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The Evolution and Structure of Industrial Clusters in Japan

Hideki Yamawaki

This paper focuses on two aspects of the evolution and structure of clusters in Japan, namely, what gives rise to clusters and what benefits are acquired by small firms from participating in clusters. The determinants of clustering are discussed by way of a review of the history of 14 industrial clusters which cover a wide range of industries and locations in Japan. It is noted that different factors dominate in different cases. Among the more important ones are the existence of leading large firms, the availability of a pooled labor market, and the presence of public research and testing facilities. The four most important benefits from clusters reported by small firms are: (i) specialization; (ii) ease of procurement; (iii) diffusion of technology; and (iv) public policy support. Access to skilled workers is not reported to be a significant benefit. This may be explained by the fact that the dominant source of skills acquisition among Japanese workers is on-the-job training and such skills may be too firm-specific to be useful to others, even within a geographically concentrated cluster.

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Foreword

This paper was prepared for a project on the Role of Small & Medium Enterprises in East Asia. The project was organized by the World Bank Institute under the auspices of the Program for the Study of the Japanese Development Management Experience which is financed by the Human Resources Development Trust Fund established at the World Bank by the Government of Japan.

The principal objectives of this Program are to conduct studies on Japanese and East Asian development management experience and to disseminate the lessons of this experience to developing and transition economies. Typically, the experiences of other countries are also covered in order to ensure that these lessons are placed in the proper context. This comparative method helps identify factors that influence the effectiveness of specific institutional mechanisms, governance structures, and policy reforms in different contexts. A related and equally important objective of the Program is to promote the exchange of ideas among Japanese and non-Japanese scholars, technical experts and policy makers.

The papers commissioned for this project cover a number of important issues related to SME growth and performance in the region. These issues include: the productivity of small and medium enterprises, their adaptability to shocks and crises, their contribution to innovation and technological advance, their link to such features of the business environment as subcontracting and agglomeration, their impact on employment and equity, and their responsiveness to public policy.

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1. Introduction

As is well documented elsewhere, it is a well established fact that Japan hosts the largest number of small- and medium-sized enterprises (SMEs) among industrialized countries. When SMEs are broadly defined as those enterprises with fewer than 300 employees or less than Yen 100 million in capital, more than 99 percent of all enterprises in Japanese manufacturing were classified as SMEs in 1994. Further, 67 percent of total employees in manufacturing worked for SMEs in 1994.[1]

An equally important feature of Japan's industrial organization is that Japan's SMEs often form clusters. According to the 1996 survey of the Small and Medium Enterprise Agency, a total of 537 clusters are reported to exist throughout Japan. While the economic significance of these clusters varies widely from clusters producing primarily for exports to clusters producing indigenous goods little known outside Japan, an important question common to these clusters arise: Where do these clusters come from? What are the key drivers for the birth and growth of these clusters in Japan? What competitive advantage do they have? The purpose of this paper is to address these issues of the evolution of clusters. Specifically, the paper first identifies factors that are important in shaping the evolution of clusters in Japan. Second, it describes the structure of Japan's clusters and examines their sources of competitive advantage.

While clusters are defined generally as geographic concentrations of interconnected companies and institutions in a particular business field (Porter 1990, 1998), each cluster varies greatly in terms of key features such as geographic locations, products, functions, and patterns of inter-firm linkages. Clusters differ from each other because of differences in historical circumstances, demand conditions, supporting industries, and competitive conditions that underlie their evolution. Some clusters arise from peculiar historical conditions, yet others may develop through the confluence of various economic conditions. The initial economic conditions that shaped a cluster, however, do not necessarily remain constant beyond certain periods. Rather, economic conditions surrounding clusters may change over time because of changes in domestic and international competitive conditions.

On the basis of information provided in the previous surveys on Japan's manufacturing clusters (People's Finance Corporation 1987, 1995; MITI 1996; SMEA 1997; Ito and Urata 1997, 1998), this paper examines a sample of 14 major cases of manufacturing clusters in Japan that have shown high propensities to export. After providing a brief description on the historical development of each of these clusters, the paper extracts key driving forces for the evolution of a cluster. The 14 clusters studied manufacture a wide range of products including silk, cotton, and synthetic fabrics; apparel; ceramic goods; general machinery; automobile parts; binoculars; silverware and cutlery; hand tools; and eyeglass frames.

The remainder of this paper is organized as follows. In the next section, evolutionary patterns of this sample of 14 clusters are qualitatively examined to derive a certain set of factors that contributed to the birth of clusters. This analysis identifies historical circumstances, prior existence of related industries in

* I am grateful to David Audretsch, Bee Aw Roberts, Shujiro Urata and all other participants of the workshop for their comments and sugestions. The workshop was organized by World Bank Institute in Chiang Mai, Thailand.

1. The number of SMEs in manufacturing is 816,881 in 1994, and total employment by SMEs is 8,878,531 in 1994. Total number of SMEs in the economy is 6,469,167, which accounts for 99 percent of all enterprises. Total economy-wide employment by SMEs is 41,415237 in 1994.

the region, prior existence of related clusters in neighboring regions, technology transfers from other clusters and foreign countries, and regional government policy as most important drivers of the birth and growth of clusters. Section 3 describes structural features of these clusters and examines various sources of advantage that they create. The analysis finds that the existence of small and medium enterprises with specialized skills in an industry in a geographic space is likely to create agglomeration in Japanese clusters. Section 4 examines the development of technological and human assets in Japanese clusters. Section 5 sheds some light on the issues of cluster performance. Finally, Section 6 summarizes the key findings and concludes the paper.

2. Evolution of Industrial Clusters in Japan

A sample of 14 clusters in Japan was selected from the clusters previously studied by the People's Finance Corporation (1987, 1995), MITI (1996), SMEA (1997), and Ito and Urata (1997, 1998). The 14 clusters were chosen rather subjectively by using the following criteria: (1) The cluster is distinctive in that interconnected firms are located in a geographically concentrated area and produce a particular class of products; (2) the cluster has been important in terms of the size of economic activity; (3) the cluster has been competitive in international markets with significantly high export share; and (4) the evolution pattern of the cluster is unique. The locations of these clusters are not concentrated in one particular area but dispersed widely across Japan. In what follows, each of these clusters is briefly described focusing on its history, key conditions for birth, and inter-firm linkages.

