JAPANESE / US COMPARATIVE ADVANTAGE: WIDTH AND DEPTH OF CO-ORDINATION

Hajime Oniki

Department of Economics, Osaka-Gakuin University, Osaka, Japan

INTRODUCTION

There is a remarkable difference in the overall performance of Japanese producers relative to American ones in the 1970-80s and in the 1990s. Japanese corporations performed very well in producing automobiles and electronic appliances in the 1970-80s, but they did quite poorly in producing personal computers (PC) and information-telecommunications (IT) services in the 1990s. This chapter attempts to explain the difference. First, a brief summary of the growth of the postwar Japanese economy is given with emphasis on the importance of strategic industries. The chapter then discusses the characteristics of the process by which each product or service is created, produced, and improved.

To lay a basis for the analysis in this chapter, we consider the co-ordination for production of workers of corporations. Two measures will be introduced to characterise co-ordination: width and depth. The width is the size of the range of co-ordination activities; it may be expressed by the number of workers who participate in the co-ordination in question. The depth is the average intensity of co-ordination activities; it may be represented by the degree to which co-ordinating workers understand each other. It is pointed out that the relative importance of the width and the depth of co-ordination differs depending on the characteristics of each product or service. On the one hand, the depth plays an important role in producing such goods as automobiles and electronic appliances. On the other hand, the width is more important in producing network-type goods such as PCs, hardware and software, and IT services.

The chapter then compares Japanese corporations with American ones with respect to the width and the depth of co-ordination. On average, the depth of co-ordination is greater in Japanese corporations, whereas the width of co-ordination is greater in American corporations. Thus, the difference in the performance of Japanese corporations between the 1970-80s and the 1990s came from the shift in the strategic industry of Japan from automobiles and electronic appliances to PCs and IT services. Comparative advantage of Japanese corporations was changed in accordance with the difference in the characteristics of co-ordination between the two countries. The chapter concludes with other explanations of the absence of comparative advantage in the PC and IT industries in Japan.

Background

This chapter is a case study in the economic theory of organisation and information, in which Don Lamberton played a pioneering role in the 1970s and 1980s (Lamberton, 1971, 1988, 1992). The theory emphasises the importance of the flow of information to the functioning of various economic organisations, such as firms, corporations, governments, nonprofit institutions, and society as a whole (see Putterman and Kroszner, 1996; Buckley and Michie, 1996). Co-ordination is the form of work in economic organisations, and the flow of information is a primary means of co-ordination. This chapter presents an approach for characterising economic organisations by distinguishing wide and deep co-ordination. The distinction is related to, but not the same as, that of market and command, or that of centralisation and decentralisation.

Japanese organisations, particularly Japanese corporations, have drawn the attention of research scholars since the 1980s, because the performance of Japanese corporations in manufacturing, especially in automobiles and electronic appliances, was high in the 1970s and 1980s. Attempts were made to explain the source of the high performance of Japanese corporations and the underlying structure of Japanese society was particularly investigated (for example, Johnson, 1982, 1995; Aoki, 1988; Wolferen, 1989). It was pointed out that Japanese style co-ordination, as was seen in tightly-formed workgroups, close relation between labour and management, and lifetime employment, contributed significantly to the high performance of Japanese corporations.

In the 1980s, the growth centre of the economy in advanced countries was shifted gradually from manufacturing to the PC and IT industries. This trend has been studied by a group of social scientists, Don Lamberton being an active leader in this research area (Lamberton, 1992a, 1993, 1995, 1995a). Recently, however, it was pointed out in Japan that the growth of the Japanese PC and IT industries was far slower than the growth of these industries in the US and in other advanced countries. Research workers have attempted to explain this observation, but no agreement has been reached as to its cause (Kokuryo, 1997; Methe et al., 1997; MPT, 1996). The main objective of this chapter is to provide an explanation of this observation from the standpoint of the distinction of deep and wide co-ordination.

COMPARATIVE ADVANTAGE IN THE JAPANESE ECONOMY

The role of strategic industries

The development of the Japanese economy during the postwar period depended on the success of a small number of strategic industries. The Japanese economy, at each stage of its development, was able to generate one or two strategic industries having the capability of exporting goods to the world market. In the 1950s, the textile industry was the driving force of the economy, and in the 1960s, shipbuilding became the most important exporting sector. The iron and steel industry was the source of development of the Japanese economy in the 1970s. Since the beginning of the 1980s, two industries (automobiles and electronic appliances) have been contributing to the Japanese economy as major strategic industries. What industries, if any, will become strategic to the Japanese economy in the coming age?

