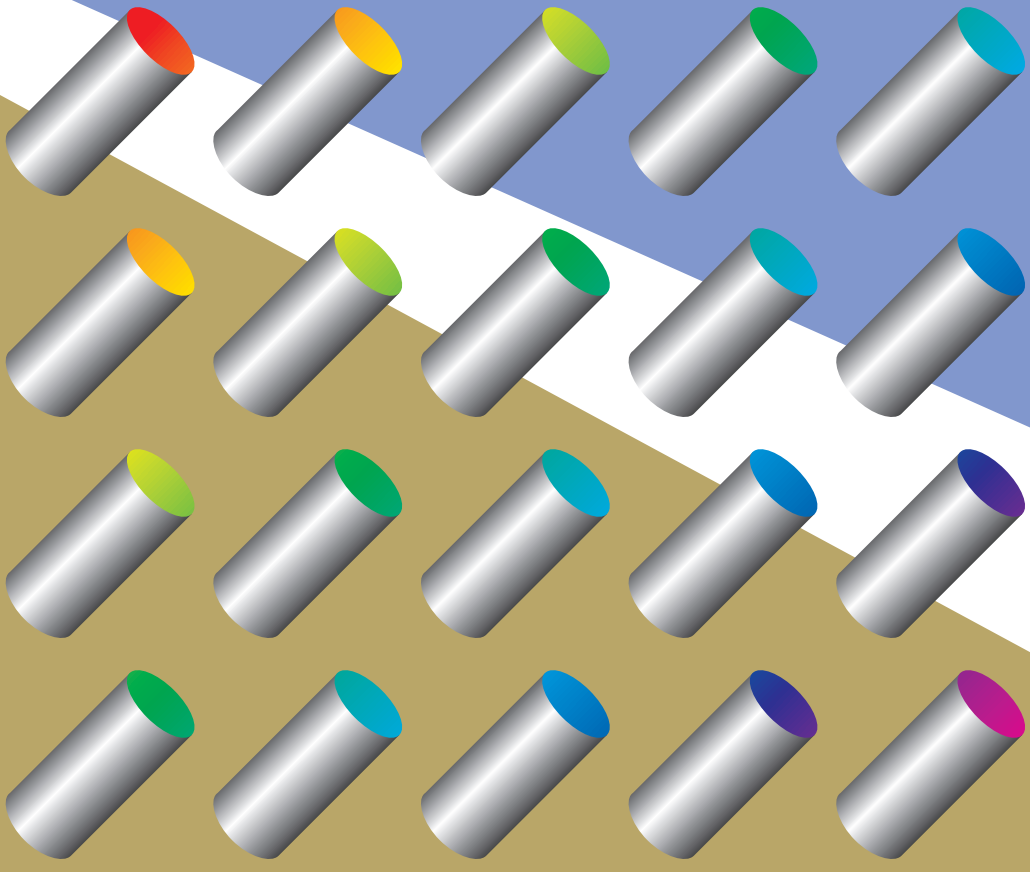
Industrialization of Developing Countries:

Analyses by Japanese Economists

Edited by

Kenichi Ohno
Takahiro Fujimoto



21st Century COE Program

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—The 21st Century COE Program Joint Report—

University of Tokyo
"Manufacturing Management Research Center" (MMRC)

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"Asian Development Experience and Its Transferability"

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Preface

As the Japanese economy is finally getting out of the post-bubble recession, the time has come to charter a new course for Japan's renewed dynamism. How should Japan identify and position itself on the global stage in the twenty-first century, and what should it endeavor to achieve? Despite economic recovery and some progress in domestic reforms, Japan in recent years has not presented or followed a clear long-term vision in its external policy, especially in its dealings with economic matters regarding technology, trade, investment and aid. There are issues that have attracted our attention, such as the alleged threat posed by emerging China, official promotion of FTAs, global mega-completion and industrial reorganization, a declining trend in Japanese ODA, Japan's attempt to protect its intellectual property rights, and the return of some Japanese overseas investments to Japan. But these events do not collectively tell us where Japan is headed. In fact, Japan's diplomatic relations with neighboring East Asian countries, which should be strengthened, actually seem to have eroded recently. We need to stop drifting and begin to draft a new grand map which can lead us to a new voyage, beyond adjustment of interests and inertia of the past.

The mission of the National Graduate Institute for Policy Studies (GRIPS) is to provide realistic and concrete policy analyses which can meet the requirements of our time. Our intellectual contribution is directed not only to Japan but also to developing countries where the majority of world population live. We want to continuously innovate the methodology of research and education. We aim to do that through building intellectual networks which are open and can promote interaction among exceptional talents and superior insights. Our Twenty-first Century Center of Excellence (COE) Program, *Asian Development Experience and its Transferability*, is an important means to realize this goal.

Although our COE program is in the intermediate stage, we already have some interesting results to report from intensive field works in developing countries. We have organized this symposium to share and discuss them with a broader circle of experts. We have invited the University of Tokyo's COE Program, *Manufacturing Management Research Center*, which studies industrial issues in developing countries and is highly acclaimed, as ours, to be a co-host. We anticipate, through our preliminary discussions, that our two COE programs will have common orientation and be able to produce, by mutual learning and complementarity, a concrete vision that can guide Japan's globalization and its contribution to the developing world. This vision still remains a rough sketch today, but we would like to present it to you before it is polished up to become a detailed blueprint.

We hope that our intellectual inputs will be a catalyst for a new round of productive policy discussions.

July 2006
Toru Yoshimura
President, National Graduate
Institute for Policy Studies

Contents

Architecture-based Comparative Advantage in Japan and Asia

Takahiro Fujimoto*

1. Introduction

Asia has become a global center of manufacturing during the last quarter of the 20th century. At first, Japan was the only major exporter of manufactured goods in Asia. As the yen rapidly appreciated after the Plaza Accord in 1985, newly industrialized economies (NIES) such as Korea, Taiwan, Hong Kong, and Singapore emerged as exporters of relatively standardized goods. Japanese manufacturing firms also started to shift their production facilities mainly to ASEAN countries.

In the 1990s, China emerged as a major exporter of certain labor-intensive goods. NIES also continued to expand their manufacturing bases. The Japanese economy stumbled, but its trade surplus continued to be significant. America made a comeback as a center of digital network goods and software. How can we explain these dynamics of manufacturing competitiveness? The best way to understand them is to go back to the basics of comparative advantage theory.

When there is a good fit between a nation's characteristics and an industry's characteristics, the industry tends to enjoy competitive advantages in that country. The Ricardian Theory of Comparative Advantage implied that "good fit" translated into relatively high labor productivity vis-à-vis other countries (Ricardo, 1971). Neoclassical economists such as Heckscher, Ohlin, and Samuelson maintained that countries having a large endowment of a certain

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factor of production (for example, labor-rich countries) would have a better fit with industries that heavily use that particular resource (for example, labor-intensive industries), assuming that technology is identical across the countries (Hecksher, 1949; Samuelson, 1948). A recent version of competitive advantages (e.g., Porter, 1990; Cho & Moon, 2000) also follows this tradition of fit between industry and country characteristics.

In more recent years, however, various phenomena have emerged that existing theoretical frameworks have difficulty explaining. These phenomena include Japan apparently being surpassed by China, Korea, and Taiwan in some technology-intensive products (e.g., DRAM, CD media, DVD recorder), which were assumed to be Japan's stronghold for many years.

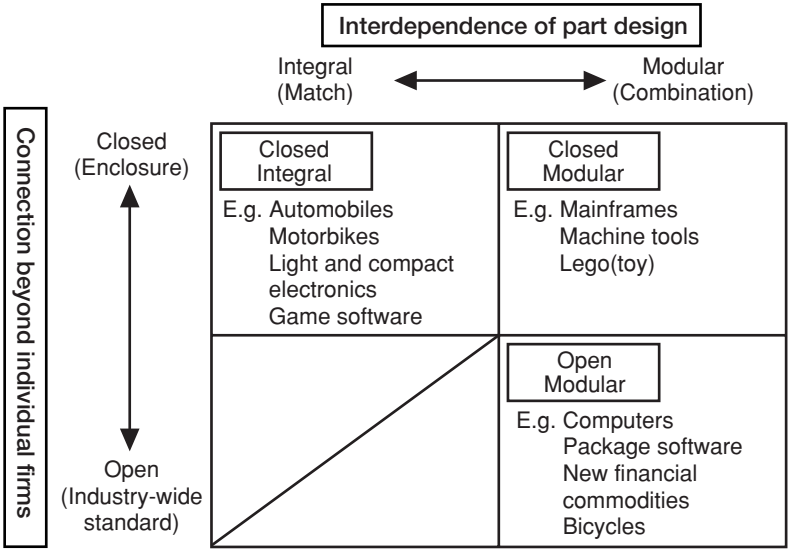
2. Export competitiveness of Japan's integral architecture products

Against this background, the author holds that we need an additional framework that focuses on a "fit between organizational capacity and architecture" — a version of the comparative advantage theory derived from our observation of manufacturing activities on the shop floor.

Specifically, this framework argues that Japanese manufacturing firms in the early postwar era, facing high economic growth amid shortages of work force, materials and money, tended to engage in economically rational long-term transactions and long-term employment. As a result, they built organizational capability that emphasized teamwork among a multi-skilled workforce, or *"integrative organizational capability of manufacturing,"* which raised productivity and quality simultaneously. The Toyota Production System is a typical example of such capability (Monden, 1993; Fujimoto, 1999).

There are two basic types of product-process architecture: (1) "*integral architecture*," with complex interdependence between product functions and product structures (such as automobiles), and (2) "*modular architecture*," in which the relationship between a product's functional and structural elements has a simple and clear one-to-one correspondence (such as personal computers) (Ulrich, 1995).

Figure 1. Products Categorized by Architecture Type of Design Information



It is then thought that Japan, which is a country with a large endowment of "*integrative organizational capability*" stemming from its long-term employment and long-term transaction practices, tends to have a competitive advantage in "integral architecture" products — a prediction based on our "*architecture-based comparative advantage*" hypothesis. In other words, Japan, where coordination-oriented organizational capability is concentrated due to its historical trajectory in the late 20th century, tends to export *coordination-intensive goods*, or products with integral architecture.

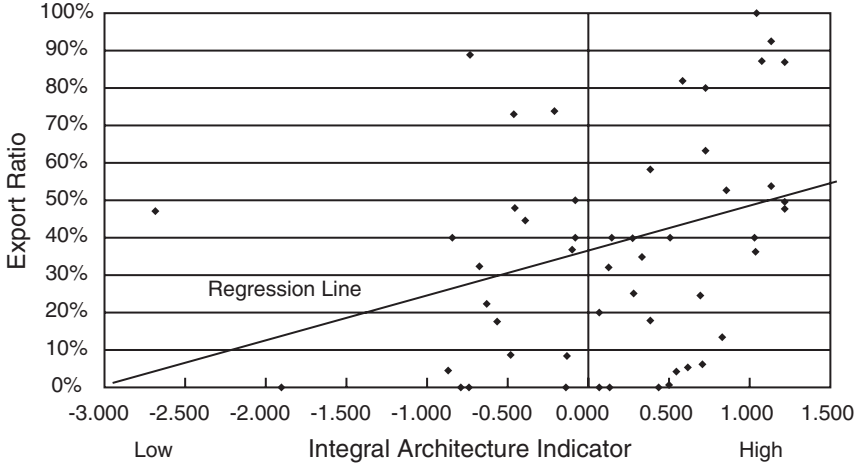
3. Preliminary empirical results

Can this new approach to industrial competitiveness, featuring capability-architecture matching, demonstrate additional explanatory power on the reality of Japan's industrial competitiveness? Although the research is still at an exploratory stage, the Manufacturing Management Research Center (MMRC) at the University of Tokyo conducted a survey analysis of selected Japanese

manufacturing firms in cooperation with the Ministry of Economy, Trade and Industry (METI). The survey targeted both assembled products and processed products, including automobiles, household appliances, electronics, and parts, industrial machines, chemicals, iron and steel, textiles, and food and beverages (Fujimoto & Oshika, 2006).

The results revealed that our "integral architecture index," constructed from about a dozen questions regarding architectural characteristics of each product surveyed, has a statistically significant and positive correlation with the export ratio of the product in question (export value/domestic production value) (Figure 2). The positive correlation is observed in both fabrication-assembly goods (e.g., machinery) and processed goods (e.g., chemicals). The integral architecture index is also positively correlated with not only the export ratio, but also the foreign activity ratio (export plus overseas production/domestic production), indicating that Japanese multinational firms tend to do well with integral architecture products wherever they are produced.

Figure 2. Ratio of Export and Integral Architecture Index (assembly products: 52 samples)

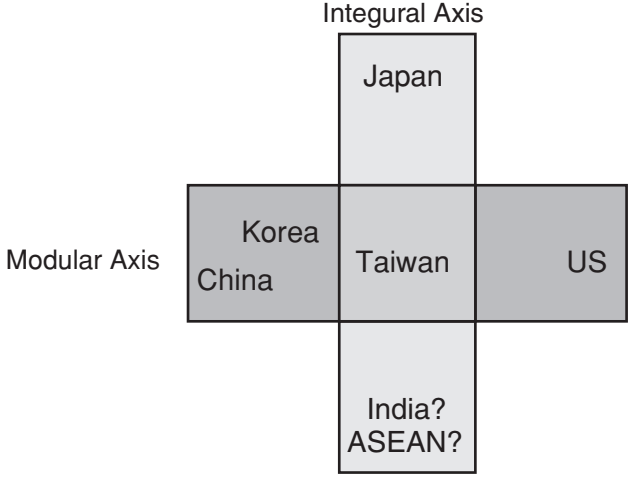


4. Hypotheses on architectural advantages in the Asia-Pacific Area

Let us turn to architecture-based comparative advantages outside Japan. The following hypotheses are very preliminary and impressionistic, and are based mostly on *ad hoc* empirical and historical observations of each geographical area (Figure 3).

The basic logic is the same across regions and can be described as follows. Each region has its own historical path. A certain type of organizational capability tends to become concentrated in a certain region as a result of an initial capability-building process, which generates region-specific capability. Products with a certain type of product-process architecture tend to match better with a certain type of organizational capability, which results in relatively high productive performance in terms of, for example, productivity, lead time, and quality.

Figure 3. Architectural Geopolitics: A Prediction in the Pacific Region



Hypothesis on America: America has been a country of immigrants for the past few centuries. It has continued to attract human resources with industrial and technical knowledge and skills. For a society that has this dynamism, it makes sense to minimize coordination in order to make use of newcomers' capability as quickly as possible.

As a result, American industries have emphasized division of labor, specialization, standardization of work, clear job demarcation, and use of the market mechanism, while minimizing coordination efforts. Thus, the American System of Manufacturing throughout the 19th century emphasized interchangeable parts and specialized equipment while minimizing coordination on the shop floor (e.g., fitter). The American Mass Production System perfected this idea in the early 20th century. In the last decades of the 20th century, America rediscovered the power of a manufacturing system that economizes coordination cost through the Silicon Valley model of designing and producing digital network goods.

With this social and historical background, the framework of architecture-based comparative advantage predicts that America-based firms show comparative advantages in certain *technology-intensive modular architecture goods*.

Hypothesis on China: In the late 20th century, China, under the Communist Party regime, adopted a Soviet-style national innovation system, in which industrial R&D activities were highly concentrated at the central level. Manufacturing firms in China were virtually factories without R&D functions. The design of Chinese products also tended to lag behind that of advanced countries. Thus, when China chose an open economy path in the 1970s, many of its manufacturing firms, and those in southern coastal provinces in particular, had to acquire design information for their new products by licensing foreign technologies or copying foreign products.

To quickly catch up on product design, many Chinese firms, both state-owned and private, opted to buy licensed or copied parts as generic modules and quickly started up new manufacturing businesses by mix-and-match of such *de facto* generic components. The author calls this type of products "*quasi-open architecture*." Many of the machinery industries, such as motorcy-

cles, trucks, air conditioners, TVs, and other digital consumer goods, were supplied by more than one hundred assembly makers. Copied parts themselves were also produced by hundreds of local suppliers. These firms also tended to rely on mix-and-match of standard equipment and low-wage temporary workers from low-income regions of inland China.

As a result, by the end of the 20th century China became a major exporter of *labor-intensive modular architecture goods*. Thus, through a very different historical path, America and China became two major producers of relatively modular goods on the Pacific Rim. This contrasts sharply with postwar Japan, which became a major exporter of integral architecture products.

Hypothesis on Korea: The most distinctive feature of the postwar Korean economy is a small number of large conglomerates, called *chaebols* (e.g., Hyundai and Samsung), which somewhat resemble prewar *zaibatsu* in Japan; the two terms share the same Chinese characters. Each chaebol was controlled by its founder-owner and family. Because of strong top-down control by the founder-owners, Korean chaebols tended to have strength in quick decision-making and investment on capital-intensive processes.

Thus, Korean large firms had advantages in standard capital-intensive goods, where mix-and-match of the latest production equipment resulted in competitive products, such as general-purpose steel, DRAM, and crystal liquid display. In other words, Korean export power is highly concentrated in *capital-intensive modular architecture goods* produced by large firms, many of which stem from chaebols.

Hypothesis on Taiwan: Taiwan is another significant exporter of manufactured goods. The Taiwanese economy may be characterized as a "competitive small country" on a par with the Netherlands. Taiwan, because of its complicated history in the 20th century, and because of its geographical location at the intersection of America-China-Japan-ASEAN axes, has had strong economic links with the U.S., Japan, and mainland China. Taiwanese export-oriented firms tend to be good at making the most of their overseas linkages in building their organizational capabilities.

Where the products are modular and technology-intensive (e.g., digital network goods), Taiwanese specialized producers tend to create networks with American firms. Where the products are integral (e.g., the automobile),

Taiwanese firms tend to link with Japanese production networks. Thus, their strength resides in the *versatility* of quickly moving between modular and integral architectures.

Hypothesis on ASEAN countries: As far as manufacturing competitiveness is concerned, ASEAN countries (except Singapore) have not demonstrated concentration of distinctive organizational capability. Although there is a significant degree of variety among ASEAN countries, none of them has industrial agglomeration of local firms that are technologically competitive. ASEAN countries have long functioned as production bases of the Japanese and Western multinational firms.

As such, ASEAN's manufacturing firms were mostly dependent on product designs originating from multinational firms. Certainly, it is not realistic to foresee emergence of a cluster of ASEAN local firms with distinctive design capability in the near future. However, some ASEAN countries, such as Thailand and Vietnam, may emerge as production bases of *labor-intensive integral architecture goods*. Their potential advantage over typical Chinese factories may be that it is easier for the former to keep multi-skilled workers with relatively low wages. Although China possesses a huge supply of low-wage single-skilled workers, the wage level tends to be high and rising for multi-skilled workers because of the volatile nature of the Chinese labor market.

Training multi-skilled workers is thus the key for this possible path of ASEAN countries toward strength in producing integral goods. In order for ASEAN economies to avoid direct competition against China, which is overwhelmingly strong in labor-intensive modular products, they may find it beneficial to differentiate themselves from China by focusing on low-price, labor-intensive integral architecture goods. In order to produce such products competitively, it is crucial to strengthen teams of multi-skilled workers. The most effective training fields for this type of work force are, obviously, factories of Japanese firms. Thus, ASEAN firms may have a chance to become the export center of *labor-intensive integral architecture goods*, but only potentially at this point.

