The Japanese Model: Shifts in Comparative Advantage Due to the IT Revolution and Modularization

By Motohashi Kazuyuki

Factors behind the Economic Slump of the 1990s

Economic growth in Japan dropped off sharply in the 1990s. This is thought to be in large part a cyclic phenomenon reflecting the collapse of the bubble economy in the late 1980s. But slow growth has continued, with average annual growth of 1.4% through the decade of the 1990s, prompting comment that structural factors may also be involved. Moreover, certain industries appear to be losing competitiveness. Japan's electronics industry, for example, boasted overwhelming export competitiveness into the 1980s, but manufacturers in South Korea, Taiwan and elsewhere in East Asia have been catching up, with the result that Japanese manufacturers now face serious competition, especially in the area of semiconductors and other information devices. And thanks to China's continued vigorous courting of foreign investment, foreign-invested enterprises are pouring in and helping China to gain ground on the developed nations in the IT sector. China already commands top share worldwide in the production of many consumer electronic items.

There are a number of macroeconomic factors contributing to Japan's economic malaise. Slumping stock and real estate markets, for example, impede efforts to liquidate non-performing loans, which in turn erodes the intermediation function of financial institutions and places a drag on the economy. Also, deflation has recently been putting a pinch on corporate profitability and household finances. The resulting dampened demand has put further downward pressure on prices, thus causing worries about the country plunging into a deflationary spiral. On the other hand, some industrial sectors, such as the automotive industry, remain relatively competitive and continue to be reasonably profitable, but there are other industries, such as electronics, where export competitiveness has plummeted. These facts suggest that we must examine Japan's economic situation from a microeconomic perspective, taking into consideration such factors as the supply and demand structure and innovation mechanisms in particular industries.

Some would argue, however, that the aforementioned problems are brought about by a still more fundamental factor, namely, that something has gone wrong with Japanese-style economic institutions, as typified by its bank-centered capital markets and corporate governance mechanisms, and employment practices such as the seniority system and lifetime employment. The Japanese model was once pointed to as the source of Japan's industrial competitiveness, but it is now argued that the Japanese model has gone on the blink due to changes in the external environment. One key change in the external environment has been the galloping pace of progress in information technology and the changing economic model (the IT revolution) that it spawned in the 1990s. This is related to the differing levels of international competitiveness that we are observing in different industries. The impact of the IT revolution and other changes in the external environment upon the comparative advantage of the Japanese model varies from one industry to the next. Continuing with our comparison of the auto and electronics industries, we find that the auto industry is still able to maintain its comparative advantage within the Japanese economic model. In the electronics industry, however, the innovation mechanism has undergone great change, and companies operating under the Japanese model cannot keep up. This article will examine the relationship between the changing external environment (especially the IT revolution) and the Japanese economic model, and on the basis of this examination, shall comment on the current state of, and prospects for, Japan's international competitiveness.

What is the "Japanese Model"?

The term "Japanese model" is a comprehensive reference to a unique management style that has been practiced by Japanese corporations as Japan's economy developed in the post-war 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 preponderant 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 non-market mechanisms.

Aoki Masahiko (President and Chief Research Officer of the Research Institute of Economy, Trade and Industry [RIETI]; Professor at Stanford University) has pioneered the field of comparative institutional analysis (CIA), and his work has contributed a great deal to the economic analysis of the Japanese model. In neoclassical

economics, a corporation is treated as a black box, but to analyze the Japanese model, there must be an analytical 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, 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; on the contrary, 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. This sort of corporate model is effective in sectors (such as autos) where different divisions are highly complementary in the decision-making process, but in sectors (such as petrochemicals) where the degree of modularity increases and the strategic judgment of management becomes necessary, this model does not work as well. This suggests that there are sectors of the economy where the Japanese model offers comparative advantage, and sectors where it does not.