The determination of strategic industry depends on the level of technological development, the skill and the cost of the labour force, the availability of capital and money, and, above all, the structure of the world trade market. This is nothing but an application of the principle of comparative advantage in the international division of labour. Until the middle of the 1980s, the core of the development of the Japanese economy was in the manufacturing sector, from which all of the Japanese strategic industries emerged. The sectoral composition in the overall economic trend was changed in the 1980s; the service sector, particularly the IT-related industries, became the main source of economic growth.

In the 1990s, the Japanese economy has not been able to find a new strategic industry; it is merely riding on the momentum from the past. A significant portion of the two strategic industries of the 1980s (the automobile and the electronic appliance industries) has moved to other East and Southeast Asian countries. Automobiles are still assembled in, and exported from, Japan, but a large portion of the parts of automobiles produced in Japan is imported today. Factories making electronic appliances have also moved out of Japan, although products with high value-added can still be produced competitively within Japan. It is clear that Japan is rapidly losing comparative advantage in automobiles and electronic appliances; without some new strategic industries, Japan will likely face a squeeze from the international balance of trade. In the worst case, the level of per capita GNP in Japan may start decreasing.

The PC and IT industries in Japan

The need for strategic industries has long been recognised by MITI (the Japanese Ministry of International Trade and Industry). For most of the industries strategic to the Japanese economy in the past, MITI adopted industrial policies, such as protection during the period of infancy and promotion of research and development. Most of MITI’s policies were successful and contributed greatly to the growth of the Japanese economy.

As early as the mid 1960s, MITI considered the computer industry (mainframe computers then) to be a potentially strategic industry for the Japanese economy. MITI, together with NTT (then the NTT Public Corporation), protected and subsidised the NTT family of manufacturers of telecommunications equipment so that they might become competitive producers of mainframes. As a consequence, major computer manufactures in Japan, such as NEC, Fujitsu, Hitachi, and Toshiba, survived within Japan despite the world-wide dominance by IBM. Further, starting in the late 1970s, MITI also subsidised research and development for LSI (large scale integrated circuits) by these manufacturers. Consequently, the productivity of LSI memories in Japan was raised significantly toward the middle of the 1980s to the extent that trade frictions took place between the US and Japan.

The personal computer industry was born in the beginning of the 1980s. During the fifteen years after its birth, the PC industry grew virtually from nothing to the size of the telecommunications industry or of the broadcast industry. As is widely known, the PC is a child of the mainframe computer. By the time the PC was born, the design and the operation of mainframe computers had been well developed. The distinction between hardware, operating systems, and applications software had already been established. The main objective at the time of the birth of the PC was how to create a new type of computer smaller in size, and cheaper in value, than mainframes. The drive for creating PCs was promoted by the emergence of LSI. In particular, the advent of the MPU (microcomputer processing unit, or CPU: central processing unit) was a key factor in the creation of PCs. Thus, at the time that the PC was first marketed in the US, in European countries, and Japan, the idea of the PC today was already there. In short, it was considered to be a miniature of mainframes.

When the production of personal computers started in the early 1980s, however, MITI adopted virtually no industrial policy for the PC industry. The Japanese PC industry was thrust into a competitive environment, although MITI did not appreciate this. Probably, MITI was too busy with the LSI industry to extend protection to the emerging PC industry. MITI may have considered LSIs an indispensable element in almost all industrial activities, whereas the PC industry seemed to be just a branch application of LSIs. Also, MITI may have adopted no industrial policy for the PC industry because the PC was considered to be a miniature of mainfranies, which were the core of computer products.

There was an expectation in Japan that, because the future PC was considered to be a miniature of the mainframe, Japan would receive comparative advantage from predicting PCs. Japanese corporations were well known, by that time, for their capability in creating miniature products, such as transistor radios and portable tape recorders. Although Japanese corporations might not be able to create a new product or service from scratch, they were good at improving and trimming a product which had been produced and sold in the market. The PC at the beginning of the 1980s fitted this model perfectly. In addition, the PC was considered to be similar to electronic appliances, for which Japanese producers possessed comparative advantage. After all, the PC is a product made by assembling electric and electronic parts, as electronic appliances are.

Today, we know that this expectation did not materialise. Almost all major software products used in Japan are imported from the US, though the minor changes of rewriting the language from English to Japanese may be made in Japan. Second, the operating system is the monopoly of the Microsoft Corporation. Third, even in the area of hardware, Japanese products barely compete with US ones. New ideas in designing hardware and software seem to come exclusively from the US. The overall performance of the Japanese PC industry, when compared with that of other manufacturing industries, such as automobile and electronic appliances, is a disappointment to the Japanese. The objective of this chapter is to pursue an answer to the question: Why was the performance of the Japanese PC industry low relative to that of the American PC industry?

