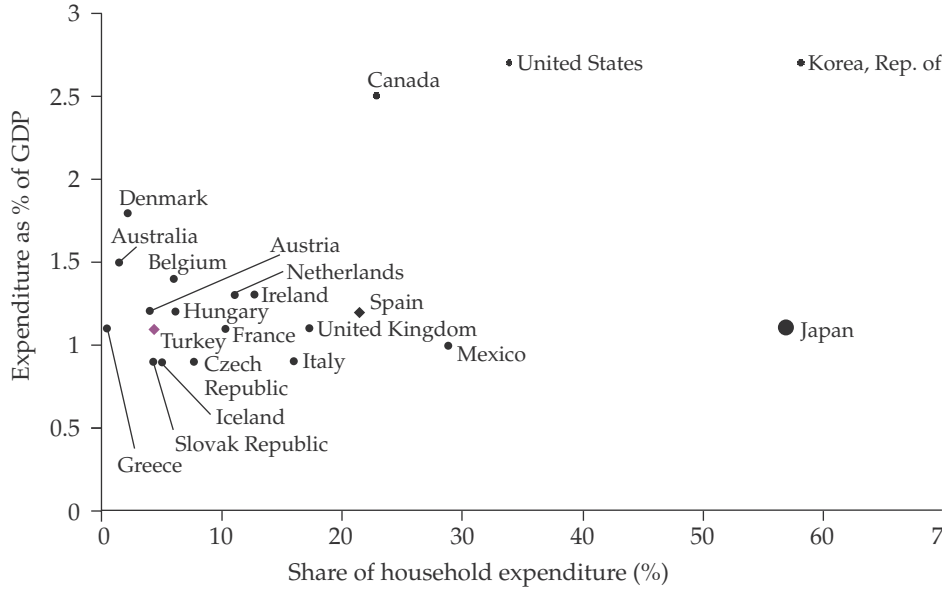
Economic growth and education have a positive correlation in longitudinal data, and the knowledge infrastructure based on early attainment of universal secondary education and mass higher education by the mid-1970s is regarded as a factor in Japan's economic success.

More than 70% of university students study in private institutions, indicating that wealth from the economic development after World War II has enabled households to invest in education. Based on this large private contribution to higher education finance, the government concentrated its investment in the engineering and natural science programs necessary for development of the manufacturing sector. Research in universities has been mainly in the public sector, and a majority of postgraduate students study in national universities.

The main reason for the high private investment appears to be the perception that it is a good investment. Yano (1991) analyzed the returns to different levels of education. The rate was higher for a university education compared to a senior high school education. This is reasonable if the education system is seen as a screening device.

Kaneko (1987) argued that the participation rate in higher education continued to increase even as the return to higher education decreased. This is basically

Figure 7.1. *Expenditure to Tertiary Education Institutions as Percentage of GDP and Share of Household Expenditure in Tertiary Education Expenditure in OECD Countries*



Local currencies were converted to U.S. dollars using purchasing power parity rates.
Source: OECD (2004).

because the job and income prospects of high school graduates are worse than those of graduates with higher education.

For all tertiary education, expenditures in Japan were around the OECD country mean of $10,052 annually per student in 2001. The Japanese figure is $11,164. Total expenditure on tertiary education as a percentage of GDP was 1.1% in Japan (0.5% as public expenditure, 0.6% as private), slightly lower than the OECD country mean of 1.3%. However, the share of household expenditure is tremendously high (57%), second only to the Republic of Korea (58%). The data show that countries with a large share of household expenditure in tertiary education spend more than 2% of GDP on such education. In that sense, Japanese public investment in higher education is extremely low and not enough. (All data are from OECD 2004. Local currencies were converted to U.S. dollars using purchasing power parity rates.) Comparison to other countries is in Figure 7.1.

The Central Council for Education (CCE), an advisory council of the Ministry of Education, Culture, Sports, Science, and Technology (MEXT), argues that public expenditure on higher education (0.5% of GDP) is too low, and should be increased to the level of advanced countries (CCE 2005).

Kondo (2002) finds that the economic condition of households is becoming a factor in whether someone gets a higher education. And there is no sign that the high reliance on household financing of higher education will decline. Quite the contrary: public universities have started to raise tuition fees to compensate for a reduction in financial support from the government. Fundamental changes in policy, such as drastic increases in student loans or grants, or support from industry, are urgently needed. In fact, MEXT reports that the percentage of university students who utilize loans or scholarships increased from 21.2% in 1996 to 31.2% in 2002 (the most recent data available).

Globalization's Challenge to the Education System

Adapting its educational system to globalization is a critical challenge for Japanese society. The rapid upgrading of workforce skills in neighboring countries has created a more severe competitive environment. In many cases, there is no reason for manufacturers to keep investing in Japan.

Beginning in 1988, the government implemented the Japan Exchange and Teaching (JET) Program. In 2004, under this scheme, 6,103 youth from all over the world were brought to Japan to assist in the foreign language education of secondary students. MEXT established an action plan for upgrading English education in 2003. However, the high reliance on Japanese in daily education and research up to the postgraduate level still functions as an obstacle for improving the English language ability of the Japanese population.

In engineering and natural sciences, the effect of globalization has been more direct and drastic, because the language factor is not that crucial. Indeed, most Japanese engineering programs have maintained high reputations. The students in general study hard, are engaged in laboratory work, and do graduate-level research even in undergraduate courses. The Japan Accreditation Board for Engineering Education (JABEE) is working to improve programs through the Washington Accord, a multinational agreement related to accreditation of engineering programs. (See www.washingtonaccord.org for further details.)

Integration into an international academic and industrial community will enhance the quality of education and training not only in engineering, but also in social sciences and business studies. However, some areas, such as law and the civil service, tend to be slow regarding such changes because of their domestic orientation, as shown by the experiences of many developed countries.

Labor Market Changes and Education

The labor market has changed since the 1980s in several ways that affect education and training. These are outlined here. Other changes in the labor market and their effect on employment practices and skill formation are taken up in later sections.

First, the labor market has become more competitive because of the stagnation during the 1990s. Graduates are under strong pressure to demonstrate how they can contribute to the company that hires them. The percentage of graduates from universities and junior colleges who do not get full-time regular jobs has increased. Although less dramatic, this is also true for those receiving graduate degrees. Data are in Table 7.2.

Table 7.2. *The Percentage of Students Receiving Master's Degrees Who Got Full-Time Jobs First Exceeded the Percentage for Those Receiving Undergraduated Degrees in 1999*

	1990			*2004*		
	Continue studying	*Full-time regular job*	*Others*	*Continue studying*	*Full-time regular job*	*Others*
Junior college	3.2	85.1	*11.7*	13.7	61.6	24.7
Undergraduate	6.8	81.0	12.2	14.0	55.8	30.2
Master's	15.3	72.2	12.5	15.0	65.5	*19.5*
Doctoral	0.3	63.5	36.2	2.9	56.3	40.8

Source: MEXT (2004).

Second, the labor market impact of being a bachelor of arts from a "brand name" university may have changed. The increased number of postgraduate degree recipients being hired is one factor. Another is the smaller share of admissions based on the traditional examination system.

Universities, including prestigious schools, introduced multiple methods for student admission in the early 1990s. These included using essays, interviews, and the like. The main purpose of the policy change was to get a more diversified student body. Those with some special talent, study experiences abroad, and adult workers have had the opportunity to get into universities, sometimes without demonstrating academic achievement assessed by test scores.

Third, the behavior of job applicants has been changed by the increased use of the Internet in the recruitment process. Announcement of openings through placement offices and professors has become less important. This means those who do not have such traditional channels can more easily apply to prestigious companies. Some enterprises do not even ask the name of the applicant's university when recruiting.

More firms are relying on standardized tests developed by private companies for assessing the general ability of university graduates. However, it has been pointed out that there is a high correlation between the selectivity of a university at entrance and scores on the private tests at graduation. In that sense, the tendency for Japanese enterprises to attach importance to general trainability is not changing, at least when they recruit new graduates.

Policy Responses in Education

Changing skill requirements because of internationalization and the development of information technology have led to education policy changes. From the mid-1980s, the government tried to change the national curriculum in primary and secondary education to promote more creative, problem-solving learning. At the same time, based on criticism regarding cramming, the Ministry of Education (Monbusho) tried to minimize the knowledge requirements in order to give students a more relaxed learning atmosphere. Class hours for basic skills were reduced in favor of holistic learning hours, and Saturday classes were abolished.

The curriculum in primary and secondary education is now set by Monbusho's successor, MEXT. The ministry has a strong influence on student achievement, as the entrance examinations for senior secondary and higher educational institutions follow its guidelines.

Concern about Academic Achievement

By the late 1990s, experts in education and university professors started to point to a decline in the academic achievement of primary and secondary students. Fujita (2001) argued that MEXT policies in the previous decade had been educational "disarmament" in the face of most industrial countries paying more attention to academic achievement.

Kariya and Shimizu (2004) pointed out a downturn of achievement, especially in students with disadvantageous social backgrounds who cannot afford the private supplementary lessons common for even middle-class children seeking admission to more prestigious schools.

Changing study attitudes are also a factor. The decrease in the youth population because of the low birthrate, and the spread of an individualistic culture (which is common to all postmodern industrial societies) certainly has changed learning incentives. It is no longer difficult to find some opportunity for higher or postsecondary education. Although prestigious universities still maintain high selectivity, a significant number of universities, as well as most junior colleges and special training colleges, admit almost all applicants.

The result in the 2003 Trends in International Mathematics and Science Study (TIMSS) indicates that the mathematics and science achievement of Japanese eighth-grade students is no longer the best in the world, although it remains at a high level. PISA 2003, an international standardized assessment, also indicates Japanese students have significantly high academic achievement in mathematics and science literacy and problem-solving skills, but are only average in reading skills, compared to other OECD countries.

Both surveys indicate that most Japanese students are not enjoying learning mathematics and science, and are less confident in their ability and achievement compared to other countries.

It is simplistic to argue that the high average academic achievement shown by indicators such as TIMSS promise economic success. Moreover, there is no evidence that knowledge based on the standardized national curriculum accumulated in preparing for entrance examinations directly ensures a person will have high productivity. However, the drop of academic achievement at the secondary level may well be a barrier to learning in professional fields.

Ensuring Quality

The government has strengthened its quality ensurance policies. All higher education institutions have been required to submit to government-authorized accreditation procedures from 2004. At the professional school level program-based accreditation is required. The effect will be less at the undergraduate level because accreditation is at the institutional level.

In any case, it is unlikely accreditation itself will have a direct impact on quality because the government does not have the legal power to make nonaccredited institutions close immediately. However, not to be accredited is very disadvantageous in the market. Market competition in enrolling new students and in sending graduates into the labor market has given higher education institutions significant incentives to strive for quality improvement.

Policy changes, such as incorporation of public universities, establishment of for profit, mainly more vocational-oriented universities under the Special Districts for Administrative Reform, and official governmental recognition of offshore programs by foreign universities also will stimulate market competition in higher education. However, the main part of higher education programs remains unrelated to specific job expectations.

Vocational Skills

Business enterprises have played a leading role in the development of the competitiveness of Japan's labor force. This has been closely tied to the use of long-term employment and a seniority-based wage system. Under these practices, enterprises

have recruited new graduates on the assumption they will remain employees until reaching retirement age.

Use of long-term employment dates back to at least the 1920s, when emerging heavy and chemical industries made extensive use of imported technology. Companies adopted the strategy of employing significant numbers of young people immediately after they completed their basic education, and taught them job skills in-house. Large enterprises established their own schools, offering subjects such as English and mathematics. To tie this labor force to the enterprise, the companies used a significant seniority component in wages. An employee who worked to retirement age received a large retirement payment.

Japan's industrial plant was heavily damaged by World War II, but companies made a quick recovery. By the 1950s, many large firms revived the prewar in-house training system, and hired primarily those who had just finished their nine years of compulsory education.

Importance of In-House and On-the-Job Training

As the economy rushed into its high-growth period in the late 1950s, skill development within enterprises also expanded. Rapid technological gains required ceaseless improvement in occupational capacity, and the expansion of production needed an efficient organizational operation. Realizing the necessity of continuously training their employees, enterprises strengthened their in-house education and training system for all workers, from technicians to executives.