Brief Histories of Japan's Clusters[2]

KIRYU (GUMMA)

Kiryu City, located in Gumma prefecture, is an old town that specializes in silk and man-made silk and other synthetic fabrics. Its roots can be traced back to the Edo period (the 1600s) when the city became famous as a prime production location of high-quality silk (*habutae*) and specialty silk weaves such as *kinrandonsu*. The cluster's modern history starts in 1878 when the city imported Jacquard looms to produce silk fabrics with sophisticated weaves. After just four years since its introduction of this new technology, Kiryu's firms started to export silk fabrics to the U.S. market. Its major product shifted from silk to man-made silk fabrics during the 1920s and further to synthetic fabrics (e.g., acetate and polyester). While the cluster hosts more than 600 weavers with 2,000 employees, the majority of them are very small (90 percent of firms with fewer than five workers) and operate as subcontractors who receive fees on consigned production. Surrounding these weavers are small firms that have highly specialized yet complementary skills in different production stages such as threading, design, dyeing, and embroidery. The cluster exported more than 35 percent of sales to foreign markets through the 1980s.[3]

FUKUI AND ISHIKAWA

Fukui and Ishikawa prefectures, two neighboring prefectures facing the Sea of Japan, form a large cluster of textile manufacturers. The cluster in Fukui arose in the early 1900s when the prefecture imported the silk weaving technology from Kiryu in Gunma. Later, the cluster grew rapidly as many new firms followed to enter the industry. The prefecture government helped nurture the region's rayon textile industry by introducing new technology through the government-managed technical centers during the 1910–30 period. After WW II, new materials such as nylon and polyester were introduced in this region

2. The description below draws heavily from People's Financial Corporation (1987, 1995), MITI (1996), and Ito and Urata (1997, 1998).
3. People's Finance Corporation (1987, 1995).

through private licensing agreements between Japanese and U.S. firms. Fukui is the largest cluster of synthetic fabric in Japan in terms of shipment, and exports more than 70 percent of products abroad.

The synthetic fabric industry in Ishikawa grew rapidly during the mid-1960s to fill the large demand increase in polyester fabric. The prefecture government provided assistance for local firms during this period as a policy to develop the region's economy. The cluster's export share is very high ranging between 70 and 85 percent during the 1980s. The two clusters' weavers are typically characterized as small- and medium-sized firms and operate, on average, with fewer than 50 looms.[4] The distinctive feature of inter-firm relationship in this cluster is that the majority of weaving firms function as subcontractors for chemical firms (or major textile firms), trading companies, and local wholesalers. Local weavers receive fees and margins based on the quantity of products consigned by chemical firms and trading companies that in turn supply yarns. Subcontractors engage in different activities such as threading, weaving, and dyeing in the production process according to their skills and competencies.

KOMATSU (ISHIKAWA)

Komatsu City is an old city in Ishikawa prefecture that evolved from a major manufacturing location of silk weaves to the industrial supply base for the world's second largest construction machinery producer, Komatsu Ltd. The origin of the city's textile industry goes back to the 17th century when a local lord promoted production of silk and tea. While Komatsu's textile industry declined drastically during the late 1970s and 1980s, its machinery industry prospered as the construction firm grew. Komatsu started its operation in 1912 and developed a network of suppliers and related industries in the city.

NISHIWAKI (HYOGO)

Nishiwaki City specializes in cotton fabric woven with dyed yarns. Its products account for 60 percent of domestic market share in this specialty niche. The industry's roots are traced to 1793 when the city imported a weaving technology from Nishijin in Kyoto. It expanded greatly during the 1920s with the success in exports of cotton fabrics for shirt and bed linen in South East Asian markets. After WW II, the city's industry grew again with exports of specialty fabrics such as gingham. The organizational structure of the cluster is similar to those of Fukui and Ishikawa and built on a network of small firms with specific and complementary capabilities (dyeing, preparations, and weaving). The majority of such weaving firms again function as subcontractors working for trading companies and apparel firms and receive fees on consigned production.

GIFU (GIFU)

Gifu City is ranked among the largest three manufacturing locations of apparels. Its origin is relatively new and traced to the period right after WW II. The cluster arose from a peculiar historical circumstance that the people who returned from China after the war started selling used clothes in front of the train station of Gifu. Later, new entrants started to manufacture apparel with fabrics procured from the neighboring clusters specialized in fabrics (Hashima in Gifu and Ichinomiya in Aichi). More than 70 percent of Gifu's apparel makers specialize in women's clothes. Gifu has approximately 900 apparel firms with a total of 11,000 employees whose major activities are in product design, sales, and distribution, and a large number of small sewing firms with a total of 10,000 employees.[5] Apparel firms place orders for sewing firms, and sewing firms in turn consign part of the work to a pool of area households. A large portion of sewing operations are thus carried out mainly by female workers who work for sewing firms (approximately 23,000 workers in the entire Gifu prefecture) and those who work at home as part-timers (another 20,000–30,000 workers).

4. Ito and Urata, Table 10 (1997).
5. People's Finance Corporation (1995).

SETO (AICHI)

Seto City, located adjacent to Nagoya, is well known for its ceramics goods. The cluster's roots can be traced to the Heian period (the 1100s) when the city started producing ceramic wares. The location factor was crucial for the development of this cluster as the area was well endowed with deposits of a certain type of earth indispensable for high quality ceramics. While the area's major products were traditionally ceramic wares such as tea cups and pots (*setomono*), the industry diversified into new products called novelty goods such as ceramic toys, dolls, and ornaments during the WW I as the production of these goods declined in Germany and the UK. Approximately 400 firms (160 vertically integrated firms and 250 subcontractors) existed in the cluster with a total of 4,000 employees through the 1980s. The small subcontracting firms possess specialized skills in the several stages of the production process (cast designs, casting, baking, and painting). Their primary target is the U.S. market of mid-quality products.[6]

MORODOMI (SAGA)

Morodomi in Saga prefecture is currently a part of the furniture cluster in the region. The cluster arose rather recently after 1955 when a toll bridge over Chikugo River was built connecting the cities of Ohkawa in Fukuoka and Morodomi. Ohkawa at that point had already developed as a major production location of furniture and was in search of new locations to expand its manufacturing base. The neighboring town, Morodomi, was located in the middle of typical agricultural area and was not linked conveniently with Ohkawa because of the Chikugo River. The new bridge significantly reduced transportation costs required to travel between these two cities and thus expanded the size of the market and viable economic area. With the new bridge built, furniture makers in Ohkawa moved into Morodomi and invested in new capacity. In 1966 the toll of the bridge was eliminated. The number of firms in Morodomi increased from six in 1956 to 41 in 1971.[7]

OTA (GUMMA)

The roots of the automobile parts cluster in Ota City are traced back to the establishment of Nakajima Aircraft in 1918. While Nakajima as a manufacturer of military aircraft grew rapidly during the 1930s and through the early 1940s, the company was divested after WWII. A part of the divested company became Fuji Heavy Industries that manufacture automobiles (Subaru cars) and aircraft. Some of the old Nakajima employees started new business to supply parts and machinery to Fuji Heavy Industries. These spin-offs of Nakajima and other new entrants grew significantly during the 1950s and 1960s and formed an important network of auto parts suppliers in the city. The cluster is presently structured hierarchically with more than 70 firms operating as first-tier, second-tier, and third-tier suppliers for Fuji Heavy Industries. Average sizes in employment of these three classes of suppliers in the region are estimated 258 for the first tier, 24 for the second tier, and six for the third tier. While Fuji Heavy Industries is the cluster's core assembler, Ota's auto parts manufacturers also do business with other auto assemblers such as Nissan Diesel in Ota City, Daihatsu and Hino in Gumma prefecture, and Nissan, Honda, and Isuzu in the neighboring regions.[8]