5. Implication for ODA in ASEAN Countries

Historically, Japan's ODA to ASEAN nations has been significant in terms of volume. It may need to be more strategic in the future. That is, a significant portion of Japan's ODA to ASEAN firms may be used for the training of multi-skilled workers. Large scale systems and high-tech equipment may look spectacular, but with only these it is difficult to differentiate ASEAN to create distinctive manufacturing competence *vis-à-vis* China, a giant in modular manufacturing. The main players of such capability-building should be Japanese and ASEAN manufacturing firms, but policy makers can assist their strategic linkage.

Policy makers of both Japan and ASEAN need to share a strategic vision and a road map regarding manufacturing competitiveness in Asia. High technology and large systems are favorite items for bureaucrats, but if all countries go for such technologies, they do not necessarily provide a strategic solution for sustainable manufacturing competitiveness.

Because the Asia-Pacific region is highly competitive in manufacturing, its policy makers and industrialists need to have a keen sense of comparative advantage. The architecture-based framework of comparative advantage may give them some additional insights. As Ricardo advocated, a country cannot be a major exporter of all goods. This principle holds true in the case of product architectures as well.

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Vietnam's Industrial Policy Formulation

To Become a Reliable Partner in Integral Manufacturing

Kenichi Ohno*

The Vietnam Development Forum (VDF) is a joint research project of the National Graduate Institute for Policy Studies (GRIPS) in Tokyo and the National Economics University (NEU) in Hanoi. It is part of the 21st Century Center of Excellence (COE) Program of GRIPS funded by Japan's Ministry of Education, Culture, Sports, Science and Technology (MEXT). One of the most important objectives of VDF since its establishment in early 2004 has been to support industrial policy innovation by Vietnam's Ministry of Industry (MOI). For this purpose, VDF has organized a large number of workshops and research weeks, published books and research papers[1], and staged VDF-MOI joint missions to Thailand, Malaysia and Japan. VDF has also directly assisted the drafting of motorbike and supporting industry master plans and commented on the overall, electronics, and automobile master plans of the Vietnamese government. This paper presents a broad conclusion drawn from our policy research. It was originally addressed to Vietnamese policy makers. By re-presenting it to researchers in development and aid studies, we hope to receive their comments and suggestions as well.

1. The need for new industrial policy

Vietnam is deeply committed to global and regional integration, and no one doubts the seriousness of this commitment. Vietnam has already taken many steps to realize this goal, including the completion of the AFTA process, the conclusion of the bilateral trade agreement with the United States, intense negotiation for WTO accession, and preparation for other free trade areas (FTAs). Work is also progressing in the legal area as the government doubles its effort to create or amend a large number of laws for consistency with international practices. All this is highly commendable.

However, diplomatic and legal preparations are not enough. In order

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[1] See particularly Ohno and Thuong, eds., (2005) and VDF (2006b).

for Vietnam to truly enjoy the fruits of international integration, its real sector must also be prepared. Vietnamese firms need to be competitive enough to survive and even prosper in the new open environment where import protection and special favors are, in principle, no longer allowed. This is the area in which Vietnam's preparation is the weakest.

Free-market advocates may argue that, once the economy is open and free, the market mechanism will activate the ingenuity of the Vietnamese people and the national economy will grow and become more efficient. This argument is too naïve, as the majority of Vietnamese policy makers already know. The fact is that the balance of power between large advanced economies and latecomer developing countries is lopsided. Vietnamese firms cannot at present compete squarely with Toyota, Panasonic, LG or Intel in the global market. Instead, they must work with these multinational corporations (MNCs) to improve their abilities and become crucial suppliers in their global value chain. A good policy is needed to encourage and support this effort.

But what kind of policy is needed, more concretely? The days of planning are over. Vietnam can no longer use rigid control to maintain international isolation. The strategy of *infant industry promotion*, adopted by Japan and Korea in the early postwar period, is also out of the question. Under this strategy, domestic industries were protected and nurtured until they became sufficiently competitive. But Vietnam cannot introduce such protection because of its commitments to WTO and various FTAs.

Even the strategy of FDI-led growth, exercised by ASEAN4 in the 1970s–90s, is no longer applicable to latecomers like Vietnam. Although Malaysia, Thailand, Indonesia, and the Philippines vigorously absorbed FDI, they were slow to remove their tariffs, import restrictions, and localization requirements. In these countries, FDI promotion and industrial protection coexisted for at least a few decades. External barriers were lifted only after they achieved significant industrial agglomeration. Vietnam, however, is asked to remove barriers *now*, before such agglomeration occurs.

For this reason, Vietnam's industrial policy in the 21st century must be new and different from those of other countries in the past. It must reflect the fact that even newcomers must open up very fast. Globalization is inevitable, and Vietnam must position itself to become a meaningful player in the global

arena, making sure that its contribution to East Asia and the world will rise over time. What kind of policy can that be? That is the key question for the Ministry of Industry (MOI) in particular and the Vietnamese government in general to consider. That is also the question we address in this paper.

2. Weaknesses in Vietnam's policy formulation

To design and implement industrial policy in the age of strong globalization pressure, Vietnam must overcome two methodological problems. At present, master plans are designed and drafted by a small group of officials assigned for the task. They work very hard but cannot produce desired results because crucial information and cooperation are lacking. More concretely, the weaknesses of Vietnam's industrial policy stem mainly from the following two missing links.

(i) The lack of cooperation with *stakeholders* (i.e., concerned groups) in the entire drafting and implementation process. In the case of industrial master plans, the most important stakeholder is the business community.
(ii) The lack of inter-ministerial coordination within the government in deciding concrete action plans.

These problems are unique to Vietnam; they are not observed in other high-performing East Asian countries. In our missions to Thailand, Malaysia, and Japan, no serious problems were reported in either government-business cooperation or inter-ministerial coordination in formulating industrial policy.

The main problem caused by the lack of cooperation with stakeholders is that *policy is not supported by the business community and therefore is not implementable*. This problem is particularly acute in sectors dominated by private and FDI firms, such as motorbikes, automobiles, and electronics, which are not under MOI's direct supervision. Even where state-owned enterprises (SOEs) used to play key roles, in such areas as steel and cement, the share of private and FDI production is rising. The drafting process must involve all key players, especially private and FDI firms. Without solid channels to absorb their information and concerns, policy remains ineffective.

Another problem caused by the lack of stakeholder involvement is

that *information and analysis are neither to-the-point nor up-to-date*. Even if MOI drafters are intelligent and hard working, it is difficult for a small team to gather all relevant information. This is particularly true with external information such as global industrial trends or the latest strategies of MNCs. Such information should be obtained through close and continuous contact with the business community. A good policy cannot be built on outdated information.

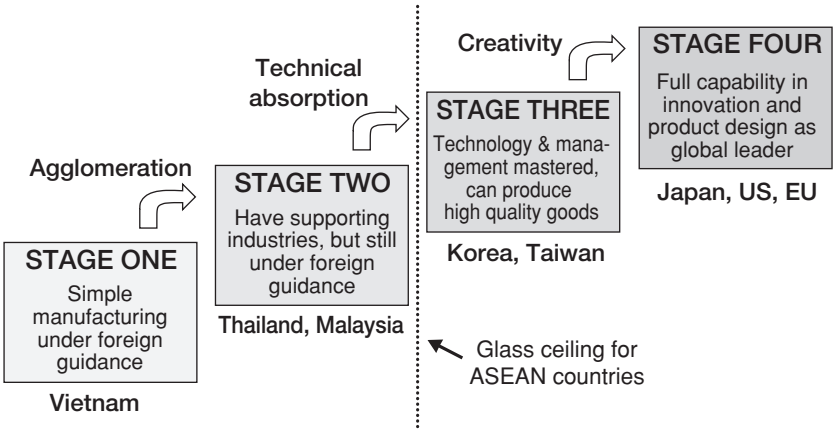
As for the lack of inter-ministerial coordination, the main result is that *supporting measures are simply mentioned without details*. Measures outside the authority of MOI, such as tariffs and tax incentives or a reform of technical schools and universities, are especially hard to prescribe in detail, since there is no mechanism to discuss and agree on policy measures among related ministries in close consultation. At present, ministries interact only superficially through commenting on mutual drafts and exchanging basic information. This is another reason why timely and effective policy implementation is so difficult in Vietnam.

3. Good policy, modest results

Thailand, Malaysia, and Japan have all constructed effective channels for stakeholder involvement and inter-ministerial coordination in industrial policy making. Thailand has set up industry-specific institutes and official committees to link the government, businesses, and experts. Malaysia has a three-layer structure consisting of the Industrial Planning Committee, the Steering Committee, and technical resource groups, which together mobilize several hundred people to draft an industrial master plan. In Japan, deliberation councils and industry associations have long been the key instruments for sharing information among all stakeholders at any time. The functions of these institutions are explained in detail in VDF (2006b).

The experiences of these countries make it clear that Vietnam is far behind them in industrial policy formulation and that it has much to learn from them. It must be admitted that Vietnam's policy making method is in the early stage of development. It is still primitive and defective, and inherits many characteristics of the planning days which are no longer valid. Another crucial fact is that the way to achieve good involvement and coordination is not one, and

Figure 1. Breaking the Glass Ceiling



Source: Ohno, 2005.

that Vietnam should design a mechanism that is most suitable for its situation and needs. This means that Vietnam must selectively import the good practices of neighboring countries, with necessary revisions and additions, to suit its circumstances. Since institutional evolution is difficult to forecast or plan with any precision, the adaptive process will inevitably be a long one with many trials and errors.

However, a negative lesson from Thailand and Malaysia is also worth attention. While industry-led growth of Thailand and Malaysia has been remarkable by the standards of developing countries in general, it falls short of East Asia's high performance criteria. These two countries are still unable to break through the "glass ceiling" after several decades of industrialization. The glass ceiling here refers to the difficulty in moving from the second to the third stage in the path of industrialization that I have described on another occasion (Ohno, 2005).

A developing country in the catch-up process typically starts with simple assembly to fulfill foreign orders (stage 1), builds industrial agglomeration and supporting industries (stage 2), graduates from foreign guidance to master technology and management (stage 3), and finally achieves innovative,

original design capacity (stage 4). I argue that none of the ASEAN countries has graduated from foreign dependency despite their quantitative achievement. They still rely heavily on foreign managers and engineers to run their factories and maintain quality. Since core competence and value creation are not internalized, a risk is always present that industries will shift to China or elsewhere when circumstances change.

The governments of Thailand and Malaysia are acutely aware of this problem and trying to remedy the situation as a matter of top national priority. Specifically, this requires strengthening small and medium enterprises (SMEs) and creating linkages among them, developing industrial skills, promoting supporting industries, stimulating R&D, and other efforts in human resource development. Nevertheless, local capability of Thailand and Malaysia still falls short of the high requirements of Japanese manufacturing FDI. This is a problem that has been recognized for a long time--at least for two decades--but remains unresolved.

At the risk of over-simplification, we may even say that Thailand and Malaysia are the countries whose governments have succeeded in offering good policy frameworks but whose domestic businesses remain less dynamic than expected. The gap between good policy and modest results is especially striking when we look at the performance of Taiwan and Korea. From the situation of war devastation and dire poverty, they emerged as leading manufacturers of high-quality products in a few decades. They received foreign technical assistance at first, but the time they spent for learning was relatively short. As soon as they mastered technology, they sent foreign advisors home. R&D, product design, enterprise management, and factory operation are now carried out entirely by locals. They invest vigorously abroad to expand production networks, and have become Japan's formidable competitors. And Taiwan and Korea achieved all this in no more than the time it took for Thailand and Malaysia to reach their current levels.

Why did Taiwan and Korea move up so fast, while Thailand and Malaysia learned more slowly? Is the reason difference in national character, or is it the difference in policy quality? If Taiwanese and Korean people are genetically more suitable for high-quality manufacturing than Thai and Malaysian people, the government cannot do much to change people's DNA. But if indus-

trial policies adopted by Taiwan and Korea have been superior in matching national aspiration with needed actions, we are compelled to study much deeper into policy design and implementation to improve the industrial policy framework and content of Vietnam[2].

Vietnam at present is a country of weak policy formulation. However, Vietnamese people are frequently praised as skillful, diligent, and persistent in comparison with other peoples in the region. This points to a possibility of greatly upgrading the industrial capability of Vietnam once policy weaknesses are removed.

4. Coping with China

How to cope with China, with its enormous size and rapidly expanding manufacturing capacity, has become one of the most urgent issues for countries all over the world. China has large numbers of managers, scientists, engineers and unskilled workers, ample industrial materials, a relatively high level of technology backed by a long history of industrialization drive, and a thick network of overseas Chinese businesses. The China challenge looms large in the industrial policy debates of Thailand, Malaysia, and Japan. It must also be a top issue in formulating Vietnam's new industrial policy.

It is clearly unwise to directly compete with Chinese products in the global market. To avoid this, a country must differentiate its products from Chinese ones and position itself as a producer complementary to China rather than competing with it. If this is done successfully, the country can form a production partnership with China and use Chinese low-cost inputs to its advantage. The crucial question is how to do this concretely. The proper positioning requires a clear understanding of the fields in which China excels and the fields in which it does not.

Since China is a big country, it is not easy to find industrial categories

[2] Two facts complicate such a study. First, the policies adopted by Taiwan and Korea were very different in that the former promoted dynamism of SMEs while the latter featured large business groups (*chaebols*) supported by large banks. Second, the state-led industrialization strategy adopted by Korea, in particular, is no longer available to today's latecomer countries under the pressure of globalization.

in which it does not produce. One needs to go into the level of individual products and even different grades of the same products to find a niche. Even then, there is no guarantee that China will not produce that product next year. Many countries want to promote "high-tech" industries to upgrade their skills and compete with China. However, the popularity of this strategy must be evaluated against the following precautions: (i) there is a significant gap between national aspiration and actual capability; (ii) no differentiation will occur if all countries adopt this strategy; and (iii) China is also targeting such areas.

Thus, finding a niche in terms of specific products, including "high-tech" products, has certain limits. The better way to distinguish oneself is to analyze China's strengths and weaknesses from the viewpoint of business architecture, as explained below.

5. Integral manufacturing

We propose one concrete industrial strategy for Vietnam in order to overcome the difficulties addressed in earlier sections. The strategy is targeted at building domestic capability in assembly-type manufacturing, such as electronics and electricals, motorbikes, and automobiles, and the production of parts and components for these industries[3]. Although assembly-type manufacturing industries differ from one another in some aspects, they are common in the sense that (i) they extensively use metal, plastic, and rubber parts; (ii) product quality depends heavily on the quality of these parts; (iii) they also require labor-intensive assembly with precision; and (iv) innovation and model changes are quick and frequent. For this reason, assembly-type manufacturing industries can to a large extent share the same supporting industries and human resources. That is why they should be grouped together in strategic planning.

Vietnam's workforce is particularly suited to labor-intensive assembly with precision, (iii) above, and that is why such FDI inflows are accelerat-

[3] Assembly-type manufacturing has been the driving force of economic transformation of Japan, Taiwan, Korea, ASEAN4, and China, and it is also expected to play the same role in Vietnam. For other industries, such as garment, footwear, food processing, software, energy, industrial materials, construction, logistics, trade, telecom, finance, and tourism, other strategies must be sought; the argument in this section is not applicable to them.

ing in recent years. However, Vietnam must also learn and internalize the other aspects, (i), (ii), and (iv) above, to fully take advantage of the strength of assembly-type manufacturing. If this is done successfully, assembly-type manufacturing will surely become the main pillar of Vietnam's industrialization, providing jobs, improving skills, and raising national income.

Even without any further policy reform, FDI will probably continue to come to Vietnam and, given sufficient time, the country will reach the income and industrial levels of Thailand and Malaysia today. However, as argued above, these ASEAN neighbors remain heavily dependent on foreign technology and management. Despite many decades of supporting industry and SME promotion, their human resources and local parts makers remain too weak to break through the "glass ceiling" and reach the level of Taiwan or Korea. If Vietnam does not have a good policy, it is also likely to stop at the level of Thailand and Malaysia today.

Another important consideration noted earlier is that Vietnam is required to integrate much more quickly than ASEAN4. Thailand and Malaysia absorbed large amounts of FDI, but they were not "open" in the sense that they kept high tariffs, localization requirement, import restrictions, and so on for a long time. They used these measures for at least a few decades to develop and protect their industrial base. Vietnam, in contrast, must open up now, before building such an industrial base, and face global competition. Vietnam's industrial strategy must therefore be different from and bolder than those of Thailand and Malaysia.

Let us now propose a new manufacturing strategy for Vietnam based on the above considerations.

(1) Vietnam should liberalize its trade and investment regimes unconditionally and more decisively than ASEAN4 did in the past, create the most free and low-cost business environment in East Asia, and attract a large amount of FDI without selectivity[4] . This decisive openness should be the strongest selling point in FDI marketing.

[4] The only permissible reasons for rejecting FDI are environment, cultural indecency, and national security. This rule should be applied sparingly under transparent criteria.

(2)Linkage between domestic firms and foreign multinationals should be promoted as a matter of highest priority. Vietnamese firms should double efforts to become suppliers of FDI manufacturers and foreign buyers, and improve their capabilities. The government should support their effort.

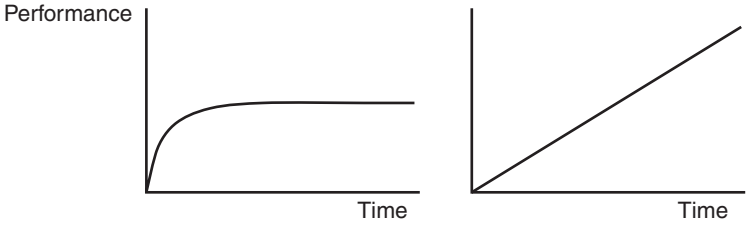
(3)Vietnam should learn the *monozukuri*[5] spirit of Japan's *integral manufacturing*, as explained below, as quickly as possible. Vietnam should aim to become a reliable developing country partner in high-quality manufacturing with Japan and other developed countries producing integral products.

Professor Takahiro Fujimoto of Tokyo University and his research team have come up with a business architecture theory to explain the differences among the manufacturing industries of major economies such as Japan, China, the United States, Korea, Taiwan, and ASEAN countries. This theory has a significant implication for Vietnam's industrial strategy. According to Prof. Fujimoto, there are two basic architectural types in manufacturing: modular architecture and integral architecture. In modular architecture, the modality of interaction among components is standardized for easy connection. For example, desktop computers are a typical modular product in which globally common components from various companies are freely combined. By contrast, in integral architecture, the complexity of interaction is happily accepted, and improvements are achieved through numerous trials and errors. For example, automobiles must be manufactured with integral architecture if multiple objectives such as performance, comfort, fuel efficiency, and safety are to be attained simultaneously. Generally speaking, modular architecture is suitable for obtaining quick results at low cost while integral architecture is appropriate for the pursuit of ever-higher quality in the long run.

[5] *Monozukuri* literally means "making things" or "manufacturing."

Figure 2. Modular versus Integral Manufacturing

	Modular manufacturing	Integral manufacturing
Parts interface	Parts are common and can be used for any model	Each product has unique parts, specifically designed
Merits	Quick results and flexibility	Endless pursuit of quality
Demerits	No differentiation,excess entry, low profit, lack of R&D	Much energy and time needed to achieve results
Institutional requirements	Openness, quick decision making, flexible outsourcing	Long-term relations, building internal skills & knowledge

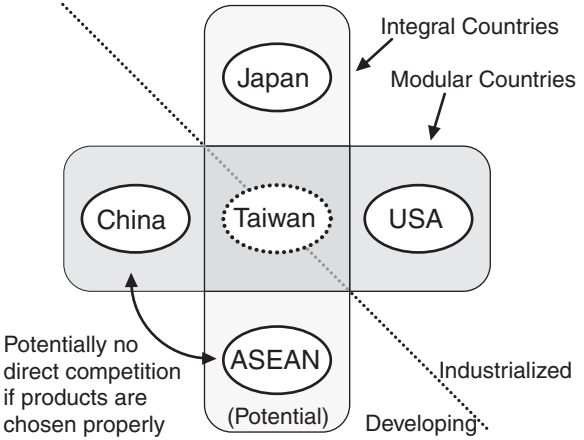


Correspondence between products and business architecture is not fixed; it evolves dynamically with the business strategy of each firm or country, technical progress, and consumer tastes. In addition, business architecture often has structural layers in which, for example, modularization may proceed in final assembly while integration may deepen in components.