Computer software, telecommunications services, and other IT products and services were also considered in the early 1980s to be candidates for strategic industry status. Computer software is a product close to computer hardware; anyone who can produce computer hardware efficiently should be able to produce computer software efficiently. Telecommunications services can be viewed as an extension of computer services, too. First, for telecommunications, computerised equipment, such as smart terminals and digital switches, is widely used. Second, telecommunications networks combine computers (terminals). The properties possessed by computers should, therefore, be shared by telecommunications networks. Third, a telecommunications network may be viewed as a giant computer in which the functions are not concentrated in one geographic location, but distributed and dispersed in many distant locations. In the late 1980s and the early 1990s, a great deal of effort was concentrated on producing computers, software, and telecommunications services in Japan as efficiently as possible. The quality and the quantity of skilled labour devoted to producing them was remarkable. The outcome of these efforts devoted in the PC and other IT industries, however, was quite different from the outcome in the automobile and the electronic appliances industries.

CHARACTERISTICS OF PRODUCTS AND SERVICES

Determinants of comparative advantage

We will attempt to explain the presence and the absence of comparative advantage in Japan with such products as personal computers, telecommunications services, automobiles, and electronic appliances. This section is devoted to comparing the characteristics of each of these products. In the standard economics textbooks, it is stated that comparative advantage of a product is determined by technology and factor endowments. Such a statement may be appropriate to explain the difference in comparative advantage at large. Examples include the one between agriculture and manufacturing, or the one between lightweight manufacturing and heavyweight manufacturing. Here, however, we are concerned with comparative advantage of products classified into finer categories; say, personal computers and electronic appliances. For such a microscopic comparison, factor endowment, such as the capital-labour ratio, is not important; the main determinant of comparative advantage should be sought with some aspects of technology and management spelled out in more detail.

We need to consider technology and management for creating and developing a new product, for constructing a production system, and for improving the product and the production system. The level of technology and management appropriate for this kind of analysis depends on the quality and the type of technology-oriented workers and how they are organised. It should be the case that some difference in the characteristics between PCs and electronic appliances, on the one hand, and the level of technology and management of producer corporations, on the other hand, interact with each other to generate the presence or the absence of comparative advantage.

Comparison of the structure of products and services

Tables 1 and 2 list the products (and services) we will examine in this chapter. We are interested in PCs and IT-related products, such as telecommunications hardware/infrastructure and telecommunications software/services, as they are candidates for strategic industries for the Japanese economy in the future. For the sake of comparison, we also consider automobiles and electronic appliances, since Japan obtained comparative advantage in them in the 1980s. We also consider LSI (CPU and memories), since Japan also obtained imperfect comparative advantage in LSI memories in the 1980s, and LSI is an information-related product. Thus, we will consider eight products altogether: telecommunications hardware/infrastructure, telecommunications software/services, PC hardware, PC software, automobiles, electronic appliances, LSI used as the CPU for PCs, and LSI used for memories of PCs. We are interested in finding the presence of comparative advantages in Japan with automobiles and electronic appliances in the 1970-80s, and the absence of comparative advantages with telecommunications hardware/infrastructure, telecommunications software/services, PC hardware, and PC software in the 1980-90s.

In general, a product has many characteristics, such as physical properties, economic data, utility to users, characteristics in the production process, and so on. We are concerned with those characteristics which have direct relationships with the level of technology and management. In particular, we will compare these eight products from two standpoints: the structure of each of the products, and the characteristics of research and development for each of the products. In addition, we also compare each of the products in terms of institutional factors affecting free entry and promotion of competition. In the second row of each of Tables 1 and 2 is entered the location of comparative advantage for each of these products. The US has comparative advantage in telecommunications software/services, PC hardware and software, and LSI, particularly CPU. Japan has comparative advantage in automobiles and electronic appliances. Comparative advantage in telecommunications hardware/infrastructure and LSI for memories is shared between the US and Japan.

We first concentrate on the physical and the functional structure of each of the eight products. It is seen that the first six products in Table 1 are produced by combining parts or assembling components. Telecommunications hardware/infrastructure is a network system, which is composed of cables, switches, terminal equipment, and so on. PC hardware is far smaller than telecommunications hardware/infrastructure, but it is composed of components, too. Telecommunications software/services and PC software are software-type products. A software-type product is a collection of steps (for example, orders or instructions) to be followed by computer hardware (in the case of PC) or by a telecommunications network system (in the case of telecommunications services). Frequently, the steps composing a software-type product are grouped into a set of subprograms. Furthermore, sub-programs are grouped into upper-level programs, and so on; the entire system possesses a hierarchical structure. Unlike telecommunications hardware/infrastructure or PC hardware, the components of a software-type product are combined not physically, but informationally. As a consequence, as indicated in Table 1, the degree of flexibility of the interface among the components of a product differs depending on whether the product is assembled physically or assembled logically. Software interfaces are flexible so that a portion of a product can easily be changed or replaced. The same is true with telecommunications hardware/infrastructure or with PC hardware. The interface between their components, however, is less flexible; it needs more work to replace a part of the hardware product than a part of the software product.