Companies developed formal on-the-job training systems and quality control (QC) circles were started. For companies that had begun to participate in international markets, further improvement in the quality of their workforce was indispensable. Workers shared this sense of crisis. QC circles, which had started on the initiative of employees, enhanced the commitment of workers and improved their vocational capacity. Box 7.1 further discusses QC circles.

On-the-job training has been developed into a strategic core of human resource development in Japanese companies as part of their long-term employment practices. Firms treat higher education graduates as basic talents that will determine the future of the enterprises. From this viewpoint, companies rotated graduates through different work areas every several years.

These policies have been widespread at large companies. However, most small and medium enterprises (SMEs) have not been able to afford such large-scale, systematic, in-house training. Nonetheless, even the personnel management system of SMEs has been based on a combination of hiring new graduates and using on-the-job training to improve skills and increase loyalty.

The skill development methods of Japanese firms have given them great flexibility, and hence great adaptability. So, too, have the relatively fuzzy job boundaries that went with the broad training workers received. Thus, when companies needed to restructure after the first oil crisis in 1973, they could comparatively easily move existing workers to different jobs. In this way, most firms succeeded in maintaining employment.

On an ongoing basis, having a labor force with such great adaptive ability has contributed to firms being able to both absorb and generate innovation in production processes. The characteristics of long-term employment from the perspective of national occupational-skill formation are summarized in Box 7.2.

Box 7.1. *QC: Knowledge Created and Shared for Product Improvement*

QC has evolved considerably in Japan since its initial introduction in 1948 as an explicit management strategy. Japanese firms, eager to catch up with U.S. firms, imported a number of business practices from the United States. QC was one of them.

Originally in the United States, QC was in the form of statistical quality control, conducted primarily by staff specifically assigned to sort finished goods as "pass" or "fail." Japanese companies soon realized the need for production-line workers to be directly involved. QC then evolved into a totally new style, creating contrasts in organizational learning between Japan and the United States. Often acclaimed as better, Japanese QC is more of a participatory approach, decentralized and horizontal, while traditional QC in the United States had been a rather unilateral approach that was centrally managed. It was around 1962 that Japanese companies started to adopt Japanese-style QC.

Today in Japan, QC generally refers to an activity by small groups of workers (QC circles) on the production line who work together toward continuous improvement (*kaizen*) and management of their product quality. Each worker has exclusive information about the specific pieces the worker is in charge of.

Typically, the members of each circle meet, often outside regular working hours, to ensure that there is a common understanding of the issues in their product, the factors behind these issues, and the corrective actions to be taken. This information and knowledge sharing is conducted through discussion based on presentations given by the workers. Occasionally, these presentations are made to other groups of workers within the firm, allowing sharing to go beyond individual circles. Managers support and encourage QC activities with incentives. They form a part of the larger QC scheme, called total quality control (TQC).

QC circles usually do not set any agenda addressing prioritized topics; every kind of minor issue is raised at meetings. As a result, defects are detected at an early stage and are dealt with. QC thus provokes small improvements, where approvals by mangers are not needed. Similarly, these small changes only require low cost and little time, and therefore are low risk. This intimate sharing of information is implemented on a daily basis, enabling an effective cultivation of knowledge within the firm.

Further information can be found in Aoki and Dore (1996). Pioneering work in this area was done by Komatsu (1984) and Goshi (1984).

Government Vocational Training

Development of occupational capacity within enterprises has been the norm in Japan's economic development. However, public vocational training has had a role for SMEs. In the 1960s and 1970s, attendance at public vocational schools decreased, while the number of high school students increased. Facing the decreasing need for public vocational training, public policy shifted from direct provision to promotion of in-house training by firms.

Immediately after World War II, the government sought to introduce a western-style apprenticeship system portable among firms. However, the 1958 Vocational Training Act relaxed restrictions on initiatives by employers. Firms had already taken steps to employ and train new school graduates, and had lobbied for a law to match this reality. Government-supported training must meet government-set standards.

In 1985 the Vocational Training Act was revised as the Human Resources Development Promotion Act. This treated on-the-job training that provides knowledge, skills, and good work attitudes through the process of work practices as the main device for development of occupational capacity.

Box 7.2. *Employment Practices and Occupational Capacity Development*

The characteristics of long-term employment from the perspective of national occupational-skill formation are summarized as follows.

Merits
- Incentives for enterprises to invest in employee capacity development.
- Frequent use of on-the-job-training, which is more effective than other types in some areas.
- Widespread training, making workers more flexible in the tasks they can perform.
- Transfer and dissemination of skills and technologies among workers is easier, because worker incentives to hide skills and knowledge are weak.
- Individual workers can have a long-term view. This makes it easier for them to develop their own competency.
- Morale among workers is easier to maintain because selection of executive workers is delayed, allowing long-term competition inside the company. (But this delay has negative aspects, as noted below).

Demerits
- Unemployed workers and short-term workers may be excluded from opportunities.
- Possible obstacle to development of lifelong education utilizing formal educational institutions.
- Timing of the selection of executive workers tends to be delayed, which may harm the formation of good leaders.
- There is a possible moral hazard for workers who do not climb the promotion ladder very high but can stay on in a certain position regardless of performance.
- Skills and technologies tend to be enterprise-specific, which is a barrier to job mobility between enterprises.

Most active workers have utilized training opportunities provided by the work place, or commercial training services such as English conversation schools, outside of the formal schooling system. However, a government role in vocational training and skill development is being revived in connection with lifelong learning, as discussed later.

Labor Market Changes and Skill Formation

Japan's labor market has been affected by trade liberalization and, later, globalization, as well as the rise of knowledge industries. This has had consequences for skill-development methods, which are discussed in this section.

Trade Liberalization and Women Workers

Trade liberalization proceeded gradually in the 1970s, and firms sought to adapt their methods for developing occupational capacity to the new environment. The basic style of recruiting new graduates into long-term employment with continuing on-the-job training was not changed. However, in the 1970s the number of the nonregular workers increased. These were part-time workers and others to whom long-term commitments were not made. They were primarily employed at jobs requiring skills that could be acquired quickly and easily. This contributed to improved productivity because of low wages and flexible work assignments.

Most of those workers were women who had finished bringing up their children. In Japanese society, a strong division of labor by gender has existed. Even today, a significant number of women quit their jobs when they marry in order to concentrate on child care and homemaking. As home appliances spread, housework eased. At the same time, the importance attached to educating children increased educational expenses. This sent many wives back into the labor force. Their homemaking obligations made part-time work preferable, and that was also convenient for firms. Thus, those re-entering the labor force generally took part-time jobs.

The tendency to leave and re-enter was especially strong until the 1980s. Thus, in the 1980s, the labor force participation rate of women aged 20 to 24 was more than 70%, while the rate for those 25 to 29 was less than 50%, and for women 40 to 49 it was 60%. This graphs as an *M* curve—two peaks with a trough between.

The Global and Knowledge Economies

The global economy and the knowledge economy are themselves changing the culture of working places to some degree. This relates both to foreign companies operating in Japan and Japanese firms that have developed into multinational enterprises.

The number of postgraduate students in engineering has increased significantly. On the other hand, professional education in business and social sciences has not increased much, although the government has given priority to such programs. The most important reason for this is the reward system for postgraduate degree holders at traditional Japanese companies.

Kato (2003) argues that foreign firms (including joint ventures) and traditional Japanese companies have different reward systems for MBAs. Although there is substantial variation among them, foreign firms tend to set a higher salary for MBAs from the beginning. In contrast, Japanese firms tend to set an initial salary that is almost the same as the salary of someone the same age who has been working at the firm since graduation from college. The increased mobility of executives may change this, just as firms have started to reward engineers for inventions and patents. In any case, the traditional way of using a university education as a screening device is no longer advantageous for Japanese firms. Data are in Figure 7.2.

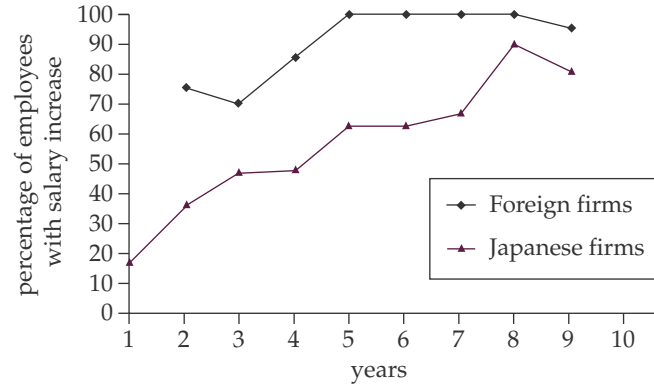
Employment Practices and the Knowledge Economy

Japanese industry has faced the need to adapt to the knowledge economy even as the economy has been stagnating. Together these factors have put pressure on Japanese employment practices. Indeed, there is spirited debate about whether the traditional system can be sustained.

Long-term employment was inevitably accompanied by a large seniority component in wages and promotion. When the percentage of young workers with low salaries was large, this was financially efficient. However, the aging of the work force and slowing of growth have made it impossible to maintain the old pattern.

Nikkeiren (Japan Federation of Employers' Association) indicated the direction of "Japanese Management in a New Age" at the beginning of the 1990s. It argued that firms should limit the number of long-term employees, and should employ fixed-term workers in both special high-skill and no- or low-skill job categories. Reality has rapidly advanced in this direction. Entrance on a long-term employ-

Figure 7.2. *Salary Increase of Master Course Graduates (%)*



Source: Kato (2003).

ment track by new graduates has been reduced, and the number of nonregular workers with a fixed-term or part-time contract has increased.

Table 7.3 indicates that the largest share of both high school graduates and university graduates still have full-time status. However, other employment statuses and job seekers have increased dramatically, and this is especially true for those with lower educational status and female workers. This may reduce the management risk and labor costs of firms, as it is not easy to dismiss full-time regular employees.

Changing Labor Market Opportunities

The chance of long-term, full-time employment has been especially drastically reduced for those with just a secondary education. To cope with the knowledge economy, firms have gradually limited the application of the long-term employment system to those with greater professional knowledge.

In Japan, the gap in benefits, wages, and opportunity for advancement between those with regular employment and those with nonregular employment has been significantly large, especially compared with other advanced nations. This reflects, in part, the division of labor by gender. When most nonregular workers were women, and women were considered peripheral to the regular paid labor force, the two groups were quite literally in different worlds.

Now, however, young workers are flowing into this peripheral labor market seeking part-time and fixed-term jobs once going primarily to women re-entering the labor force. Therefore, the differences between being a regular and a nonregular worker have become a major issue.

New Mechanisms for Skill and Human Resource Formation

The Japanese approach to skill and human resource formation is at a crossroads. Facing a different economic environment, firms no longer sustain the company-led occupational capacity development system. At the same time, the Japanese education system has embarked on a program of offering lifelong learning for occupational skills and human resource formation.

Table 7.3. *Employment Status of Young Workers (20–24-Year-Olds) in Japan*

		Total	*Number*	*Self/family-employed*	*Executive*	*Regular*	*Other employee*	*Unemployed, seeking jobs*	*Unemployed, not seeking jobs*
University graduates									
Male	1992	100.0	478,360	1.1	0.8	91.8	3.6	2.1	0.6
	1997	100.0	553,797	1.5	0.4	82.3	7.3	6.8	1.7
	2002	100.0	607,900	0.9	0.3	73.1	13.0	10.9	1.7
Female	1992	100.0	257,187	1.1	0.3	82.9	9.3	4.1	2.3
	1997	100.0	349,662	1.5	0.3	72.3	17.0	6.7	2.1
	2002	100.0	420,900	0.4	0.1	64.1	25.1	8.6	1.8
Secondary school graduates									
Male	1992	100.0	2,043,188	4.0	0.7	80.4	7.7	4.6	2.6
	1997	100.0	1,919,186	4.3	0.5	74.4	10.9	7.3	2.5
	2002	100.0	1,389,800	3.2	0.4	59.6	21.8	11.8	3.1
Female	1992	100.0	2,028,932	2.2	0.3	66.6	11.2	13.1	6.6
	1997	100.0	1,693,523	2.0	0.2	56.0	19.1	16.1	6.6
	2002	100.0	1,181,900	1.8	0.1	38.2	33.4	18.8	7.7

Source: Employment Structure Basic Survey.

The next sections look at corporate response to skill-formation needs and policies related to developing occupational capacity development outside of firms. Lifelong learning is then taken up.

