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INNOVATION AND INDUSTRIAL STRUCTURE IN THE ERA OF INFORMATION TECHNOLOGY AND GLOBAL COMPETITION

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INNOVATION AND INDUSTRIAL STRUCTURE IN THE ERA OF INFORMATION TECHNOLOGY AND GLOVAL COMPETITION*

by MINORU NISHIDA

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INNOVATION AND INDUSTRIAL STRUCTURE IN THE ERA OF INFORMATION TECHNOLOGY AND GLOBAL COMPETITION

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1. A Theoretical Review of Competitiveness and Innovation in Japanese Industries

1-1 The New Theory of Technological Innovation

Development of Japanese industries in large part has been long dependent on the basis of imported technologies from America and Europe. However, they have reached the advanced level and stage of creating new technologies through cummulative improvements, far more than mere absorption of and adaptation to the imported technologies.

The nature and process of technological development in Japan seems to be well explained with evolutional theory of technology, i.e.,"learning-by-doing hypothesis of technological innovation" presented by Devendra Sahal (1981) (1982) and with the same ideas by Nathan Rosenberg (1976) (1982) and Giovanni Dosi (1984). Also Klein=Rosenberg (1986) presented a "chain-link model" of innovation, where they emphasized interactive exchange of experiences and knowlege among various sectors of the firm.

No need to say, however, application of these theories is not to be limited to experiences of Japan. In order to explain by these theories the Japanese success in some fields of industries over the US and Western Europe, it is necessary to show that Japan had conditions more suited for the evolutional theory of innovation than other developed nations.

M.Nishida (1987) tried to do this work by refering to some behavioural and organizational characteristics of Japanese firms as follows. In Japanese manufacturing firms, there has been such a tradition that a large part of the most qualified engineers are allocated to factories instead of working in laboratories, because it is believed that a factory is the most important source of technological competitiveness of the firm. Groups of workers at the factory in co-operation with those engineers contributed to improvements of process and products, which resulted in many incremental innovations. The traditional value of the society on collective behaviour served as a solid base for effective co-operation and co-ordination among various functional groups within a firm. The "Keiretu" group, which is a group of subcontracting firms usually affiliated with a larger assembling firm, also served as an important factor to extend effective co-ordination of works to the outer zone of a single firm. These factors may be thought to encourage the process of "learning-by-doing" within the firm as well as of "learning-by-using" among the firms linked to each other in user-producer relationship.

1-2 Rationality of Japanese Organization

There soon appeared several important studies which developed more refined theoretical explanations of rationality of Japanese industrial organization. H.Shimada (1988) proposed an idea of "human-wear" by which he meant intensive interaction between workers and the machienery. He insists that in typical Japanese factories much more emphasis is put on "human-wear" than in factories of American firms, so that it leads to more improvement of products as well as higher productivity and quality in the Japanese factories.

M.Aoki (1988), also Aoki & Okuno (1996), contributed to demonstrate institutional characteristics of innovation mechanism in the Japanese firms. Aoki made clear a J-firm is characterized by "horizontal co-ordination" and "horizontal information structure," as compared with hierarchical co-ordination and "vertical" information structure in an A-type firm. This characteristic is, as Aoki claims, linked with a particular incentive scheme involving a long-range promotion scheme and lifetime employment.

B.Asanuma (1989) brought about very important new learnings in the studies of the subcontracting group called "Keiretu". Through elaborate empirical studies of the Japanese automobile and electric parts industries, he found that the rationale of grouping of the maker (assembling firm) and suppliers existed in the stylized fact of "design-in," i.e., cooperative development of parts and components for a new model, which led to perceptibly decreasing the development period and costs of the new model. Theoretically, this is explained as the effect of investment in "relational skills" by both parties.

1-3 National System of Innovation

Christopher Freeman (1987), as well as B.-A. Lundvall (1992), proposed to use an idea of the "national system of innovation" to describe the characteristics of innovation process of different nations. Freeman tried to make a definition of the "Japanese system" of innovation with four factors, including dominant influence of "reverse engineering" of imported technologies and the specific device of industrial policy for promoting information-sharing among relevant groups within the society. Alhough his approach is very interesting, it seems too much inclined to emphasize the peculiarity of the Japanese historical system.

We can refer to the analytical framework of Michael E. Porter as a more general approarch to the question. His laborious work, including comparative studies among ten industrialized nations with various characteristics, "Competitive Advantage of Nations" (1990), tries to show the general framework to analyse conditions which stimulate innovations in an economy. Then, he concludes that each nation succeeds in those industries where the "national environment" is favorable to such conditions as shown below, enabling continuous improvements and innovation in those industries. The national environment is thought to be made out of its historical factors such as culture, religion, family structure, and education system and so on.