Japan is a country of integral architecture, intensely interested in efficient factory operation and product integrity. By contrast, the United States excels in modularization and is good at slicing the supply chain of a product into appropriate elements, standardizing them, and making profits by the novelty of combination. China is also a country of modular architecture, but its comparative advantage lies in labor-intensive modular products rather than knowledge-intensive modular products as in the case of the United States. Professor Fujimoto considers China to be a country of quasi-modularity since its manufacturing features mass production of products with copied design and technology rather than original innovation.

Since the United States and China are both modular countries with different development levels, they are complementary production partners. The

Figure 3. Production Alliances Based on Business Architecture



Source: Professor Takahiro Fujimoto's explanation to the joint VDF-MOI mission in Tokyo, June 2005.

former can supply technology and capital while the latter can offer cheap labor to produce modular products. Meanwhile, Japan is a country of integral manufacturing with high technology, high wages, and an aged population looking for a developing country partner. Using cheap unskilled labor in China and ASEAN is not enough to fully exploit the potential of integral manufacturing. If ASEAN, the traditional destination of Japanese FDI, learns to become a manufacturing partner with long-term vision and strong aspiration for high quality, Japan and ASEAN can form a strategic alliance in manufacturing integral products that are differentiated from Chinese products. However, this alliance remains merely a possibility because no ASEAN country has acquired the necessary skills and attitude for Japanese-style manufacturing. As noted above, Thailand and Malaysia are currently struggling to become full-fledged manufacturing countries. They still need Japanese managers and engineers to stay, and they depend heavily on FDI parts producers.

To become a partner in integral manufacturing requires ability to design and operate factories efficiently; maintain, adjust and repair machines; design parts; produce precision molds and dies; educate highly skilled industrial *Meisters*, and so on. These requirements are not new. But the point is that they

must be accomplished well with purpose and tenacity. This will enable ASEAN to graduate from simple assembly by foreign orders to participation as indispensable players in the global manufacturing network. This will also upgrade the Japan-ASEAN economic relationship to a higher level.

Among ASEAN countries, Vietnam and Thailand are top candidates for this feat. Vietnam should set a clear goal with appropriate action plans, and the Japanese government and business community should actively provide technical assistance and business cooperation for this purpose.

This perspective explains why supporting industries (especially high-quality plastic and metal processing industries) and human resource development (especially high-level production managers and engineers) are so crucial for Vietnam. They are needed to significantly raise domestic manufacturing capability and to differentiate Vietnam from China and other ASEAN countries. Copying China's manufacturing style or receiving Chinese technical assistance is not desirable for Vietnam because these lead to low-price, low-quality competition yielding little profit, as well as a direct clash with Chinese products.

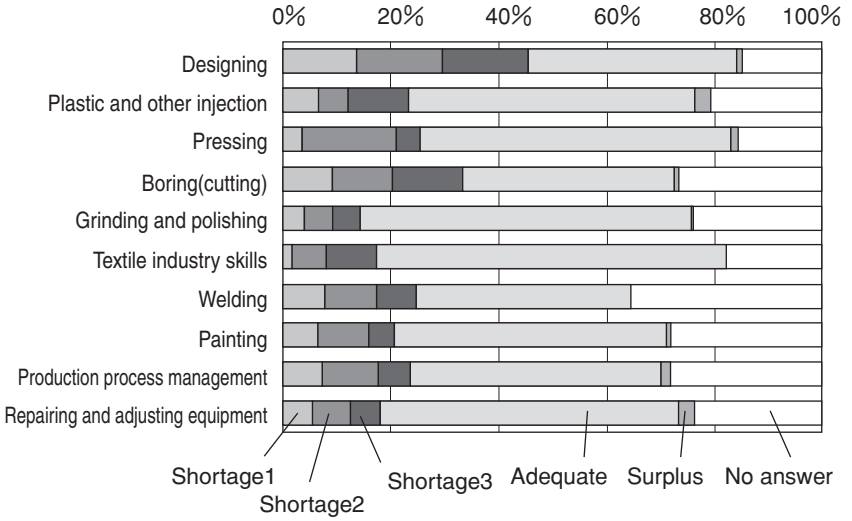
6. Anticipated skill shortages in Japan

Japan desperately needs a developing country partner in integral manufacturing but has found none so far. It needs such a partner because its wages are too high and its population is aging, making it very difficult to find young engineers and production managers in sufficient number and quality inside Japan. The highly skilled postwar baby boomers, born 1947–49, will reach retirement age soon. Those born in 1947 will turn 60 years old in 2007 and will begin to leave factories. This is called the "2007 problem." Their skills must be transferred to the next generation but Japan lacks a sufficient number of successors.

According to the *White Paper on Monozukuri*[6], the number of monozukuri workers in Japanese manufacturing was 1.93 million in 2005.

[6] Ministry of Economy, Trade and Industry; Ministry of Health, Labor and Welfare; and Ministry of Education, Culture, Sports, Science and Technology, *White Paper on Monozukuri*, 2005. Data in the text were obtained from a survey by the Ministry of Health, Labor and Welfare on enterprises with five or more regular employees.

Figure 4. Shortages and Surpluses of Monozukuri Workers in Japan



Note: These are the survey results on the ten basic industrial skills with the largest numbers of workers in 2005. Shortage 1, 2, and 3 are shortage in quantity, shortage in quality, and shortage in both quantity and quality, respectively.
Source: Ministry of Economy, Trade and Industry; Ministry of Health, Labor and Welfare; and Ministry of Education, Culture, Sports, Science and Technology, *White Paper on Monozukuri*, 2005.

When asked if the "2007 problem" (retirement of skilled workers) was a serious concern, 30.5% of the manufacturing firms responded yes. Among them, the main reasons for their concern included the long time required for skill transfer (68.5%), lack of younger engineers with enthusiasm (64.5%), and difficulty in communication between teacher and student due to a large age or skill gap (41.9%).

Figure 4 shows the worker shortages for the ten largest basic industrial skills in Japan. As of 2005, worker shortages are not yet severe, with only 25.6% of the respondent firms reporting skill shortages in quantity or quality (or both), 47.9% reporting adequacy, and 1.7% reporting surpluses (these numbers are averages for the ten skills). However, as time progresses, skill shortages are likely to worsen. Many firms are expected to retain skilled workers beyond the retirement age, and although this will delay the impact of the 2007

problem for several years, Japan will inevitably face skill shortages unless fundamental solutions are found.

I have highlighted Japan as a principal monozukuri partner for Vietnam because Japan is the only country in East Asia that has achieved a high level of integral manufacturing. In addition, Japan is already the most important manufacturing investor in Vietnam. Moreover, if Vietnam masters integral manufacturing, it can also cooperate more effectively with, for example, German automobile producers or Italian machinery companies. That is why I sincerely hope that high aspiration for assembly-type integral manufacturing will be incorporated as one of the strategic pillars of Vietnam's overall industrial master plan.

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Competitive Strategy of Global Firms and Industrial Clusters[1]

Case Study on the Hard Disk Drive (HDD) Industry

Tomofumi Amano*

1. Introduction

This report discusses the location strategies of multinational firms and the industrial policies of the countries that are the recipients of their investment. For firms engaged in international business, the timing of foreign investment, selection of locations, and maintenance and expansion of their local operations are all important strategic matters.

Then what foreign investment strategies have been used by firms that have succeeded in strengthening their competitive advantage? What are the unique aspects of the policies taken by recipient countries? This report will focus upon the *strategic nature of investment* for global firms and the *strategic nature of investment-attracting policy* for the recipient countries.

Because the determinant factors of foreign investment have been a core theme for studies on multinational firms, there is already a large literature upon the topic. However, much of it consists of studies that identify and classify the location factors based on economic theories and empirical studies using cross-section or pooled data. While these studies indicate the general framework of multinational firms' location selection, it is difficult to derive from them the strategic implications related to individual firms' foreign investment.

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[1] This report is an expansion and revision of the content of Chapter 5 of the following book for the purpose of presentation at the GRIPS/MMRC Joint Symposium: Amano Tomofumi, *Higashi Ajia No Kokusai Bungyō To Nihon Kigyō: Aratana Kigyō Seichō He No Tenbō (East Asian Linkage and Japanese Firms: A New Perspective of Corporate Growth)*, Yuhikaku.

Foreign investment in a growth region is an important strategic matter for firms. Industry-specific conditions must be taken into account to appropriately examine its strategic nature. However, to this end, the focus should be placed on how firms recognized the industrial environment and what approaches they took; in other words, we must focus on firm-specific recognition of the environment, decision-making, and implementation, rather than on the general determinant factors of investment.

This report takes the hard disk drive (HDD) industry and looks at how major Japanese and U.S. firms have made investments in Asia. Over the past 20 years, the HDD industry experienced dramatic changes in technology and market conditions. For HDD manufacturers, investment in Asia during this period was a critical issue for their survival. How did they perceive this challenge and what strategies did they take? This point is closely related to the first focus: *strategic nature of investment*.

The second focus, *strategic nature of investment-attracting policy*, will rather become clear by looking at the investment history of surviving firms. These firms have concentrated their large-scale investment in specific areas. In these areas where a large number of firms have gathered, collaborative relationships can be observed between local governments, local universities, local firms, and global suppliers. Such agglomerations have served to attract investment to these areas in a sustainable manner.

These areas are called *industrial clusters*. In a global industry like the HDD industry, the greatest concern for the recipient country is the risk of the client firms leaving the country to invest in another country due to subsequent wage increase or rivalry against newly developed countries. The challenge for the recipient country is to consolidate investment, and one means to achieve this could be to increase the attractiveness of the area as an *industrial cluster*.

In the process of East Asia's economic development, investment from other countries gathered in a number of areas and industrial clusters were formed in these major areas. This enabled the recipient countries to provide abundant and diverse resources to the multinational firms located inside these areas. There was also intense competition among the recipient countries for attracting investment. The point is how these countries strategically differentiated their policies from the others in forming attractive industrial clusters.

2. Competitive Strategy of Global Firms and Industrial Clusters

This section explains the three basic viewpoints applied to the case study. They are *(1) global location strategy and clustering; (2) integration of global production networks; and (3) consolidation of foreign investment in recipient countries.*

Global Location Strategy and Clustering

During the past several decades, in which economic globalization has made remarkable progress, firms have actively expanded the geographical base of their operations through direct investment or strategic partnerships. *Competition in Global Industries* (Porter, 1986) is a representative study and an early attempt at systematizing international business expansion.

Porter analyzes firms' global strategies by focusing on two concepts: *allocation* and *coordination. Allocation* refers to the internationally distributed allocation of the value chain, while *coordination* means the coordination among the distributed bases. He defines a global strategy as "a strategy to achieve a global competitive advantage through concentrated allocation or coordination of distributed activities, or both" (Porter, 1986, p.35) and states that "in order to understand the competitive advantage of a global strategy or the cause of globalization of a firm, one must know the conditions for achieving cost reduction or differentiation through globally concentrating the activities and/or coordinating the distributed activities" (*ibid*., p.36). He indicates that such conditions are: (1) proximity to markets; (2) economies of scale and experience effect; (3) effective consolidation and coordination of activities; and (4) comparative advantage of each country.

This framework presents the basic idea of a global strategy. In order for a firm to achieve a global competitive advantage, both two factors are essential: the expansion of activities and building of operational foundations at the overseas locations by seizing the internationally spread opportunities for achieving advantages and growth; and the integration of networks of the internationally spread activities under a unified philosophy and business strategy.

In addition to this, the approach of committing to local industrial clusters is vital for the foreign subsidiaries. In an industrial cluster, many firms and institutions are located together, forming multi-dimensional networks to create the characteristics of the area. Inside clusters, markets of diverse human resources and intermediate goods are also formed. Thus firms can secure the diversity, quality and quantity of their managerial resources. Moreover, as technical domains are specialized through division of labor, knowledge accumulates more effectively and operation costs are reduced through the economy of scale. These benefits are collectively called *agglomeration economies*.

David McKendrick, Richard Doner and Stephan Haggard (McKendrick, Doner, & Haggard, 2000) analyzed the agglomeration economies in the HDD industry. They refer to areas such as Silicon Valley and the Japanese archipelago as *technology clusters*; they refer to areas like the Southeast Asian region, mainly Singapore, Thailand and Malaysia, as *operation clusters*.

The agglomeration economies that firms can enjoy in a t*echnology cluster* include (1) early recognition of new technology and market opportunities; (2) creation of new technology, products and services through many start-ups and technology spillovers; (3) prompt problem-solving and product development; (4) access to venture capital; (5) human resource pools that are specialized and differentiated for each technical field; and (6) prompt imitation of product innovations.

In an *operation cluster* firms can enjoy (1) low transportation costs; (2) shorter transportation times between the respective stages of the value chain; (3) economies of scale in production; (4) quick production launch; (5) skillful human resource pools that are specialized for each process or function; (6) prompt imitation of innovation related to assembly, production and physical distribution; (7) monitoring of the quality of suppliers; and (8) low inventory costs.

One of the purposes of a global strategy is to establish the firm's own base within the local industrial cluster, in other words, to take part in creating such agglomeration economies and fully enjoying the benefits they produce. In studies on international business, the need for *localization* is often discussed. A firm that expands overseas but does not localize its overseas base cannot fully enjoy the benefits of globalization. The same applies in the context of an indus-

trial cluster. Spreading the value chain itself is insufficient for achieving essential advantage. The key is how deeply a firm can get involved in the industrial cluster, and how well it can find and develop resources there. The advantages to be gained in a cluster are sometimes highly firm-specific and relation-specific, unlike the initially available advantages like low wage level and land resources; these specific advantages become the firm's core competitive advantage.

Integration of Global Production Networks

As business opportunities spread worldwide and a firm's scope of operations broadens, the firm's business management becomes more complicated. One of the important conditions for a multinational firm to smoothly carry out its global operations is to know how to integrate its decentralized and complicated management into a single direction. The purpose of *integration of global production networks* is to ensure that the activities that have achieved a global spread through foreign investment are not conducted in a disorganized way, but are implemented in an integrated manner under a common vision and business strategy.

A firm that has effectively integrated its specialized functions with an eye on the changes in environmental conditions could turn the benefits into a competitive advantage in the market through the division of labor. Furthermore, it could enjoy large *integration benefits* by creating synergy between its bases. On the other hand, a firm that is lacking integral ability could lose its operation efficiency through international division of labor. In globalization, the logic of integration is in fact more important than the logic of division and spread.

In order for a firm to integrate its operations beyond national borders, the strategic abilities, leadership, and coordinating ability of the firm's headquarters are essential. It is the duty of the headquarters, or the top management, to instill its business philosophy and business strategy in overseas growth markets and to make the firm's resources complement each other. The management requirements for integrating global production networks are (1) presentation of vision and strategy; (2) leadership of top management and the management team; (3) integration of organizational structure; and (4) sharing of organizational culture.

The first requirement is *presentation of the vision and strategy* because in order to integrate businesses beyond national borders, vision and strategies need to be clearly indicated as the purpose of integration. It is ideal to have overseas employees and partners understand and share basic principles and strategy, including the firm's purpose of doing business and the desired future direction, beyond cultural barriers.

However, merely indicating the vision and strategy is not enough; the leadership of the top management and the management team and integration of the organizational structure are also important. The top management and the management team at the headquarters should launch concrete initiatives to put the vision and strategy into practice within the local operation bases. Also, they should indicate the vision's importance to the local management team and employees.

Furthermore, the firm needs to identify the way of sharing the responsibilities and communication between the headquarters and the local bases to implement its vision and strategy in an organized manner. At the first stage, the headquarters needs to take the initiative in overall matters. However, as the subsidiaries become localized, their responsibilities increase and the communication becomes two-way and multi-tiered. Finally these division and communication systems will be optimized so that the firm can fully enjoy the merits of integration.

The last requirement is *sharing of the organizational culture*. Internationalization of business can be regarded as an act of sharing the firm-specific organizational culture among group companies while respecting the *differences in culture* in each country. A firm's organizational culture is expected to gradually permeate the overseas operation bases through its operation. This culture becomes the code of conduct for the members of the organization. In other words, it becomes the corporate identity. A firm having a reasonable code of conduct is likely to be capable of integrating its international business activities smoothly.

Industrial Clusters and Consolidation of Foreign Investment

The country on the receiving end of investment is interested in effectively attracting multinational firms with the above-mentioned behavioral prin-

ciples. In this case, the point of concern is the issue of *mobility of investment*, namely that a firm that has been attracted under initial conditions such as low wage levels and ideal land conditions could move to another country in light of wage differences and investment opportunities in newly developing countries.

In order to have a multinational firm continuously invest in the initially chosen area, the recipient country needs to take the lead in developing competitive advantages that do not rely only on wage level and land resources. The key to achieving this is forming *industrial clusters*.

As discussed earlier, *industrial clusters* involve various *agglomeration economies*. The recipient country must promote regional development with these agglomeration economies in mind. For example, development of expressway systems and port improvements are indispensable for achieving low transportation costs and shorter transportation times. It is also necessary to simplify customs procedure. In regards to forming pools of intellectual human resources and promoting innovations, it is important to develop human resources through collaboration between industry, academia, and government. Another possible measure would be to implement special taxation that meets the industrial needs.

The regional development of an industrial cluster involves both planned factors and emergent factors. Establishment of development zones, development of public infrastructure, and revision of the tax system are planned factors. These are important, but may easily be copied by others. More important factors are emergent ones such as industry-specific networks and a pool of qualified human resources, which are accumulated through the industrial development of the recipient country. Both planned and emergent factors are critical to provide located firms incentives to secure their investments, which contributes to the consolidation of investments for the economic growth of recipient countries.

3. Structural Changes in the HDD Industry

The above-mentioned three concepts provide the analysis framework for studying the HDD industry case. From this section onward, the report will look at this industry. This section focuses on the structural changes in the industry since the 1980s, with particular emphasis on the competition between Japan-

ese and U.S. firms over investment in Asia.

Changes in the Product Architecture and Industrial Structure

Product architecture in the HDD industry was led for a long time by IBM. The firm has a long history in the data storage business, starting with tapes, moving on to floppy disks in 1970, and establishing the standard for the "Winchester" HDD in 1973. In 1989, it developed the magnetic head technology that applied the principle of magneto-resistance (MR) to the recording head, allowing recording of 1 gigabyte per square inch. Furthermore, in 1996, it succeeded in developing the giant magneto-resistive (GMR) head. In this way, IBM has constantly led the development of cutting-edge technology in this field.

Dramatic changes occurred to the industrial structure from the second half of the 1970s through the 1980s. After the HDD industry took off with the establishment of the standard for the Winchester HDD, U.S. computer manufacturers outsourced HDD production to external firms, and U.S. and Japanese firms with a high level of technology entered and formed the industry. As the computer platform changed from mainframes to minicomputers, office computers, workstations and personal computers, the HDD interfaces evolved to enable the use of HDDs as modules. The demand structure shifted from large general-purpose machines to small computers, and there was a transition from centralized processing using mainframes to distributed processing using small computers.