It should be noted that a role for "capacity development initiated by individual workers" is clearly stated in the 1997 revision of the labor law. An education and training benefit system in which benefits are paid directly to individuals started in 1998. Specifically, individual workers are subsidized by the government for educational and training programs offered by private providers. In 2002, 380,000 workers used the system for 14,000 officially recognized courses. The program is part of the employment insurance system, so it is not available to young workers with no work experience and others similarly outside the system. Compared to male workers, female executives with higher education are more active users of the individual-led investment in the formation of skills and vocational competencies.

Corporate Response to Skill-Formation Needs

Until the beginning of the 1990s, Japanese-style corporate management was recognized as very efficient. Japanese companies combined long-term, full-time employment with occupational capacity development within the firm. However, companies also relied heavily on the existence of part-time and fixed-term peripheral workers.

Past heavy reliance on company-led in-house training has come to be seen as hindering growth of mechanisms for professional capacity formation outside the workplace. This has become a weakness of Japanese occupational capacity development in the knowledge economy.

As a result, firms are changing the system they use to develop occupational competency within the company. As Figure 7.3 indicates, the share of total personnel costs going to education and training decreased rapidly during the 1990s. However, the decline was from very high levels during the bubble period; since the mid-1990s the level is about the same as in the 1970s.

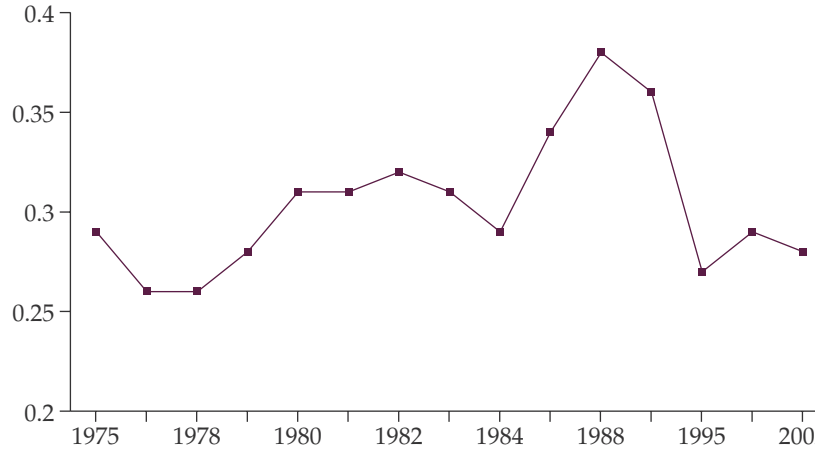
An education and training system covering a wide range of job tiers can be called "bottom-raising." Such a system has been a feature of Japanese-style management. However, since the 1970s firms have also been developing a "selection-type" system that concentrates training investment on selected workers. According to the Ministry of Health, Labor and Welfare (2004), 40% of Japanese enterprises prefer "selection-type" training. Although a large number of firms favor bottom-raising for future training, those with a high ratio of higher education graduates tend to prefer the selection type. This means that the knowledge economy is changing the training policies of knowledge-based companies toward concentrated investment in a limited number of core workers.

Policies to Develop Resources Outside Firms

Under the current shift in Japanese employment practice, company-led programs of occupational capacity development are clearly facing a limit to their development. It is necessary to develop a new, well-balanced mechanism at the national level.

Opportunities outside of firms should be constructed. Higher education institutions should take a central role in the context of the knowledge economy. The challenge is how to relate school content to professional knowledge and skills. Both the

Figure 7.3. *Share of Education and Training Cost in Total Personnel Cost*



Source: Ohki (2003).

quality and value of the educational curriculum need to be examined from the viewpoint of the industrial world.

Labor markets for job skills (rather than across enterprises) have developed for only a few professions, and only for a small portion of workers with those job skills. (See, for example Cole and Tominaga 1976.) Professions based on expertise are expanding in the knowledge economy, and Japan should establish standards in these areas. More generally, vocational competencies defined and measured in ways that are meaningful to any potential employer are needed. This has been difficult up to now because of the strong company-led training system.

From 2004, professional graduate schools such as law and business have been operating under the higher education policy. Trials of curriculum development and accreditation for their programs may increase social recognition of professional degrees and qualifications. Traditionally, employment prestige has been based primarily on what firm a person works for; there is now some shift toward prestige coming from one's profession.

Training of nonregular workers and the young unemployed should be drastically expanded, given the urgent economic and social crises represented by freeters and NEETs. It is necessary to develop a vocational training system for general clerical work, sales, and the like, together with a mechanism for public verification and qualification of competency.

Establishment of a Lifelong Learning System

In Japanese society, lifelong learning has been regarded as an opportunity for self-fulfillment or as a cultural activity mainly for housewives and retired people, rather than a means for acquiring occupational skills or qualifications. Now, vocational aspects of lifelong learning are receiving emphasis.

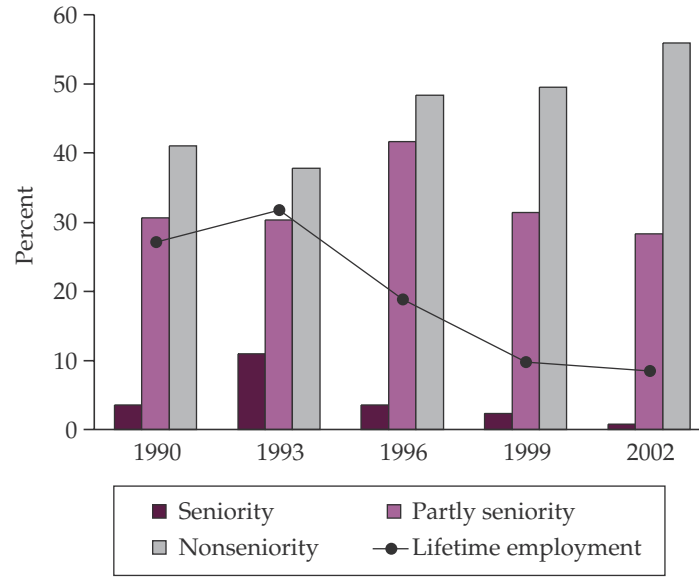
The Ministry of Health, Labor and Welfare has long operated vocational training facilities offering one or two years of full-time training, but the number of users has been very small. Through the 1950s, they were much more widely used, but their role shrank as most students went on in regular secondary and higher educa-

Table 7.4. *Early Job Leave of University Graduates (within three years)*

Graduation	*1991*	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*
Total	25.0	23.7	24.3	27.9	32.0	33.6	32.5	32.0	34.3	36.5
Male	19.9	18.7	19.2	22.4	26.4	27.8	26.8			
Female	38.8	36.5	37.2	42.0	45.7	45.7	44.4	n.a.	n.a.	n.a.

Source: Ministry of Health, Labor, and Welfare (2004).

Figure 7.4. *Human Resource Management Policies of Japanese Enterprises*



Source: Ministry of Health, Labor, and Welfare (2004).

tion. However, because of limited study opportunities and the highly developed use of the formal education system as a screening device, adult learners seeking vocational skills are again looking to the public schooling system.

Social and individual demands for vocational-oriented lifelong learning is certainly expanding. There are several reasons for this.

First, the share of nonregular workers, especially those with lower educational status and women, continues to increase. Companies do not have incentives to provide them with training opportunities.

Second, significant numbers of university graduates leave their first job quite early (Table 7.4).

Third, most are voluntarily leaving, even though few long-run opportunities for upgrading their working condition result from leaving. The ratio of voluntary to nonvoluntary unemployment is around 2 to 1 for those age 20 to 29.

Fourth, attitudes toward lifetime employment and the seniority system are changing. The share of companies that put importance on them is clearly decreasing, as indicated in Figure 7.4.

Needed Changes

It can be argued that Japanese society is at increasing risk of losing the gains and rewards of its past efforts for workers on the traditional career path. The hard work needed for career development in schooling and at work may not be rewarded if employees are kicked off the path. Also, raising children is difficult, given the high family expenditure needed for education. This is expected to remain the case because of the difficulty of getting stable jobs, especially for women. (A forceful presentation of this view, which we share, is Yamada 2004.)

The implication is that changes are needed in Japan's labor market, and in education and training systems. This section summarizes some of the changes needed that have not been covered earlier. These include making re-entry easier, especially for women after child rearing, but also for the NEETs and freeters; ensuring fair access to education and training; creating educational programs and accrediting systems that ensure graduates have requisite skills; and increased emphasis on foreign language skills.

Re-entry into the labor market should be easier, especially for women after child rearing, but also for NEETs and freeters. The labor market system should be changed to allow 1) re-entry by dropouts and 2) more flexibility in changing jobs without being disadvantaged. These changes would generate more vibrant knowledge sharing among industries. Giving those now left out of the system—including freeters, part-timers, and the unemployed—the opportunity to re-engage in, and contribute to, society has obvious advantages. Greater utilization of women workers will not only vitalize the labor market, but also ensure the household income stability that makes it easier to raise children.

Fair access to higher and lifelong education and training opportunities should be ensured through more effective utilization of public and private education service providers. This means greater governmental efforts for quality ensurance and more targeted subsidies and student loan programs. Given the high tuition fees, even at public higher education institutions, and the high reliance on private higher education, student loans are an effective tool for ensuring accessibility. In addition, provision of loan opportunities for adult learners should be widened as part of enhancing vocation-oriented lifelong learning. Education and training programs are a key part of providing a social safety net.

Higher education should offer more specialized majors that are linked to the labor markets of their subjects. There is a surplus of places in higher education institutions. To address this and improve quality, the accreditation system introduced in 2004 and quality ensurance—especially as regards the competencies of graduates—should be linked. The provision of potential students with information on the quality of the various learning institutions vying for their enrollment is important. More generally, national and institutional evaluation activities should produce proper information for all stakeholders in education services, including students and enterprises. Redundant higher education programs should be closed or redirected into effective lifelong learning programs.

Education and training opportunities should be utilized more actively to make Japanese more competitive in the global economy. As early as primary school, education needs to be more internationalized both in depth and breadth. The foreign languages proficiency of students and workers—especially in English—lags other OECD countries (except the English-speaking countries) and most countries in the

Asia-Pacific region. Language education should be intensified for all levels of students. Literacy in English enormously increases the scope of knowledge sharing. Considering the significant increase of economic and social exchange among East Asian countries, Asian languages (especially Chinese and Korean) also should be promoted. Student and teacher exchange programs with both OECD countries and within the region, as well as with African and Latin American countries, are highly effective for developing social capital to work in the global working community.

Conclusion

Japan is facing inconsistent demands from micro and macro perspectives. On the one hand, there is a strong micro demand for a stable and protected life. Thus, one survey indicates 78% of workers support Japanese-style long-term employment and 67% support seniority-based salaries. At the same time, a more individualistic culture among the young has been accompanied by low personal incentives to study in schools. Still, most young people think training and capacity development should be done by workers on their own rather than on the job.

Education supply is sufficient, but it is not clearly linked to paths leading to specific occupations. Education experiences no longer ensure lifetime employment. A freelance life, rather than full-time work, is preferred by many of the young, but this may be just because they have no hope in the long run (Yamada 2004). This has moved education higher on the policy agenda.

On the other hand, global realities makes the desired stability difficult. The government's macro policies clearly demand strong education and training systems. Fostering world leaders and qualified professionals, as well as basic English-language competency, has always been on the national policy agenda. With global competition, a high-standard knowledge infrastructure is even more indispensable. To this end, the government has started to reinforce such knowledge and skill formation through revitalizing primary and secondary education.

Our observations suggest that existing labor and industrial customs are not likely to change drastically. This means that for the time being, Japanese society will experience the coexistence of its traditional systems and a globalized system.

Some of the points made in this chapter have implications for other countries, especially developing ones. These are summarized in Box 7.3.

The cabinet-led Council on Economic and Fiscal Policy published *Japan's 21st Century Vision* in April 2005. The report notes the fear that Japan will be left behind by further globalization, and that people are less optimistic about their lives and society. The report raises five specific actions that should be taken. These are as follows.

1. Create an education system that enhances comprehensive human capacity (*ningen ryoku*). (The term refers to the well-rounded skills and knowledge of a person as a constituent of society, as well as the strength of the person to retain well-being as an individual.)
2. Establish intellectual foundations and disseminate innovations.
3. Ensure the smooth flows of goods, people, and capital.
4. Take a leadership role in resolving issues on a global scale.
5. Train human resources with superior specialized knowledge, linguistic ability, and negotiating skills.