CIA stresses the importance of institutional complementarity. For example, there is complementarity between long-term employment relations, on the one hand, and seniority-based promotions and pay, on the other, because they both encourage employees to develop firm-specific skills and to pursue the overall long-term interests of the firm. The employer has a strong incentive to invest in human resource development because the possibility of losing employees to other firms is not high. There is also complementarity between these employment practices and the governance system contingent on main banks. (Aoki, 2001) Under the contingent governance system, the main bank will carry out reforms at a firm experiencing difficulties (by dispatching personnel to assume top-level managerial duties, for example), while leaving management to the firm as long as everything is going smoothly. Unlike the shareholder governance practiced in the West, management is free under the contingent governance system to seek what is best for the firm over the long term. It is easier to maintain stable employment under such conditions.

In this manner, many different institutions mesh together in a complementary fashion to form a single system, so that a change to any single institution requires readjustment of the entire system. Japanese corporations, for example, have been abandoning seniority-based pay in favor of merit-based pay. But without a well-developed external labor market, it is difficult to break up the institution of long-term employment, and the attempt to do so can adversely affect morale, especially among employees who have been with a firm for a long time. Also, the Japanese model is in place throughout the entire nation, so individual types of businesses do not have the option of going it alone in adopting the Western model. This would suggest that there are types of business where Japan is internationally competitive, and types of business where Japan is not.

The Advance of Modularity Led by the IT Revolution in the Electronics Industry

This discrepancy in performance between different sectors arises from reliance on different technologies and mechanisms for innovation. The Japanese model is effective in sectors where complementarity among divisions is strong and coordination is required, but in sectors with a high degree of modularity where speedy innovation is required, initiative and coordination in different divisions become an obstacle. As the IT revolution accelerated through the 1990s, it changed the mechanism for innovation, especially in the electronics industry, resulting in a structure within which the Japanese model no longer offered comparative advantage.

Thanks to rapid improvements in integrated circuit technology, computers are becoming smaller and faster, while buildout of the Internet and other telecommunications infrastructure continues apace. These advances are prompting enterprises to invest in information systems and are triggering changes in the structure of the economy. This IT revolution is being fueled by the vertiginous pace of progress in the IT industry. In the field of integrated circuits, for example, Moore's Law states that the memory capacity of computer chips and the level of integration will double every 18 months. In telecommunications, as well, broadband is coming rapidly to the fore, making it possible to transmit large volumes of data in a very short time. Technical breakthroughs are also happening in digital telecommunications, where time division multiplex (TDM) and wavelength division multiplex (WDM) technologies now make it possible to transmit copious amounts of data through a single optic fiber. Technology commentator George Gilder has stated that bandwidth doubles every six months, a proclamation that has come to be known as Gilder's Law.

In conjunction with the progress of telecommunications technology, IT systems have been rapidly penetrating into the very fabric of society, to the point where our economic activities would grind to a halt without them. To understand the impact of the IT revolution upon the economy, it is important to bear in mind the ongoing digitization of information relating to business operations, products and technology, and to remember that the buildup of the Internet and other types of network infrastructure is pushing a quick acceleration of activity in the distribution sector. The flow of publicly available information via the Internet is growing much faster than the flow of internal

company information (i.e. 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 confidential 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.

The progress of information technology and the rise of a network-based model of management are seen most prominently in the electronics industry, where we do not find integrated manufacturers producing all the various components and assembling them in-house into the final product. Instead, specialized manufacturers concentrate on their own strengths and work together in "unbundled" supply chains. With a product like personal computers, interfaces for CPUs, memory chips, hard disks, CD drives and other components have become standardized, giving rise to "modular architecture." Because innovation competition takes place among the makers of each separate module, technological innovation for the product as a whole proceeds at a breakneck pace. And because complex systems are broken down into separate modules, the developers of the various modules need not worry about making their product compatible with the other modules, and development of the separate module occurs in parallel. (Baldwin and Clark, 2000) With personal computers and other products where the interface between separate components is based on an open module structure, different firms can enter the market to supply as many or as few components as they choose, and they compete among each other. (Ando and Motohashi, 2002)