In the mainframe era of the 1970s, a computer and an HDD were connected via IBM-IF, and the physical address of the HDD was controlled by the host computer. Later, with the rise of minicomputers, office computers, and workstations, the interface between the computer and the HDD evolved into the storage module drive (SMD) and subsequently into the Shugart Associates System Interface (SASI) in the second half of the 1970s.[2] With the introduction of the SASI, the host computer came to control the HDD not through physical addressing, but through logical block addressing. Until this point, development

[2] Shugart Technology was a leading HDD manufacturer and was the predecessor of the present Seagate Technology.

of HDDs required close coordination with the computers due to the need for such addressing.

However, when the personal computer (PC) market began to take off at the end of the 1970s, things began to change. Apple Computer, the pioneer of the PC market, had not revealed its basic input/output system (BIOS) for its Apple-1. However, after IBM revealed the BIOS source code for its IBM-PC XT, the design of controllers and HDDs became more open.

In the middle of the 1980s, the small computer system interface (SCSI) was introduced as the interface connecting the computer to the HDD in the PC field. As a result, the HDD came to be connected to an external expansion bus via a controller board, and it became possible to support various HDDs using the BIOS parameter table. With this, the modularization of the HDD made rapid progress. After that, in the PC field, standardization of external interfaces made headway with the introduction of intelligent drive electronics (IDE), achieving the complete modularization of the HDD by moving the hard disk controller that had been mounted on the PC motherboard to within the drive. The IDE specification was later certified by the American National Standards Institute (ANSI), and is being standardized as the AT attachment (ATA).[3]

Because the external interfaces became standardized and it became sufficient to comply with the rules of a specified interface, drive manufacturers no longer had to adjust their HDD specifications according to the computer in the design phase. They could now make the internal design of their HDDs as they liked, which expanded the possibilities for technological innovations and cost reductions. These changes were so dramatic that they completely changed the competition rules of the industry; they served as the background to the subsequent entry of many firms into the industry and their fierce competition in development and cost.

[3] BIOS is the basic program that controls a computer's input and output. SCSI is an interface connecting the computer with peripheral equipment. It was developed based on the SASI to make it more versatile. IDE is the interface standard jointly developed by Compaq Computers Corporation and Western Digital Corporation. It has achieved wide distribution as the standard interface due to its mechanical simplicity.

Figure 1. (A) Changes in HDD Shipment Value by Inch

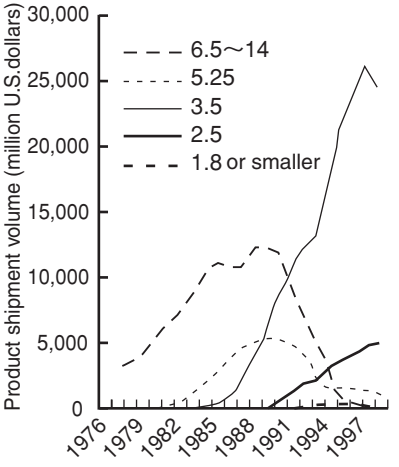
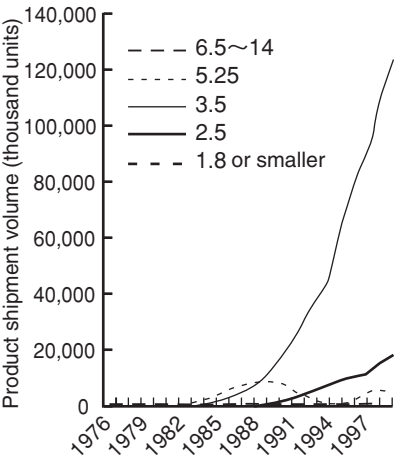


Figure 1. (B) Changes in HDD Shipment Volume by Inch



Source: Created based on McKendrick, Donner and Haggard [2000], p. 27.

Miniaturization of HDDs and Changes in Competitive Conditions

During this course, HDDs also became more compact. Figure 1 shows the changes in the world's total HDD shipment value and shipment volume by inch. The type of HDD that contributed to the growth of the industry in the second half of the 1970s when the industry had just started was the 6.5- to 14-inch drive for mainframes. The HDD industry had originally been monopolized by IBM. However, because new computer manufacturers emerged in the first half of the 1970s and procured their HDDs from external suppliers, the original equipment manufacturer (OEM) market for HDDs grew.

HDDs were first miniaturized from the 14-inch drive for mainframes to the 8-inch and 6.5-inch drives targeting minicomputers and office computers. By the first half of the 1980s, the 5.25-inch drive for desktop PCs was gaining popularity (Figure 1 (A)). This market was cultivated by such emerging firms as Seagate Technology, MiniScribe, and Computer Memories.

After that, the small HDD for PCs was further miniaturized from 5.25 inches to 3.5 inches, and the 3.5-inch drive achieved full-fledged diffusion in the 1990s. In this process, the emerging manufacturers of the 5.25-inch drive took bold growth strategies in entering the competition arena of the 3.5-inch

drive. Conner Peripherals was hived off from the leading 5.25-inch HDD manufacturer, Seagate. Within a few years, Seagate, Quantum, Maxtor, and Western Digital entered the market.

The important turning point was when HDD size shifted from 5.25 inches to 3.5 inches. Comparison between the shipment value and the shipment volume of HDDs in Figure 1 shows this fact. The changes in the HDD shipment value by inch in Figure 1 (A) suggest that the industry followed the miniaturization trend in a sequence from 14 inches to 6.5 inches, 5.25 inches, 3.5 inches, and 2.5 inches.

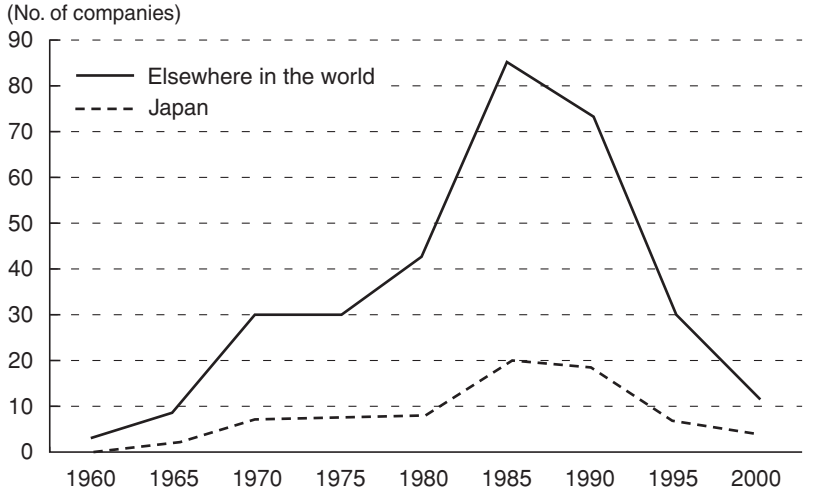
The changes in HDD shipment volume by inch in Figure 1 (B) indicate an essential difference between the miniaturization up to 5.25 inches and that from 3.5 inches onward. The miniaturization of the HDD up to 5.25 inches, though it brought changes to the market segment structure, did not change the basic structure of the industry; the shipment volume remainined at a low level.

In the process of miniaturization from 3.5 inches onward, the HDD manufacturers faced demand for product volume exceeding that for the 5.25-inch drive. The modularization trend created an incentive for increasing the production volume and accelerating innovation, and firms could secure profits only if they could manufacture HDDs of higher performance at lower costs. Instead of adopting a flexible development framework to adapt to market changes, firms had to take bold growth strategies by focusing on growing market segments such as that of the 3.5-inch drive.

Figure 2 shows the changes in the number of firms in the HDD industry. The figure clearly indicates the changes in the industrial structure caused by the expansion of the 3.5-inch drive market. The number of firms peaked in 1985 with 105 players in the industry. This was the time when the 3.5-inch drive market was launched in the United States. A large number of firms attempted to enter this market segment at the time, seeking potential business opportunities.

After the peak, however, many firms withdrew from the HDD industry, and the number of firms remaining in the industry rapidly declined. Only 15 firms remained in the industry in 2000, which means 90 firms, or about 86% in proportion to the number of firms in the industry in 1985, withdrew from the industry over 15 years. This rapid decline indicates that unusually fierce compe-

Figure 2. Changes in the Number of Companies in the HDD Industry



Source: Created based on data from the International Disk Drive Equipment and Materials Association (IDEM), *Trend* FOCUS, and an interview survey of firms.

tition characterized the small HDD market segment.

Market Performance as of 2000

To look more closely at the intensification of competition in the small HDD market throughout the 1990s, the performance of the market is identified based on the shipment volumes of HDD manufacturers and major component manufacturers as of 2000 (FY1999) as well as the changes in the sales and operating margins of major firms (see Table 1).

The small HDD market is divided into 3.5-inch ATA (drives for PCs; sold at around 10,000 yen), 3.5-inch SCSI (drives for servers; sold at around 30,000 yen), and 2.5-inch or smaller HDD (drives for mobile computers). The 3.5-inch ATA accounts for the largest volume, commanding a 73.6% share of the 184 million-unit HDD market. Meanwhile, the 3.5-inch SCSI commands a share of 11.0% and the 2.5-inch HDD a share of 15.4%.

As mentioned earlier, the SCSI and the ATA are only different in terms of the interface; they share the same magnetic heads and media for the 3.5-inch drives. As for price, the SCSI for servers is about three times more expensive than the ATA for PCs. With regard to the media used, the 3.5-inch

Table 1. Volume of HDD Shipped Worldwide (2000)

(thousand units)

	2.5-inch or smaller	3.5-inch ATA	3.5-inch SCSI	Total
Seagate (U.S.A.)		30,100	8,900	39,000
Quantum (U.S.A.)		26,800	2,500	29,300
Maxtor (U.S.A.)		25,400		25,400
IBM (U.S.A.)	11,100	8,300	5,100	24,500
Fujitsu (Japan)	5,300	14,500	3,200	23,000
Western Digital (U.S.A.)		18,200		18,200
Samsung (South Korea)		10,100		10,100
Toshiba (Japan)	7,200			7,200
Hitachi (Japan)	4,700		600	5,300
Others		2,000		2,000
Total	28,300	135,400	20,300	184,000

Notes: 1. The "2.5-inch or smaller drives" are all ATA. The "ATA" is for PCs and the "SCSI" is for servers.
2. Maxtor acquired Quantum's HDD business in April 2001.
3. Hitachi acquired IBM's HDD business in December 2002.

Source: "'01 HDD Market Survey: Current Status and Prospects of HDD-based Digital Home Electric Appliances" (June 2001) Japan Economic Center.

drives use aluminum and the 2.5-inch drives use glass.

By type of drive, U.S. HDD manufacturers achieve overwhelming production volumes in the 3.5-inch ATA segment. In particular, the top HDD manufacturer, Seagate, which boasts a tremendous production volume in this segment, also secures a 44% share in the high-priced 3.5-inch SCSI for servers. The firm's strategy is to secure its share of the high-end market while pursuing a high production volume in the ATA segment in order to attain a high production scale of its in-house manufacturing components.

The firms that made both HDDs for PCs and those for servers, similar to Seagate, included Quantum, IBM, and Fujitsu in 2000. They competed in developing cutting-edge component-level technology. They tended to self-manufacture some of the core components, including the head and media.

Other firms, such as Maxtor, Western Digital, and South Korea's Samsung, do not have the capacity for in-house development of core components, partly owing to their later entry into the industry compared to Seagate and IBM. Therefore, they specialize in the 3.5-inch ATA for PCs.

IBM and Japanese firms including Fujitsu, Hitachi, and Toshiba have also placed emphasis on 2.5-inch and smaller HDDs for mobile computers. This market segment is expected to grow in the future. Hitachi's 2002 announcement

that it would acquire IBM's HDD business was a strategy to gain dominance in the market of HDDs for mobile computers. Hitachi and Toshiba specialize in HDDs for mobile computers.

In addition to the drives, the market conditions of the key HDD components at the time should be studied. Table 2 shows the major manufacturers and the shipment volumes of the key components mounted on HDDs.

The supply markets of the major HDD components are dominated by Japanese firms. Such HDD manufacturers as Seagate, IBM, Fujitsu, and Hitachi

Table 2. Shipment Volume of the Key HDD Components (2000)

(A) Media (hard disk [HD]) (thousand units)

	Aluminum	Glass
Komag (U.S.A.)	46,500	
Fuji Electric (Japan)	39,400	1,800
Showa Denko (Japan)	34,800	8,900
IBM (U.S.A.)	53,900	
Mitsubishi Chemical (Japan)	34,200	700
Seagate (U.S.A.)	34,900	
Fujitsu (Japan)	12,800	
Nippon Sheet Glass (Japan)		11,100
Hoya (Japan)		25,600
Others	12,700	
Total	269,200	48,100

(B) Magnetic heads (thousand units)

IBM (U.S.A.)	102,800
Alps Electric (Japan)	101,600
Seagate (U.S.A.)	118,200
TDK (Japan)	154,300
Hitachi (Japan)	19,000
Fujitsu (Japan)	50,200
Read-Rite (U.S.A.)	66,100
Others	
Total	612,200

(C) Spindle motors (thousand units)

Nidec (Japan)	113,100
Matsushita-Kotobuki Electronics Industries (Japan)	31,500
Minebea (Japan)	31,100
Victor Firm of Japan (Japan)	11,900
Sankyo Seiki Manufacturing	8,100
Others	2,400
Total	198,100

Note: Samsung withdrew from the spindle motor market in 1999.
Source: "01 HDD Market Survey: Current Status and Prospects of HDD-based Digital Home Electric Appliances" (June 2001) Japan Economic Center.

manufacture magnetic heads and media (hard disks [HD]) in house, but even these firms procure any volume that cannot be covered by their own production capacity from these outside suppliers. In addition, because self-manufacturing of components requires development of cutting-edge technology and global production capacities, many HDD manufacturers do not self-manufacture the components. Therefore, the market for supply of the key components is enormous.

By type of component, the supply of magnetic heads is dominated by Alps Electric and TDK. As for media, there was intense competition among Japanese firms in the aluminum media market for 3.5-inch HDDs as of 2000. However, because the absolute number of media required for HDDs for PCs decreased with the improvements in the recording density, the media became oversupplied from around 2000. After that, the industry's structure changed with the withdrawal of Komag and the acquisition of Showa Denko by Mitsubishi Chemical, leading to a state of oligopoly. The supply of glass media for HDDs is dominated by Hoya and Nippon Sheet Glass. In the spindle motor market, Nidec boasts an overwhelming share.

It could be said that U.S. HDD manufacturers are more competitive in small HDDs, centering on 3.5-inch drives, and Japanese firms differentiate themselves by focusing on the 2.5-inch and smaller HDD market for mobile computers. On the other hand, Japanese firms are found to be more competitive in the key component markets. Why is there such an inconsistency in focus between the U.S. and Japanese firms when they are both part of the HDD industry?

4. Shift Towards Asia

Competition Strategies in Growth Markets

How did the structure of U.S. HDD manufacturers taking the offensive in the 3.5-inch HDD market and Japanese firms gaining an advantage in the key component market come about amidst the rapid expansion of the HDD industry? To answer this question, we must look at the growth strategies of major firms during this period.

Figure 3. (A) Sales of U.S. Manufacturers

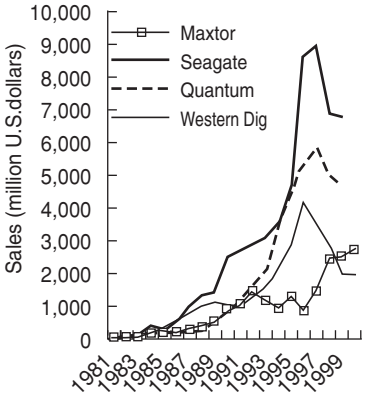
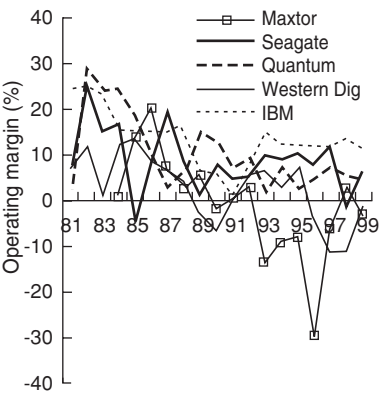


Figure 3. (B) Operating Margins of U.S. Manufacturers



Notes: 1. Financial data is on a consolidated basis.
2. Operating margins are EBIT margins.
Source: Created based on financial data from the Development Bank of Japan.

Figure 3 shows the changes in the sales and operating margins of U.S. HDD-specialized manufacturers. Due to the limitation in acquiring long-term data, earnings before interest and taxes (EBIT) were used for the operating margins instead of sales profits. The EBIT are the values close to operating profits, which are obtained by adding the interests paid to the ordinary income and subtracting the interest income from that total.

As Figure 3 (A) shows, U.S. HDD manufacturers dramatically increased their sales during this period, growing robustly with focus on the OEM market in 3.5-inch HDDs for PCs. In particular, Seagate continuously kept its top position in the industry. Its sales doubled in 1996 due to its acquisition of Conner Peripherals. Seagate has been followed by the second largest manufacturer, Quantum.

Compared to these two firms, Maxtor and Western Digital, which are latecomers that only deal in drive assembly, began to show a decline or a slowdown in growth in the second half of the 1990s. The reasons are said to be that they failed to integrate their global operations and that they were late in placing their new products on the market because they found quality problems at the mass production stage due to not manufacturing the key components by them-

selves.

In this industry, the scale of operation has a large influence on profitability. Figure 3 (B) suggests that the industry leaders, Seagate and Quantum, have maintained a certain level of profitability over a long term. The firm secured high profitability by growing. Meanwhile, the operating margins of Maxtor and Western Digital fell into the red in the second half of the 1990s and have stayed in the red since then. Because they could not expand their scale of operation smoothly and because they were not market leaders, they had no choice but to give in to PC manufacturers' pressure to lower the prices and thus failed to make profits.

The situation was not promising for Japanese HDD manufacturers either during this period. In the case of general electric appliance manufacturers, the profits and losses for individual divisions cannot be identified from the published financial reports. However, according to some interviews, it seems to have been difficult for them to make notable achievements in terms of profit, because the scale of commercial production was small for 3.5-inch HDDs, and the market for 2.5-inch or smaller HDDs was limited to laptop PCs with the proportion of domestic production also being high.

Figure 4. (A) Sales of Major Component Manufacturers

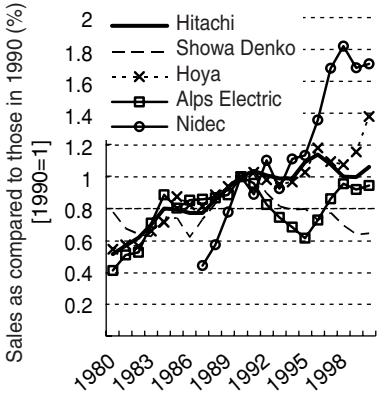
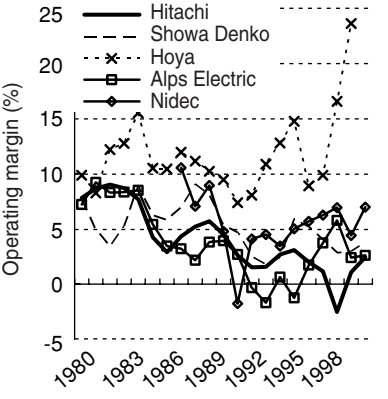


Figure 4. (B) Operating Margins of Major Component Manufacturers



Notes: 1. Financial data are on a non-consolidated basis.
2. Data for Hitachi is shown for reference.
Source: Created based on financial data of the Development Bank of Japan.