Porter emphasizes the importance of long sustained commitments in the industry, continuous efforts for improvement of products and process as well as upgrading the skills and competitive advantages, co-operation among relevant parties of the industry, devotion of the managers and workers to their tasks, supported by continuous investments in education and trainning of the workers, co-operation and co-ordination between assemblers and suppliers (and firms in the related industries) through systematic exchange of information among them. Obviously,such factors are found as perceptible characteristics of the Japanese industrial system.

The competitiveness of Japan in some industries in international market, however, has been swiftly changing recently. Manufacturing industries of America has been focusing on improvement of the product quality and productive efficiency , fairly succeeded in it since the late 1980s. The technological gap between Japan and Asian developing countries also has been reduced through direct investments into them by Japanese manufacturing firms, which have involved transfer of technology even in the fields of high tech-

nology. In addition, an extreme change in the foreign exchange rate of the Yen has raised the costs of Japanese manufacturing substantially. Now the competitive advantages of industrial products made in Japan are not absolute but relative.

Expansion of free trade and investment around the world, along with changing exchange rates, has brought us to the era of "mega competition" in which workers in the developed industrial nations are put into direct competition with huge numbers of their counterparts in many developing countries. In such circumstances, we must reconsider the relevance of our innovation system. In this course, we may well refer to the case of the video cassette recorder (VCR) industry in order to see the inevitable process of international transfer of technology and how to deal with the outcome of this process.

2. Significant Changes in Circumstances Surrounding Japanese Industries: A Symbolic Case of the Video Recorder Industry

The Video tape recorder was first invented and produced by a medium sized American company, AMPEX Corporation, in the middle of 1950s, which became dominant in the world market of time-shift machines for the broadcasting station. Then, a long lasting race was launched in the early 1960s among electronics companies in the US, Europe, and Japan for the goal of developing a very small model for home-use video recorder*. In 1975-76 Japanese companies, SONY and JVC, each succeeded in manufacturing a workable model small enough for home-use video cassette recorder, and in the mid-1980s the JVC model (VHS) became the "dominant design" of the VCR through strategic competition in the world market.

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* Here we can refer to R. Rosenbloom & K. Freeze (1985), M.B.W. Graham (1986), and M. Nishida (1985) (1987) (1989) as well.

The Development of the VCR was far more than mere downsizing of the VTR for broadcasting use, but a decisive product innovation involving important technological breakthrough in several points. There is no need to mention a big influence of the VCR innovation on the Japanese economy and its industrial trade position in the world. However, it is true that this product innovation is not necessarily based on the adoption of brand-new technological principles, but was achieved through applying refined electronics technology combined with accumulated skills in high precision manufacturing. Important is the fact that VCR innovation was able to be completely successful only with synthesis of three elements of building-block technology, i.e.,high technology of electronics in the audio-vidual products, refined magnetic recording technology, and application of sophisticated manufacturing skills to mass production.

Observation of this VCR innovation gives us a very interesting case, when we try to show the characteristics of the stage of Japanese industrial development in 1980s to mid-1990s. It reminds us of the "product cycle" theory presented by Raymond Vernon (1966). His theory, which is composed of four propositions, intended to explain the mechanism of how domestic production of the major new products is in time replaced by overseas production. Although Vernon's model fits well in the case of colour television sets, our observation shows it does not necessarily hold in the case of VCR innovation.

[Proposition 1] Major new products and process are invented and developed in the most advanced country with the highest level of incomes and most mature and sensitive consumers. This was without doubt true of the VTR for broadcasting use as well as CTV, but is

not relevant enough to the case of VCR. When Japanese companies developed the VCR design to become dominant, the level of income in Japan was far less than that of America in the mid-1970s. In fact, Vernon's first proposition seems to follow the demand-pull thesis concerning causes of innovation. As we have shown previously, the most important factor to explain the Japanese lead in development of VCR is comprehensive accumulation of building-block technologies and skills. Therefore, in this aspect, the "learning-by-doing" hypothesis of innovation seems to be more effective in this case of VCR.

[Proposition 2] Production at the early stage of the new product is launched in the country where it has been developed. This was the case in VCR as well as in CTV.