This same type of modularization of production systems and breakdown of vertically integrated systems can also be seen with many other products. Japan's DRAM makers once enjoyed overwhelming international competitiveness, but they have been completely overtaken by manufacturers in South Korea. The technology for DRAM manufacturing used to be in the hands of semiconductor manufacturers, and the semiconductor equipment makers operating under the umbrella of each semiconductor manufacturer provided precisely the fabrication equipment needed to produce just those DRAM chips. Gradually, however, these technologies came to be embedded in the equipment themselves (due to the unbundling of semiconductor manufacturing and semiconductor device manufacturing), and Japanese semiconductor manufacturers lost their technology-based comparative advantage. Even with system-on-a-chip designs, which are much more customized than DRAM chips, the rise of fabless operations specializing in design and foundries specializing in manufacturing is tearing away at vertically integrated systems. In highly customized sectors like this, it is extremely important to have the capacity for effective sharing of information between different stages of the production process, and this has become possible with the latest network systems. In the electronics industry, where production systems are modularizing and innovation competition is heating up, the effectiveness of the Japanese model (under which different sectors must spend a lot of time to get in synch with each other) is on the decline.

Organizational IQ: The Strengths and Weaknesses of Japanese Enterprises

A survey using a questionnaire based on the concept of "organizational IQ" was conducted by RIETI. (RIETI, 2001) The survey concentrates on: (1) the electronics industry (which has been among the first to feel the effects of the IT revolution); (2) the move to modular manufacturing; and (3) the adoption of open-network management.

The idea of organizational IQ is analogous to the concept of individual IQ, which measures an individual's powers of cognitive recognition and information processing. 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 of organizational IQ was introduced by Stanford Business School professor Haim Mendelson and other researchers, who conducted a questionnaire survey of firms in Silicon Valley and used the results to analyze the relationship between organizational IQ and corporate performance. (Mendelson and Ziegler, 2000) In Japan, the International Competitiveness Study Group at RIETI used the same questionnaire to survey firms in the electronics industry to compare Japan and Silicon Valley.

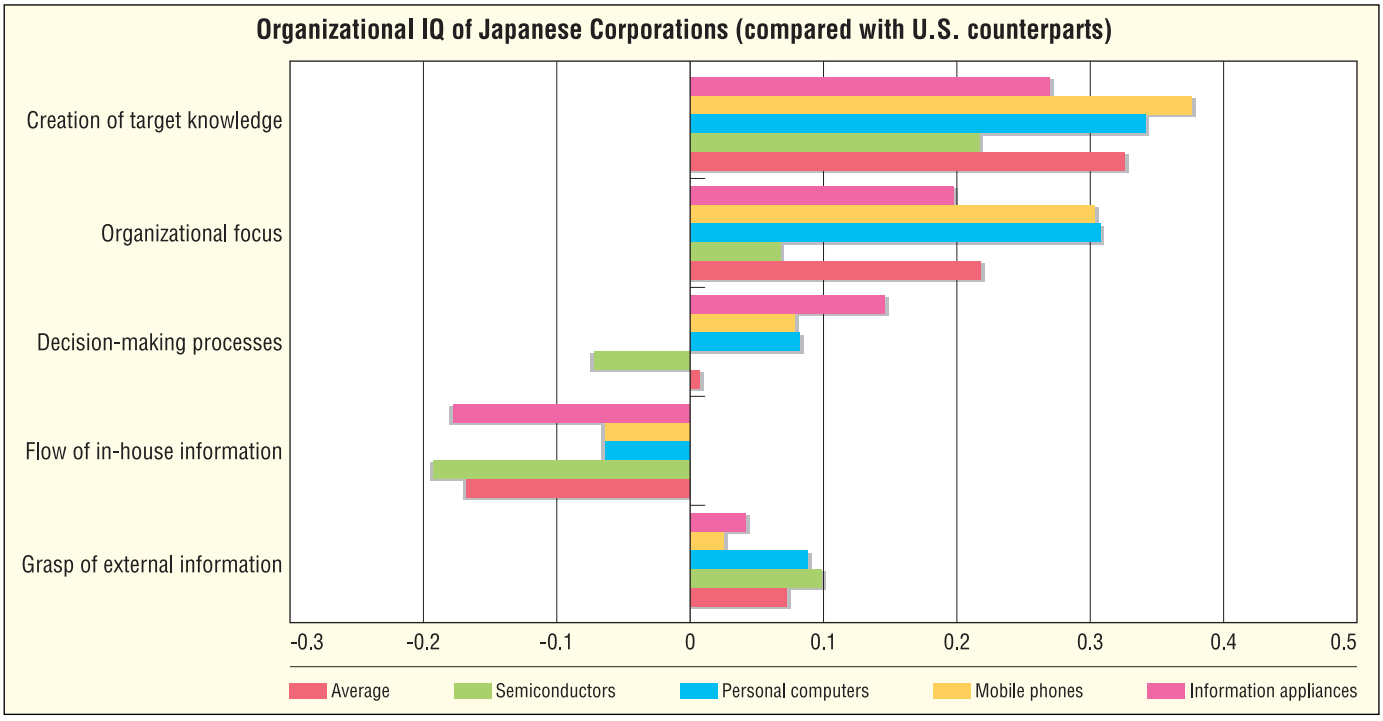
An organizational IQ score was calculated for each firm, and was based for the most part on the following elements:

(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
(4) Organizational focus: clarity of development processes, operational objectives and evaluation criteria
(5) Creative activities aimed at creation of target knowledge; ability to carry through on ideas

The study compares the organizational IQ of firms in Silicon Valley and Japan in each of the above five categories. (Fig. 1)

These survey results show that Japanese firms scored a higher organizational IQ than their Silicon Valley counterparts in many categories, but the

Figure 1 The Organizational IQ of Japanese Corporations (Silicon Valley = 0)

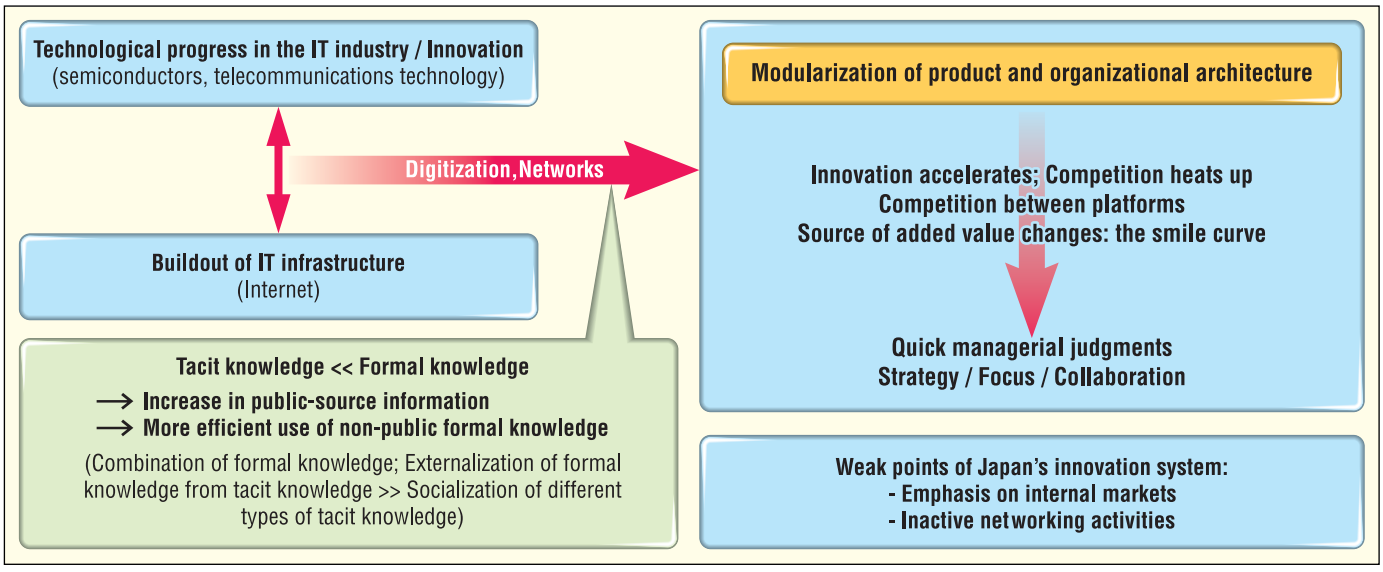


results must be interpreted with caution, as the questionnaire deals with subjective material. Because Silicon Valley respondents, for example, on the whole gave more pessimistic responses than their Japanese counterparts, this lowered their overall organizational IQ score. Accordingly, any comparison of Japan and the United States should not treat the survey results as absolute scores; rather, the U.S. scores should only be treated as a baseline for determining what categories the Japanese firms were relatively strong and weak in. And the results could also be used to observe trends in relative scores in different categories.

If we look at Figure 1 once again, we find that Japanese firms in all sectors scored highest in "Creation of target knowledge" and lowest in "Flow of in-house information." To better understand these results it is helpful to use (as RIETI did in 2001) the SECI model created by Nonaka Ikujiro and Takeuchi Hirotaka. The SECI model divides knowledge in a corporation into two types: tacit knowledge and formal knowledge. These two types of knowledge serve as the basis for knowledge creation through the following four processes: (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). (Nonaka and Takeuchi, 1996) The process of creation of target 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 at "externalizing." The flow of in-house information, by contrast, involves internal circulation within the firm of tacit and formal knowledge; in other words, it involves the socialization of tacit knowledge and the combination of formal knowledge. Looking at the individual items under the category of "Flow of in-house information," we find that Japanese firms got low organizational IQ 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."