Box 7.3. *General Implications for Developing Countries*

- Human resources are a key factor in development. Japan worked to spread literacy and general education from the earliest stages of its modern economic development.
- Japan utilized many resources for human resource development. These included not just public education, but also training within the industrial sector and voluntary initiatives by workers.
- Globalization has a significant effect on the nature of human resource development systems. As foreign trade and the integration of economies increase, the skills needed to manage a business and market products become broader and more complex.
- The different social and economic contexts of each country mean there is room for innovative approaches tailored to diverse needs.

It is too soon to tell just what will be done in the way of actual policies to implement this vision. The Japanese human resource training system is at a crossroads. The government well recognizes this, and now must take steps to meet the challenge.

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8

National Innovation System: Reforms to Promote Science-Based Industries

Hiroyuki Odagiri

A national innovation system is the business, industrial, and policy conditions that support and regulate the activities of those involved in innovation. Any such system must be dynamic, reforming and adapting itself as the domestic and world economies evolve, and as scientific and technological progress changes the environment in which firms and countries operate

This chapter discusses such reform and adaptation in Japan's national innovation system. It begins with a historical and quantitative overview of Japan's innovation system, including the role of government research institutes (GRIs) and universities. It then examines how the environment surrounding Japan's national innovation system has changed, especially in the last decade. This includes some of the consequences of Japan's catching up with the advanced countries, and the emergence of so-called science-based industries as the expected drivers of growth in the 21st century. Government policies to promote science-based industries are then taken up. The main emphasis is on university-industry collaborations, intellectual property policy, and the promotion of start-ups. All these relate to the issue of the research and development (R&D) boundary of the firm. The chapter also speculates on whether the conditions for an environment friendly to science-based industry can coexist with the traditional Japanese employment and corporate systems.

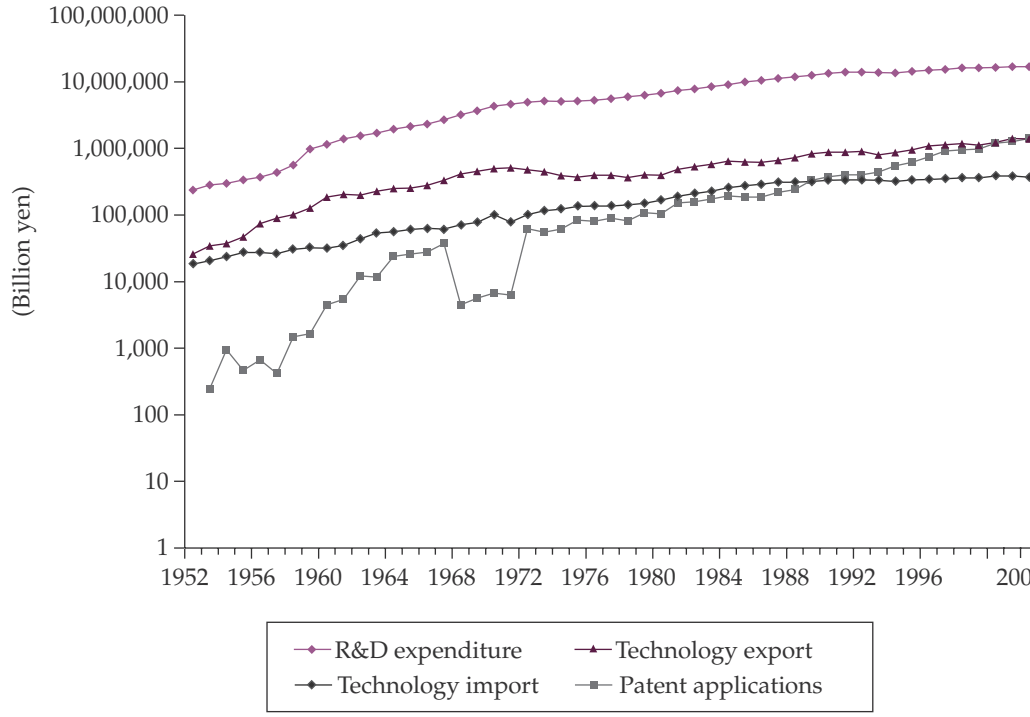
Early Industrialization

Modern industrialization in Japan began in earnest following the Meiji Restoration of 1867. The new government raised "rich nation, strong army" as its slogan, and started efforts to catch up with the United States and Europe economically and technologically. It hired a number of knowledgeable people from these countries (at surprisingly high salaries in many cases), imported equipment, built infrastructure (such as a transportation and communications network), and introduced social and legal frameworks (such as company law and patent law).

Particularly noted is the investment they made to establish an education system, both at the compulsory elementary level and at higher levels. As a result, by the beginning of the 20th century, illiteracy was virtually absent.

An engineering school named Kogakuryo, which later became the Engineering Department of the University of Tokyo, was established in 1873, only six years after the Restoration, and started to supply educated engineers. Among the graduates of Kogakuryo were the founders of the present Toshiba and NEC and among the graduates of the University of Tokyo were the founders of the present Hitachi,

Figure 8.1. *Trend of Innovation Activity in Japan, 1952–2002*



Note: R&D expenditure, technology export, and technology import are in million yen, 1995 price (deflated with GDP deflator for 1952–80 and R&D deflator for 1981–2002. Patent applications are the number of applications by Japanese to the Japan Patent Office (JPO). JPO started to accept multiclaim applications in 1988. Therefore the number of applications after 1988 is not strictly comparable to earlier years.

Source: Soumusho (R&D expenditure), Bank of Japan (technology export and import), JPO (patent applications).

Toyota Motor, and Nissan Motor. See Odagiri and Goto (1996) for the history of these firms. Although early studies of Japanese development often stressed the role of government policies, we argued in this book that the entrepreneurship of such people was the real driving force of Japan's industrialization.

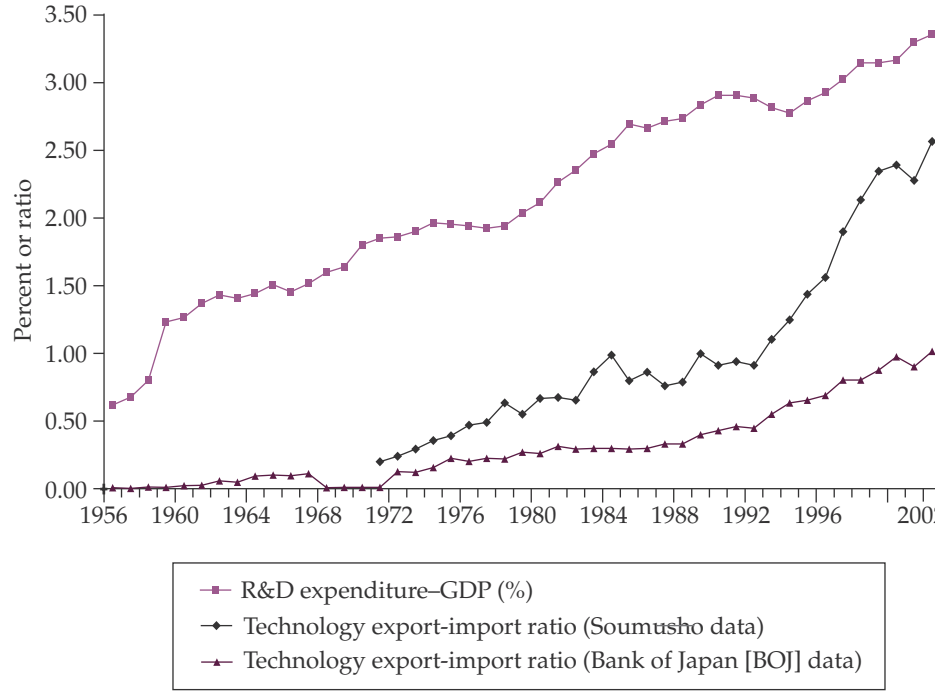
Postwar Trends

When World War II ended, Japan lagged behind the United States and Europe, partly because of wartime isolation from scientific knowledge developed in these countries (such as petrochemicals and penicillin) and partly because of Japan's heavy bias from the mid-1930s toward war-related industries, such as aircraft and shipbuilding. Still, the country had inherited industrial and technological bases, both tangible and intangible. In particular, there were a large number of skilled and experienced workers. With these, the country resumed its efforts to catch up with the West.

These efforts can be traced by the trend of four innovation-related indicators for 1952–2002 in Figure 8.1.

Japan actively imported technologies, particularly during the 1950s and 1960s. On a real-yen basis (1995 prices), technology imports (that is, payment for technologies licensed from abroad) increased from ¥26 billion in 1952 to ¥512 billion in 1971,

Figure 8.2. *Trends in R&D/GDP (%) and Technology Export-Import Ratio*



Note: The difference between the BOJ and Soumusho series is briefly explained in the text. For more detail, see Yoshimi (1993).

an annual growth rate of 17.0%. During most of this period, the government regulated technology imports, which meant firms had to apply for the foreign exchange to pay royalties. Without this regulation, technology imports might have been even greater.

Technology importation is not a simple process. Imported technology may be immature or unsuitable to local natural and social conditions. Quite often, fierce domestic competition propelled Japanese firms to import new technologies at a commercially untested stage. Thus, they had to spend heavily on R&D to develop the technologies further in order to make them amenable to manufacturing processes and to make them commercially viable.

Partly as a result of this, domestic R&D expenditures also increased with an annual rate of 16.9% during 1952–71. Domestic R&D's share of GDP increased from 0.62% in 1956 to 1.85% in 1971. Figure 8.2 tracks the data.

Gradually, the weight of R&D shifted from improvement of imported technologies to own inventions. This resulted in an increase in patenting activity. From 1971 to 1987 the number of patent applications by Japanese to the JPO increased at an annual rate of 9%, as shown in Figure 8.1.

Technology exports also started rising, not only because of increasing inventions by Japanese firms but also because of increased licensing to Japanese subsidiaries abroad, which began rising during the 1980s. Thus, as shown in Figure 8.2, the ratio of technology exports to technology imports improved.

According to BOJ statistics, technology exports caught up with the imports only in 2002. However, Ministry of Internal Affairs and Telecommunications data show technology exports have been exceeding imports since 1993. Unlike BOJ, Ministry

of Internal Affairs and Telecommunications data include receipts attributable to provision of know-how in plant exports and exclude transactions related to trademarks. With Japan as a net exporter of plants and a net importer of trademarks, the export-import ratio has been always higher with Ministry of Internal Affairs and Telecommunications data than BOJ data.

The ratio (Ministry of Internal Affairs and Telecommunications data) is particularly high in the automobile industry, reaching 75.0 in 2002, followed by chemicals (5.9), iron and steel (4.8), and pharmaceuticals (3.4). It also exceeded unity (at 1.05) in the electric, electronic, and communications equipment industry, suggesting Japan is now at the forefront of global high-tech competition. The high ratio in automobiles is due to the active globalization of Japanese carmakers. 86.7% of technology export in automobiles is between parents and subsidiaries, whereas the share is 49.2% for manufacturing excluding automobiles. For technology importation, the share between parents and subsidiaries is 13.4% for all manufacturing. This suggests the majority of imports are arm's length transactions between independent firms. However, it is 71.8% in chemicals (which includes pharmaceuticals), probably because many foreign multinationals have subsidiaries in Japan.

An international comparison of innovation activities is shown in Table 8.1. In terms of R&D to GNP ratio, Japan is ahead of other large countries, although the absolute amount of expenditure is less than half that in the United States. In terms of scientists per population, Japan is highest but, if converted to a full-time equivalent basis, Japan and the United States may be at a comparable level (see note to Table 8.1).

Differences in patent laws make an international comparison of patenting activity difficult, but Table 8.1 shows the share of U.S. patents registered by nationals of various countries. Japan's share is 20%, easily exceeding Germany, France, and the United Kingdom combined.

The share of R&D expenditure made by private industries was around 70% in both 1991 and 2001 in every major advanced country except France. A marked difference between the two years is that, while Japan saw a slight decrease in the private sector portion, it increased in other countries. In 1991 and earlier, Japan was the only country in which industry funded more than it expended, implying that Japanese firms received hardly any R&D funds from the government, whereas U.S. and European industries received sizable amounts from the government. Since then, the share of government funds has decreased in the United States and Europe. By contrast, Japan increased government R&D funds. This increased government involvement is taken up later.