[Propositions 3 and 4] As the design of the new product becomes matured and a method of production is established, concern about production cost begins to take the place of concern about product characteristics. In this stage, local production starts in the secondly advanced countries, where the market is rapidly expanding and labour costs are relatively lower, and then a part of the market demand of the most advanced country goes to imports from the secondly advanced countries. And in the last stage, where the product and production method become fully standardized, the less developed countries may offer competitive advantages as production locations, because competition is focused on cost and price.

Proposition 3 and 4 did hold true in the case of CTV. As for the case of VCR, however, the local production outside Japan was still limited to a small segment of the total production in the

mid-1980s after ten years since SONY and JVC first started their production of VCR to be the dominant design in the world market. At that time it was believed that mass production of the VCR in competitive cost is hard to achieve outside Japan, as it required application of high precision manufacturing technologies to mass production as well as a ready supply of a good variety of electronic parts and devices in high quality and low cost. In short, because of characteristics in mechanical design of the VCR different from that of CTV, development of local production of the VCR was thought possibly to show different behaviour than that predicted by Vernon's hypothesis.

But the situation now is drastically changed. Under the conditions of the drastic upswing in the Japanese Yen's value relative to US dollars repeated in 1985-86 and 1994-95, all Japanese VCR producers began to shift their manufacturing facilities on a substantial scale to ASEAN countries (especially Singapore,Malaysia and Thailand), and China as well. Those local assembling facilities are not bounded for supplying local demands as was the case previously, but made to work as bases of large scale production for exports to the Japanese market as well as the American and European markets. In 1994, overseas production in number by Japanese VCR makers, including joint production with local firms, exceeded domestic production in Japan. Also, the number of imported VCRs into the Japanese market from Asian countries will possibly approximate to that of exported VCRs from Japan in a few years.

One may claim, however,we should take into consieration another factor of production and export of the video camera. Certainly it is true that since the mid-1980s the market of very small video cameras for consumers' use has expanded steadily, and its domestic production and export from Japan to the world market has been

increasing in number. This contributed toward delaying the life cycle of the VCR (including video camera) industry to reach the matured stage. But, the amount of domestic production of the industry climbed to the height of 2,245 billion Yen in 1984, then declined slowly to 1,962 billion Yen in 1991, and slipped down to 1,097 billion Yen in 1993. Meanwhile, as for the VCR solely, the amount of production decreased to 1,039 billion Yen in 1991 from 2,090 billion in 1984.

Thus, the world arrangement of VCR production has substantially changed, and the prediction of Vernon's theory has come true, as the result of foreign direct investments and technology transfers by Japanese producers in response to a rapid change in the international cost advantages caused by the rising Yen's value. Now, it might require us to reconsider the competitiveness of Japanese industries generally and the nature of desired innovation to create future employment in Japan.

3. Perspectives and Industrial Policy Requirements

3-1. Changes in Trade Patterns and Industrial Structure

Through experiences of long lasting trade conflicts with USA and Europe, Japan has learned the necessity of changing the economic structure and behaviour so as to greatly expand its imports and reduce a huge trade surplus. By the continuous efforts of the Japanese government as well as leading business firms since 1986, coupled with the effect of the drastic rises in Yen's value, the trade structure of Japan has clearly changed. We find a perceptible increase in imports of manufactured goods and services in these ten years. The ratio of import of manufactured goods to the total amount of imports of Japan increased to 59.1 % in 1995 from 31.5 % in 1985 and 24.3 % in 1981. Accordingly, the share of im-

ported goods in the domestic market of the manufactured goods has significantly increased since 1985 to 1995: from 3.2 % to 10.2 % for capital goods, and from 4.8 % to 16.9 % for consumers' goods.

Among imported manufactured goods, capital goods and consumers' goods have raised their shares. The former, from 28.7 % in 1985 to 34.7 % in 1995, and the later one from 15.7 % to 30.6 %. Not only imports but also the structure of exports has widely changed. The export of automobiles and consumer electronics products decreased by a large number. Productive capacity of these products shifted to North America, EU, and East Asian areas. In the case of semiconductors, although figures of exports still show rapid growth, a large part of the total investments by Japanese IC producers has been shifted to the USA and EU, and to East Asia as well.

The number of overseas production facilities of Japanese firms in consumer electronics amounted to 311 in 1995, as compared with 138 in 1985 and 78 in 1975. It is characteristic of this industry that almost 60% of the overseas production facilities is located in the East Asian area. The ratio of overseas production to total production (in number) of Japanese firms in the industry ranges from 26.6 % (washing machines) to 53.3 % (VCRs) and 78.0 % (CTVs) in 1994. The overseas production (in number) of automobiles by Japanese firms reached a figure of 4.65 million in 1995, as compared to 10.19 million of decreasing domestic production and 3.78 million of shrinking exports to the world market.