Automobiles and electronic appliances are also produced by assembling parts. Needless to say, they are hardware products. In that sense, they are similar to telecommunications hardware/infrastructure and PC hardware. However, the interface between hardware components is stronger with automobiles and electronic appliances than with telecommunications hardware/infrastructure or PC hardware. It is rare, if not impossible, to replace a part of an automobile with a different part except for consumables, such as tyres and batteries. One could modify a part of an automobile, say, a steering wheel, if so inclined. However, such modification or replacement is not common. Certainly, it is not intended when the automobile is designed. In the case of electronic appliances, replacing a part of the product does not occur except when a part is broken. As a consequence of this, every part of an automobile or of an electronic appliance is designed to wear out at approximately the same time. In contrast, a part of telecommunications hardware/infrastructure or a part of PC hardware can be replaced or upgraded at the user's convenience. In summary, the degree of the flexibility of interfaces is highest with telecommunications and PC software, second highest with telecommunications hardware/infrastructure and PC hardware, and lowest with automobiles and electronic appliances.

The last two products in Table 1, CPU and memories for PCs, are produced in one piece; they are fabricated, not assembled. Hence, there is no possibility of upgrading the CPU or memories by replacing a portion, though upgrading is possible by replacing the entire unit. When a part of the product is broken, there is no way to fix it. For this reason, we can state that, although LSI is produced for information processing, it is structurally closer to automobiles and electronic appliances than to telecommunications hardware/infrastructure or PC hardware.

Comparison of R&D for products and services

The characteristics of the structure of each of the eight products are reflected in the way R&D is carried out. This is summarised in the rows of Table 2. First of all, we compare R&D investment for each product. For telecommunications hardware/infrastructure, R&D investment is large, since the telecommunications network is large and expensive and is extended to the entire country. For example, a switch for a telecommunications exchange is shared by, say, one thousand subscribers, and optical fibre can transmit one thousand telephone calls at the same time. It pays to invest a large amount of money to develop a new type of telecommunications switch. The R&D investment needed to develop a piece of software or a service may not be as great as in telecommunications hardware/infrastructure. The exact amount of investment, of course, depends upon the function of the software and the contents of the service.

When it comes to personal computers, the R&D investment for hardware and software is far smaller than that for telecommunications, since the economic size of a telecommunications network and the economic size of a PC are very different. In Table 2, the R&D investment for PC hardware and PC software is indicated respectively as medium and small. Automobiles need a large R&D investment, but a medium gestation period. R&D investment for electronic appliances is smaller, and its gestation period is shorter, than for automobiles. This comes from the fact that the average price of electronic appliances is far lower than the average price of automobiles. LSIs are very small in size, but the R&D investment is large and the gestation period is long, particularly for CPUs. It is reported that the initial design of a 32-bit CPU architecture was started as early as the mid-1970s, 20 years before the shipment of Intel 486, the first 32-bit CPU. Even for memories, R&D investment is very high and the gestation period extends for several years.

CHARACTERISTICS OF CO-ORDlNATION

Width and depth of co-ordination

All of the products listed in Tables 1 and 2 are the outcome of sophisticated engineering and managerial efforts. A single output relies on the co-ordination of a large number of workers, professional and others. For this reason, the way in which co-ordination for production is achieved affects strongly the quality and the price of each of these products. We attempt to explain the presence or the absence of comparative advantage in the US and Japan with each of these products in terms of the difference in co-ordination between the two countries. To do this, we first describe the characteristics of co-ordination in the US and Japan.

To avoid any possible misunderstanding or confusion, let us clarify the meaning of co--ordination used in this chapter. In general, co-ordination in economic activities indicates the fact that goods and services are produced by combining the labour of workers who have different skills. Thus, co-ordination always comes with division of labour. A classical example of co-ordination occurs in Adam Smith’s manufacture of pins. Today, co-ordination exists within a large corporation composed of factories, headquarters, administration offices, warehouses, and other branches engaging in various functions. Co--ordination also exists between corporations. Economic theory commonly states that sellers and buyers of a product co-ordinate in the market; they are guided by the price of the product working as a signal. In this chapter, we deal with the co-ordination on the supply side of a market (co-ordination between the producers of the goods), since our objective is to compare comparative advantage between Japan and the US in a particular industry. Thus, we will talk about co-ordination, e.g., between producers of PCs in the US and producers in Japan.