The Role of Market Competition during the High-Growth Era

During the high-growth era of 1950s and 1960s, incomes were rising and markets were expanding. Opportunities for firms to achieve fast growth and high returns were there but market competition was fierce. This was the main engine behind active technology importation and R&D during the period. Box 8.1 summarizes the ways firms responded to the opportunities.

If firms failed to innovate, they went down. If, on the other hand, they succeeded in inventing new technologies or in introducing and commercializing imported technologies, the returns were often very high. Such returns were reinforced by the protection policy of the government. Because both import and inward

Table 8.1. *International Comparison of Innovation Activities: 1991 (Upper Row) and 2001 (Lower Row)*

	Japan	*United States*	*European Union*	*Germany*	*France*	*United Kingdom*	*China*	*Korea, Rep. of*
R&D expenditure (billion yen)*	13,772	31,066	22,159	6,856	4,834	3,597	2,525	1,335
	16,528	42,201	27,907	8,212	5,258	4,399	8,961	3,324
R&D expenditure–GDP (%)	2.92	2.68	1.90	2.53	2.37	2.02	0.74	1.92
	3.29	2.79	1.93	2.53	2.18	1.89	1.09	2.92
Proportion of R&D expenditure funded	72.7	57.4		61.9	42.5	49.6		
by industries (%)**	68.9	68.5		66.5	52.5[a]	46.2		72.4[a]
Proportion of R&D expenditure funded	18.2	38.7		35.7	48.8	35.0		
by government (%)**	21.0	26.7		31.0	38.7[a]	30.2		23.9[a]
Proportion of R&D expenditure by industries (%)	70.7	72.7		69.5	61.5	67.1		
	69.3	74.5		71.0	62.4	67.4		74.0[a]
Proportion of basic R&D expenditure	13.3	16.9		20.9	20.3			
in total R&D expenditure (%)	14.6	20.9			23.6[a]			12.6[a]
Number of scientists***	582,815	981,659	746,543	241,869	129,780	128,000	471,400	
	728,215	1,261,227[b]	971,497[a]	259,597	172,070[a]	157,662[c]	742,700	136,337
Number of scientists per 10,000 population	47.0	38.7	20.3	30.2	22.2	22.1	4.1	
	57.2	45.2[b]	25.7[a]	31.5	28.4[a]	26.6[c]	5.8	28.8
Share of U.S. patents (%)	21.8	53.0		7.9	3.1	2.9	0.4	0.1
	20.0	52.6		6.8	2.4	2.4	2.1	0.1
Technology export/technology import****	0.94	4.42		0.79	0.71	1.01		
	2.27	2.36		0.67	1.19	2.22		

* Current value, converted with OECD PPP (purchasing power parity). The figure for China, 1991, is believed to be underestimated. The figures include expenditures for humanities and social sciences except for the Republic of Korea.

** R&D expenditures are also funded by universities, nonprofit institutions, and foreigners; hence, these two do not add up to 100%.

*** Headcounts (HC) for Japan. FTE (full-time equivalent) value is estimated to be about 77% of HC in 2002.

**** Soumusho data for Japan.

a. 2000.

b. 1999.

c. 1998.

Box 8.1. *Responses to Market Opportunities*

In the 1950s and 60s many new firms entered the new and expanding markets with innovative products and processes. This includes not only such now world-famous cases as Honda Motor Company and Sony Corp but also less known firms such as Tsuzuki Spinning Company, a privately-held textile company. In addition, many established firms entered into new markets. For example, Suzuki Motor Corp, established in 1909, was originally a producer of looms; it shifted to motor vehicles in the mid-1940s and became a leading producer of motorcycles and minicars in the 1950s. Still other firms diversified. Thus, Toray Industries, which began as a rayon maker in 1926, expanded product lines to become Japan's largest manufacturer of synthetic textiles, and diversified into chemicals.

There are also many cases in which smaller, fringe firms challenged market leaders with innovative products and innovative plant layouts and new processes. For these and other cases, see Odagiri and Goto (1996).

foreign direct investment (FDI) were restricted until the gradual liberalization of the 1960s and 1970s, domestic firms could serve the market with little fear of competition from foreign multinationals.

Foreign firms could exploit technological superiority neither by exporting products to Japan nor by investing in Japan to manufacture locally. Hence, they opted to license technologies to Japanese firms. When capital liberalization was completed in 1973, many foreign firms became more stringent in licensing. Sometimes, they refused licensing and favored direct investment. Sometimes, they demanded technologies from Japanese firms in cross-license arrangements.

It is important to note that, even during the protectionist period, Japanese firms knew capital and trade liberalization would soon occur. This was seen as a threat to their survival. Fear was particularly acute in such industries as automobiles and electrical equipment because, from prewar experience, Japanese firms knew that foreign multinationals, such as General Motors (GM) and General Electric (GE), were far ahead of them technologically and financially. In fact, GM and Ford together had a 70% to 80% share in Japan around 1930. Similarly, in electrical equipment, all the major manufacturers (except Hitachi) relied on U.S. or European firms for technologies and management methods and had foreign capital participation. Therefore, they were keenly aware of their technological lag. Besides, the multinationals had overwhelming financial power: GM, for instance, had sales 26 times greater than Toyota in 1965. Such threats encouraged Japanese firms to invest heavily to catch up.

The Role of Government Policies

Several government policies, such as tax concessions, subsidies, and low-interest loans, also helped the firms. (For more on these policies up to the mid-1980s, see Goto and Wakasugi 1988.) Tax credits for R&D expenditures started in 1966. With this scheme, a firm could deduct from its income tax a percentage of any increase in R&D expenditure above the previous highest expenditure level. During the 1980s, the deduction was 20% of the increase (from the past maximum), up to 10% of the corporate tax. The total tax credit from this and other R&D-promoting tax policies was estimated to be ¥38 billion in 1980. This is just 1.2% percent of industry R&D expenditures in that year.

Although the amount was small in aggregate, the scheme did help firms if they were increasing R&D expenditure each year. However, during the deflationary 1990s, there was little increase in nominal R&D expenditure. In fact, expenditure decreased in 1993 and 1994. As a consequence, many firms could not take advantage of the scheme. Therefore, the government started a new scheme in 2003. A firm can deduct 10% to 12% of its entire R&D expenditure from its corporate tax, subject to a 20% limit.

The government has also offered subsidy programs. The amounts have been relatively small. As shown in Table 8.1, Japanese industries have funded most of their R&D expenditures themselves. The share funded by government was ¥162 billion in 2001, a mere 1.4% of total R&D expenditure by the industries. This is much smaller than the 9.3% for the United States. The government's percentage has been basically stable in Japan, whereas it substantially decreased in the United States during the 1990s. In 1989 for instance, the share in Japan was 1.2%, compared to the United States' 34.3%. (Data are from various annual *White Paper on Science and Technology.*)

Government funds were allocated through several programs by several ministries, including the Ministry of International Trade and Industry (MITI), Ministry of Agriculture, Forestry, and Fisheries (MAFF), Ministry of Health and Welfare (MHW), Ministry of Post and Telecommunications (MPT), and the Science and Technology Agency (STA). (These were reorganized and renamed in 2001.)

MITI was mostly responsible for policies related to manufacturing. It financially supported a number of R&D projects through such programs as the Large Scale Industrial Technology R&D Program and Basic Technologies for Future Industries Program. Usually, research associations (RAs) or, more commonly in later years, independent corporations, were set up by participating firms. Research was carried out at laboratories staffed primarily by people seconded from member firms. In a few well-known cases in the 1970s and 1980s, such as the VLSI (very large-scale integrated circuits) and FGCS (fifth-generation computer systems) projects, central laboratories were established and researchers from all member firms worked together. In most other cases, the researchers worked within their own firms' laboratories to perform the RA projects; hence, it was sometimes dubious if real collaborations took place among the firms. For more on RAs, see Goto (1997). For a case study of FGCS, see Odagiri et al. (1997).

The Role of Universities and GRIs

Universities and GRIs also perform R&D. In 2001 (the last year before GRIs' major reorganization, to be explained presently), 47% of the government's R&D budget went to universities and 42% to GRIs. GRIs were founded by national or local governments. Agriculture has had the largest share of GRI researchers: 37% of 31,000 in 2001.

Many GRIs were reorganized in 2001 as semi-independent corporations. For instance, the Agency for Industry Science and Technology was reorganized into the National Institute of Advanced Industrial Science and Technology (AIST). The new AIST still gets the majority of its research funds from the government but increasingly on a competitive basis. It also accepts an increasing proportion of its funds from industries.

Universities are, of course, major centers of basic research. In 2001, universities accounted for 20% of national R&D expenditure, of which 62% was in physics, engineering, agriculture, and health. In the university R&D of these four fields, 54% of the funds were for basic research, compared to 15% for Japan's total R&D in all fields.

Table 8.2. *Number of University Students*

	Undergraduate		*Master's*		*Doctorate*	
Panel A: Total number of students finishing the course		*Index*		*Index*		*Index*
1965	162,349	100	4,790	100	2,061	100
1970	240,921	148	9,415	197	3,152	153
1975	313,072	193	13,505	282	2,882	140
1980	378,666	233	15,258	319	3,614	175
1985	373,302	230	19,315	403	4,358	211
1990	400,103	246	25,804	539	5,812	282
1995	493,277	304	41,681	870	8,019	389
2000	538,683	332	56,038	1,170	12,375	600
2003	544,894	336	67,412	1,407	14,512	704
Panel B: By type of universities (2003)		%		%		%
National (14.%)*	102,639	18.8	39,211	58.2	10,284	70.9
Municipal (10.8%)*	21,309	3.9	3,280	4.9	782	5.4
Private (74.9%)*	420,946	77.3	24,921	37.0	3,446	23.7
Panel C: By fields (2003)		%		%		%
Humanities	93,744	17.2	4,836	7.2	1,383	9.5
Social science	215,205	39.5	9,830	14.6	1,162	8.0
Science	19,549	3.6	5,722	8.5	1,500	10.3
Engineering	101,401	18.6	28,498	42.3	3,212	22.1
Agriculture	15,933	2.9	3,471	5.1	1,093	7.5
Health	30,479	5.6	3,733	5.5	4,561	31.4
Mercantile marine	198	0.0	12	0.0	_	0.0
Home economics	10,822	2.0	444	0.7	50	0.3
Education (incl. teacher training)	31,767	5.8	5,036	7.5	362	2.5
Arts	15,222	2.8	1,431	2.1	96	0.7
Others	10,574	1.9	4,399	6.5	1,093	7.5

Note: All the figures exclude those of junior colleges (*tanki daigaku*).

*Percentages in terms of the number of universities.

Source: Ministry of Education, Culture, Sports, Science, and Technology (MEXT).

As to the supply of scientists and engineers, Table 8.2 (Panel A) shows the number of bachelor's degree graduates increased more than three times between 1965 and 2003. The increase is even more impressive for those in master's and doctoral programs. Panel C of the same table shows that, although the majority of undergraduates are in humanities and social sciences, among graduate students, science, engineering, and health dominate.

An important characteristic of the Japanese university system is the coexistence of public and private universities. Public universities are either national or municipal (local). Private universities outnumber public ones in terms of the number of establishments and undergraduate students. However, graduate education is primarily at national universities. In terms of the quality of faculty and difficulty of being admitted, national universities top the lists, and they are generally considered the most prestigious.

The fact that major research-oriented universities were national (until the 2004 reform to be explained later) had important consequences for Japan's national innovation system for at least two reasons.

First, reorganization of a national university, such as starting a new department, required approval not only from the Ministry of Education, Culture and Sports (something required for private universities as well) but also financial backing from the Ministry of Finance. This meant reorganization in response to emerging scientific fields tended to lag.

Second, all the faculty members of national universities were government employees, and thus subject to the civil servant code. This made collaboration with the private sector difficult. For instance, it was prohibited for a faculty member to assume a directorship of a company or to teach on a part-time basis while working at a company. As the need for university-industry collaboration came to be recognized in the 1990s, these regulations were gradually lifted and, with the shift of formerly national universities to a semi-independent status in 2004, the changes are expected to accelerate. This topic is developed further later.

Japan's Completion of Catch-Up and the Response of the United States

By the 1980s, Japan has more or less caught up with the United States and Europe. That Japan's R&D-GDP ratio outweighed that of the United States for the first time in 1987 and has been higher since then was a clear indication of this catch-up. This had a number of consequences.