In the meantime, how did the business performance of component manufacturers change? Looking at the financial data of major firms in Figure 4, in the media market, Showa Denko has seen stagnation in both sales growth and operating margins, but Hoya has achieved an outstanding growth rate and profitability. The fact that Hoya has established a monopolistic position in the glass media for the 2.5-inch HDD has also contributed to its high profitability.

Among the manufacturers of magnetic heads and motors, Nidec boasts a monopolistic share in spindle motors, achieving notable sales growth. Its operating margin has remained within the region of 7% as well. In the case of Alps Electric, the firm had conventionally focused on magnetic heads and electronic components for home electric appliances. Nevertheless, it formulated a business restructuring plan in 1993 and shifted the production of electronic components for consumer products to China; it also restructured its domestic operations with focus on heads for HDDs. These efforts began to show results in 1996, and the firm's sales and operating margin have been recovering.

As a matter of course, these data are based not on individual operations, but on the overall operations of firms, so various factors are involved in their changes. As each firm defines its divisions differently, it is impossible to extract and compare information on the HDD-related segments alone. However, at least for the firms mentioned here, manufacturing of HDD components is a very large-scale operation and a business that contributes greatly to the firms' sales and operating margins.

Be they manufacturers of HDDs or HDD components, firms that assumed the market would expand, took active measures in anticipation of such growth, and built an operational framework that could withstand rapid business expansion succeeded in increasing their market control and profitability; even taking into account the restriction of data, this can be said about firms' strategies amid the rapid expansion of the 3.5-inch HDD market. Many of the Japanese component manufacturers that succeeded to grow and increased their competitiveness during this period established close relationships with leading U.S. HDD manufacturers. Firms that fell behind in achieving growth faced a decline in profits, both in the areas of HDD and their components.

U.S. HDD Manufacturers' Shift to Asia

Foreign investment in Asia played an important role in expanding operations in the growth phase that started in the 1980s. This is an aspect in which notable differences are observed between firms that achieved remarkable growth and those that became stagnant. The first point is the timing of the investment.

Table 3 shows the timing of HDD manufacturers' investment in Asia. The industrial leader, Seagate, was also the first firm to invest in Asia. Seagate was a venture firm founded in 1979 by an IBM engineer, Alan Shugart. Since Shugart himself was the person who promoted the standardization of the interface of 3.5-inch HHD, he thought it was only a matter of time until the HDD would

Table 3. Timing of HDD Manufacturers' Investment in East Asia

Year	Company	Place of investment
1983	Seagate Technology	Singapore
	Ampex	Hong Kong
	Computer Memories	Singapore
	Tandon	Singapore
	Tandon	India
1984	Seagate Technology	Thailand
	IBM	Japan
	Maxtor	Singapore
	Miniscribe	Singapore
	Quantum (OEM to MKEI*2)	Japan
1985	Microscience International	Singapore
1986	Micropolis	Singapore
	Tandon	South Korea
1987	Connor Peripherals	Singapore
	Control Data	Singapore
	Cybernex	Singapore
	Microscience International	Taiwan
	Priam	Taiwan
	Seagate Technology	Thailand
1988	Unisys	Singapore
	Western Digital	Singapore
1989	IBM (Saha-Union)	Thailand
	Seagate Technology	Malaysia
	Kalok	Philippines
	SyQuest	Singapore
	NEC	Philippines
1990	Connor Peripherals	Malaysia
	Microscience International	China
1991	Fujitsu*1	Thailand
	PrairieTek	Singapore
	Xebec	Philippines
1992	Integral Peripherals	Singapore
	Ministor	Singapore
1993	Connor Peripherals	China
1994	DEC	Malaysia
	Hewlett-Packard	Malaysia
	Quantum	Malaysia
	Western Digital	Malaysia
	MKEI (Quantum OEM)	Singapore
1995	IBM	Singapore
	Hitachi	Philippines
	Toshiba	Philippines
	Fujitsu	Philippines
1996	IIBM	Thailand
	Seagate Technology	Thailand
	Fujitsu	Vietnam
1998	MKEI (Quantum OEM)	Indonesia
2002	Western Digital	Thailand
	Hitachi*3	Thailand

Notes: *1.Fujitsu launched Fujitsu (Thailand) Co., Ltd. (FTC) in 1988, but shifted its HDD production to FTC in 1991.
*2. MEKI: Matsushita-Kotobuki Electronics Industries.
*3. Hitachi acquired IBM's HDD division.
Source: Created based on McKendrick, Donner and Haggard (2000) at p. 99 and data from interviews.

become adaptable to a wide variety of applications. Therefore, he established a production base in Singapore in 1983 and in Thailand the following year, driving forward the mass production of the HDD, already with a full understanding of how the modularization would affect the industry.

Seagate frequently conducted M&A in its growth process. It acquired Grenex (a thin-film media manufacturer) in 1985 and Aeon (an aluminum substrate manufacturer) in 1986. Furthermore, it purchased HDD software manufacturers in the 1990s and acquired Conner Peripherals, which had originally hived off from Seagate, in 1996. By procuring funds from the stock market and acquiring external resources through M&As, Seagate came to posses the largest HDD production capacity in the industry. Much of the production capacity it established through this process is located in Southeast Asia.

The next firms to invest in East Asia were Tandon and Maxtor. Tandon advanced into countries such as Singapore, India, and South Korea in the first half of the 1980s. However, this expansion ended in failure and the firm was acquired by Western Digital in 1988. Conversely, Western Digital managed to invest in Singapore through the acquisition of Tandon. Firms including Maxtor, Conner Peripherals, and Miniscribe also invested in Asia in and around the mid-1980s.

In the beginning, the race for foreign investment was started by U.S. venture firms. At that time, many of them chose Singapore as the place for investment. Since the OEM market (non-captive market) for the 3.5-inch HDD for desktop PCs was developing, backed by the rapid expansion of the PC market, U.S. venture firms daringly attempted to invest in Asia in order to establish a competitive advantage in the OEM market.

From the end of the 1980s, the place for investment by U.S. firms spread from Singapore to Thailand and Malaysia. Seagate invested in Thailand in 1987, in Malaysia in 1989, and once again in Thailand in 1996. Western Digital expanded into Malaysia in 1994, and Quantum also invested in Malaysia in the same year.

IBM's case is interesting. The firm had engaged in developing and manufacturing all types of HDD, from drives for servers to 2.5-inch or smaller drives for mobile computers. It had also conducted in-house development of key components, including magnetic heads and media. IBM America outsourced the development and manufacturing of 3.5-inch and 2.5-inch HDDs for PCs to IBM

Japan in 1984. IBM Japan initially developed and manufactured HDDs in Fujisawa, Japan. However, due to the competitors' shift to Southeast Asia and the impact of yen appreciation, they started to outsource the manufacturing of HDDs to Saha-Union Public Firm in Thailand in 1989. Moreover, IBM America shifted its operations related to HDDs for servers from San Jose in the United States to Singapore in 1995, and established a wholly owned manufacturing base in the Prachinburi Province, Thailand, in 1996.

Quantum also expanded its operations by using contract manufacturing. The firm was founded in 1980 and had expanded its business mainly through the 5.25-inch HDD. Quantum listed its stock in 1982 and came to command a 25% share in the HDD market. However, in order to further expand its production capacity, it entered into a partnership with Matsushita-Kotobuki Electronics Industries in 1984, regarding contract production of the 3.5-inch HDD. Matsushita-Kotobuki was first manufacturing the HDD at its base in Ipponmatsu, Ehime Prefecture, Japan but in order to evade the impact of yen appreciation, the firm launched overseas production of HDD in Singapore in 1994.

Concentrated Investment and Geographic Advantage

U.S. manufacturers invested in Southeast Asia, centering on Singapore and gradually spreading to Malaysia and Thailand. Eventually, a mass production framework in Asia became a requisite condition for securing large-scale transactions in the 3.5-inch HDD market. As indicated in Figure 2, the number of firms entering the industry declined and the number of firms withdrawing from the industry increased rapidly after this period. The overseas mass production capacity began to function as an entry barrier for surviving in the industry.

HDD manufacturers that achieved foreign investment consistently began to increase their overseas production ratios at this time. According to a study by McKendrick, Donner and Haggard (2000), which examined the changes in the overseas production ratio with regard to the HDD industry, the overseas production ratio of U.S. firms, which had only been 4% in 1983, increased to 67% by 1990. These firms had conducted a major shift to overseas production in the second half of the 1980s.

In contrast, the overseas production ratio of Japanese HDD manufacturers was only 2% in 1990 and 54% in 1995; they only began to make full-

fledged expansion into Asia from the mid-1990s. The main reason for the foreign investment was to deal with the second yen appreciation in the mid-1990s. Despite having a competing operational domain, Japanese HDD manufacturers were more than a decade late in engaging in foreign investment. It is doubtful that Japanese firms that made foreign investments with an eye on the exchange rate fluctuations were able to act based on a consistent global strategy.

As an example of concentrated foreign investment in Southeast Asia, the investment process of Seagate will be studied below in detail. Seagate's expansion into Asia began in Singapore in 1983, later spreading to Thailand and Malaysia. Seagate had 12,000 workers in Singapore and 16,700 workers in Thailand and Malaysia compared with 11,000 workers in the United States in 1990, and the number of workers in Asia increased to 15,000 in Singapore and 57,000 in Thailand and Malaysia against 9,000 workers in the United States in 1999. The firm now has 4,000 workers in China.

Seagate's employee makeup in Asia by region points to some interesting facts. One is that the firm has regarded Singapore as the central base in Asia for a long time. In terms of labor cost, it would have been wiser for the firm to downsize its base in Singapore and expand its bases in Thailand, Malaysia, and China. However, it did not do that. Seagate positioned Singapore as a base for supplying engineers and supervisors, which complements the U.S. headquarters, and as the core base for the industrial cluster in Southeast Asia. Therefore, the number of Seagate employees in Singapore never decreased throughout the 1990s.

Among the Southeast Asian countries, Singapore has substantial preferential measures for foreign firms, including tax incentives. For example, in Thailand, the Board of Investment (BOI) gives approvals for inward investment by foreign firms, and by dividing the land area into three zones from Zone 1 to Zone 3, it provides a tax allowance of 40% to 50% for firms investing in Zone 2 and Zone 3, which are far from Bangkok. Malaysia provides a tax allowance for re-investment and a tax allowance of a little over 10% for collaboration with universities and public research institutions. The Thai government usually takes about three to six months to approve an investment project.

Compared to neighboring countries such as Thailand and Malaysia, the support policy of Singapore had distinctive characteristics. First of all, its

taxation system was highly preferable for foreign firms conducting sophisticated operations, including an R&D allowance (23.1%), an equipment purchase allowance (61.5%), an allowance for collaboration with universities or public research institutions (61.5%), a depreciation allowance (53.8%), a human resources development allowance (46.2%), and an allowance for technical assistance to small and medium-sized enterprises (SMEs) (69.2%). At the same time, the time required for gaining an approval for an investment project was three months in 80% of all cases, which was extremely short compared to other countries. This point was very important for making large-scale investment with a short payback period in the IT industry, which has short lifecycles. The Singaporean government was thoroughly aware of the needs of the U.S. IT industry.

A more important point was that Singapore provided, in addition to the above-mentioned general incentives applicable to all industries, industry-specific incentives for the HDD industry. Singapore provided substantial preferred measures in association with a wide range of activities in the HDD industry, including (1) development of engineers and operators, (2) diffusion and development of technology, and (3) development of local vendors.

The organization that played the central role was the Magnetic Technology Centre (MTC; renamed as the Data Storage Institute [DSI] in 1996). The MTC was established within the National University of Singapore at the government's initiative in 1984. Since then, it has promoted basic research related to data storage and joint projects between industry and academia, and has produced a large number of engineers for the HDD-related industry. It also provided support measures for SMEs, provided them with basic knowledge and techniques for quality control and production management, and engaged in operator training.[4]

U.S. HDD manufacturers sought assistance from the Singaporean government and the government made active efforts to support Singapore's HDD industry. As a result, many firms related to the HDD industry established "advanced mass production bases" equipped with a technology development capacity and a mass production capacity in Singapore. Under a favorable envi-

[4] According to an interview by the author with the Data Storage Institute (DSI) (2004, February).

ronment, Seagate developed engineers, supervisors, and operators in Singapore, appointed them as core personnel, and spread a low-cost operation framework throughout Southeast Asia. When launching production bases in Malaysia and Thailand, the operational experience in Singapore and the human resources it had developed there played a key role. The concentrated human resources development at the core base and prompt transfer of knowledge to the neighboring mass production bases enabled Seagate to conduct what can be called a *vertical launch* of HDD mass production.

Furthermore, the firm developed local suppliers and encouraged global suppliers to establish their bases close to Seagate's bases. The firm provided technical guidance to local suppliers to raise their technical level. Seagate also appointed local workers as personnel in charge of procurement and repeatedly applied unique ideas in product design in order to be able to manufacture HDDs using local components. For global suppliers, the firm increased the incentive for establishing their bases nearby by increasing the production ratio in Southeast Asia and securing production volume. Since component cost accounts for a large share of the HDD production cost, such local supplier networks are likely to have contributed greatly to increasing the firm's cost competitiveness.

Seagate's efforts have been copied by other U.S. HDD manufacturers, and have sparked successive waves of investment. Underlying the rapid increase in the overseas production ratio in the second half of the 1980s were such efforts by the aforementioned pioneering firm, with subsequent firms immediately following its example.

Hesitant Japanese General Electric Appliance Manufacturers[5]

The U.S. HDD manufacturers' investment in Asia can be understood as part of the competition to acquire production resources on a global scale amidst the rapid expansion of the 3.5-inch HDD market. However, Japanese electric appliance manufacturers were not quick to respond to this trend. The reason was closely related to their conventional business circumstances.

The HDD sections of Japanese electric appliance manufacturers were usually established within the in-house computer divisions as sections provid-

[5] For the efforts made by Japanese general electric appliance manufacturers, see Amano (1999).

ing storage devices. From the end of the 1970s through the first half of the 1980s, they supplied storage devices to U.S. office computer manufacturers as OEM suppliers and expanded their operations. Since the HDDs for office computers had close technical relevance to computers, Japanese electric appliance manufacturers provided technical support and engaged in joint development with U.S. computer manufacturers; they gained tremendous trust from leading client firms, including IBM. The HDD business earned the biggest profits for computer manufacturers at the time, and some firms gained nearly 70% of their overall profits from the HDD business.

One example of this success is Fujitsu. The firm jointly developed an 8-inch HDD with Memorex Products in 1979, and independently developed a 48-MB HDD in 1981. It also succeeded in developing a 10.5-inch drive and supplied the product to the United States. Until the mid-1980s, the OEM business of HDDs for U.S. office computer manufacturers was one of the core businesses of the firm. Although the HDD business required cutting-edge technology, the unit prices for products were extremely high. Fujitsu exerted efforts to develop HDD-related technology in-house and in affiliated firms, and won orders from U.S. clients.

However, such success produced the opposite result in the world of small HDDs. In the second half of the 1980s when U.S. HDD manufacturers achieved rapid growth, Japanese electric appliance manufacturers faced a very severe situation. The market for medium and large-size HDDs was eroded by that for small HDDs, and shipment values for the HDD operations of Japanese electric appliance manufacturers, which had relied on medium and large-size HDDs, dropped sharply. Moreover, yen appreciation spurred a decline in profits. In order to break through this situation, Japanese electric appliance manufacturers finally began to review their operational structure in the early 1990s, but the process did not progress smoothly.

In the case of Fujitsu, which fared relatively well among the Japanese firms, the firm launched Fujitsu (Thailand) Co., Ltd. (FTC) in 1988 and attempted to shift its 3.5-inch HDD operation to FTC in 1991. However, the operation did not succeed, and Fujitsu withdrew from global production. It invested in Thailand once again in 1994, but full-fledged mass production only started in the second half of the 1990s, nearly ten years later than that of U.S. firms.

NEC Corporation was more passive. The firm had produced HDDs mainly for its PC98 series computers and computers for its internal systems divisions, as well as for the captive market in which products were sold through its distributors and exclusive dealers. NEC expanded into the Philippines in 1989, but all products were sold to Japan and the components were supplied from Japan; only the labor-intensive processes were outsourced to the local Japanese subcontracting firms, and the finished products were imported into Japan.

Overseas production was adjusted in line with exchange rate fluctuations, so the overseas production ratio changed wildly. The firm lacked the attitude to commit itself to establishing a mass production framework in Asia. As a result, costs became high and the firm had no choice but to withdraw from the in-house manufacturing of HDDs in 1998, and from the entire HDD production business in 2001.

Toshiba and Hitachi, at first, intentionally avoided full-scale entry into the 3.5-inch HDD market and specialized in the 2.5-inch HDD for laptop PCs. The two firms invested in the Philippines in 1995 and gradually increased their overseas production ratios. However, the market of the 2.5-inch and smaller HDDs for mobile computers was smaller in absolute scale compared to that for the 3.5-inch HDD, and had little growth potential.[6] Because they could not allocate a substantial amount of management resources to their HDD operations, the firms purposefully avoided entering into full-fledged competition with U.S. firms.

Compared to U.S. HDD manufacturers, Japanese firms were later to expand overseas, and their commitment to overseas production was irresolute. Their main investment location was the Philippines, which was far from Singapore and Thailand. By looking at their mode of investment, it is doubtful that they promoted foreign investment with a view to forming local industrial clus-

[6] In 1994, the world's total demand for HDDs was 62.58 million units, of which 900,000 units were for 2.5-inch and smaller HDDs, accounting for 14% of the total. In 2000, the world's total demand was 184.02 million units, of which 28.3 million units were for 2.5-inch and smaller HDDs, accounting for 15% of the total. The proportion increased little, but the production volume of the 2.5-inch HDD nearly tripled during these six years. The market is expected to grow further in the future.

ters and strategically expanding the scale of operations as the U.S. firms did. They seem to have regarded the shift of production to overseas bases a temporary measure to deal with the relative personnel costs that soared in Japan due to yen appreciation. Such differences between Japanese and U.S. firms manifested as differences in their competitive advantages in the HDD market in the 1990s when the 3.5-inch drive became the standard.

Rapidly Growing Japanese Component Manufacturers

In contrast to the struggling general electric appliance manufacturers, Japanese component manufacturers gradually gained strength in the 1990s. These firms paid attention to the growth of U.S. firms from an early stage and established business connections with them. Since U.S. firms started increasing their production in Asia the Japanese component manufacturers have attempted to establish their production bases near the U.S. firms' bases.

Japanese component manufacturers started investing overseas relatively earlier than Japanese general electric appliance manufacturers. They promoted overseas production in pace with the trend of U.S. HDD manufacturers rather than that of the Japanese HDD manufacturers.

The first Japanese firm to begin the trend of investment in Southeast Asia was the top spindle motor manufacturer, Nidec. It is a venture firm, founded by Shigenobu Nagamori, which was hived off from TEAC Corporation in 1973. At the time, Japanese general electric appliance manufacturers tended to produce motors in-house or at their affiliated firms, so it was relatively difficult to expand the motor business within Japan. Therefore, the firm conducted active sales and marketing activities in the United States.

At that time, U.S. HDD manufacturers were switching from self-manufacturing the spindle motors to procuring the motors from outside. Thus, Nidec was able to start a deal with Seagate in 1983. HDD manufactures including Seagate concentrated their development resources in the development of the drives and magnetic heads in order to catch up with the rapid market expansion of the 3.5-inch HDD. Nidec acquired orders for motors from most HDD manufacturers, weaving its way through this niche.