ITABASHI (TOKYO)

During the 1960s, approximately 95 percent of binoculars sold in the world market were produced in Itabashi in Tokyo. At the height of its growth in this period, the Itabashi area had around 220 assemblers and 600 related businesses in various stages in the preparation and production of components such as mirrors, lenses, and prisms. While the number of assemblers was reduced to 60 because of the emerging new competition from South Korea, Taiwan, and Hong Kong and the declining demand through the 1980s, the area remains the dominant production location in the world with a world market share of 75 percent.[9] The cluster's roots are traced to the early 1900s when Japan introduced the optical technology of Zeiss

6. People's Finance Corporation (1987, 1995).
7. People's Finance Corporation (1995).
8. Ito and Urata (1997) and MITI (1996).
9. People's Finance Corporation (1987).

from Germany. A cluster of optical equipment manufacturers arose in Itabashi during this period. Later, binocular manufacturers moved into this area to use skills and capabilities accumulated in the existing network of supporting and related industries, exploiting their agglomeration economies.

TSUBAME (NIIGATA)

Like the silk cluster in Kiryu described earlier, the silverware and kitchen utensils clusters in Tsubame City arose during the Edo period (1600–1865) as a major production site of traditional Japanese-style nails. The rise of Tsubame as a production site of nails is often explained by its location near copper mines.[10] The industry's modern history began in 1911 when Tsubame's businesses started manufacturing Western-style silverware to fill the gap in world demand caused by the sharp decline of silverware exports from Europe and the United States. At that point, Tsubame's firms had already accumulated technical skills and competencies in metal working and processing that was required to produce silverware. After WW II, Tsubame's businesses leaped to the rank of major export industries in Japan as sales to the U.S. market grew rapidly. Floods of exports to the U.S. market, however, induced a U.S. sanction of imports of silverware in 1959. To circumvent the restriction of exports of silverware, some of the firms diversified into houseware and kitchen utensils, sparking new businesses in this new field.[11]

The structure of inter-firm relationships is best characterized by hierarchical subcontracting relationships among different types of firms with complementary skills. Manufacturers that take orders from trading companies and wholesalers subcontract out several stages in the production process to first-tier suppliers who have metal working and processing capabilities. First-tier suppliers in turn ask second-tier suppliers to polish final products before shipping to the manufacturers.[12]

SANJYO (NIIGATA)

Sanjo City is a neighbor city of Tsubame City and a major manufacturing site of hand tools. The cluster arose after WW II and developed gradually during the 1970s and 1980s as exports grew significantly. The prior existence of supporting and related industries in Tsubame certainly played an important role to provide seed for this newer cluster. The cluster in Sanjyo is organized with a structure similar to the one in Tsubame. A large number of subcontractors (approximately 400 in 1985) exist with complementary skills in metal working and processing and work for a smaller number of manufacturers. Thus, it is characterized as a subcontracting system structured vertically along different stages of the production process.

SEKI (GIFU)

Seki City, located in Gifu Prefecture, is an old town that prospered as early as in the Kamakura Period (1185–1333) because of its geographic location. The city was located at the intersection of two major corridors: the route connecting two ancient capital cities, Kyoto and Kamakura, and the route connecting two strategic regions at that time, Mino and Hida. Because of its strategic importance and heavy traffic of warriors, the city soon became well known for sword forging. It is believed that a cluster of approximately 300 sword masters worked in the city during the Muromachi period (1333–1568).[13] While the city remained prosperous through the Edo period (1600–1865), it faced a major threat when the new Meji government banned the making and carrying of swords. It was quite natural that Seki's sword manufacturers quickly repositioned to cutlery manufacturing and took advantage of its sword forging skills and the existing supporting and related industries. A cluster of cutlery manufacturers thus arose in the Seki city. Their market share in the Japanese market is particularly high (more than 50 percent) in knives, Japanese-style kitchen knives, and cutlery for barbers. Because the production process of cutlery involves several layers of different types of activities, cutlery makers (approximately 200 firms in 1991) subcontract out most of these activities to smaller subcontractors with different skills and capabilities. The

10. Ito and Urata (1997).
11. People's Finance Corporation (1987, 1995).
12. Ito and Urata (1997).
13. People's Finance Corporation (1995).

large majority (70 percent) of these subcontractors operate as tiny establishments with fewer than three workers.

SABAE (FUKUI)
Sabae City in Fukui prefecture specializes in the manufacturing of eyeglass frames. The cluster's roots are traced to the late 1900s and the early 1910s when the prefecture government helped transplant manufacturing skills of eyeglass frames with a goal to develop the region's weak economy. Highly skilled technicians from Tokyo and Osaka that had been the largest clusters of eyeglass frames were sent to Sabae and helped diffuse their skills and technology. By the 1930s, Sabae's frame production surpassed those of Tokyo and Osaka, making it as the largest cluster of eyeglass frames in Japan. The cluster continued to grow after WW II and became dominant in the Japanese market controlling approximately 90 percent of the market by the end of 1980s.[14] There are approximately 1,000 small- and medium-sized firms in this eyeglass frame cluster. The majority of these firms are very small, and their average size is 7.9 workers. The production process of an eyeglass frame is divided into approximately 150–250 stages and requires relatively labor-intensive skills. Several types of firms with different skills and competencies coexist and constitute a cluster of related industries in the city.

Key Drivers of Cluster Formation

What is the key driving factor that underlies these 14 clusters in Japan? Several important drivers are likely to emerge from the descriptions of the clusters given above, which are listed in column 4 of Table 1.

Table 1. *Characteristics of 14 Manufacturing Clusters in Japan*

Location (Prefecture)	*Products*	*Startup period*	*Key initial conditions*	*Key features in industrial organization*
Kiryuu (Gunma)	Silk, man-made silk, and synthetic fabrics and weaves	1600s (Edo)	Historical cluster (silk) Foreign technology import (Jacquard Loom)	Extensive subcontracting Coexistence of firms with complementary skills and capabilities
Ishikawa	Synthetic fabrics	mid-1960s	High demand growth for polyester after 1966 Regional government policy to promote the synthetic textile industry	Extensive subcontracting Coexistence of firms with complementary skills and capabilities
Fukui	Synthetic fabric	early 1900s (Meiji)	Technology transfer from other cluster in Japan (Kiryuu) Prefecture government helped nurture the industry through its operation of technology center between 1910–30	Extensive subcontracting Coexistence of firms with complementary skills and capabilities