Co-ordination on the supply side of a particular industry may be dealt with from a variety of viewpoints. Rather than attempting to list all of the possible co-ordinations on the supply side, we will pick up those co-ordinations which play an important role in the determination of comparative advantage in the US and Japan. In general, comparative advantage obtains when the product is supplied with high quality and low price. Therefore, we will concentrate on the co-ordination which is useful in bringing about quality improvement and price reduction. There are two areas of activities which particularly affect the quality and the price of a product: R&D and production management. In the following, we will focus our attention on co-ordination in these two areas of activity. Thus, we are going to compare co-ordination in the US and co-ordination in Japan in R&D and production management. In order to express the difference in co-ordination between Japan and the US, we consider certain attributes of co-ordination. We are interested in the width of co-ordination and the depth of co-ordination.

The width of co-ordination is the size of the range of co-ordination activities; it is typically expressed by the number of workers who are directly or indirectly involved in the co-ordination. For example, when we consider R&D in designing a new type of LSI, the number of workers comprising the team engaged in the development of the new type is the width of the co-ordination. When a telecommunications provider decides to purchase software in order to offer a new type of service on its network, then the width is expressed as the total numbers of workers participating in the teams of the software vendors which could sell appropriate software to the telecommunications provider. When several software vendors compete with each other and only one can sell a product to the telecommunications provider, we still consider the size of the co-ordination to be the sum of the workers in all of the software vendors which could sell their product to the telecommunications provider.

The depth of co-ordination is the average intensity of co-ordination activities; it indicates how closely the activities for the co-ordination are combined. It may be called the strength, or the density, of the co-ordination. Roughly speaking, the depth of co-ordination is the amount of information which needs to flow between the workers engaged in the co--ordination. For example, in a team engaged in R&D for a new type of automobile, the design work needs a lot of information exchange between the members of the team; thus, the depth of such co-ordination is great. In reality, the workers in such a team need to talk a lot to each other, need to pass and receive many documents and diagrams, need to meet many times in conferences, and so on.

The attributes of co-ordination are not limited to width or depth. Co-ordination is a fundamental human activity and has many characteristics. In this chapter, however, we will limit our attention to width and depth only, since these two are by far the most important in determining comparative advantage in the products listed in Tables 1 and 2.

Comparison of co-ordination in the US and Japan

Co-ordination within a large corporation may, to some extent, be similar in the US and Japan. Such a corporation will typically carry out its R&D with its own resources. The development of a new product takes place largely within the R&D department. In the case of automobiles and LSI memories, a large team is formed within the R&D department to develop a new model. In the case of telecommunications software/services and electronic appliances, multiple teams for developing a new product or service may be formed in a corporation; in many cases, they compete against each other. From the standpoint of the corporation as a whole, this pays even if only one of the teams succeeds.

Japanese corporations are known for their lean production management. In many cases, production activities are performed by a number of teams of relatively small size; the number of workers on a production team is somewhere between five and fifteen. The width of co-ordination in such a team is limited, though the depth is great. Every member of the team knows everybody else very well, not only what task each team member is assigned, but also how each performs the assignment. Thus, when a machine being used by the team breaks down, or when one of the team members is absent for several days, it is possible for the team to continue without significantly lowering the efficiency of the team as a whole. Efforts to strengthen the depth of co-ordination in such a team are made even outside work hours. For example, team members frequently go out to dine or have a party together in order to get to know each other well. The system of permanent employment, which is common in Japanese corporations, helps develop deep co-ordination.

Thus, a prominent characteristic of Japanese co-ordination lies in its depth. The cost of having deep co-ordination, naturally, is the width of co-ordination, which is usually small in Japanese corporations. Since the workers in a team tend to communicate intimately with a relatively small number of fellow workers, a solid team is formed as a consequence, and it is difficult to form a large team. In the typical case, Japanese workers do not communicate with others outside their own team. This characteristic of Japanese co-ordination may be viewed as a culture or tradition of Japanese society. Japanese people are educated from childhood to adapt themselves to such an environment. Almost all of the social structures in Japan are formed to support, and to be supported by, Japanese-type co-ordination. In short, we can regard it as part of Japanese culture.

In general, co-ordination in the US, in contrast to that in Japan, can be characterised by its width. In the US, the importance of communication with fellow workers in teams is not as great as in Japan. Instead, US workers spend more time and effort communicating with workers outside their teams. Again, this is part of the culture of American society. In this chapter, we accept this finding as given and consider its implications. First of all, labour mobility is higher in the US than in Japan; in particular, there is less permanent employment in the US. There are workers in the US who continue to stay in one organisation for a long time as a consequence of their own choice and their employer's choice. There is certainly cost to the worker of moving from one organisation to another, and also there is cost to the employer of replacing one worker with another. In Japan, both the cost of changing a place to work and the cost of replacing a worker are much higher than in the US. The high cost of moving and replacing in Japan may be a source of, and also a consequence of, deep co-ordination. An implication of wide co-ordination in the US is that the domain of procurement for a product is wide. Thus, US corporations purchase from suppliers outside their own organisations as well as inside. One could say that US producers are more open than are Japanese producers.