As stated in the preceding section, progress in the field of information technology 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 which makes active use of formal knowledge. As can be seen in the results of the organizational IQ survey, Japanese firms excel at making use of tacit knowledge, but they do not make effective use of formal knowledge outside the company. The individual items in the organizational IQ survey also show that Japanese firms got extremely low IQ scores for "management of product development in cooperation with outside organizations" and "selection of strategic development partners." Particularly in the electronics industry,

Figure 2 How the IT Revolution and Modularization Have Changed Competition Rules



where the pace of technological progress is quick and the business climate is undergoing rapid change, a firm cannot rely exclusively on in-house resources, such as personnel and information; it must keep an ear to the wind, stay well informed of developments in the external environment, and correctly position itself within its business domain while aggressively pursuing tie-ups with other entities. The Japanese model is based on a "go it alone" business practice, whereby a firm relies on its in-house tacit knowledge to develop creative new ideas and build up competitive advantage, and this model has worked well for a long time. But the IT revolution has changed things, and the Japanese model is no longer suited to today's environment.

Toward a New System: Leaving the "Go-It-Alone" Business Practice Behind

Figure 2 is a schematic diagram showing the product architecture and production system modularization that have resulted (especially in the electronics industry) from the IT revolution discussed above, as well as the main issues facing Japanese firms that have been slow in structuring their businesses and focusing on their business domains in such a way as to respond to the situation spawned by the IT revolution. (Fig. 2)

In the innovation competition taking place within the IT revolution, the keywords are "speed" and "collaboration." To achieve speed, a firm must rely on its core competencies and carefully consider its many options before choosing what is best and concentrating its resources in those areas. A strategic approach and leadership are needed. Western firms are aggressively pursuing cross-border merger and acquisition (M&A) 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 faster 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 wake of the 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. From the standpoint of innovation, it would seem appropriate to create linkages with universities and research institutes in order to spur corporate innovation forward. And it would also be appropriate, working within the analytical framework of a national innovation system (NIS) to develop a "doctor's prescription" to strengthen complementarities between the mesh of institutions that support innovation, e.g., product markets, intellectual property rights, financial markets and labor markets.