14. People's Finance Corporation (1995).

Location (Prefecture)	*Products*	*Startup period*	*Key initial conditions*	*Key features in industrial organization*
Komatsu (Ishikawa)	Silk General machinery for construction machinery	1640 1921	Historical cluster (silk) Existence of a large assembler	Network of supporting and related industries Vertically structured subcontracting system for a large assembler (Komatsu)
Nishiwaki (Hyogo)	Cotton fabric	1793	Historical cluster (cotton fabrics) Technology transfer from other cluster in Japan	Extensive subcontracting Coexistence of firms with complementary skills and capabilities
Gifu (Gifu)	Apparel	late 1940s	Historical circumstances Prior existence of related industries nearby Availability of large pools of female workers in the region	Extensive subcontracting Extensive use of female part-time workers
Seto (Aichi)	Ceramic novelty goods	1100s (Heian)	Historical cluster (ceramics) Access to high-quality raw materials	Extensive subcontracting Coexistence of firms with complementary skills and capabilities
Morodomi (Saga)	Furniture	1955	Construction of a new bridge connected two neighboring cities Reduction in transportation costs Expansion of viable economic area	Subcontracting
Ota (Gunma)	Automobile parts	1918	Existence of large assemblers (Nakajima in pre-War period) and Fuji Heavy Industries (in the post-War period) Prior existence of supporting industries for inherited by Fuji Heavy Industries	Hierarchically structured assembler-supplier relationship A large cluster formed with other assemblers (Nissan Diesel in Ota; Daihatsu and Hino in Gunma; Nissan, Honda, and Isuzu in neighboring regions)
Itabashi (Tokyo)	Binoculars	early 1900s (Meiji)	Foreign technology import from Zeiss, Germany Large military demand during the Korean war Prior existence of related industries (optical equipment)	Existence of several integrated makers Extensive subcontracting Coexistence of firms with complementary skills and capabilities
Tsubame (Niigata)	Silverware, kitchenware, and metal household ware	1600s (Edo)	Historical cluster (Japanese-style nails) Import substitution during the WW I Repositioned by diversifying into household wares during the 1960s to circumvent VERs in the U.S. market	Hierarchically structured subcontracting system Coexistence of firms with compelementary skills and capabilities

Location (Prefecture)	*Products*	*Startup period*	*Key initial conditions*	*Key features in industrial organization*
Location (Prefecture)	*Products*	*Startup period*	*Key initial conditions*	*Key features in industrial organization*
Sanjo (Niigata)	Hand tools	late 1940s	Geographic proximity to other cluster (Tsubame) Prior existence of related and supporting industries in the neighboring cluster	Extensive subcontracting Coexistence of firms with complementary skills and capabilities
Seki (Gifu)	Cutlery	1100s (Kamakura)	Historical cluster (sword forging) Importance of geographic location as a hub connecting major cities Repositioned into cutlery production after the Meiji government banned the making of swords	Extensive subcontracting Coexistence of firms with complementary skills and competencies
Sabae (Fukui)	Eyeglass frames	1910s (Meiji)	Technology transfer from other clusters in Japan (Tokyo and Osaka) Regional government policy to develop the region's economy	Extensive subcontracting Coexistence of firms with complementary skills and capabilities

Source: People's Finance Corporation (1987, 1995), MITI (1996), SMEA (1997), and Ito and Urata (1997, 1998).

Historical Conditions

The roots of some clusters go back to the Edo period in the 17th and 18th centuries (Kiryuu, Komatsu, Tsubame, and Nishiwaki), yet others can be traced to the periods as early as the 12th century (Seto and Seki). These clusters had already been known for their products by the time when they transformed their manufacturing systems to the modern systems. Through their long histories, these clusters accumulated the skills required to manufacture high-quality specialty products. One factor that made these cities important historical manufacturing locations may be the availability of raw materials and key ingredients nearby (Seto and Tsubame). Another factor may be historical circumstances such as the existence of an extensive network of routes connecting major cities (Seki). Clusters may also arise from historical accidents and discontinuities as observed in the emergence of the silverware cluster in Tsubme during WW I and the apparel cluster in Gifu, which can be traced to the development of used-clothes market in front of the train station after WW II.

Existence of Large Assemblers

The second factor that is to some extent determined by historical circumstances is the existence of one or a few large firms that manufacture products based on assembly-type operations. Examples from Komatsu and Ota illustrate this point. The machinery cluster in Komatsu had its beginnings in the establishment of a construction machinery company, Komatsu. The automotive parts cluster is another classic example where Nakajima Aircraft and later Fuji Heavy Industries started their operations in Ota. The existence of these

large assemblers stimulated the entry and growth of other firms that supply parts and related products to them.[15]

Prior Existence of Supporting and Related Industries in the Region

The automotive parts cluster in Ota illustrates the importance of prior existence of supporting industries in the region. A network of supporting and related industries was nurtured by Nakajima Aircraft during the pre-war period, which was in turn inherited by Fuji Heavy Industries after the war. Nakajima's employees spun off after the war to create new parts firms to supply Fuji Heavy Industries. The cluster created a network of automotive parts industries with the skills accumulated through Nakajima's aircraft manufacturing history.

Another example is the case of binocular clusters of Itabashi in Tokyo. That cluster emerged building upon the existing network of optical equipment and precision instrument manufacturers in the region. A number of binoculars makers and suppliers for their parts were stimulated to enter the region because of the existence of related industries.

Prior Existence of Supporting and Related Industries in the Neighboring Region

As prior existence of supporting and related industries in the same region plays an important role to foster a new cluster in a different field, their prior existence in the neighboring regions also stimulates the growth of other clusters. The case of the hand tools cluster in Sanjo illustrates this point. Sanjo is located closely to Tsubame's silverware cluster that has its beginnings in a much earlier period. Tsubame's cluster had already created a network of small- and medium-sized subcontracting firms with the special skills in metal working, forging, processing, and polishing when the cluster in Sanjo emerged (Figure 1). Another example is the case of Gifu's apparel cluster. That cluster took advantage of its geographic proximity to the textile fabric clusters in neighboring regions. The cluster in Gifu primarily procured the requisite fabrics from the neighboring clusters.