Table 4. Major Component Manufacturers' Operational Expansion Into East Asia And Its Timing

(A) Media manufacturers

	Overseas bases (operation; year of foundation)	Domestic bases (operation)	Remarks
Showa Denko	Malaysia (aluminum substrates; 1997)	Ichihara Plant (aluminum/glass media)	Showa Denko and Showa Aluminum merged in March 2001. It acquired the HD operation of Mitsubishi Chemical in 2002.
Mitsubishi Chemical	Singapore (aluminum/glass media; 1996)	Mizushima / Naoetsu Plants (aluminum/glass media)	
Komag (U.S.A.)	Malaysia (aluminum media; 1993, 1996)	San Jose in California (only development)	Asahi Komag, founded in 1987, was dissolved in March 2001. Komag closed all plants in the United States and shifted the operation to Malaysia.
Fuji Electric	Malaysia (aluminum/glass media; 1996)	Matsumoto / Yamanashi Plants (aluminum / glass media)	
Nippon Sheet Glass	Philippines (glass blank sheets, substrates, media; 1997), Malaysia (same as above; 1999)	Yokkaichi Plant (blank sheets, substrates, media)	The base in Malaysia is ADP (joint venture between Kobe Steel and Nippon Sheet Glass). It transferred its Philippine base to Hoya in 2004.
Hoya	Thailand (substrates; 1990), Singapore (media; 1995)	Akishima Plant (blank sheets)	Hoya received Nippon Sheet Glass'substrate base in the Philippines by transfer in 2004.

Notes: 1. Blank sheets are aluminum sheets punched out in a doughnut shape or glass sheets processed into a doughnut shape.
2. Substrates are blank sheets polished on the surface and cleaned. Media are substrates to which a magnetic film has been sputtered.

(B) Magnetic head manufacturers

	Overseas bases (operation; year of foundation)	Domestic bases (operation)	Remarks
TDK	Dongguan Plant in China (back-end process; 1994), Philippines (back-end process; 1996)	Chikumagawa Plant (development, front-end process)	TDK is the top supplier of magnetic heads for HDD.
Alps Electric	Wuxi Plant in China (back-end process; 1995)	Nagaoka Plant (development, front-end process), Furukawa Plant (back-end process)	
Read-Rite	Thailand (back-end process; 1991, 1995)	Milpitas Plant in California (development, front-end process)	Read-Rite established Read-Rite SMI with the capital participation of Sumitomo Metal Industries in 1991, but it was dissolved in 2001. The firm has continued its magnetic head operation in Thailand and undertakes processing work from HGA.

(C) Spindle motor manufacturers

	Overseas bases (operation; year of foundation)	Domestic bases (operation)	Remarks
Nidec	Thailand (motor component processing and assembly; 1990)	Kyoto / Nagano Plants (development, processing, assembly)	Nidec invested in Thailand in 1990, and has established and expanded its plants in nearby locations including Bangkadi and Rojana.
Matsushita-Kotobuki Electronics Industries	Indonesia (motor component processing and assembly; 1998)	Ipponmatsu Plant (development, processing, assembly)	
Minebea	Thailand (motor component processing and assembly; 1990)	Karuizawa Plant (development, processing, assembly)	

Source: Created based on data from interviews with firms, "Market Survey on HDD" for the relevant years, Japan Economic Center and "Electronic Manufacturers' Investment in East Asia," Electronic Economic Research Center, 1995.

In the case of Nidec, U.S. HDD manufacturers had been major clients from the beginning, so the firm had seen the need to establish its production framework in Southeast Asia from the mid-1980s. Nidec established a branch office in Singapore in 1984 to gather information while engaging in sales and marketing activities, and achieved investment in Thailand in 1990. The direct cause for the investment was a request from Seagate, which had already started manufacturing in Thailand, and from IBM-affiliated Saha-Union.

Later, while U.S. HDD manufacturers expanded their mass production at their overseas operation bases, Nidec established and expanded its plants in Thailand. After Nidec advanced into Thailand, Fujitsu, IBM (Prachinburi), and Western Digital also advanced into Thailand and nearby Malaysia, so it became even more advantageous to establish operation bases in this area. Nidec mentioned the following points as the reasons for choosing Thailand: (1) clients are concentrated in the area; (2) supply chains are developed, and about 70% of the components can be procured within Thailand; (3) there is access to the BOI's tax exemption measures and the preferential treatment for the HDD industry; and (4) they believe that people in Thailand are diligent and friendly.

Currently, Nidec controls the Ayutthaya, Bangkadi, Rojana, and Nidec Hi-tech Motor (NHMT) (acquired from Seagate) plants in Thailand, with about 9,000 workers. The firm has a separate production line for each client.

Nidec deals with most of the HDD manufacturers, including GSM, Maxtor, Western Digital, Hitachi Global Storage Technologies, and Fujitsu.

While Nidec conducted one of the most daring foreign investment campaigns of Japanese HDD-related component manufacturers, manufacturers of other types of components also shifted their operations overseas one after the other in the mid-1990s. In the area of hard disk media processing, U.S.-based Komag (1993 and 1996: Malaysia), Mitsubishi Chemical (1996: Singapore), Fuji Electric (1996: Malaysia), and Hoya (1995: Singapore) established their plants close to HDD manufacturers' bases. Their overseas expansion was also influenced by the local production activities of U.S. HDD manufacturers that were their major clients. Therefore, investment locations came to be concentrated in Singapore and Malaysia.[7]

5. Establishing Bases within Industrial Clusters and Creating Competitive Advantages

Growing Competitive Pressure and Establishment of Bases within Industrial Clusters

The HDD industry's shift to Asia cannot be discussed only from the viewpoint of the timing of the establishment of overseas production bases. In this industry, the significance of establishing production bases within industrial clusters in Asia gradually increased through the 1990s. This is closely related to the changes in competitive pressure within the industry. From the 1980s to the 1990s, the competitive pressure in the industry changed and HDD manufacturers' establishment of production bases in Southeast Asia came to take on a different meaning in terms of competition.

In the first half of the 1980s when U.S. HDD manufacturers began to consider the establishment of bases in the Southeast Asian region, particularly Singapore, the only roles of Southeast Asia were to accept matured products and manufacture low added value at a low cost by providing low-cost labor and investment incentives.

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[7] Based on "Market Survey on HDD" for the relevant years (Japan Economic Center) and "Electronic Manufacturers' Investment in East Asia," (Electronic Economic Research Center, 1995).

Table 5. Changes in the Competitive Pressure in the HDD Industry and Comparative Advantages of Each Country

			Comparative advantages of each country		
	Competitive pressure	Role of Southeast Asia in the HDD industry	Singapore	Thailand	Malaysia
1980-1985	Cost	New products were produced in the United States and the matured products were shifted to Southeast Asia.	Labor cost, general incentives, infrastructure, supervisors and engineers	Labor cost, general incentives, proximity to Singapore	—
1986-1992	Cost, Time to Market	Development of new products was launched in the United States, and when the processes became stable, mass production was conducted in Singapore. When the products matured, they were shifted from Singapore to Thailand or Malaysia.	Weak industrial cluster effects (human resources, industrial linkage), industry-specific incentives, general incentives	Supervisors and engineers, labor cost, proximity to Singapore	Supervisors and engineers, labor cost, proximity to Singapore
1993-2000	Cost, Time to Market, Time to Volume, Yield Improvement	The pilot run is conducted in the United States, and the production is directly launched in Southeast Asia.	Strong industrial cluster effects (specialized human resources, industrial linkage, technology spillover), strong industry-specific incentives, general incentives, proximity to Thailand and Malaysia	General incentives, weak industrial cluster effects, proximity to Singapore and Malaysia, labor cost	General incentives, weak industrial cluster effects, proximity to Singapore and Thailand, labor cost

Note: General incentives are general preferential measures for foreign investment and industry-specific incentives are preferential measures for investment which are specific to the HDD industry.
Source: McKendrick, Donner & Haggard (2000), p. 60.

The situation began to change in the second half of the 1980s. U.S. firms launched new products in the United States, commencing mass production in Singapore when the processes became stable, and shifting the production to Thailand or Malaysia when the products matured. Meanwhile, the product life cycles became shorter in the market, generating the need to shorten the time required for placing a new product on the market (Time to Market). Singapore played the key role in shortening the Time to Market.

After the mid-1990s, firms faced the need to expeditiously place new stable-quality products at low prices from the start. Therefore, while conducting a pilot run in the home country, the firms came to directly launch mass production in Southeast Asia. Today, they even conduct pilot runs in Southeast Asia.

By 1996, firms no longer simply sought low-cost labor from the investment locations. They were now required to shorten the development period in the United States, and to solve the quality problems involved in the process, from the pilot run to the launch at their local bases in Southeast Asia, so as to smoothly place the products on the market. In order to withstand such competitive pressure, the firms needed to promote localization in Southeast Asia and effectively exploit the various effects of industrial clusters.

The firms that responded actively to this issue were the U.S. HDD manufacturers and the Japanese component manufacturers. U.S. HDD manufacturers made concentrated investments in Southeast Asia from an early stage and actively involved themselves in the formation of local industrial clusters. They invited key component suppliers to these locations in order to enjoy stronger cluster effects. As their local production increased in scale, it became more beneficial for component manufacturers to move into these locations, so Japanese component manufacturers advanced into these areas.

Nidec in the earlier example was also quick at shifting its operations to Southeast Asia. Currently, the firm not only conducts the daily operations related to mass production, but also conducts product launches and pilot runs at its production bases in Thailand. They say they will transfer more of their back-end product development operations to Thailand in the future. It can be said that the firm has steadily reinforced its ties with industrial clusters under the increasing competitive pressure.

In contrast to these successful strategies, many Japanese general electric appliance manufacturers that were late in expanding overseas invested in the Philippines, far from the major industrial cluster areas. This can either be construed as having prioritized low wages to industrial cluster effects or having intentionally avoided the industrial cluster areas where U.S. manufacturers had a firm foothold.

Significance of Establishing Bases in Industrial Clusters in Terms of Operations

What, then, is the significance of establishing production bases in such mass production clusters in regards to the HDD industry? First of all, there are two significant points in regards to operations.

The first point is the ability to deal with daily production fluctuations and quality problems. Since most HDDs are currently destined for the PC OEM market, there are considerable production fluctuations on a daily basis. Information regarding market trends is relayed through the chain of production, to the component manufacturers by way of information systems. Thus, HDD manufacturers and component manufacturers must change their production volumes every day. Such daily adjustments of production volumes and response to quality troubles need to be conducted locally.

The second, more important point is the ability to improve yield upon launching a new model. Even if the key HDD components are of good quality when shipped from the component manufacturers, this does not guarantee a high quality final product. The quality of the finished product can only be confirmed after combining the components in the HDD manufacturer's final assembly process. In particular, when launching a new model, how quickly the manufacturer can correct the *compatibility problems* between the components and improve yield greatly affect the profits of the HDD manufacturer and the component manufacturers.

A case of a media manufacturer is highlighted below as a textbook example of this point.[8] This media manufacturer conducts business with its client firms in the following manner. When an HDD manufacturer commences initial development, the firm always has the homeland development team participate in the client firm's development to acquire information on the product's specifications and process attributes. Then the firm conducts the initial process development in the homeland, gradually shifting the operations to Singapore. The homeland staff and local staff carry out the pilot run at the overseas loca-

[8] Based on an interview with Hoya's subsidiary in Singapore (2004, February).

tion in cooperation with each other. During the same period, the client firm also shifts its pilot run and process development operations to Southeast Asia and works on launching the production. The two firms actively exchange information during this course.

The reason for conducting the pilot run at the overseas location is that, even if the trial products created in the product and process development phases comply perfectly with the intended design, when they are moved to the mass production phase, the percentage of good-quality products can be low due to the peculiarities of the actual facilities and the process characteristics. Also, even if a component manufacturer delivers good-quality components that meet the specified specifications, *defects* could occur when they are assembled into a product in the HDD manufacturer's final stage of production, due to a bad combination or incompatibility of components. In particular, problems frequently occur with respect to the interface between the head and the media.

The parameter adjustment in the media manufacturer's production process is important in solving this yield problem. Therefore, the media manufacturer in this case example has a separate production line for each client, conducts lot control, carries out 100 percent inspection in the pilot run phase, and informs the HDD manufacturer of the results. If the HDD manufacturer requests correction of a product's attributes, the firm makes adjustments by changing the parameters in the production process.

Due to the need for frequent adjustments in the mass production phase and early achievement of economies of scale, it is highly beneficial for component manufactures to locate their operations close to the HDD manufacturers' bases.

Access to Human Resources and Technology Spillovers

It is also possible to discuss the significance of establishing production bases within industrial clusters from the viewpoint of access to human resources and technology spillovers. This refers to the direct or indirect use of the labor market formed within a cluster.

In the case of mass production-type products such as the HDD, the manufacturers often face the need to establish a new plant or suddenly expand its production capacity. In such a case, it would be too late to start training

human resources with the know-how to launch such operations. The key to determining the production location would be the ability to promptly hire people who already have the necessary skills at that location. This point is evident in IBM's case.

Since its contract production to Saha-Union in Thailand in 1991, IBM has expanded its production in Southeast Asia. It established a wholly owned production subsidiary in Prachinburi in 1997. As of 2003, Saha-Union produced over 12 million units of product and the Prachinburi Plant produced over 28 million units. About 7,000 employees are working in the two locations combined.

When IBM established its Prachinburi Plant, it conducted personnel exchanges with Saha-Union, which had a long production experience. The firm had the staff hired at the Prachinburi Plant receive training in Saha-Union, and had engineers from Saha-Union dispatched to the Prachinburi Plant. In this case as well, the yield upon the initial production launch was very low at about 50%, and the firm was required to promptly solve the quality problems and smoothly inaugurate the production. Thus, the above-mentioned personnel exchanges were indispensable for launching production in the new plant.

Later, in the second half of the 1990s, IBM expanded the Prachinburi Plant and hired people at the mid-career level. It is notable that two-thirds of the engineers hired at this time had been working for nearby competitors, such as Seagate or Fujitsu, and the remaining one-third were people who had moved from semiconductor-related firms. Sometimes, such people coming from other firms brought their subordinates with them.

A similar situation occurred in Singapore. IBM established a production base for HDDs for servers in Singapore in 1994. The person who supervised the launch of this production base was an engineer who had over 20 years of experience with IBM's competitors, including Seagate. He took his subordinates with him when he joined IBM. A person who was assisting him stated as follows.

> When he started business in 1994, many senior staff members gathered under him. All of us had worked with him for ten years or more. I had the experience of working with him for another firm for ten years. We had accumulated work experience, sometimes in the same firm, and sometimes in different firms. However, when he was going to establish IBM Singapore, we all came back to him. So we already knew each other and had experiences at the time of establishment. This is why we could launch the business so quickly.[9]

This statement expresses the essence of the white-collar labor market in Southeast Asia very well. U.S. HDD manufacturers and Japanese component manufacturers that expanded their operations to Asia in a decisive manner launched production quickly by actively hiring people who had accumulated experience with other firms.

In recent years, many firms have also acquired such human resources through M&A. Western Digital acquired Fujitsu's plant in 2002 to expand production of the 3.5-inch HDD. The main reason for the acquisition was to acquire a large amount of experienced human resources along with the manufacturing equipment.

In an industrial cluster, information moves around through movement of labor, close business relationships between firms, and frequently held seminars. Best practices concerning production or distribution operations often come to be shared within an industrial cluster through various routes. By establishing a production base in a cluster and taking root there, a firm is able to increase its sensitivity to such information and effectively incorporate it into the firm's operations.

Many of the Japanese general electric appliance manufacturers that invested in areas far away from ASEAN's major industrial clusters could not enjoy such benefits at the initial phase of their production launch. The slow speed of the mass production launch of Japanese electric appliance manufacturers is attributable in part to limited access to experienced human resources at the locale. Due to this lack, the firms had to dispatch many engineers from Japan, so they took a long time to develop a local framework for solving problems independently and are likely to have failed to reduce the overhead costs in

[9] Based on an interview with IBM Singapore (1998, December).

proportion to the increase in the production scale.

6. Closing Remarks

The competition between firms in the HDD industry from the 1980s through the 1990s indicates how Japanese and U.S. firms competed fiercely based on the premise of accelerated innovations in line with the modularization of HDDs and a trend toward global competition. With additional involvement Asia, investment competition took place to gain dominance in this region, which is rich with management resources.

U.S. HDD manufacturers and Japanese component manufacturers that managed to achieve high business growth through investing in East Asia formed full-fledged industrial clusters in ASEAN countries including Thailand and Malaysia, centered around Singapore. Their expansion into Asia and their use of industrial clusters were backed by long-term principles, and they gradually involved the entire region. In that sense, these firms were strategic.

Japanese HDD manufacturers, in contrast, expanded into Asia passively to deal with yen appreciation and competitive pressures from U.S. firms. Applying no long-term principles, they did not maintain a consistent strategy. Their investment in Asia in the initial stage was not so different from their conventional outsourcing and reduction of processing costs within Japan, highlighting the difference with the competitors that pursued full production scale and speed. However, by the end of 1990, they also began to expand the scale of operation though M&A and are making efforts to form full-fledged industrial clusters in the Philippines and China, following the example of U.S. HDD manufacturers.

In the HDD industry, the expected functions of industrial clusters became more advanced with the increase in competitive pressures, so firms have made efforts to enhance the functions of industrial clusters and develop human resources. The countries on the receiving end of investment also developed industrial policies for making the industrial clusters more sophisticated. The efforts of the Singaporean government are notable in this respect. Since the mid-1980s, Singapore has rolled out investment-attracting policies that reflected the intentions of the investors, targeting specific industries, including the HDD industry.

The shorter time for approving investment projects and tax incentives focusing on capital investment and R&D, which the government presented, sufficiently met the needs of the HDD industry for short payout periods and intensive development of production technology at the locale. The initiatives targeting the HDD industry, including development of engineers and operators, technical/management support for local vendors, and support for R&D and commercialization of magnetic recording technology at the National University of Singapore, formed strong incentives for the investors in the industry to sophisticate the functions of the local area. U.S. firms and some Japanese component manufacturers used these support measures to actively localize part of their technology development and operational management function, so as to pursue scale and speed as well as improve the quality of local management. Additionally, the engineers and supervisors that had been trained at the local bases became indispensable when the firms expanded their business into other ASEAN countries or China.

The case study of the HDD industry reveals that U.S. firms and some Japanese component manufacturers were able to achieve competitive advantages in this industry because they quickly selected their business practices in line with technology and market changes, and committed themselves to pursuing potential in Asia in order to achieve an advantage in that business area. They did not merely aim to establish buffer locations to take advantage of low wage levels, but aimed to enhance their global competitive advantage through building global production networks with bases in Asia among their core bases. The local governments approved of such large schemes, and industrial clusters were formed to serve both parties' interests.

Finally, if multinational firms aim to strategically advance the functions of investment locations, and local governments develop support measures that match the needs of the industry, their strategies will bring extremely significant benefits to the country on the receiving end of the investment. While the establishment of large-scale bases will naturally have the effect of creating employment, particularly important factors are advancing the functions of the local bases and improving the quality of local human resources through the creation of diverse educational opportunities within the industrial cluster.

To maintain competitive advantages, firms need to clearly indicate their goals for advancing the functions and developing human resources at the bases of their global production network, and they need to take advantage of the external effects of industrial clusters. The countries on the receiving end of investment also need to cooperate with firms to produce employment opportunities for the workers and to foster the development of potential leaders within their ranks. When the firms' global strategies and the countries' industrial and human resources development policies intersect in this strategic way, business provides fruitful opportunities for developing high-quality human resources in the recipient countries.