EXPLANATION OF COMPARATIVE ADVANTAGE

Automobiles and electronic appliances

Japan obtained comparative advantage in automobiles and electronic appliances in the 1980s, and the value of exports of these products exceeded that of any other Japanese exporting industry throughout the 1990s; they are the strategic industries of Japan at the present time. Automobiles and electronic appliances have more similarities than differences according to the characteristics listed in Tables 1 and 2. These products are assembled from parts, and the interface between the components of a product is strong for both of them. Product-improving R&D is performed mostly within the corporation. The difference between automobiles and electronic appliances arises from the difference in unit price. Roughly speaking, the average price of an automobile is ten to twenty-five times greater than the average price of an electronic appliance. Consequently, the number of models supplied by a producer is far greater with electronic appliances than with automobiles.

Both R&D and production management in automobiles and electronic appliances fit Japanese-type co-ordination. The development of a new product is undertaken internally by a team of workers co-ordinating closely; i.e., under deep co-ordination. The average size of an R&D team in automobiles is far greater than in electronic appliances. In automobiles, the overall design of a new model is determined by the time that the development project is started, so that every R&D team responsible for the detailed design of the model is supposed to be successful in its project. The exception to this is a basic research team, such as one developing a new technology. In electronic appliances, when R&D for a new product is started, multiple R&D teams are formed to investigate diversified possibilities for development. Each team works more or less independently and perhaps one R&D team out of ten succeeds. The reward to each of the R&D teams, however, is not much different (except for an exceptional contribution).

Thus, the way R&D is performed in the automobile and the electronic appliances industries is similar, despite the different average size of an R&D team. An R&D team attempts to co-ordinate closely to combine the efforts of each member of the team. Such an objective is most likely to be achieved in Japanese corporations relying on deep co-ordination. Deep co-ordination in each team plays an important role in integrating the work of the members of the team. A team does everything to design and develop a new product. Different members of the team design different parts of the new product. Without deep co-ordination, the components of the new product would not fit together. A deeply co-ordinated team will achieve the best output from the components.

In the production management of automobiles and electronic appliances, too, the Japanese-type co-ordination works very well. The production of an automobile or of an electronic appliance starts with the production of each of its parts. In many cases, parts producers in Japan are subsidiaries of the automobile corporation and are closely controlled by it. Deep co-ordination is observed in the relation between the parent and the subsidiary corporations. This is desirable since automobiles and electronic appliances are produced in large quantities. Once a model is developed and designed, and a production management system is established, the main objective is to maintain a smooth stream of production from parts to the final product. Minor improvements for minimising the damage from troubles in the production system and for cost reduction are quite effective. In Japanese corporations, such minor improvements are realised through deep co-ordination. By exploiting the advantage of deep co-ordination, Japanese producers of automobiles and electronic appliances succeeded in model development and cost reduction in the 1980s to secure a large share of Japan's total exports. Even today, Japan retains a comparative advantage in automobiles and electronic appliances.

LSI: CPU and memories for PCs

Large scale integrated circuits (LSI), as the name suggests, are produced in one piece as an integrated product. The ways in which CPUs and memories are designed are the same, except that the degree of complexity of circuits is far greater within CPUs than in memories. A team with deep co-ordination should perform the design and the development of LSI. Production management of LSI, CPUs, and memories also calls for deep co-ordination. Once a particular model of CPU or of memory is established and its production is started, the production line should be managed and maintained by a team with deep co-ordination. For instance, maintenance of a clean-air environment is vital in LSI production. Lack of deep co-ordination may lead to contamination of a tiny portion of the product, leading to massive rejection of products. Minor and partial improvements of an LSI production line are not inconceivable, but these would reduce the advantage of large-scale production. The production of LSI is similar to the production of information in that the initial investment is very high but the marginal cost of production is low since the production of each piece is done by copying the mother circuits. Such characteristics of R&D and production management of LSI should fit with Japanese-type corporations, since deep, rather than wide, co-ordination is called for. However, in reality, the supply of CPUs for PCs has been effectively monopolised by the Intel Corporation, a US producer. US comparative advantage in producing CPU came not from the difference in the mode of co-ordination, but from a technical monopoly. Intel started producing CPUs in the early 1970s and has retained a monopoly on each successive CPU model until today.

Comparative advantage for producing LSI memories has been shared by US and Japan since the middle of the 1980s. Initially, the US had a comparative advantage in memories. In the middle of the 1980s, MITI led major Japanese corporations, such as NEC, Hitachi, and others, to promote intensive R&D for producing LSI memories. These Japanese corporations paid a great deal of attention to establishing and improving an efficient production line for memories, thereby increasing the rate of turnaround and decreasing unit cost. The export of LSI memories from Japan to the US was increased significantly in the middle of the 1980s; microchip trade wars took place between the US and Japan. In the middle of the 1990s, the US and Japan share comparative advantage in LSI memories; they both export and import, and the trade balance in chips between the two countries is somehow maintained. Japanese corporations tend to produce ASICs (application specific integrated circuits), whose characteristics lie between those of CPUs and memories.