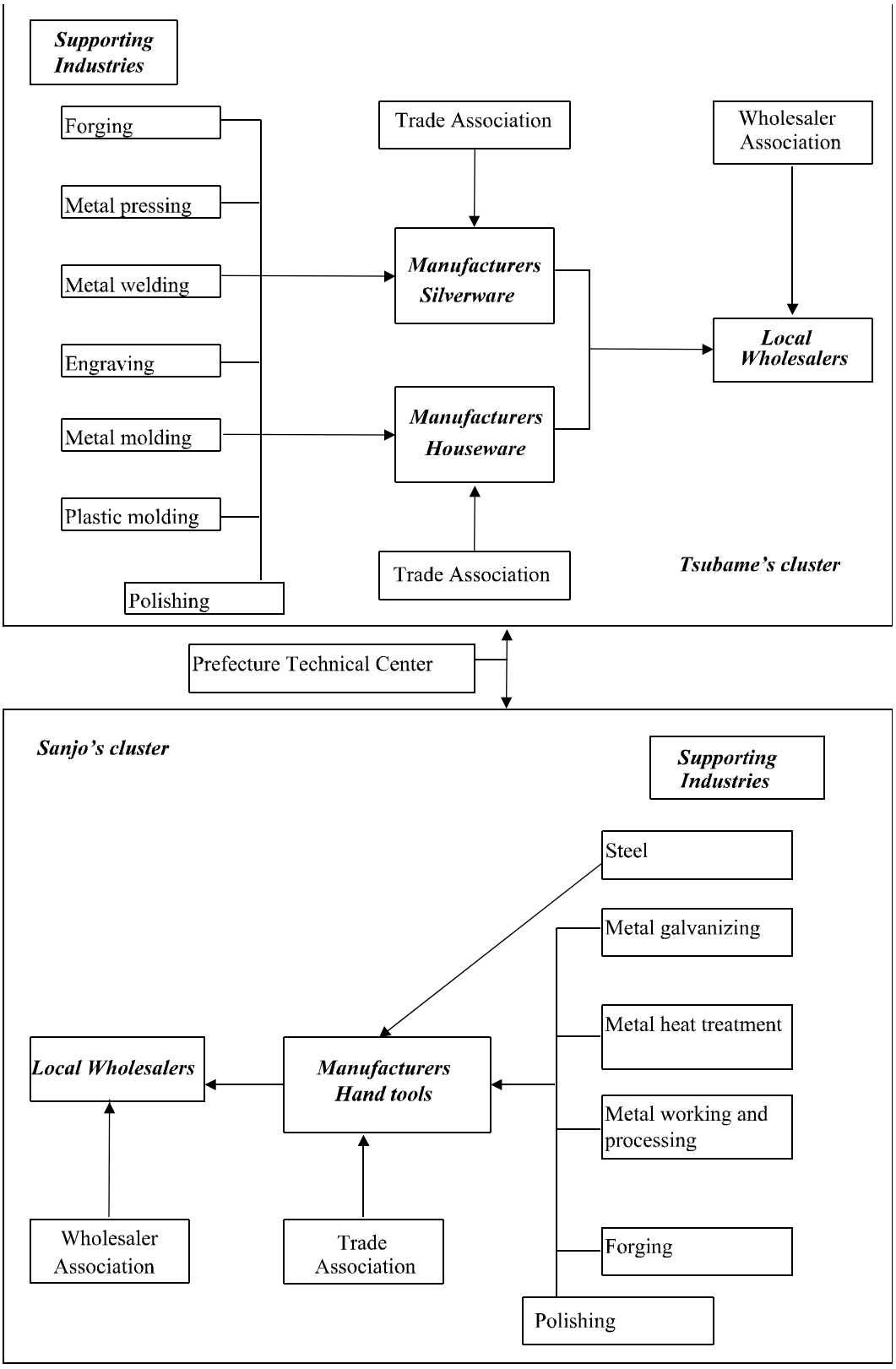
Pooled Labor Market for Part-Time Workers

Some of Japan's clusters gained advantages from the fact that they got access to pooled labor markets of part-time workers in their regions. The apparel cluster in Gifu resorted to a large pool of part-time female workers who offered the requisite skills while alleviating disadvantages caused by cyclical demand fluctuations. By the same token, the textile clusters in Ishikawa and Fukui also took advantage of the existence of large pools of part-time workers from the regions' agricultural sectors.

It is important to note, however, that these part-timers normally work as subcontractors for first-tier and/or second-tier suppliers in several stages of the production process that require the most labor-intensive work. Their skill levels are generally much lower than those of regular workers. It is not clear from the case analysis whether Japan's localized industries supported pooled labor markets for skilled workers and engineers. This issue of skill formation and labor market will be discussed later in Section 4 of this paper.

15. Similar examples are the cases of Hitachi in the city of Hitachi and Yamaha in Hamamatsu (MITI 1996).

Figure 1. *Structure of the Tsubame-Sanjo Cluster*



Reduction in Transportation Costs

A significant reduction of transportation costs expands economically viable geographic space and increases the size of relevant market. The expansion of an economically viable geographic space will in turn attract new businesses. The furniture cluster in Morodomi illustrates this point. Morodomi's furniture cluster emerged only after a new bridge was constructed and linked two cities previously divided by a river. Furniture makers in the neighboring city invested in Morodomi, responding to a great reduction in transportation costs, which stimulated the growth of many new businesses in the newly created economic zone.

Regional Government Policy

The regional governments often played important roles in providing seed for new clusters. Typical examples of prefecture government policy are given by the cases of Ishikawa and Fukui prefectures that took initiatives to nurture and modernize their textile industries with the goal in developing the regions' ailing economies. Fukui's prefecture government also designed the startup of the eyeglass frames clusters in Sabae with the same goal in developing the regional economy.

One of the policy tools Japan's prefecture governments used was the establishment of public testing and research centers, and technology centers to guide and foster technological developments of particular products. The first technology center was established in 1894 in the Hyogo prefecture where textile spinning was the strategically important industry. During the period between 1894 and 1926, a total of 41 public testing and research centers and technology centers were established in different prefectures throughout Japan to promote technological developments in textiles, ceramics, agriculture, chemicals, and food. The public technology centers for textiles in Fukui and Ishikawa mentioned above were among these first technology centers in Japan.

A large number of public testing and research centers and technology centers were established in the subsequent periods, opening 46 centers during the 1927–45 period and another 57 centers during the 1946–64 period.[16] The major functions that these centers are expected to provide are (1) technological guidance and consulting, (2) testing and inspection, (3) R&D, (4) seminars, and (5) dissemination of information on latest technologies and products.

Technology Transfer

A factor closely related to government policy is the import of technology from other locations. A technology can be imported from other domestic clusters in Japan and foreign countries. The textile clusters in Fukui and Nishiwaki imported technologies from other textile clusters in Japan. The same applies to Sabae's eyeglass frame cluster, which imported the requisite technologies and skills from other related clusters in Tokyo and Osaka. On the other hand, Kiryu's textile cluster procured the Jacquard technology from abroad, and the binoculars produced in Itabshi were built on the technology imported from Germany. Imports of new foreign technologies and their diffusions provided seed for the formation of clusters.