For one, U.S. and European firms became more and more reluctant to license technologies to Japanese firms who, they had observed, grew to be their formidable competitors in world markets. Often they started to require technologies to cross-license rather than just monetary payments in return for the technologies. In consequence, Japanese firms became more conscious of the need for original inventions.

For another, the U.S. government shifted to a more pro-industrial public policy stance. Mowery and Rosenberg (1993, p. 58) assert that "the contrast between the position of the newly elected Reagan Administration in 1981, denying any role for the federal government in the development and commercialization of new civilian technologies, and the Reagan Administration of 1987–1988, is dramatic," raising as an example the launching of two military-funded research programs in civilian technology development.

The United States also strengthened patent protection "in three major ways: extending patent protection to new subject matter; giving greater power to patent holders in infringement lawsuits; and lengthening the term of patents" (Gallini 2002, p. 133). During the 1980s, patents were extended to genetically engineered bacteria, software, and business methods. Also, the creation of a court specialized in patent cases—the Court of Appeals for the Federal Circuit—significantly increased patent-holder success in legal disputes (Gallini 2002).

In fact, several cases have been made against Japanese firms since the 1980s. One example: In 1984, Corning Inc. (a U.S. firm) sued the U.S. subsidiary of Sumitomo Electric Industries Ltd. (SEI, a Japanese firm) for infringement of Corning's patent on optical fiber, which concluded in 1989 with a $25 million award to Corning. The news stunned all Japanese firms not only because the amount was huge but also because, against SEI's defense that its process technology differed from Corning's and hence did not infringe Corning's patent, the court used the doctrine of equivalents to give a

broad interpretation of Corning's patent, leading to the conclusion that SEI infringed Corning's patent. It thus gave a strong lesson to Japanese firms on the need to respect the intellectual property of others. (Litigation by Japanese firms to enforce respect of their own intellectual property come later.)

Changes in the Drivers of Growth

In the years since Japan reached the cutting edge, the linkage between industrial innovation and science has intensified. The increase in the number of papers cited in patent applications in the United States—from 0.31 in 1985 to 2.15 in 2002—reflects this. This number has been called "science linkage" (Narin, Hamilton, and Olivastro 1997) and is interpreted as indicating the extent that industrial R&D is linked to science, although it is also influenced by other factors, including changes in what can be patented. Biotechnology and medicine have 4 and 12 times, respectively, the average. (Data are from CHI Research, published in National Institute of Science and Technology Policy NISTEP 2004.)

Accordingly, the industrial composition of the Japanese economy is shifting—and has to shift—toward *science-based industries* (SBIs), such as biotechnology, in which the development is pursued by means of innovations based on sciences. Innovations are based on science in two senses. First, scientific research outcomes are applied and developed for industrialization. Second, science is used to resolve bottlenecks that arise in the course of R&D and production. Note that discoveries during R&D or production feed back to scientific research, so the flow of information is bidirectional. This interplay between scientific and industrial activity is an especially important characteristic of SBIs.

SBIs are distinguished from engineering-based industries—though of course the distinction is by no means a discontinuous jump. All industries making technological progress rely on science and engineering, as well as the sort of ongoing incremental improvements in process and method that Japanese firms have excelled at. The information and electronics industries probably give the best examples. The development of a mobile communication system requires both scientific knowledge and engineering know-how, as does development of semiconductors. In biotechnology, DNA chips, for instance, require engineering knowledge in hydrodynamics.

Still, the focus is on SBIs because the deepened connection with science is considered the most prominent characteristic of innovation in the 21st century.

The increasing importance of SBIs has, in turn, affected the national innovation system gravely and called for important policy changes. Some of these are taken up in the next section.

Policies to Promote SBIs

In 2001, based on the recommendation of the Council of Science and Technology Policy, the Japanese government determined a Science and Technology Basic Plan, in which four areas were given strategic priorities:

- life sciences (including biotechnology),
- information and telecommunication,
- environmental sciences, and
- nanotechnology and materials.

Box 8.2. *R&D Activities of Ministries*

MEXT handles the largest share of the central government's R&D budget because it handles the Grants-in-Aid for Scientific Research. These are the largest pool of funds competitively supplied to academic researchers, and are similar to National Science Foundation (NSF) and a large part of National Institutes of Health (NIH) grants in the United States. MEXT's share of the R&D budget was 63.0% in FY2004.

The Ministry of Economy, Trade, and Industry (METI) follows; its FY2004 share was 17.2%. The Ministry of Health, Labor and Welfare (MHLW) provides funds related to medical research (including biotechnology), while MAFF funds applications of biotechnology to agriculture and fishery.

Long-term series on sources of support by specific agencies is complicated by the extensive government reorganization of 2001. MEXT was created by combining the Ministry of Education, Culture, and Sports with most of the STA. MHLW combines the former Ministry of Labor and MHW. METI is an enlarged MITI, having absorbed some parts of STA and MPT. Other, larger, parts of MPT were absorbed by a new Ministry of Internal Affairs and Communications.

It is hoped that their promotion will foster development of industrial technologies and stimulate development of related industries. These industries, therefore, may be regarded as the core SBIs.

Following the Basic Plan, the government increased its R&D budget to these fields by 14.1% from FY2001 (excluding the special funds allocated later in the fiscal year) to FY2004, while its total R&D budget increased only 4.5% (fiscal year ending in March of the following calendar year). The four fields together accounted for 22.7% of total government R&D budget.

R&D funding is made through several different ministries. Coordination among the ministries has been fostered since the start of the basic plan in 2001 but remains insufficient. For instance, ministries may independently start similar projects. Also, they often provide funds to particular (usually famous) researchers without being aware that they are also the recipients of funds through other government projects.

In this regard, Japan can learn from the U.S. system in which NIH handles most life-science R&D funds. NIH also has a large staff with knowledge of and experience in life sciences that conducts R&D.

Box 8.2 provides data on the R&D support activities of various ministries.

The majority of government R&D funds goes to academic research through Grants-in-Aid and other programs. Some funds go to GRIs, and some to industrial firms, usually through RAs or other joint R&D organizations formed by firms (which may include small or foreign-owned firms), GRIs, and universities.

Besides increased government R&D funding, several important initiatives have been taken since the latter half of the 1990s with the aim of transforming the national innovation system toward one that is more conducive to SBIs. Here, the focus is on three: university-industry collaborations, strengthening intellectual property rights (IPRs), and the promotion of start-ups. (Much of the following overlaps the second half of Odagiri 2004.)

University-Industry Collaborations

SBIs are by definition characterized by strong linkages to scientific research. Because a major part of such research is done by universities, close collaboration

between universities and industries is called for. Probably the most common flow of information from academic research to industrial innovation occurs through publication of papers. More directly, when industrial R&D teams face technological difficulties, they may seek the advice of academics or propose joint research.

Licensing university-held patents has become common. However, development of a commercially viable product from such a patent is rarely straightforward. The licensed patent may not cover all the necessary technology and know-how, and it may be smoothly transferred only when the university inventor is actively involved. Also, as the term "absorptive capacity" implies, a sufficient capability is needed on the licensee's side and, even with such capability, unexpected bottlenecks may arise in the course of development. Advice by university inventors or other academics may help the industry to acquire the necessary capacity or to overcome the bottlenecks

Industries often find it advantageous to commission research or conduct joint research with universities. Joint research is attractive because the complementary capabilities of university scientists and industry engineers can be combined to identify and address hurdles at an early stage.

To promote SBI, there must be an environment in which active university-industry collaboration, in the form of patent licensing, consultation, commissioned research, and joint research is feasible and encouraged. Accordingly, Japan is shifting in this direction.

It is not that collaboration was historically absent in Japan. In fact, universities have played an important role in Japan's industrial and technological development since the mid-19th century (Odagiri 1999). However, particularly after World War II, rigid regulations began to be applied to the conduct of university faculties, making collaborations cumbersome. The rules were strictly enforced because most major universities were national universities, and their professors were civil servants. Much collaboration was thus done on an informal basis, for instance, based on personal relationships between professors and company researchers including, often, former students.

With a series of deregulation and reforms since the latter half of the 1990s, university-industry collaborations are being actively encouraged. For example, professors can now be directors of private companies. In addition, to promote joint research with industries, several policies have been adopted. These are:

- Red tape regarding acceptance of company research funds and of company researchers in university laboratories has been relaxed.
- Special facilities for joint research have been built at many universities.
- Space can be offered to start-ups at a low rent, if the start-ups are established to commercialize technologies originating at the university.
- Technology licensing offices (TLOs) have been founded at many universities (not within universities like in the United States, but as separate organizations). These help faculty apply for patents and negotiate licensing agreements, and help companies find suitable university patents to license and suitable faculty to do joint research with.
- Patent fees have been reduced for applications made by university researchers or TLOs.
- Special tax concessions are given for company R&D expenditures made as part of a university-industry collaboration.

With the National University Corporation Act, every national university was incorporated into a semi-independent corporation in 2004. Although the majority of their budgets continue to be from the central government, they can now keep their income. This means they have some incentive to increase revenue not only by offering relevant courses to students, but also by attracting industry funds for collaborations, and promoting patenting and licensing of university inventions. In addition, the reform is expected to facilitate collaborations by, for instance, allowing universities to offer flexible employment arrangements for professors who want to collaborate with industries.

With these reforms, university-industry collaborations have been rapidly increasing. The number of university-industry joint research by national universities increased from 1,139 in 1990 to 4,029 in 2000 and 6,767 in 2002 (all Japanese data by fiscal year and from MEXT). The number of start-ups based on university-invented technologies increased from 11 in 1995 to 179 in 2003 and, as a result, the number of such companies in operation at end-August 2004 was estimated to be 916. By comparison, in the United States, 450 start-ups were formed in 2002 (by calendar year), and the accumulated number during 1980–2002 was 4,320, of which 2,741 were in operation at the end of 2002 (Association of University Technology Management 2003).

By April 2005, 36 TLOs had been established by universities, and several cases of licensing have been reported. As of September 2003, 280 cases had been reported in which the professors of national universities were acting as directors or auditors of companies.

Intellectual Property Reform

IPRs, such as patents and copyrights, have strategic importance in SBIs. This is primarily because huge R&D expenditures are required in SBI, and IPRs are considered to be the most effective means of appropriating the returns to R&D investment.

Strengthening IPRs, including being pro–patent holder, may appear to be the right policy for promoting SBI. However, strong IPRs may actually hurt technological progress because it restricts the usage and diffusion of invented technologies (Merges and Nelson 1990). In particularly, an increase in "research tool patents," such as those on DNA chips and transgenic mice, can hinder progress as the need for permission from patent owners can make R&D more costly and time-consuming. If each patent holder acts aggressively, many R&D projects might become economically infeasible. The positive incentive effect and the negative usage restriction effect have to be balanced in any design of an IPRs system.

Patent Protection

In the trade-off between "diffusion and exclusion," the Japanese patent system used to be more tilted toward diffusion than the U.S. system (Ordover 1991). This inclination was rational during catch-up because Japan gained more from the usage of patented knowledge than from raising incentives for inventors. However, now that Japan has reached the knowledge frontier, it has an urgent need to encourage inventions.

The World Trade Organization's agreements on TRIPS (Trade-Related Aspects of Intellectual Property Rights) in 1995 and U.S.-Japan agreements during the 1990s have led the Japanese government to align its patent system with the more protection-oriented standard of the United States. Consequently, patent applications with multiple claims started to be accepted in 1988, and the pregrant opposition system was changed to a postgrant opposition system in 1994. The scope of patentable inventions was gradually expanded during the 1990s, particularly as regards software, business models, and biological inventions.

In 2002, Japan enacted the Basic Law on Intellectual Property. With this act the government established an Intellectual Property Policy Headquarters within the Cabinet to promote "the creation, protection, and exploitation of intellectual property" (Article 1). Particular emphasis was placed on wider utilization of patented technologies and a stronger enforcement of patent rights.

The usefulness of a patent is a function of its enforceability. Patent litigation is a notoriously costly and time-consuming process in Japan, mainly because there was no court specialized in patent-related litigation and no judges (and only a few attorneys) with the requisite technological knowledge. To remedy this, a special court, named Intellectual Property High Court, was established within the Tokyo High Court in April 2005.