PC hardware and software

PC hardware is a physical product assembled from components such as a CPU, hard disks, a keyboard, a display, and others. Each component of PC hardware can be designed and produced independently of others since the interface through which a component is combined with other components of PC hardware is standardised and predetermined. In other words, PC hardware is a single product in the usual sense, but it is not a single product in the following sense: PC hardware is a collection of components (products) connected with each other systematically but loosely. In this sense, PC hardware is like a network; a component may be replaced or upgraded as long as the interface requirement is satisfied. In this chapter, we call such a product a network-type product.

Historically, the design of the PC was derived from that of the mainframe. In this sense, the PC is a miniature descendant of mainframes. Since Japan was successful in producing miniature products, such as transistor radios and cassette tape recorders in the 1960-70s, it was expected that Japan should be able to obtain comparative advantage in producing PCs. Actually, Japan did not. From the time the PC was produced in large numbers in the early 1980s, i.e., the time the IBM PC was introduced and dominated the business PC market, the US kept significant comparative advantage in producing PCs. Until 1992, however, the Japanese PC market was effectively separated from the US because of language difference. In 1992, however, thanks to significant technological progress, the language barrier was removed and a rapid increase in the import of PCs from the US to Japan started. The average price of PCs in Japan dropped by 50 per cent within a year. Major Japanese corporations producing PCs have been struggling to keep their market share in Japan by giving up most of the profits they had enjoyed prior to 1992. Since Japanese PC producers are large and they have diversified into other computer-related products and communications equipment, they can afford to do this.

Why did the US achieve comparative advantage in producing PC hardware? The answer is the efficiency achieved by wide co-ordination. The fact that the PC is a network-type product, and not a product like automobiles or electronic appliances in which the components are combined tightly, and does not allow partial replacement or upgrading, made R&D based on wide co-ordination very effective. PC hardware producers in the US source their components not only within the US but also world-wide. In the late 1980s, Taiwan became a base supplying efficient and inexpensive PC components to US producers. In the early 1990s, Singapore, Malaysia, and other ASEAN countries joined. Japanese PC producers tried hard to develop and produce their own parts for PCs. Because they lacked wide co-ordination, they ended up with products far more expensive than the products from US producers.

Japanese corporations, however, are still strong in producing certain hardware, such as displays for PC. A display, in effect, is an electronic appliance; it is in no sense a network-type product. Japanese corporations, having deep co-ordination, worked well in producing such products. The US has greater comparative advantage in PC software. Whereas PC hardware is a physical product assembled from components, PC software is an information product assembled from logical components. Apart from this difference, PC hardware and PC software are like each other in their structure and in their R&D requirements. Software can be replaced partially and upgraded almost freely. The design and development of a software component can be achieved quite independently from the entire software product, since, like PC hardware, the interface between software components (sub-programs) and the main software is well established. Thus, software can be produced and improved component-wise, making the presence of wide co-ordination very effective. For this and other reasons, Japan imports most major software from the US, and Japanese export of software to the US is virtually nil.

Telecommunications hardware/infrastructure and telecommunications software/services

When considering comparative advantage in telecommunications hardware/infrastructure and software/services, we should note that there are two major differences from the products we have been analysing. One difference is that telecommunications services cannot be exported or imported, since they are provided on the spot by combining the productive factors located near the user (there is an exception to this: international telephone services today may be imported through call back services). The second difference between telecommunications and other products is that public regulation plays an important role in telecommunications. In this section, we limit our attention to the implications for comparative advantage in telecommunications to the characteristics of the product or service.

Telecommunications hardware/infrastructure, when considered logically and functionally, is similar to PC hardware. It is made of physical components of a network-type product (system) for processing (transmitting and exchanging) information. In other words, the telecommunications network is like a very sophisticated and large-scale PC in which the components are located separately but connected to each other. Of course, the physical and the economic scale of the telecommunications network is far greater than the PC, and the number of users of the telecommunications network is also far greater. In spite of these differences in scale, telecommunications hardware/infrastructure is structurally similar to PC hardware. In particular, a portion of the telecommunications network can be replaced and upgraded freely. Such a partial improvement is a daily matter in the operation of telecommunications providers. Since, however, a component of the telecommunications network, such as local and long-distance switches or cables, is large in scale and high in value, the component itself may be considered a sophisticated electronic appliance. In producing such a product, both wide co-ordination and deep co-ordination may be effective. This is a part of the reason why Japan possesses some comparative advantage in producing telecommunications hardware.