The eight factors given are not meant to substitute one for another. Instead, several of them are often present together and complement each other when a cluster emerges in a particular region. This list of key driving forces is by no means exhaustive, but it is considered important for the 14 major clusters in Japan studied in this paper. While these are derived from the experience specific to Japan, they are similar to and

16. As of 1991, 171 public testing and research centers and technology centers exist in Japan (JICA 1992).

thus consistent with the previous lists of driving forces for industrial localization derived mainly from the U.S. and European experiences. Porter (1990, 1998), drawing on histories of U.S. and European clusters, identifies (1) historical circumstances; (2) unusual, sophisticated, or stringent demand; (3) prior existence of supplier industries, related industries, or entire related clusters; (4) existence of one or two innovative companies; and (5) chance events. The work of Krugman (1991) suggests key factors for the formation of an localized industry: (1) historical accidents, (2) labor market pooling, (3) supply of specialized inputs, and (4) technological spillovers. In addition, Krugman (1991) argues that industrial localization is promoted by the confluence of economies of scale, transportation costs, and demand.

Evolution of Clusters

The initial conditions that shaped the emergence of a cluster may not remain unchanged in the long run. Rather, they may change because of historical events, technological innovations, and unexpected shifts in demand. Some of the clusters studied in this paper faced such discontinuities that these discontinuities forced the clusters to reconsider their business strategies. Through the process of repositioning, a cluster's original products are often phased out and replaced by new products. Some clusters decline eventually.

Historical Event

Unexpected historical events may force firms in cluster to diversify into new fields. The houseware cluster in Tsubame emerged while some of the city's manufacturers repositioned from silverware to this new business to circumvent the VERs imposed on Japanese silverware exports in the U.S. market during the 1960s. The cutlery cluster in Seki emerged after the Meji government banned the making of swords. In both cases, the manufacturers adopted diversification strategies into new but related businesses that rely on the clusters' core competencies. The skills required in the new fields were already accumulated in the clusters through their histories of prior business fields.

Technological Change

Development of new production processes and emergence of new products often change clusters' configurations of product lines. Our examples of textile clusters illustrate this point. All the silk clusters were forced to shift their products to man-made silk during the 1920s and to synthetic fabrics in the post-war years. Another example is a cluster specialized in traditional hand tools used for the construction of Japanese-style wooden houses (Miki in Hygo prefecture).[17] That cluster has been shrinking owing to the emergence of new construction methods that do not require much use of such traditional tools at house construction sites.

Demand Condition

Unexpected demand growth and decline often change the growth path of a cluster. The unexpected increase in demand in the international market of silverware during WW I triggered the growth of Tsubame's cluster. The demand growth for polyester during the 1960s helped the repositioning of the textile clusters in Fukui and Ishikawa. The large military demand created during the Korean War for

17. Not included in the sample of 14 clusters.

binoculars played an important role for the emergence of the cluster in Itabashi. Plus, the expansion of Japan's auto industry certainly helped the development of Ota's cluster of auto parts.

International Competition

Clusters often lose their international competitiveness and decline over time. When a cluster that relies heavily on export markets declines, its cause is often traced to at least three main factors: (1) aggregate economic fluctuations, (2) emerging new industries abroad, (3) shifts in foreign demand. Fluctuations of Japanese yen against foreign currencies are the most significant of the aggregate conditions because they can dramatically affect clusters' cost conditions relative to their counterparts in foreign countries. The clusters that specialize in more labor-intensive production processes face major threats from newly industrialized countries because Japanese workers' relatively high wages offset clusters' advantages based on subcontracting and specialized skills. All the 14 clusters except Ota's automobile parts clusters have been facing major competitive threats from international rivals in recent years.

3. Structure of Industrial Clusters in Japan

Inter-Firm Linkage

Our examples of clusters indicate that there are at least three distinctive features in Japan's clusters in terms of inter-firm linkages (column 5 in Table 1): (1) the extensive use of subcontracting between manufacturers and suppliers; (2) the hierarchically structured relationships between manufacturers, first-tier suppliers, and second-tier suppliers; and (3) the coexistence of a large number of firms with different but complementary skills in the cluster.

The first two characteristics are not necessarily the features specific to clusters, but they are the features specific to Japan's manufacturing system in general (e.g., Uekusa 1987; Asanuma and Kikutani 1992).

On the contrary, concentration of numerous firms with complementary skills in a business field within a certain geographic area is considered the distinctive feature of clusters. Figure 1 shows a schematic picture of this feature in Tsubame's silverware and houseware clusters and the nearby hand tools cluster in Sanjo. In both clusters, the firms in various supporting industries create a horizontal network among themselves based on their complementary capabilities.[18] These firms supply for manufacturers through vertical subcontracting relationships. In addition to manufacturers, suppliers, and wholesalers, there are several local institutions that coordinate member firms' activities, facilitate the communications between them, and disseminate technological and product information. They are local trade associations, wholesalers associations, local chambers of commerce, and prefecture technical centers.

While Tsubame's silverware and houseware clusters consist of 148 silverware manufacturers and 127 houseware manufacturers in 1991,[19] the numbers of manufacturers in some clusters are much smaller. Clusters in which one or few large manufacturers form hierarchically structured subcontracting relationships with smaller suppliers are often observed in the machinery and automobile industries. Our examples of the auto parts cluster in Ota and the machinery cluster in Komatsu illustrate this type of assembler-supplier cluster.[20]

18. Firms specialized in polishing often work as second-tier subcontractors. See Ito and Urata (1997, 1998).
19. The numbers of subcontractors are 182 in silverware and 265 in houseware. In addition, there are more than 1,000 subcontractors specializing in polishing (Ito and Urata 1997, Table 8).
20. This tendency that Japanese automobile manufacturers form clusters with suppliers is observed for their U.S.-based companies as well. See Head, Ries, and Swenson (1995).

Size

To see the general pattern of firm and cluster sizes in Japan, Table 2 shows several descriptive statistics for the 537 clusters in Japan surveyed by the Small and Medium Enterprise Agency in 1996. A cluster in this survey is defined as a group of firms in a business field in a geographic space. The survey includes clusters with values of production over Yen 500 million in 1996. The range of products in this survey varies widely from indigenous foods for purely domestic markets to machinery for export markets. Of the 537 clusters, 36 percent of them existed before the Meiji period (before1868), 28 percent of the clusters emerged during the Meiji period (1868–1912), and 21 percent of the clusters started after 1945. Among the 537 clusters, 126 clusters are found in textiles and constitute the largest number of clusters in Japanese manufacturing, accounting for 23.5 percent of the total.

Table 2. *Number of Clusters, Average Cluster Size, and Average Firm Size, by Industry (1996)*

Industry	*Number of clusters*	*Number of firms/ cluster*	*Employment/ cluster*	*Employment/ firm*
Food processing	83 (15.5%)	82	1,260	15.37
Textiles	126 (23.5%)	241	1,518	6.30
Clothing	34 (6.3%)	208	4,986	23.97
Wood products and furniture	78 (14.5%)	102	823	8.07
Clay, stone, and glass products	62 (11.5%)	125	920	7.36
Machinery	56 (10.4%)	128	1,986	15.52
Miscellaneous	98 (18.2%)	111	1,175	10.59
Total	537 (100.0%)	145	1,496	10.32

Source: SMEA (1997)

The number of firms per cluster varies across industries, ranging from 241 in textiles to 82 in food processing. Average size of cluster measured in terms of employment per cluster varies again widely among industries. An average cluster in textiles is likely to employ approximately 5,000 workers and likely to be the largest when compared with clusters in other industries. On the other hand, a typical cluster in wood products and furniture employs 823 workers and is likely to be the smallest. On average, in 1996, a cluster in Japan employs approximately 1,500 workers.