Japan's innovation system is anchored by major corporations, and the industrial community does not have strong linkages to universities or public research institutes. Standing in complementary relation with this phenomena are a financial system characterized by the indirect financing that is seen as one hallmark of the Japanese model, and a labor system marked by: (1) human resource development focused primarily on in-house training; and (2) a low level of personnel turnover between enterprises. Major corporations all have their own central research institutes, and their mission amidst Japan's post-war economic growth was to turn cutting-edge technologies from the West into marketable products. Then in the 1980s, after Japan's industrial technology caught up with the West, these institutes shifted their attention to basic research. Corporate research institutes were thoroughly wedded back then to the "go-it-alone" attitude, and thus had few dealings with universities and public research institutes, and the venture capital companies that were playing such a huge role in the United States had only a limited role to play in Japan.

In the United States, by contrast, major corporations engage in collaboration across the boundaries of corporate groups. Since the 1980s, spurred forward in part by efforts to commercial-

ize breakthroughs in research at universities and public research institutes, a system for creating innovation through the use of networks was developed. In addition, venture capital firms have also played an important role in high-tech fields like information technology and biotechnology. These phenomena have come about because network-based innovation is complementary with the Western model, which is characterized by highly developed direct financing that is amenable to liquid labor markets and the supplying of risk money.

National innovation systems evolve in each country differently, on the basis of each country's own 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 such outstanding economic performance in the post-war years because its enterprises made effective use of in-house tacit knowledge, companies churned out new products on the strength of bottom-up initiative, and new production systems, such as Toyota Motor Corp.'s, were developed. It would appear that Japan's innovation system worked quite well from the immediate post-war years, when Japan was in the process of catching up with the West, until the collapse of the bubble economy in the early 1990s. But since the 1990s, amidst the wave of global competition that has erupted as a result of the IT revolution, comparative advantage has rested with the American-style network-based innovation system, especially in the electronics industry.

Japan's innovation system, with its primary reliance on the work of central research institutes at major corporations, has been faced with a need to remake itself since the collapse of the bubble economy in the first half of the 1990s. Corporations, their performance slipping, are losing their ability to fund expensive basic research, and their mission is shifting back towards the development of marketable products. Also, as global competition grows fiercer, product development is accelerating, and Japanese firms are beginning to shed their "go-it-alone" business practice, abandoning research and development (R&D) and opting instead for an acquisition and development (A&D) approach, where they leave basic research to others and concentrate their in-house efforts on product development. Moves are afoot to establish a system of legislation designed to encourage "choice and concentration." These moves include enactment of the TLO Law (Law for Promoting University-Industry Technology Transfer) and measures to help firms rebuild their businesses. Various policies have also been adopted to promote venture capital firms, but to change Japan's innovation system it will be necessary to reform the country's major corporations, which have thus far anchored the system. Japanese corporations need a clear-cut management strategy that will allow them to boldly focus on their core competencies and pursue strategic collaboration.

As we have seen, to reform a system characterized by institutional complementarity, it is necessary at the same time to strengthen the function of external markets, such as labor and capital markets. But if we take the Japanese system and turn it into something else, will the auto industry lose the comparative advantage that it has managed to retain thus far under the current system? Scholars have noted the emergence of a product architecture and the beginnings of production process modularity in the auto industry (Takeishi and Fujimoto, 2001), which is thought to be due to the rise of information technology and the digitization of information relating to business operations. Over the long run, it appears that it will be necessary to switch to an economic system geared to modularity. As we move in that direction, however, how do we preserve the incentive to generate creativity through the use of tacit knowledge within the firm, which has always been a big strength of Japanese corporations? This is a very important issue that we must deal with. JJTI

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