Telecommunications software/services are like PC software. They are information products to be designed and improved logically. The reason that the US has comparative advantage in PC software applies equally to telecommunications software/services. As with telecommunications hardware/infrastructure, telecommunications software/services may not be directly exported or imported. In particular, Japanese telecommunications providers, such as NTT, tend to design and produce telecommunications services within the corporation. However, past records indicate that most telecommunications services, such as tone-dialling, call-forwarding, and caller ID services, were first created and offered in the US; Japan followed, providing these services a number of years after they became available in the US. Had free trade prevailed in telecommunications software/services, it would have been evident that the US had a definite comparative advantage. We point out that a portion of this comparative advantage must have come from the presence of wide co-ordination in the US.

However, we lack an analytical tool to determine what percentage of comparative advantage came from the difference in the type of co-ordination, and what came from historical, locational, regulatory, and other differences.

CONCLUSION

In this chapter, we attempted to explain the presence or the absence of comparative advantage in IT-related products, such as PC hardware and software and telecommunications hardware/infrastructure and software/services. Comparative advantage is partly explained by the difference in the characteristics of co-ordination between the US and Japan. Wide co-ordination in the US suits network-type products. Deep co-ordination in Japan suits non network-type products. Since PC and telecommunications services, in fact almost all information-related products and services, are network-type, the US naturally has comparative advantage. This is the main conclusion of the chapter.

The determinants of comparative advantage, however, are not limited to the characteristics of co-ordination. In the case of CPUs, natural monopoly arising from technological reasons is the main explanation for US comparative advantage. The same is true for PC operating systems. In the case of PC hardware, an ineffective judiciary system in Japan prevented suppliers of compatible models entering the market, thereby slowing down the development of competition. Furthermore, when the possible reorganisation of NTT was being discussed in Japan, it was repeatedly stated that NTT was uncompetitive because of excessive regulation imposed by MPT. We do not deny this. After all, comparative advantage is an outcome of multiple and complicated economic and social factors. What I have been seeking in this chapter is a determinant of comparative advantage which is common to all information-related products and services, including PCs and telecommunications services. If the main conclusion of this chapter is accepted, then the following question arises naturally: Is it possible to introduce wide co-ordination into Japanese corporations to obtain comparative advantage in information-related products and services? And, if so, how can this be done? This is an open question which remains to be investigated.

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E-mail: oniki@iser.osaka-u.ac.jp
Web: http://www.crcast.osaka-u.ac.jp/oniki/

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Table 1

Characteristics of IT Products/Services in Comparison with Other Products (1): Physical and Functional Structures

Products/Services	Telecom hardware/ Infrastructure	Telecom software/ Services	PC hardware	PC software	Automobiles	Electronic appliances	LSI: CPU for PC	LSI: Memories
Location of comparative advantage*	JP, US	US	(JP) US	US	JP	JP	US	JP, US
Structure of products or services								
Assembled from components (?)	Yes	Yes	Yes	Yes	Yes	Yes	No	No
Interface between components	Weak	Weak	Medium	Weak	Strong	Strong	None	None
Standardized interfaces between components (?)	Yes	Yes	Yes	Yes	No	No	NA	NA
Upgrading component	Possible	Free	Free	Free	Partially possible	Almost impossible	Impossible	Impossible
Need for balance between components	Low	Little	Low	Little	Medium	High	NA	NA

”JP” indicates Japan, “US” United States.

Table 2

Characteristics of IT Products/Services in Comparison with Other Products (2): Research and Development

Products/Services	Telecom hardware/ Infrastructure	Telecom software/ services	PC hardware	PC software	Automobiles	Electronic appliances	LSI: CPU for PC	LSI: Memories
Location of comparative advantage*	JP, US	US	(JP) US	US	JP	JP	US	JP, US
Characteristics of R&D								
Size of R&D investment	Large	Medium	Medium	Small	Large	Medium	Very large	Large
Gestation period	Very long	Medium	Medium	Short	Medium	Short	Very long	Long
Pattern of R&D organization:								
Team / Individual	Team	Individual	Individual	Individual	Team	Team	Team	Team
Centralized / Decentralized	C/D	Very D	D	Very D	C	Medium	C	C
Pattern of emergence of new products / services: (Continuous improvement / Discontinuous innovation)	Continuous and partially innovative	Continuous and innovative	Continuous and partially innovative	Continuous and innovative	Continuous improvement	Innovative	Continuous improvement and enhancing	Continuous increase in capacity and speed
Causes preventing free entry and full competition	Remains of natural monopoly/ regulation	Regulation	Patents, copyrights (on bus, BIOS)	Copyrights	None	None	Technological monopoly	Protection of circuit design

”JP” indicates Japan, “US” United States.