A typical firm in a clothing cluster in Japan employs 24 workers, while a typical firm in a textile cluster employs only six workers. Average firm size in food processing and machinery is in between these two polar cases, employing approximately15 workers. On average, again in 1996, a typical firm in a manufacturing cluster in Japan employs approximately 10 workers.[21]

21. The SMEA survey does not include in the sample the assembler–suppliertype cluster in which one or few large manufacturers operate as a core.

Some clusters are highly fragmented with large numbers of small firms. A typical example of such a case is textile clusters. According to Table 2, a typical textile cluster in Japan consists of 240 firms with fewer than seven employees. On average, 145 firms exist in a cluster in Japan, each employing approximately 10 workers.

Sources of Advantage in Japan's Clusters

Interpreting the seminal work of Marshall (1920), Krugman (1991) pointed out that the advantage of concentrated production is generated by three distinctive sources: labor market pooling, specialized inputs, and technological spillovers. In this section, we will first lay out these three causes with additional consideration and then examine which one of them is most important for the clusters in Japan by reviewing the SMEA survey result.

Labor Market Pooling

By concentrating a number of firms in an industry in the same location, a localized industry gains an advantage from offering a pooled market for workers with specialized skills. Both workers with specialized skills who seek employment and firms that seek such workers are better off if they get access to the pooled labor market in the same location (Marshall 1920; Krugman 1991).

Whether this factor is relevant and important for Japanese clusters depends presumably on the mobility of skilled workers between firms within a cluster and between geographic areas. Because Japanese workers tend to stay in the same firm until retirement, the benefit of agglomeration arising from labor market pooling for skilled workers may be relatively small in a Japanese cluster. On the other hand, this advantage may be more important in labor markets for part-time workers. As in the cases of apparel and textile clusters, part-time workers are often female workers who are local residents and work at home. Their wages are under normal circumstances much lower than regular employees.

Availability of Firms with Specialized Skills and Competencies

Agglomeration is created in a localized industry because it can support suppliers with specialized skills and capabilities. Capacity utilization of specialized machinery can be increased and maintained at a high level in a localized industry that produces the same kind of products. This in turn makes the localized industry more efficient (Marshall 1920; Krugman 1991).

If the minimum efficient scale of production varies across a range of products and through different stages of the production process, then manufacturers can choose an optimal combination of operations by working closely with a number of specialized suppliers. Manufacturers can benefit from the availability of such suppliers as they choose a right technology in response to the scale of production at each stage of the process through a subcontracting-based manufacturing system.

The availability of the number of firms with complementary skills also allows manufacturers to produce a large variety of product. If variety is produced through a wide range of materials and components that are handled efficiently by specialists as well as through stages of specialized operations, then manufacturers will benefit from working with suppliers with such capabilities.

While such division of labor can be contracted between firms in the different geographic spaces, it is more efficiently and easily organized between nearby firms. An example of the mechanical pencil industry in Japan shows that the manufacturer may suffer from working with suppliers scattered geographically in

different stages of the production system (Mishina 1993). The long travel distance of work in process impaired the timeliness of delivery and therefore reduced production efficiency in this case.

Technology Spillovers

Because firms in a localized industry are proximate, information flows easily among them. Localization, therefore, generates knowledge spillovers between nearby firms (Marshall 1920). Whether such knowledge spillovers are confined within a particular geographic space or go beyond a geographic boundary has been disputed in the existing literature (Krugman 1991; Audretsch 1999). The empirical work that addresses these issues of knowledge spillovers seems to show that, at least in the United States, knowledge spillovers tend to be geographically bounded within the geographic area where the new knowledge was created (e.g., Jaffe, Trajtenberg, and Henderson 1993, Audretsch and Feldman 1996).

A variety of regional institutions work as vehicles that facilitate the transmission of knowledge across firms within the same cluster in Japan (Figure 1). Public technical centers managed by the prefecture governments offer technical consulting services and seminars and disseminate information on new technology and product. Local chambers of commerce, trade associations, and business organizations coordinate business activities within clusters and provide market and technical information. Local wholesalers and general trading companies disseminate information on emerging new markets, products, and technologies.

Table 3 summarizes the result of the questionnaire survey conducted by the SMEA in 1996, which was described in the previous section of this paper. Out of the 537 clusters studied in this survey, a total of 471 clusters responded to the questionnaire. Of the 471 respondents, 138 are classified in textiles and apparel; 73 are in wooden products and furniture; 54 are in stone, clay, and glass; and 50 are in machinery and metal products. Table 3 presents the number of respondents who consider a specific source of advantage important as a percentage of the total number of respondents in the industry in the survey. The respondents are not restricted to choose only one item among the advantages listed in the questionnaire.

Table 3. *Sources of Advantage in Japan's Clusters, by Industry (response rate in percentage)*

Advantages	*All industries*	*Textile and clothing*	*Wood prod. and furniture*	*Stone, clay, and glass*	*Metal prod. and machinery*
Ease of procurement	42.3	23.9	50.7	59.3	50.0
Access to labor market	6.8	5.1	5.5	3.7	8.0
Availability of skilled workers and engineers	10.0	9.4	13.7	5.6	8.0
Specialization/division of labor	42.6	53.6	47.9	31.5	64.0
Access to supplier/subcontractor	24.2	30.4	23.3	13.0	38.0
Access to customer base	10.8	11.6	12.3	13.0	6.0
Competitive environment	19.5	16.7	20.5	25.9	14.0
Diffusion of technology and technological cooperation	31.2	37.6	26.0	46.4	16.0
Opportunity for business alliance	11.9	8.0	13.7	14.8	10.0
Access to market information	24.8	29.0	16.4	16.7	24.0
Regional policy	27.4	26.8	23.3	20.4	28.0
No advantage	2.8	2.9	1.4	1.9	0.0
No. of clusters in sample	471	138	73	54	50

Source: SMEA (1997), Table 17.

Looking at column 2 in Table 3, the largest number of clusters (42.6 percent of 471 clusters) found specialization and division of labor as an important advantage that clusters create. An equally important advantage is the ease of procurement within clusters (42.3 percent). This result suggests that agglomeration occurs in a cluster because it can support suppliers that possess specialized skills. Such capabilities are complementary to each other, which allow divisions of labor among them. Manufacturers benefit from the existence of specialized suppliers because they can choose optimal combinations of technologies for a wide range of products.