The significant increase of foreign direct investments by Japanese manufacturing firms can be ascribed to several factors. The first is their intents to reduce trade conflicts with the USA and EU. Secondly, they had to manage to escape from the volatile change in foreign exchange. The third factor is rapidly growing

markets in East Asia outside Japan, in contrast with the matured domestic market of consumer goods. They prefer to produce "in" or "near the market", in order to catch the larger share of the growing local markets.

In place of consumer goods, whose share in Japanese export has fallen to less than 20% in 1995, exports of various capital goods and machinery parts raised their share of the total exports from 40% in 1982 to 61.6 % in 1995. In parallel with this change, we can observe an increased variety of exports, instead of concentrated exports in a few specific goods of extremely large volume such as colour TVs, VCRs and automobiles. Also, we can refer to a tendency of departure of the Japanese economy from "full-set type" industrial structure, as an enevitable consequence of the shift in the pattern of Japanese foreign trades from "vertical" to "horizontal" structure. Here we mean by the term full-set type industrial structure that a nation builds and maintains capabilities within borders enough to supply almost every kind of manufactured goods.

It is not only an actual but also a necessary condition that Japan be more and more inclined to production and export of a rich variety of high-functional or original capital goods and intermediary goods, in order to be able to co-exist with the industrial development of the East Asian area. At the same time, it is also necessary for Japan continuously to make more efforts for developing major new products in the field of consumer goods, in order to maintain technological skills resulting from active interaction of manufacturing experiences with the related stages or process of production.

At any rate, the site of production of even a new product may be transfered to the developing countries sooner than before, so

that the developed nations must contantly be creating innovations and new employment for the people, if they want to hold or raise their income level. Is this possible or not? When it becomes difficult, we might have time to reconsider our way of life, but hopefully not in the very near future.

3-2. Dereguration and Innovative Competition

The real risk with which Japan is confronted is that the efficient industries exposed to international competition will not be able to stay in Japan and become "hollowed", as a result of the excessive rise in the Yen's value, while overemployment and inefficiency in many other domestic industries remain pervasive because of government regulation and protection from outside competition. To expand government spending is of no use in the long run to resolve the problem. It is mportant is deregulate those industries such as communication, transportation, distribution, finance and insurance, and agriculture. Deregulation and open competition will lead to more innovations in all industries as well as increased efficiency and real incomes of the whole economy.

In the era of "mega competition", the US, Europe, and Japan must face vigorous competition from NIES and many developing countries, and thus manage how to maintain domestic employment. Certainly, as it is located nearest to the "hot spot" of economic growth, Japan is thought to have relative advantages in taking benefits from the economic growth of this region. At the same time, it is required that Japan open her domestic market for the products of those developing countries. In order to take this role, Japan has to promote innovation and create new businesses involving new employment. Such innovations are required that

create major new systems of products or services as well as process innovation.

Moreover, in the context of "mega competition", we must pay more and more attention to the global environment problem. Certainly, Japan has already much contributed to the world in the field of environment protection; for example, it developed new types of car engines with low emmisions and less consumption of energy, as well as pollution control and energy saving in processing industries such as steel and petrochemicals. But much more effort of the whole developed nations is demanded for development and diffusion abroad of environmental technology and systems. In this context, we should not lessen but rationalize and maintain environmental regulation, in spite of the general trend toward deregulation.

3-3. Innovation and Small Firms in the Era of Information Network

A New form of industrial organisation, "network organization" is becoming pervasive. Here two types of capability are to be needed: ingenuity to "edit" new works on network, i.e.,to propose a creative idea and shape network organisation among firms to realize it, as is emphasized by Kenichi Imai (1990), and on the other hand, intensive and refined skills to perform works in any specific field. On either side, small and medium sized firms will have good possibilities to play an important role.

Up to the present, small firms have taken an important part in the industrial development of Japan; as suppliers of components for mass production goods, or as specialty suppliers of machinery parts and materials with which to support product/process development of large firms. They have been often affiliated to large

firms in "KEIRETU" groups, the rationality of which is accounted for with the efficiency of "repeated" or "continuous transaction" as demonstrated by the elaborate work of Asanuma (1989), and recognized by the report of MIT study group, M.L. Dertouzos et al. (1989). In the coming electronic network society, small firms may have more opportunity to develop more open, free and flexible cooperation with other firms, either small or large, instead of rather the closed relations of "Keiretu" groups.