University Patents

The production and utilization of patents by universities and national institutes have been another policy emphasis. One important policy change was in the 1999 law dubbed the Japanese Bayh-Dole Act after 1980 legislation in the United States. Researchers on projects commissioned and funded by the government can claim ownership of any inventions resulting from the work. This is intended to give researchers more incentive to patent and to promote commercial application of their patents. In addition, patent fees were reduced for academic inventions, and TLOs have been set up at many universities.

Although the rise in university patenting and licensing may not be spectacular yet, a gradual change has been occurring and, together with making national universities more independent, a big impact on Japan's national innovation system is anticipated in coming years.

Promotion of Start-Ups

Several policy measures have been taken to promote start-ups besides those already discussed involving universities. Under the 1999 Law for Facilitating Creation of New Business—dubbed the Japanese SBIR program after the U.S. Small Business Innovation Research program—the government has provided subsidies and debt guarantees to help small and medium enterprises (SMEs) develop and commercialize new technologies. Those eligible include existing SMEs, start-ups, and individuals.

The government also began, in 2002, to give tax advantages to individuals investing in start-up companies (called the Angel Tax System). The minimum capital required to found a stock company was reduced from ¥10 million to a mere ¥1, provided the company is established to start a new business and on the condition

that the capital is increased to at least ¥10 million within five years of establishment. Start-up firms are also allowed to use stock options when compensating directors and employees.

With these and other policies to promote start-ups, the number of high-tech start-ups has been increasing. For instance, according to the statistics of the Japan Biotechnology Association that defined "bio-venture companies" as the firms using biotechnology as tools or objectives, employing 300 or less, and being less than 20 years old, the number of bio-venture companies in operation increased from 108 at the end of 1995 to 464 at the end of 2004.

Financing start-ups has been made easier. Three stock markets (JASDAQ, MOTHERS and HERCULES) were opened or reorganized to make it simpler for new firms to trade. The number of initial public offerings (IPOs) has accordingly increased: in 2003, about 100 firms made IPOs in these markets. Many venture capital firms have been established, although many lack sufficient capabilities to evaluate potential investments, advise on managerial and technological matters, or even recruit talent.

The R&D Boundary of the Firm

The "R&D boundary of the firm" is a term to indicate the line between those things done within the firm and those done in collaboration with others or entirely outside the firm. Addressing where the boundary is drawn has become a critical strategic decision.

It is now generally regarded as not only inefficient, but also impractical, for firms to perform all R&D-related work in-house. Through R&D alliances, licensing, outsourcing, and such, firms have to incorporate and utilize capabilities from diverse sources to achieve innovations efficiently and swiftly. The creation of specialized firms to perform specific aspects of the R&D process, especially in the life sciences, is both a response to, and a cause of, this situation.

Such interorganizational collaboration probably applies best to biotechnology and pharmaceuticals. The number of research alliances by the 10 largest pharmaceutical firms in Japan increased threefold between 1989 and 1999 (Odagiri 2003). This includes alliances between firms and universities, and with domestic or foreign partners. It includes technology acquisitions (that is, licensing-in) and joint or commissioned R&D. As a partner in these alliances, new biotech firms, particularly those based in the United States, have been as popular as established firms. This tendency of increase in R&D alliances, with many of them being with new biotech firms, is common to major pharmaceutical firms globally, as discussed by Henderson, Orsenigo, and Pisano (1999).

According to a 2000 survey by NISTEP, the most important reasons for R&D alliances were "utilization of the partner's (nonpatented) technological knowledge and capabilities," "speed," "utilization of capital equipment," and "cost reduction." This indicates that utilizing outside assets (tangible and intangible) and capabilities, and combining them with internal ones, are now considered critical for efficient company R&D (Odagiri, Koga, and Nakamura 2002).

Firms also actively outsource routine R&D-related services to specialists. The amount spent for outsourcing reached 25% of R&D expenditures among pharmaceutical firms, according to the NISTEP survey. Examples, in the case of biotechnology and pharmaceuticals, include animal tests, supply of specific samples, production of test products, software development, genome analyses, and clinical tests.

Implications

The widespread utilization of outside capabilities implies, from the national viewpoint, that the availability of potential partners for alliances and outsourcing is a prerequisite for the development of SBIs. Universities, GRIs, and start-ups are all possible partners, as are big firms. The promotion of university-industry collaborations and start-ups is also imperative for this purpose.

Potential partners have to be broadly distributed across industries. SBIs have a wide applicability. Thus, in the case of biotechnology, bio-related informatics and services—as well as provision of laboratory equipment, bio-electronics, samples, and reagents—constitute an important part of the biotech industry. Many firms in these fields are active outsourcees. They can be large or small, established or new. The presence of such firms is a prerequisite for an innovation system oriented toward SBIs.

Coexistence of the New System with Traditional Practices

A deep question is whether the emerging innovation system can coexist with Japan's existing business and industrial practices. Do they have to change for the new innovation system to be effective? Should existing practices survive at all? Considering these topics in detail exceeds the scope and space of this chapter. Here, some of the relevant issues are raised.

To promote new industries and start-ups, the economy needs greater flexibility in its labor and financial markets than they have had. Thus, there is a need to foster reallocation of talented people through external markets, as opposed to the internal labor markets that have prevailed. And there is the need for more venturous funds, something the financial system is still not well-equipped to supply.

For a long time, the financial system of Japan, characterized by a close bank-firm relationship and the presence of stable shareholders, was considered to be complementary to the labor system characterized by long-term worker-employer attachment. The system also was considered conducive to, for instance, accumulation of firm-specific human skills and close intrafirm (and intragroup) information sharing, which made cumulative technological innovation easier (Odagiri 1992). The current competitiveness of Japan in such industries as automobiles, digital cameras, and plasma displays is closely related to this system. Such advantage has been exploited even in science-based fields. As an example, Kirin, one of the largest brewers, applied its accumulated know-how on fermentation to the mass production process of biotechnology-based drugs.

In structured interviews with 65 Japanese biotech start-ups, "difficulty in recruiting technological staff," "difficulty in financing," and "difficulty in recruiting nontechnological staff (finance, accounting, legal, etc.)" were raised as the three most significant barriers (Odagiri and Nakamura 2002).

One cause of the staffing hurdle is the relatively small number of degree holders in the biological sciences, even at the bachelor's level. Although a strict comparison is difficult because of different definitions of academic fields between the two countries, the percentage of the population in the United States with a Ph.D. probably is more than four times the level in Japan.

More important, however, is the low mobility of workers. Big firms tend to have talented people both because they can recruit better workers and because their

workers tend to receive more in-company training and wider experience. Even in the United States, not all people are willing to leave good, secure jobs for the risks of a start-up. For Japanese, the risks have historically been even greater. Still, a gradual change is taking place, and I suggest that it is feasible to incorporate more mobility into the Japanese system and yet maintain the merits of the traditional system in large parts of the economy.

An example of change: In September 2002, AnGes MG became the first university spin-off biotech company to have made an IPO. It was founded in December 1999 by a then–associate professor at Osaka University. The first chief executive officer was a Japanese with experience leading a start-up in Silicon Valley. However, the third CEO quit one of the biggest chemical companies in Japan to join AnGes, and he led the company to successful completion of its IPO.

Conclusion

Businesses and government in Japan have been making conscious efforts to transform the country's innovation system into one more suitable for SBIs. The government has not only increased budgets for research related to SBIs, but also sought to adapt the legal and policy framework to the need for university-industry collaborations, effective use of IPRs, and start-ups. Industries have been adapting in order to survive in the changing environment, for instance, by shifting less sophisticated manufacturing overseas, eliminating unprofitable and declining businesses, improving intellectual property management, and incorporating scientific advances into their R&D.

The very success of Japan's incumbent systems has made adjustment to the new global environment difficult, even painful, explaining why it has been taking so many years for Japan to recover from the post-bubble recession and start a new growth process. Yet, Japanese have twice before started new growth: after the great turmoil of the Meiji Restoration and after the destruction of World War II. The business practices have also evolved through the course of such growth. Thus, even though the exact nature of the new innovation and business system is still unclear, Japan will continue on the cutting edge of knowledge and technology creation.

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9

Moving Toward a More Advanced Knowledge Economy: Lessons and Implications

Tsutomu Shibata

The Japanese experience offers many useful insights into our understanding of a knowledge-based economy. Many of them are relevant to developing countries looking to enhance the knowledge-related aspects of their economies. To that end, the issues and lessons raised in the previous chapters are summarized here, in line with the four pillars of a knowledge economy: economic and institutional regime, dynamic information infrastructure, educated and skilled population, and national innovation system. The companion volume provides case studies of knowledge creation and knowledge sharing at six high-performance companies, and has its own summary.

Economic and Institutional Regime

Japan's postwar economic system has become a mismatch with an advanced knowledge-based economy. That system is considered responsible for the slow response of both the public and private sectors to changes in the economic environment, and thus for prolonging stagnation in the 1990s. More broadly, the incumbent Japanese economic system has been a victim of its own success and other changes in the global economic environment.

This means that most of the Japanese systems that contributed to the past successes are not functioning well. The systems in need of change for Japanese companies to compete successfully in growing areas include keirestu, main bank, lifetime employment, promotion by seniority, and memorization-oriented education. Some systems have already been changing, some substantially. Others will need to change even more.

The system malfunction culminated in the 1997 banking crisis. This led to a rethinking and reforming of traditional corporate governance and incentive models that is still going on. The government has supported private sector reforms with regulatory reforms. For example, deregulation of energy and telecommunications have brought benefits.

One of the most crucial areas of reform was the financial sector. Banks suffered from ever-increasing nonperforming loans (NPLs) during the 1990s as a result of irrational lending during the 1980s asset bubble and belated actions to address the problems. Only in the mid-2000s was the peak of the NPL problem passed. This involved mergers, significant reductions in cross-shareholding, and other major restructurings.

On the government side, first financial supervision (1998), and then planning (2000), were moved from the Ministry of Finance. A newly established Financial

Services Agency (FSA) assumed these powers in 2000. This new regulatory regime has made progress.

The regime issues addressed in this book relate primarily to labor markets and venture capital markets. The information technology (IT) revolution, as well as the greater involvement of India, China, and the former communist states, in the global economy are shifting comparative advantage in many industries to new systems. Such systems are characterized by highly mobile labor markets, flexible work practices, and venture capital finance. In IT-related industries, modular production and network-based innovation have been added to the list, as well as active mergers and acquisitions (M&A).

The success of many U.S. IT firms both absolutely and relative to formerly strong competitors has led to codification of many of the features of what happened in the United States into models. Typical, and perhaps best known, is what is termed the Silicon Valley–type because of the geographical location of so many of the new firms. Its features are remarkably different from those that characterize the successful Japanese firms of the 1980s, generalized as a model termed the J-type firm. The consensus is that some of the defining features of the J-type firm—life-time employment, together with seniority-based wages—do not provide the flexibility deemed necessary for a dynamic knowledge economy, and thus are difficult to sustain. However, it could be feasible to incorporate more mobility into labor markets while maintaining the merits of the Japanese system in a large part of the economy.

Japan's population is aging rapidly, and the labor force has started shrinking. Policies are needed to increase labor force participation, or at least slow its decline, and to increase value added per worker (labor productivity) through knowledge and innovation. Near-term measures are, among others, an extension of the retirement age and a promotion of domestic labor force participation.

Longer-term measures include providing individuals with opportunities for lifelong learning. This should promote the mobility and flexibility needed to reduce mismatches between available jobs and those looking for work or not in the labor force at all. Immigration, except for a limited number of workers in selected fields, is unlikely to increase much in the near future.

Japan's traditional labor practices, with supporting incentives and attitudes, have hindered development of venture businesses. Of particular importance is an excessively risk-averse attitude. Such aversion is a reflection of a rigid job market that rarely hires mid-career people. Although conditions are changing, it is still difficult to re-enter mainstream employment in Japan.

One of the major characteristics of economic openness is foreign direct investment (FDI). While large-scale outward FDI raised the concern of "hollowing out," the extremely smaller amount of inward FDI has led to government measures to address the imbalance. Although some increase is expected, partly through M&A, the impact on innovation will be limited in the near future.

This is partly the result of past policy and practice in absorbing technology. Japan, like the Republic of Korea and—to a lesser extent—Taiwan, China, did not rely on FDI to transfer technology. Rather, they set barriers against FDI, and domestic firms purchased technology. However, this option is no longer feasible under the World Trade Organization (WTO) and globalization. In contrast, Singapore successfully combined FDI with policies to develop human resources. Countries that rely heavily on FDI need to foster capacity development, otherwise there will be few spillover effects.