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Strategy for Cluster-based Industrial Development in Developing Countries

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In this short article we formulate an endogenous model of cluster-based industrial development based on case studies in Japan, Taiwan, and China. In this model, the initiation phase is followed by a quantity expansion phase through imitation and subsequently by a quality improvement phase through innovation. We argue that such a process of industrial development is supported by the development of market transactions among assemblers, parts-suppliers, and merchants, as well as the stimulation of innovation made possible by the benefits of industrial clusters arising from a large number of enterprises and a variety of human resources being concentrated in a small geographical area. Based on this understanding, we argue that if we provide training programs in management and marketing for enterprise managers in stagnant industrial clusters, which are often found in developing countries, such clusters may be able to grow sharply; these training programs should stimulate innovation, which should encourage growth for the clusters.

1. Introduction

In order to reduce poverty and to achieve equitable and sustainable development, we have to develop industries that provide increased employment opportunities for the poor. Therefore, the development of labor-intensive industries ought to be a central theme of development economics and a central focus of development policies. Yet, there has been a sheer lack of empirical studies inquiring into the process of industrial development in developing economies; this lack has led to the absence of strategic industrial development policies in developing countries. Thus, we do not know the answers to even simple and fundamental questions on industrial development, such as what types of entrepreneurs initiate new industries, what institutions support the subsequent development of such industries, and under what conditions new major innovations

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take place. Without answering these questions, it is difficult to formulate appropriate policies to nurture new industries or to accelerate the development of existing industries.

This study presents an attempt to uncover the common processes of successful industrial development based on the case studies of selected industrial clusters in China, Taiwan, and Japan, as well as other case studies in Vietnam, Bangladesh, Kenya, Ethiopia, and Ghana. We focus on industrial clusters not only because many of them are found in developing countries, but also because industrial clusters have clear advantages, particularly in developing countries where markets are less developed.

The organization of this article is as follows. The next section synthesizes our case studies conducted in Japan, Taiwan, and China. Section III goes on to identify the causes of the success in East Asia. In Section IV, we reexamine the conventional understanding of the advantages of industrial clusters in light of our case studies. Finally, Section V concludes the paper by drawing implications for strategy to develop industries.

2. A Synthesis of East Asian Studies

A review of the literature on industrialization in Japan, Taiwan, and China as well as an examination conducted by Sonobe and Otsuka (2006a, 2006b) of township-level industrial data over time in the three East Asian countries revealed that industrial clusters have made significant contributions to industrial development in these countries. We visited a large number of manufacturing enterprises in the major industrial clusters to identify the main features of the development process through open-ended interviews with enterprise managers, engineers, and public-sector administrators followed by formal questionnaire surveys of a large number of enterprises.

To gain insights into an East Asian model of cluster-based industrial development, we decided to make a pair-wise comparison of the same or similar industries: (1) the garment clusters in Hiroshima prefecture in Japan and that in Zhejiang province in China (Yamamura, Sonobe, & Otsuka, 2003; Sonobe, Hu, & Otsuka, 2002); (2) the motorcycle industry in Japan and that in Chongqing, China (Yamamura, Sonobe, & Otsuka, 2005; Sonobe, Hu, & Otsu-

ka, 2006); (3) the machine tool industry in Taichung, Taiwan, and the low-voltage electric machinery industry in Wenzhou, China (Sonobe, Kawakami, & Otsuka, 2003; Sonobe, Hu, & Otsuka, 2004); and (4) the printed circuit board industry in northern Taiwan and that in Jiangsu province in China (Sonobe & Otsuka, 2006b).[1]

Despite significant differences in political regimes and stages of economic development among the three countries and in production methods and skill requirements across the selected industries, we found extremely similar processes of industrial development across the eight cases. Thus, these processes may be termed "An East Asian Model of Cluster-Based Industrial Development." We characterized the development processes into three distinct phases: (1) initiation, (2) quantity expansion, and (3) qualitative improvement (see Table 1 for a summary of the endogenous model of industrial development).

Table 1. An endogenous model of industrial development

Phase	Prior experience of managers	Education	Innovation, imitation, and productivity growth	Institutions
Initiation	Merchants / Engineers	Low	Imitate foreign technology directly or indirectly	Internal production of parts,components, and final products
Quantity Expansion	Spin-offs and entry from various fields	Mixed	Imitate imitated technology; stagnant productivity; declining profitability	Market transactions; division of labor; formation of industrial cluster
Quality Improvement	Second generation of founders and newcomers with new ideas	Very High	Multi-faceted innovations; exit of many enterprises; increasing productivity	Reputation and brand names; direct sales; sub-contracts or vertical integration; emergence of large enterprises

If the production method is simple but selling the products is not easy, as in the case of the garment industry, merchants are likely to be the ones who establish the new enterprises. They do so often in the suburbs of large cities or villages not too far away from large cities, taking advantage of their

[1] In the studies referred to above, we employed rigorous statistical techniques to test a number of empirical hypotheses. In this article, we do not discuss the technical aspects of the statistical analyses. We focus here on the ideas and logic behind the rigorous statistical analyses.

experience in commercial activities in other industries. If the production method is complicated, engineers tend to be the new entrepreneurs. Once they succeed in producing new products, often after long trial and error processes, a swarm of imitators appears, as envisaged by Schumpeter (1912) in his theory of economic development.

The imitators are often spin-offs, i.e., those who have worked for the founding enterprises and initiated own enterprises by imitating production methods and products. Because most enterprises produce the same (or almost the same) low-quality products using the same low-quality materials and parts, anonymous market transactions develop; this reduces the entry barriers for new firms. Indeed, new firms can easily procure all the required materials and parts and sell their products through merchants, and they can recruit workers with desired skills from inside the cluster while investing in a few pieces of indispensable equipment. Low consumer income means high demand for low-quality products in the domestic markets. This is a clear advantage of initiating new business in developing countries; the founders of new industries earn huge profits owing to the large demand for their low-quality products. This attracts entry of new enterprises.

The active entry of numerous new enterprises results in geographical concentration of enterprises, which attracts traders, parts-suppliers, skilled workers, and engineers to the industrial cluster. An industrial cluster expands in this way. Up to this point in the cluster's development, productivity growth is modest or could even be negative, as imitation does not improve the production efficiency even though the quantity of production registers impressive growth. Typically enterprises at this stage are very small and use labor-intensive production methods.

Active entry increases the supply of products to markets sharply, thereby reducing output prices and, hence, the profitability of producing low-quality products. This triggers new competition centered on product improvement. At this stage, innovative entrepreneurs begin employing a larger number of engineers and designers to improve their products. They often start developing long-term subcontracts with specific parts-suppliers to acquire firm-specific and high-quality parts. However, improving product quality alone does not ensure high profits for innovative enterprises; to differentiate their new high-

quality products from the low-quality products produced by the majority of other enterprises, these entrepreneurs must establish a reputation as high-quality producers, develop their own marketing channels using their own marketing agents, and manage their own retail shops in order to sell their products directly to consumers and users of their products.

If they are successful, they tend to absorb those enterprises that fail to innovate and let these enterprises to produce products with the same brand names of the successful enterprises. Many enterprises that cannot catch up with innovative enterprises have to exit the industry. In our observations, it is at this stage when the production efficiency of the industry a whole visibly improves. The size of successful enterprises grows and many of them begin to export. Another important point is that the industrial cluster sets the stage for innovation towards quality improvement by attracting a pool of human resources useful for improving the product quality and improving the marketing efficiency of improved products. To use the observation by Schumpeter (1912), innovation is nothing but a new combination of the existing resources, including engineers, designers, parts-suppliers, and merchants. To realize such innovation potential, high-quality entrepreneurial ability is found to be indispensable. In other words, successful entrepreneurs at this stage are highly educated almost without exception, unlike founders of the industry, who are often uneducated but endowed with skills and ambitions.

Because we failed to collect long-term data of sample enterprises in many cases, we cannot directly trace the whole process of industrial development from the initiation to the quality improvement phases in all the case studies in East Asia. Nonetheless, all the case studies consistently provide evidence in support of the common endogenous process of industrial development described above. Therefore, we have developed a rigorous model of the endogenous industrial development process in Sonobe and Otsuka (2006b).

3. Why Is East Asia So Successful?

A critical question is why East Asian economies have developed so successfully. Like China for the last 28 years, the Japanese economy had grown at a rate of about 10% per year during the “miraculous growth periods” from

the late 1950s to the early 1970s. The growth rate of the Taiwanese economy has been no less rapid than in Japan in the past and in contemporary China. Furthermore, the patterns of industrial development among the three countries are more similar than they are dissimilar. In our view, the successful imitation and assimilation of foreign technologies, the formation of geographically dense industrial clusters consisting of a large number of small enterprises producing similar and related products, and the advent of multifaceted innovations leading to a great leap forward in the industrial structures are three of the important ingredients of the East Asian model of cluster-based industrial development.

Learning from successful experience of other countries was also likely to be the key to the success, even though it is extremely difficult to quantify this effect. During our surveys, we repeatedly heard that Taiwanese enterprise managers learned a great deal from the Japanese experience. Similarly, Chinese enterprise managers seem to have learned a number of lessons from both the Taiwanese and Japanese experiences. While it is difficult to answer the question of why Japan was successful in the transition from the quantity expansion to the quality improvement phases in much earlier years, it seems clear that the successful development of the Japanese industries became the model of the industrial development in other East Asian countries.

We believe that the successful development of the shoe industry in Ethiopia was due prominently to the repeated visits of Ethiopian entrepreneurs to Italy to learn designs, production methods, and marketing skills (Sonobe, Akoten, & Otsuka, 2006). We were also told by producers of knitwears in the rural cluster in northern Vietnam that visiting China is critically important to improve their technology and management. The development of the huge garment cluster in Dhaka owes its remarkable success to the transfer of technology and management know-how from Korea.

Foreign technologies were imitated in different manners among the three countries in the postwar periods. Since the inception of modern economic development in the late 19th century, Japan had been making every effort to catch up with the West in industrial technologies by setting up modern government-supported plants modeled after advanced factories in the West, providing general education and vocational training for workers and engineers, and so on (see, e.g., Otsuka et al., 1988; Hayani & Godo, 2005). Although such processes

were disrupted by World War II, they resumed immediately after the war. The cases of the garment and motorcycle industries examined by Sonobe and Otsuka (2006b) are two of the early examples of successful industrial development based on foreign technologies in postwar Japan.

In the case of Taiwan, foreign joint ventures, foreign trading companies, and the Industrial Technology Research Institute (ITRI), a leading national research and development center founded in 1973, played major roles in introducing new technologies from abroad starting in the 1960s. Spin-offs from the joint ventures and those who were trained at ITRI often became the founders of new enterprises in this country. In the case of China, state-owned enterprises (SOEs) were the main sources of human resources, industrial technologies, and managerial know-how for the development of collective township and village enterprises (TVEs) and private enterprises. Thus, SOEs played the role of model plants. According to Otsuka et al. (1998), SOEs were inefficient in management due to regulations but were knowledgeable about modern technologies. Moreover, SOEs had established marketing channels. Thus, the assimilation of technologies and management know-how from SOEs, as well as the use of SOEs' marketing channels, were the major means for collective TVEs and private enterprises to improve the efficiency of production and management.

The three countries differed little in the process of quantity expansion, which led to the formation of industrial clusters consisting of small enterprises. Setting up industrial zones by the government is useful and common. While marketplaces set up by the local governments played important roles in the improvement of marketing efficiency in China, the same purpose was achieved by the densely clustered wholesalers dealing in industrial parts in Taiwan and the active network of merchants in Japan.

The successful implementation of multifaceted innovations by highly educated entrepreneurs in the three countries, which has led to the quality improvement phase, seems common. According to our recent studies on industrial clusters in Sub-Saharan Africa (i.e., the shoe industry in Ethiopia by Sonobe, Akoten and Otsuka (2006), the garment industry in Kenya by Akoten, Sawada and Otsuka (2006), and the car-repair cum metal processing industrial complex in Ghana and Kenya), the industrial clusters producing low-quality products often remain in the quantity expansion stage and fail to innovate,

which, we believe, is a distinguishable feature of industrial clusters in Sub-Saharan Africa.[2] In East Asia, the entrepreneurship of highly educated managers leads to introduction of improved production methods, initiation of the use of brand names to strengthen their images, development of new marketing channels, and establishment of long-term subcontract systems.

An interesting question for less industrialized countries is whether the transition from the quantity expansion to the quality improvement phases can be facilitated and shortened by participating in global value chains organized by global-scale retailers or joint ventures with manufacturers in developed countries. These global-scale retailers and manufacturers provide improved production technologies, marketing channels, and new management methods to small enterprises in developing countries. The answer is affirmative, as far as upgrading product quality is concerned. Yet it is highly questionable whether such technology transfer leads to sustainable cluster-based industrial development. Because the source of new information is foreign buyers and manufacturers, not neighboring enterprises producing similar products within the cluster, there is no strong incentive for local enterprises to form industrial clusters. This means that the forces within the cluster leading to the transition to the quality improvement phase are absent in industrial development led by global buyers and foreign ventures. Furthermore, the ability to innovate may not be nurtured if local enterprises depend entirely on the global buyers and foreign ventures. All these considerations suggest that learning from foreign companies is most effective when the industry is in the transition from the quantity expansion phase to the quality improvement phase; by that point, the industrial cluster can provide the opportunity to innovate further, and the innovative entrepreneurs have acquired the experience needed to innovate (Sonobe & Otsuka, 2006b).

Although our study does not provide ample evidence supporting the above argument that the global value chain is not a panacea, there are several relevant observations. In the case of the motorcycle industry in China, although the joint ventures between the SOEs and Japanese enterprises contributed to the early part of the quantity expansion phase, their growth performance in the quality improvement phase has been mediocre (Sonobe, Hu, & Otsuka, 2006).

[2] An exception is the case of the shoe industry in Ethiopia, which has been growing fairly rapidly.

In the case of the printed circuit board industry in China, there is no clear evidence that local enterprises have learned much from foreign ventures: the technology level of the former is far lower than that of the latter, so direct technology transfer or learning is not yet feasible (Sonobe & Otsuka, 2006b). In all other cases we studied, it was the ingenuity and innovation of local entrepreneurs that brought on the transition into the quality improvement phase.

Our arguments are clearly supported by the case study of the leather shoe cluster in Brazil conducted by Bazan and Navas-Alemán (2004), who find that those shoe makers supplying their products not only to global buyers but also to the domestic markets and neighboring countries surpassed those who specialized in export to global buyers in the process of quality upgrading. Based on this finding and the results of other case studies, Humphrey and Schmitz (2004) conclude that enterprises in developing countries cannot learn much about how to achieve qualitative upgrading from global buyers. Likewise, some empirical studies point out that little benefit of positive externality comes from foreign ventures. Thus, the opportunities of participating in global value chains and transacting with foreign ventures can be utilized most effectively if the industry has reached the last stage of the quantity expansion phase, where some enterprises are ready to innovate.

4. Agglomeration Economies Reconsidered

Since the seminal work of Marshall (1920), three major advantages of industrial clusters have been recognized conventionally: (1) information spillovers, (2) the specialization and division of labor among enterprises, and (3) the development of skilled labor markets. While we do not have major objections to the importance of these three advantages, our analysis suggests room for reconsideration.

We agree that information spillovers are common and important in the cluster. For example, in the garment clusters in both Japan and China, if a new design introduced by an enterprise turns out to be popular, many other enterprises copy it within a few days. But information spillovers, which are essentially imitation, are not always that simple. In our observation, less simple imitation takes place through the spin-offs and recruitment of workers from

other enterprises, which is intensively discussed in our study on the motorcycle industry in Chongqing. In the case of the printed circuit board enterprises in Suzhou, a group of spin-off enterprises, whose managers used to work at the same founding enterprises, employ the same technology to produce the same products. Thus, information spillovers in the industrial cluster are inseparably related to the development of skilled labor markets, wherein skilled workers move from one enterprise to another. According to our respondents, assemblers develop long-term contracts with parts-suppliers to reduce the risk of the parts-suppliers leaking new ideas to other assemblers. If this is the case, the division of labor among manufacturing enterprises is also closely related to information spillovers.

Another important aspect of the industrial cluster is that it reduces transaction costs. Transaction costs have been neglected in the literature on economic geography and spatial economics, where the role of transport costs has been discussed extensively. Transaction costs arising from moral hazard and hold-up problems are low in the industrial cluster because rumors of such opportunistic behaviors quickly become public knowledge by word of mouth in the cluster. We believe that this is the major reason why the division of labor develops in the industrial cluster. To use the observation of Hayami and Godo (2005), the community mechanism of contract enforcement, which was originally applied in rural communities, works well in the industrial cluster as well.

It is one-sided to emphasize the importance of information spillovers as an advantage of the industrial cluster if the role of the cluster in promoting innovation is not equally appreciated. Marshall (1920) argues that information spillovers become a source of innovation: “if one man starts a new idea, it is taken up by others and combined with suggestions of their own; and thus it becomes the source of further new ideas.” Based on our empirical findings, we can add to his argument the hypothesis that the industrial cluster provides a hotbed of innovation, as it accumulates a variety of human resources useful for new innovation. We believe the validity of this hypothesis is worth investigating in other case studies.

To sum up, our analysis indicates that the major advantages of clusters are: (1) the development of markets, which facilitates transactions among manufacturers, merchants and workers, and (2) the promotion of innovations by

attracting useful human resources.

5. Concluding Remarks

Although effective policies to promote the development of SMEs have been seriously sought in many developing countries, economic theories that can guide such policy have been absent. Some economists seem to assume that the market works so well in the industrial sector that government intervention is unnecessary. Our analysis strongly indicates that the market works fairly well *in industrial clusters* because dishonest behaviors potentially arising from imperfect information are reduced to a significant extent by the informal contract enforcement mechanisms, e.g., gossip through word of mouth. This explains why people behave honestly in industrial clusters and why industrial clusters are so prevalent in developing countries. It also suggests that the market tends to fail in allocating resources efficiently in the absence of industrial clusters. In industrial clusters, marginal and small-scale enterprises (MSEs), which provide ample employment opportunities for unskilled workers, play a critical role, particularly in the early phases of industrial development. Thus, there are good reasons for the government to support the formation of industrial clusters by setting up model plants to train potential managers and workers, industrial zones to attract MSEs producing similar and related products, and marketplaces to facilitate transactions of parts, intermediate products, and final products among manufacturers and merchants.

It is well-known in the economics literature that the market generally fails in the transaction of information, particularly if the information is not patentable or the patent protection is ineffective. This is the case for "imitative innovation," which is critically important for the development of industrial clusters in low-income countries. It is obvious that because of imitation or information spillovers, investment in innovation falls short of the social optimum. Therefore, it makes sense to support activities leading to innovation in industrial clusters by means of providing training programs for technological, managerial, and marketing advancement. Our analysis strongly indicates that such an attempt is likely to be effective when the cluster is in transition from the quantity expansion to the quality improvement phases. As our analysis

implies, technical training alone is not sufficient to stimulate the transition because what is required is multi-faceted innovations in areas including technology, production organization, and marketing.

A number of industrial clusters have formed in low-income countries including South Asia and Sub-Saharan Africa. In many cases, however, they fail to enter the quality improvement phase and hence remain in the quantity expansion phase. A good example is the garment clusters in Nairobi, where a large number of small workshops, consisting of three to four workers, produce low-quality products (Akoten, Sawada, & Otsuka, 2006). Another interesting case is the shoe cluster in Addis Ababa, where a handful of educated managers are attempting multi-faceted imitative innovations by learning from the experience of Italy (Sonobe, Akoten, & Otsuka, 2006). In all likelihood, these industrial clusters will be able to take off if appropriate training programs are provided.