More important is their ability of insight into future chances of technology and demand, their alertness and flexibility, and venture spirits to undertake risk. It seems that a strength of the Japanese automobile industry has been in large part built on this point. There is more risk in big firms that many new ideas and proposals brought forth in the day-to-day operation should be neglected or rejected by bureaucracy of the hierachical organization, because most of their information appears trivial to the upper managers of the huge organization. In contrast, for a small firm a little new idea may well have real, significant value to multiply its revenue or profit, so that its managers will not look over any little chance to improve efficiency and their products. This is a reason why Japanese industrial organisation characterized by "Keiretu" groups could show more dynamic efficiency than that of America with more vertical integration.

Nevertheless, much more creativity of small firms and ventures is really needed in the present Japan, because it has already passed the catch-up stage to follow the advanced economies, and is stepping into the frontier together with other most developed nations, where there is no assured model to follow.

At the same time, it is also important, as Ian Macmillan (Professor of Pennsylvania University) emphasizes, for large firms to

promote "corporate venturing" in order to activate their organisation toward innovation. Furthermore, large firms should pay more attention to the observance of intellectual property rights of small firms. In the past, some large firms in Japan were apt to oppress small firms by acting against the intellectual property of small firms with their own advantages in the size of resources under their control, i.e., larger ability in finance and sales. In order to promote open network organization, it is deemed necessary such a situation should be altered.

In order to promote a new age of venturing, we have to improve our social infrastructure. Especially, education in Japan must change, so as to prepare young persons who have the creativity and self-reliance to live independently in the open and global society. For this to become true, environmental conditions around education in Japan, especially attitudes of the business world toward employment practices must change so as to encourage parents and teachers to change their thinking about the object of our education system.

One more phenomenon deserves to be investigated here, as related to the era of electronic networking technology and mega competition. Since the early 1990s some Japanese manufacturing firms began to try a new assembling method, called the "cell system" or work-shop system, in their factories. This intends to satisfy the needs of quick and flexible response to increasing variety and volatile change of demands in the advanced countries in this decade. The new production method is characterized by a definite decision to remove a long assembly line composed of conveyer systems and robotic machines, and substitute it with many small working teams, each of which is resposible for a production lot throughout the complete assembling process*.

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* Nikkei Business (1995), and *Nikkei Sangyo Sinbun*, 4 Apr.1996.

This method has proved far more efficient than the automatic assembly line when producing a small lot of products changing day by day, instead of mass production of the same one model of a product. Therefore, it seemed to be a very good idea that mass production of standardized products should be assigned to local factories with low wage rates in developing countries, while the factories in the home land are specialized in production of high-priced, new functional types of the products with flexible systems of production.

Recently, however, this new method of flexible production has proved to be also applicable to local factories in the developing countries**. If the overseas factories with flexible manufacturing systems are to be connected with the corporate center in the home country by way of advanced communication networks, then the relative advantages of home factories will sooner or later disappear. When this becomes true, there will be a new type of the "cluster" of industries connected overseas by digital communication networks.

This means we have to reconsider the competitiveness theory of Michael Porter (1990), who emphasized that when the "cluster" of related industries is built up within borders it will reinforce competitive advantages of the nation in that industry. The exhisting cluster in the home country may be broken down if they do not find alternative ways to hold their linkages. There may be two types of industrial clusters: one is an extensive international cluster of the supplying/related industries connected overseas via digital communication networks, and the other one is a new type of domestic local cluster of specialized small and medium sized firms which will be exploiting advanced information technologies.

** *Nikkei Business*, 11 Sept., 25 Sept., and 2 Oct. 1995.

3-4. Social Orientation concerning Innovation

While removing government regulations toward industries and promoting free competition, we need industrial policy to encourage such innovations that are desired by our society but not expected to be smoothly realized through market mechanisms.

The most urgent neccessity of our society should be innovations which greatly contribute to overwhelming the restriction of the global environment and energy resources for economic growth. It is the consumers, in principle, who are most resposible for the protection of the environment of the earth. But, environmental regulation is required to force the established business firms to spend more efforts on the protection of the earth's environment. It will also encourage new ventures to develope prospective technologies.

At the same time, such innovations are naturally subject to the strong desire for appropriation of them, because they can be utilized to increase competitiveness of business firms or nations who possess them. Therefore, we have to invent the way how to make the benefits from such innovations the common wealth of all nations.

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