The continuously high level of outward FDI by Japanese firms has led to serious challenges. These include shrinking domestic production bases and difficulty regarding feedback from production to research and development (R&D). The latter, together with the needs to maintain skills on the shop floor and to protect important technology, are bringing some investment back to Japan.

Regime-Related Lessons and Implications

All of these are particularly relevant to developing economies.

- Better supervision of the financial sector and more accurate disclosure of NPLs might well have led to the sector's problems being tackled earlier and more effectively.
- Corporate governance matters. Large Japanese firms traditionally have been run more for the benefit of the managers and employees than for shareholders, with the banks providing monitoring. Capital markets have replaced banks as the primary source of funds for large firms, and this has reduced the ability and incentive for banks to monitor. Shareholders, rating agencies, and bond and equity analysts become more important under such circumstances.
- More transparency and less cross-shareholding would have facilitated countermeasures, including changing managers accountable for bad performance.
- Reduction of public works in rural areas and of agricultural subsidies would have led to more balanced and flexible budgets.
- Vested interests can easily prevent reforms. In Japan, rural areas have been significantly overrepresented in the legislature due to the skewing of electoral districts. More reform needs to be done to make constituencies more equally reflect population distribution.

Labor-Related Lessons and Recommendations

- Japan needs a labor market characterized by higher mobility and flexibility, based on increased opportunities of lifetime learning and of re-entry, especially for women.
- Increasing value added per worker through knowledge and innovation is particularly crucial under conditions of an ageing and decreasing population.
- The retirement age should reflect longevity. In Japan's case, it clearly needs to be extended and combined with more flexible compensation schemes.
- Measures are needed to increase labor participation from unemployed women and youth, as well as immigrants.
- To encourage increased female workforce participation, specific steps include greater availability of reasonably priced day care, flexible work hours, and family-friendly (liberal) leave policies.

Open-Economy-Related Lessons and Recommendations

- Inward FDI must accompany substantial efforts to develop the capacity to absorb it. (This is particularly relevant to developing economies.)

Telecommunications Infrastructure

Telecommunications are an essential part of creating a knowledge-based society. Its advances, particularly wireless telephony and the Internet, are, together with personal computers, the most visible aspects of the IT revolution.

Partial privatization of the state telecom monopoly, Nippon Telegraph & Telephone Corp. (NTT), in 1985 led to new entries and lower prices for long distance calls. But the "last mile" was owned by NTT, and new entrants had to pay NTT high fees for access. In the late 1990s, further steps were taken to increase competition in local phone service, but NTT has been adept at finding ways to not cooperate. Division of NTT into three operating companies in 1999 also did little for competition, as the new companies all are parts of NTT. Another attempt at competition began in 2004, when a new entrant began offering discounted fixed-line service—but it is leasing lines from NTT. The government claims its regulation of the industry is not a conflict of interest, even though it has remained NTT's largest shareholder.

As to the Internet, the Integrated Services Digital Network (ISDN) technology favored by NTT and the government lost to asymmetrical digital subscriber line (ADSL) technology provided by others. This was unexpected. The current ASDL price is one of the lowest in the world. This implies that, with a wide range of technologies, it is unlikely the government can determine in advance which is the most promising.

Japanese consumers have hugely benefited from privatization and competition, but the new service providers are mostly not profitable. The old monopoly has great staying power, including its close relationship with suppliers. Thus, policy makers and regulators must become more vigilant, particularly regarding the last mile.

It is also noted that intellectual property rights (IPRs) play a crucial role in advancing the information society because digital content is easy to copy.

Telecommunications-Related Lessons and Implications

- Government policy needs to be technology-neutral in telecommunications, as IT is unpredictable.
- Privatizing a government monopoly does not automatically generate a healthy competitive environment. Competition policy must proactively seek to establish a level playing field.
- Effective corporate governance and regulatory oversight must be applied to government-controlled telecom providers.
- Wireless systems, especially with Internet access, can provide cost-effective access to the modern information society and bypass the fixed-line incumbent.
- ADSL as a means of broadband Internet access works best when there is a dense urban population, which typically means many high-rise apartments. Thus, ADSL has been successful in Korea, Taiwan, China, and Singapore. However, these conditions may not apply in other countries.
- There is a need for a global consensus on the right balance between protecting IPR and using and disseminating digital content. In particular, Internet growth in many East Asian countries has built on protection of copyrights.

IT Users and Electronics

IT productivity has been limited in Japan, even at IT-using firms and despite IT investment levels comparable to those of U.S. firms. That is, companies in the United States have been more successful in changing work practices and management systems. The use of information and communication technologies in most nonmanufacturing sectors remains unimpressive. Japan has not fostered a strong packaged-software market.

In the area of innovation, the Japanese model, characterized by a bottom-up approach and a "go-it-alone" attitude, is being challenged. With the IT revolution and the personal computer (PC) era, once-strong Japanese companies lost their competitive edge in products such as multipurpose computers and dynamic random access memory (DRAM). In particular, in electronics, Japanese integrated manufacturers, with a wide range of products and a reliance on proprietary in-house technology, have lost competitive position to more specialized component companies exploiting open systems and modularity.

IT-Related Lessons and Implications

- IT investment must be accompanied by appropriate changes in organization and work practice in order to improve productivity.
- Strong leadership and a centralized strategy are needed to introduce integrated enterprise resource planning systems effectively.
- Speed, selection, concentration, and collaboration are core concepts in formulating IT corporate strategy. To achieve speed, firms need to select and concentrate on what they do best and where they can add the most value relative to their costs—which is often termed core competencies. Firms with complementary core competencies can profit from collaborating to achieve innovation more quickly than doing everything in-house.

Skills and Human Resources

Human resources are a key factor in development. Japan promoted literacy and general education from the earliest stages of its modern economic development. However, Japanese education has emphasized memorization and, in the postwar period, been geared toward competition for entrance to "brand" universities. Little vocational knowledge was acquired from formal education. Such a system was compatible with corporate in-house job training, the use of imported technology, and mass production.

The quality of Japanese university education is not highly evaluated in international rankings. This matters. Various efforts, including corporatization of national universities and establishing professional graduate schools, have been made. The results remain to be seen.

Substantial job training provided within Japanese companies generally assumed lifetime employment. The latter commitment is being offered to fewer workers as firms seek to become more flexible. This means on-the-job training is becoming a less important source of labor skills. As a result, vocational education and lifetime learning outside the workplace have moved higher on the policy agenda. The implementation of the agenda should give a "second chance" to anyone with the

will to break from the "one-chance" society. In the one-chance society, which university someone attended, and the first organization someone worked for, have been the key factors in determining the career path someone takes, especially at large organizations, including the government.

The fact that the Japanese-language market is fairly large at 127 million has hampered the acquisition of a good command of foreign languages. Even though languages are widely taught in Japanese schools, few students actually acquire good communication skills in another language.

"Japan's 21st Century Vision," published in 2005 by the Council on Economic and Fiscal Policy, shows the government's awareness of the problems and its commitment to change. However, existing labor and industrial customs, as well as the fact that a majority of workers support long-term employment and seniority-based salary, mean drastic near-term change is unlikely. The government must take bold steps to meet the challenges, paving the way for further advancement of a knowledge-based economy.

Human-Resource-Related Lessons and Implications

- Literacy and general education were key factors in the early development of Japan. This is in line with the Millennium Development Goals of elementary education for all.
- Capacity development can be enhanced by company-provided training and voluntary initiatives by workers such as total quality control (TQC).
- Educational and training systems must facilitate changing jobs without disadvantages and re-entry into the labor market, particularly for women.
- Globalization and the IT revolution require continuous adjustment in the needed skills to do business and the means to provide the adjustments.
- The education system should encourage mastering foreign languages, particularly communication skills at all levels. An alternative is to have a limited number of secondary and upper schools at which a substantial part of the classwork is conducted in a foreign language.
- Requirements for graduation from universities should be more demanding.
- Provision of quality assurance, selected subsidies channeled to individuals, and student loans can increase access to higher education and lifelong training.

National Innovation System

During the postwar catch-up process, R&D expenditures increased rapidly to adapt imported technologies to domestic conditions. This was part of the fierce competition for domestic market share that characterized the period. Policies such as tax concessions, subsidies, and low-interest loans helped firms engage in R&D. Japanese industrial R&D received little funding from the government, especially relative to U.S. and European industries. Current R&D funding by the government is not well-coordinated.

The increasing importance of science-based industries (SBI) as a driver of growth is leading to changes in Japan's innovation system. Historically, Japan's innovation system has been anchored by major corporations that have not had strong linkages to either universities or public research institutes. Now, both sides are seeking to forge links.

The traditional Japanese business system, good at cumulative technological innovation, produced the competitiveness of such industries as automobiles and digital cameras. But to promote new industries and start-ups, some aspects of a Silicon Valley–type system are needed. Most large established firms in Japan, constrained by the traditional system, have been slow to invent products and switch to new innovations, even less disruptive ones. This makes all the greater the need to increase the number of science and technology venture businesses.

Innovations cost money, not all innovators are good at business, and not all innovations are financially successful. To an extent found nowhere else, the United States has built a venture capital infrastructure to address these issues. Japan and other countries seeking to support innovative new businesses are adopting policies and promoting private initiatives to create domestic infrastructure for would-be entrepreneurs. Besides suppliers of risk capital, this includes a supporting network of professional service providers: consultants, accountants, and lawyers who are familiar with advanced technology and IPRs.

Labor market mobility, including the ability to re-enter mainstream employment if a venture does not succeed, also needs to be promoted.

Innovation-Related Lessons and Recommendations

- Based on the U.S. experience, it is important to facilitate a shift to a network-based system in order to help spur corporate innovation.
- During catch-up, domestic R&D and education are crucial to make imported technologies applicable to domestic manufacturing processes.
- A proper competitive environment to promote R&D is needed to use imported technology fully. Appropriate government incentives for R&D could work.
- R&D funding by the government needs to be prioritized and well-coordinated among ministries. The U.S. National Institutes of Health are a model. They handle allocation of most government life-science R&D funds and also conduct R&D.
- The national innovation system needs to be changed to strengthen complementarities between the various institutions that support innovation.
- Closer collaboration between universities and industries is needed in the form of patent licensing, commissioned research, and joint research.
- IPRs for technology in advanced countries should shift from "diffusion" status to "exclusion" to encourage inventions.
- A special court for patent litigation is useful.
- Venture businesses, including science- and technology-based start-ups, should be promoted with appropriate incentives. An example is an "angel tax system" that provides favorable tax treatment for venture capital investors.
- Creation of a support system for entrepreneurs—consultants, accountants, and lawyers familiar with advanced technology and IPRs—should be encouraged.

Final Thoughts

Japan usually can change only incrementally. This might be apparent from the length of the post-bubble stagnation. Recovery from the bursting of the bubble was

slow in part because the magnitude of the crisis always remained generally mild. This contrasts with the sharp shocks of the East Asian crises in 1997.

Because of this tendency toward incrementalism, the major challenges to advance knowledge-based economy—including creation of science-based ventures, provision of a risk fund with professional skills, strengthening lifetime learning outside of the workplace, increasing university-industry cooperation, change of incentive system—may not be realized with tremendous speed. There are a few successful companies with modified long-term employment, which suggests that at least some aspects of both the traditional and new systems may coexist to some extent in the foreseeable future. Still, we can expect Japan to proceed steadily along the road to a point where knowledge and innovation are created, acquired, respected, and protected much more easily than is now the case.

Some have a notion that under a knowledge-based economy there is a tremendous widening of the income gap. We, however, must not encourage nor assume an extreme Darwinism image for a knowledge economy. Social safety nets and adequate mechanisms to enable people to keep challenging should backstop an advanced knowledge-based economy.

There is a view that the greatest lesson we learn from history is that we never learn anything from it. Although we cannot deny the view in the face of abundant intellectual overshooting even about the Japanese economy observed in the last few decades, one should be more clever. One thing Japan achieved in a modern world is economic growth with equity using knowledge as a crucial vehicle.

What has worked in the past may not work in the future, but it is still important to know the history. Regardless of how far advanced a reader's country is toward being a knowledge economy, it is the authors' hope that everyone will have found the lessons in this book useful, be they cautionary tales or examples to follow.

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