Appropriate policies to promote labor-intensive industries are badly needed to reduce the widespread poverty in low-income countries. We believe that the appropriate policies for such industrial development must support the formation of industrial clusters and their transition from the quantity expansion phase to the quality improvement phase.

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Minutes of Discussion

Session 1

Presentation 1—"Architecture-based Comparative Advantage in Japan and Asia"
Prof. Takahiro Fujimoto (University of Tokyo)

Industrial design can be classified into two types: (i) modular (*kumi-awase*) architecture, in which functions and parts have one-to-one correspondence, and (ii) integral (*suriawase*) architecture, in which correspondence between functions and parts is complex. Each country has a different organizational capability derived from history. Japan is a country of integral products with high integrating capability. The EU excels in integral products with superior capability in creative expression. The United States produces modular products supported by its creative combination capability. Korea produces capital-intensive modular products, driven by the power of concentration. China can mobilize a large amount of human resources to produce labor-intensive modular goods. ASEAN should be producing labor-intensive integral products, but this remains a potentiality at present. Business architecture theory can identify the strengths and shortcomings of each economy and suggest ways to improve their global positioning strategies.

Presentation 2—"Vietnam's Industrial Policy Formulation: To Become a Reliable Partner in Integral Manufacturing"
Prof. Kenichi Ohno (GRIPS)

The author has studied Vietnam's policies for eleven years, and established the Vietnam Development Forum (VDF) in Hanoi in 2004. Vietnam has a high-quality labor force, but its policies remain poor. In supporting the Ministry of Industry in drafting industrial master plans, the author urges Vietnam,

based on Professor Fujimoto's theory, to become a valued *monozukuri* partner of Japan in order to compete with China and to break through the glass ceiling to achieve high-level industrialization. This advice is also intended to solve Japan's 2007 problem; highly skilled old workers will begin to retire in droves in 2007. Thailand and Vietnam have high potential to become developing country partners of integral manufacturing. For this, industrial human resources and supporting industries are essential. Japan has supported Vietnam in strengthening these, but more concentrated effort should be made. In addition, Vietnam should clearly announce this as a national goal.

1. Business architecture theory and ASEAN's organizational capability

Mr. Hisaaki Mitsui (International Development Center of Japan)

I have questions for Prof. Fujimoto concerning the architecture theory. First, can ASEAN really become a partner of Japan's integral manufacturing? As we observe, supporting industries and industrial human resources in Thailand and Malaysia have not reached sufficiently high levels yet, even though they have tried for several decades.

The second question is regarding the architecture of the automobile industry. Although automobile production is classified as closed-integral, auto parts are mutually supplied among Asian countries. In addition, part suppliers are not bound by the *keiretsu* system anymore and do business with more than one assembler. Does this mean that the automobile industry has become open-modular?

Prof. Takahiro Fujimoto (University of Tokyo)

Characteristics of ASEAN countries are perhaps too diverse to generalize. And it is true that integral manufacturing in ASEAN still remains a potential. However, if we look at China, its labor force has very high mobility, just like in the US. China has a huge supply of good single-skilled workers but few multi-skilled workers. Compared with China, ASEAN workers tend to stay longer at one factory (subject to overall business conditions), which points to the possibility of training many multi-skilled workers. For example, one Japan-

ese company we visited in Hanoi had twenty excellent CAD operators, all of whom were graduates of the Hanoi University of Technology. When we visited the factory for the second time, the CAD operators had increased in number to fifty, and only a few of the original ones had quit. I have never heard such a low job turnover in China.

As for the second question, business architecture should be understood in terms of design, not in terms of transactions. Liberalization of business transactions, a situation where part suppliers produce for many assemblers beyond the *keiretsu* system, is a different matter from industrial design. Even though business transactions are open, Japanese companies still produce closed-integral products, and the design of each automobile component remains unique to each assembler. In transaction, few suppliers now depend on the conventional keiretsu system and deal with only one assembler. Most part suppliers have two or three assemblers on average.

Prof. Kenichi Ohno (GRIPS)

Each country has a unique national character that cannot be explained by logic. Job hopping also exists in Vietnam, but the degree varies from company to company. Job turnover is extremely low in some companies. Workers' mobility can be reduced by appropriate employment policy. In China, in contrast, it is much more difficult to curb mobility because Chinese fundamentally like to move. For this reason, I think there is a higher chance that ASEAN will master integral manufacturing. If ASEAN countries do not take advantage of their character and engage only in simple labor-intensive production, they can hardly compete with China, which has an inexhaustible supply of low-wage labor.

2. Matching demand and business architecture

Prof. Junjiro Shintaku (University of Tokyo)

The architecture theory remains incomplete without incorporating the demand side. Vietnam needs a market for integral-type products, if it wants to develop integral manufacturing skills following the proposal of Prof. Ohno. China has an advantage because it has a large number of domestic consumers

who prefer modular products. Domestic demand in Vietnam and Thailand may be more oriented toward integral products. For example, consumers in these countries seem to prefer integral-type Japanese motorbikes over modular-type Chinese motorbikes.

Prof. Takahiro Fujimoto (University of Tokyo)

Japanese firms make high-quality integral products, but they are not good at marketing to sell these products. Consumers who prefer modular products consider Japanese products as "excessively" high-quality. However, *Otaku*, a kind of user who enthusiastically welcomes high-quality and minute details, is a very important concept for integral product marketing. To enlarge the market of integral products, there should be a mechanism to continuously reproduce *otaku* consumers who prefer integral products.

Mr. Hisaaki Mitsui (International Development Center of Japan)

Could you explain more about the characteristics of markets that prefer integral products? And what factors create such a market?

Prof. Takahiro Fujimoto (University of Tokyo)

A market is likely to prefer integral products when a large number of consumers seek extremely high performance or delicate balance in products. In contrast, a market tends to prefer modular products when the majority of consumers enjoy low prices and continuous changes in exterior design but do not want high performance. However, it is hard to explain how these market features are formed. Much depends on history. For instance, modular-type Chinese motorbikes once flooded into Vietnam but Vietnamese consumers later returned to integral-type Japanese motorbikes. Most likely, the unique way of using motorbikes in Vietnam has created an integral-type market over time. Many urban Vietnamese ride motorbikes for commuting, while Chinese people consider motorbikes mostly as a means of cargo transportation in rural areas. Difference in usage naturally leads to different market features.

Even after studying many countries, it is quite difficult to find a formula for predicting market types. For example, Chinese motorbikes are very popular in Laos, Cambodia, Bangladesh and Pakistan, but they are unpopular in

Thailand and India.

3. Dynamics of business architecture

Prof. Yukio Sugano (GRIPS)

I have some questions about architecture theory. First, how long do you think Japanese industries can maintain their advantage in integral manufacturing? China and ASEAN may not have reached the Japanese level yet, but is it not possible for Korean companies, such as POSCO (steel) and Hyundai (automobiles) to overtake Japan in integral manufacturing in the near future?

My second question is whether it is appropriate to say that the US and EU do not have advantages in integral manufacturing. For example, they have dominated the aircraft and space industries, which are highly integral. If they seriously concentrate resources on integral manufacturing, can they not become even stronger than Japan in this area?

Prof. Takahiro Fujimoto (University of Tokyo)

Whether a country is modular or integral should be decided on a relative scale, and we should also remember that a country's character can shift over time as it accumulates new organizational capability. In the short run, however, a country's character does not change very much. POSCO has caught up with Japan in the production of general-purpose steel, which is modular, but it has a long way to go in mastering high-quality steel production, which is integral. Since the 1980s, this situation has not changed. Korea, based on modularization strategy, combines the latest equipment from all over the world, but it still cannot produce high-quality special steel such as galvanized iron sheets used in the exterior of automobiles. This is because such products require high-level integral skills in addition to equipment.

If concentrated national effort is made in R&D, any country can produce highly integral products. National flagship industries such as aircraft and space industries are often promoted at any cost, with ample subsidies. That explains why even China, a modular country, can launch space rockets, which are highly integral. But these are exceptions. We should study more general cases to determine the comparative advantages of each country. Then we must

conclude, as I showed in my table, that Korea is a fairly modular country. I am also suggesting to Korea that it should transform itself to be a more integral country. Some Korean firms, such as Hyundai Motor Company, can now produce integral products after studying integral manufacturing for thirty years.

4. Supporting industries, industrial human resources, and business architecture

Prof. Shigeru Ishikawa (Hitotsubashi University)

According to Prof. Ohno, Thailand and Malaysia are stuck below a glass ceiling and cannot develop supporting industries or high-quality industrial human resources. But this picture may be too pessimistic. When I visited Thailand in 1970, the domestic car market had reached about 400,000 units per year and the spare part market had started to develop. Local staff, who had education only through elementary school, somehow managed to produce spare parts by copying Japanese products. However, when I visited Thailand's Eastern Seaboard Industrial Zone several years ago, there were some excellent parts factories that employed engineers with university degrees. Thus, I think breaking the glass ceiling is possible if the country patiently improves the quality of human resources over several decades.

Prof. Kenichi Ohno (GRIPS)

I intentionally exaggerated the weaknesses of Thailand and Malaysia in order to encourage Vietnam. In reality, Thailand's supporting industries have reached a certain level. However, when compared with East Asian high performers such as Korea and Taiwan, I do not feel that Thailand and Malaysia have achieved sufficient development commensurate with the time they have spent and the effort they have made in the past few decades. It is very questionable whether Thailand's supporting industries, without FDI help, can produce all the core components of automobiles. After all, Thailand remains a "potential" partner of Japan's integral manufacturing system.

Prof. Takashi Oshika (University of Tokyo)

In the last several years, I have visited local suppliers in Thailand and Indonesia with the missions of the Association for Overseas Technical Scholarship (AOTS). We have found that Indonesian motorbike part suppliers are developing rapidly. Some people argue that human resource development should be left to private enterprises in ASEAN and that assistance by public organizations such as AOTS is unnecessary. Do you think that AOTS should play an active role in developing industrial human resources in Vietnam?

Professor Kenichi Ohno (GRIPS)

VDF also cooperates with AOTS Vietnam. Vietnam needs technical training support by public organizations like AOTS. In Vietnam, the motorbike market has reached the level of two million units per year, and its supporting industries have begun to grow faster than those of other industries, such as automobile or electronics. However, a large number of local firms do not know how to approach Japanese firms, why their products are rejected by Japanese companies, and what "5S" means. Under such circumstances, I think that public sector assistance can act as a catalyst to promote supporting industries. To begin with, AOTS should make efforts to make its activities known to local firms, because many of them still do not know of the existence of AOTS programs.

Prof. Nozomu Kawabata (Tohoku University)

Industrial human resources and supporting industries are very important, as Prof. Ohno emphasized. However, they are always needed, whether business architecture is integral or modular. Thus, difference in business architecture will become an issue after industrial human resources and supporting industries have developed. First, high-quality managers or engineers who can make proper production plans are required. Multi-skill workers are also necessary, but they are needed only after managers have appreciated and begun to pursue integral manufacturing.

FDI assemblers will surely come to Vietnam. Nonetheless, Vietnam cannot fully utilize its potential for integral manufacturing as long as it does only final assembly and continues to import all parts from Japan or other countries. In order to break through the glass ceiling, Vietnam should acquire metal

processing technology such as welding, boring, pressing and machining. Whether a country has such processing technology depends not only on national character but, significantly, also on history. According to Jiro Takabayashi, a business consultant, countries that have experienced capital goods production are generally equipped with processing technology. In addition, processing technology can be acquired through various activities, such as spare part production and machine maintenance.

Professor Kenichi Ohno (GRIPS):

In my opinion, difference in business architecture matters very much in the way industrial human resources and supporting industries are developed. In Vietnam, where technology improvements by domestic effort alone are hardly sufficient, local firms should rely heavily on relationships with foreign firms to scale up. To establish relations with Japanese firms, local suppliers must spend at least a few years in working with Japanese, being persistent even if their samples are rejected repeatedly. This type of learning is unlikely to occur if they supply parts to modular-type assemblers. By going through such an intensive trial-and-error process, local firms will grow up to become high-quality integral suppliers.

Session 2

Presentation 3— "Competitive Strategy of Global Firms and Industrial Clusters: Case Study on the Hard Disk Drive (HDD) Industry" Prof. Tomofumi Amano (Hosei University and University of Tokyo)

Latecomer countries want to internalize the industrialization process and attract long-lasting investments under the pressure of global competition. Meanwhile, multinational corporations (MNCs) must maximize locational advantages of production sites in different countries to maintain competitiveness. Both needs are satisfied if they cooperate in concentrated action to create industrial clusters. In the hard disk industry, whose final products are modular but whose components are integral, clusters were formed in ASEAN and have been difficult to shift to China; this is different to other computer's accessory industries. In these clusters, strategic alliance between US assemblers and Japanese part makers is observed. MNCs have promoted the growth of hard disk clusters through human resource development and linkage with local firms. Simultaneously, the Government of Singapore, for example, introduced measures such as the country-wide bonded warehouse system and efficient investment licensing to strategically target the formation of a hard disk cluster.

Presentation 4—"Strategy for Cluster-based Industrial Development in Developing Countries" Prof. Keijiro Otsuka and Prof. Tetsushi Sonobe (GRIPS)

We have conducted many case studies on relatively low-tech clusters in Asia and Africa. According to our model of endogenous industrial development, industries in developing countries follow three common phases: (i) the start-up phase, in which foreign technology is copied, (ii) the quantitative

expansion phase, in which copies of the copy multiply, and (iii) the qualitative improvement phase, which achieves multi-faceted innovation. Moreover, each phase is driven by certain required types of entrepreneurs, ability, innovation and imitation. Public policy and ODA should be mobilized to accelerate transition from one phase to another, especially from the second to the third phase. To help developing countries to achieve multi-faceted innovation ("new combination") that is realistic in each country, small and medium enterprises in the informal sector should be selectively targeted and given assistance to enhance their ability of innovation in the areas of management, technology and distribution. In addition to conducting case studies, we are now designing support programs for this purpose.

1. Theoretical foundation of the endogenous development theory

Prof. Shigeru Ishikawa (Hitotsubashi University)

The Lewis model, the Todaro model, and the Myint model are among the most popular models of economic growth in developing countries, and each has clear theoretical assumptions about sector division and so on. Your endogenous development model also seems to study the mechanism of industrialization but its assumptions on institutions, behavioral patterns, etc. are not clear to me. Can you explain? Am I right to understand that industrial agglomeration is one component of the endogenous development model? Please also explain why you are conducting empirical studies in pair-wise comparison.

Prof. Keijiro Otsuka (GRIPS)

Empirical tools to test development theories did not exist in the 1950s and 60s when the Lewis model and the Todaro model were formulated. We are now empirically demonstrating the mechanism of sectoral migration associated with industrialization. We consider industrial clusters to be a device to activate the market mechanism.

Our endogenous development model, featuring three phases—start-up, quantitative expansion and qualitative improvement—was not derived from the-

ory but was suggested by striking similarities found in many empirical studies.

A pair-wise comparison was conducted to show that successful industries followed very similar development patterns, as with shoes industries in Shanghai and Ethiopia, despite the fact that they are in different political, institutional and historical conditions. I think we have already conducted a sufficient number of case studies, and we are now planning practical training courses aimed at promoting innovations in small enterprises. We have started to discuss the curriculum of such a training program.

2. Using aid to strengthen competitiveness

Prof. Yukio Sugano (GRIPS)

There is a problem in providing ODA for training programs proposed by Prof. Otsuka and Prof. Sonobe, from the viewpoint of aid operation. General vocational training can be supported by ODA, but ODA is not generally used to help private companies to improve competitiveness, which is required for transition from the quantitative expansion phase to the qualitative improvement phase of industrial agglomeration. This should be done by self-effort or cooperation among private firms.

For instance, UNDP sets up a technical assistance center to support technical improvement in a shoes industrial cluster in the western part of New Delhi. However, the technicians and firms in this cluster have relatively low technical levels; we cannot find a firm that has reached a certain technical level, especially one that is competitive in exports. In other words, the technical assistance center does not help to improve technical levels in the cluster but only brings about an increase in the number of new entries, which is the quantitative expansion phase. The technical level in the cluster that includes firms who are competitive in export is still relatively low in comparison to those in Europe, America and Japan. In order to achieve qualitative improvement, these firms need to improve not only technical level but also design, marketing, brand-name and so on. Is it possible to use aid for these improvements? Is it adaptable to ODA?

Mr. Tsuyoshi Kikuchi (Japan Development Service)

It should be possible to execute projects for strengthening competitiveness in the ODA framework. In fact, we are currently engaged in an ODA project to draft a master plan for improving quality and productivity in the food processing industry and the electrical and electronics industry in Tunisia.

Mr. Toshio Tsunozaki (FASID)

JICA has established human resource development centers (usually called the "Japan Center") in many former socialist countries, including Vietnam. These centers offer management courses to promote the development of small and medium enterprises. Several international organizations offer similar programs for competitiveness.

Prof. Tetsushi Sonobe (GRIPS)

Our proposal is based on the idea of market failure. In many cases, industrial development stagnates without support from the government or ODA. For example, firms have no incentive to innovate if new products are quickly copied by many competitors and cannot make sufficient profits to justify introducing new technology. This is a kind of market failure. Some people may claim that aid programs for micro enterprises benefit only a limited number of entrepreneurs. However, in reality, beneficiaries will induce many other firms to imitate their innovations, leading to industrial development in the region. Scared by business risks, many small enterprises do not even try imitative innovations by themselves. These enterprises should be guided toward imitative innovations, which are actually very basic technology and management knowledge from the viewpoint of developed countries.

Prof. Kenichi Ohno (GRIPS)

ODA is not the only way to support industrial development. We should also mobilize other resources, such as foreign businesses and NPOs. If the procedure to obtain ODA funds is too slow or cumbersome, other methods should be sought. In Vietnam, VDF, a non-ODA academic cooperation unit, supports strategic policy formulation, while a Japanese trading company is developing an industrial park database and other Japanese firms are interested

in expediting logistic services. Appropriate actors should be selectively called in to perform various tasks.

3. Digital technology may impede transition to qualitative improvement phase

Prof. Takahiro Fujimoto (University of Tokyo)

The wall between the quantitative expansion phase and the qualitative improvement phase is getting higher. The reason, ironically, is rapid progress in digital technology. In the past, copying someone's product while retaining reasonable quality was not so easy because it required certain skills, such as design copy and functional revival. When imitation was tantamount to reverse engineering (dismantling a product to analyze its structure for producing a copy), a decent level of R&D was a must. At present, however, advancement in digital technology such as CAD and CAM allows anyone to easily draw copied designs. Reverse engineering is no longer necessary. Even amateurs who cannot draw a blueprint can manufacture copy products automatically. Worse, copies of CAD/CAM software, needed to copy products, are sold in the market, which dramatically reduces the cost of imitation. As a result, imitation is no longer reverse engineering that linked to R&D but simple copy that can be done at low cost, thus, prices of reverse engineering are set to low level. Therefore, Chinese products and the like are put into a dilemma of focusing on copied designs instead of promotion of innovation.

About the Presenters

(In order of presentation)

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Professor Otsuka received the Quality of Research Discovery Award from the American Agricultural Economics Association in 1992, the Nikkei Outstanding Book Publication Award from the Japan Economic Journal in 1995 and 2004, and the Best Journal Article Award from the Agricultural Economics Society of Japan in 1999.

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