The second source of advantage for a localized industry that Japanese firms consider important is likely to arise from the fact that it facilitates diffusion of technology and technological cooperation. This result seems to suggest that new technological knowledge spills over easily among the firms within the same cluster. Of the 471 clusters, 31.2 percent of them choose diffusion of technology as an important advantage of clustering.

On the contrary, access to a labor market and availability of skilled workers are considered less important sources of advantage in Japan's clusters. Only 6.8 percent of the clusters in the sample choose the access to labor market as an important advantage, and 10 percent of them consider the availability of skilled workers important.

This result obtained from the full sample remains basically unchanged for different industries, although there are some industry-specific differences. Table 3 shows the survey results for four different industries. Among the industry-specific differences, the most notable is the importance of specialization and division of labor. This advantage is considered the most significant in metal products and machinery with the highest response rate of 64 percent. Ease of procurement (with 50 percent response rate) and access to suppliers/subcontractors (with 38 percent response rate) are other advantages that are important in this industry. This result is quite consistent with the underlying manufacturing process commonly used in this industry that consists of several stages of highly specialized components production.

4. Development of Firm Capabilities in Japanese Clusters

Skill Formation

The analysis in the previous section finds that the existence of suppliers with specialized, complementary skills is the most likely source of agglomeration in a Japanese cluster. On the other hand, the SMEA survey does not seem to provide evidence that supports the hypothesis that the creation of a pooled labor market for skilled workers in a localized industry offers an advantage to both local firms and workers.[22]

Why is a pooled labor market for skilled workers not important source of advantage in Japanese cluster? The way in which skills are created and developed in Japanese firms, and the way in which such human skills are allocated among firms may provide an answer. As is well known, on-the-job training is the most commonly used method to train workers in Japanese corporations (Koike 1988). The prevalence of on-the-job-training in Japan is based on the premises that most skills are learned only by doing, and that some of these skills are specific to the firm or to the plant.

This firm-specific nature of human skills in turn tend to discourage the worker to move to another firm since the worker will lose some of the skills acquired in the firm if the worker moves to the another firm. The firm will not be able to replace the worker easily within a short period with a new recruit without impairing efficiency. This in turn motivates both workers and firms to use a mechanism that is internal to firms rather than a mechanism that use external markets to allocate human resources (Odagiri 1992).

Table 4 shows the SMEA survey result on skill formation and procurement of skilled workers. As is expected, it is quite evident from this table that more than 80 percent of Japan's industrial clusters use on-

22. This result complements the paper's earlier finding that some clusters in Japan benefited from the existence of pooled markets for part-time workers in labor-intensive industries, but not necessarily from pooled labor markets from skilled workers.

the-job-training as the method to train workers and develop their skills. This pattern holds consistently across different industries. While firms in Japan's industrial clusters are likely to use on-the-job-training as the most important method to develop human skills, they are less likely to procure them from other firms in the same cluster. Asked whether firms recruit skilled workers from other firms in the same cluster, approximately 20 percent of clusters responded positively to this question. This relatively low response rate for the use of external markets to source skilled workers by Japanese firms contrasts starkly with the high response rate for the use of on-the-job-training, which suggest their preference for an internal mechanism to allocate human resources.

Table 4. *Skill Formation and Procurement of Skilled Workers, by Industry (response rate in percentage)*

	Foods	*Textile*	*Clothing*	*Wood product and furniture*	*Stone, clay, and glass*	*Machinery*	*Others*	*Total*
On-the-job training	84.7	79.1	100	86.5	80.7	90.6	81.9	84.2
Inter-firm cooperation in skill formation	15.3	16.5	14.8	17.6	17.5	17.0	15.7	16.4
Recruit outside the cluster	9.7	5.2	14.8	6.8	8.8	11.3	9.6	8.5
Recruit from other firms in the cluster	16.7	27.0	25.9	17.6	12.3	22.6	18.1	20.2
Number of clusters in sample	72	115	27	74	57	53	83	481

Source: SMEA (1997), Table 23.

In sum, the analysis in this section and the previous section suggests that the firms in an industrial cluster in Japan are more likely to benefit from supporting large numbers of suppliers with specialized skills. Some of the human skills in these firms are firm-specific and developed internally within the firms through on-the-job-training. Since such skills are only infrequently acquired from other firms in the same cluster, a localized industry in Japan is less likely to support a pooled labor market for skilled workers.

Development of Technological Assets

While the access to a pooled labor for skilled workers in an industrial cluster in Japan is unlikely to be an important source of agglomeration, technology spillovers are more likely to be an advantage of clustering. How does a cluster facilitate the diffusion of new technology and other knowledge? As was discussed earlier in this paper, knowledge spillovers among firms in the same cluster can occur through various institutions such as trade associations, public testing and research centers, public technical centers,

wholesalers associations, and local chambers of commerce. In addition to such institutions, various forms of inter-firm cooperation and contacts within a cluster are also likely to facilitate knowledge spillovers.

Table 5 summarizes the SMEA survey result on the pattern of inter-firm cooperation in Japan's industrial clusters. Out of the123 clusters that responded to the question of what types of inter-firm cooperation they participate in, 64 percent of them pointed out joint R&D as a vehicle for collaboration, and 26 percent of them saw their firms participate in technological alliance. This general pattern remains virtually unchanged for different industries except in wooden products and furniture where technological alliance is not important. It is also worth noting that the frequency with which Japanese firms in a cluster exchange business information and reference each other through informal channels is not trivial.

Table 5. *Inter-Firm Cooperation Within Cluster, by Industry (response rate in percentage)*

	Foods	*Textile and clothing*	*Wood products and furniture*	*Stone, clay, and glass*	*Machinery*	*Others*	*Total*
Joint R&D	80.0	65.6	66.7	57.1	61.1	57.9	64.2
Technology alliance	20.0	31.3	5.6	28.6	38.9	26.3	26.0
Joint production	6.7	3.1	16.7	14.3	5.6	10.5	8.9
Production contract	6.7	15.6	11.1	14.3	11.1	21.1	13.8
Marketing contract	6.7	6.3	0.0	4.8	11.1	5.3	5.7
Informal exchange of business information and reference	0.0	31.3	27.8	9.5	27.8	15.8	20.3
Capital participation	6.7	6.3	0.0	4.8	0.0	0.0	3.3
Joint Venture	6.7	0.0	0.0	0.0	0.0	5.3	2.4
Number of clusters in sample	15	32	18	21	18	19	123

Source: SMEA (1997), Table 54.

Another interesting pattern that emerges in Table 5 is that the types of partnership that include equity ownership and therefore ownership control are not common in a Japanese cluster. Among the 123 clusters, only 3.3 percent of them report partnerships that involve capital participation, and a mere 2.4 percent of them report joint ventures as a common form of alliance.

Table 6 summarizes the SMEA survey result on alliance partners. The questionnaire asked who are the most likely partners of alliance. Among the 127 clusters where their firms formed alliance, 60.6 percent of them formed alliances with public research and testing centers and technical centers. The response rate is the highest for machinery where more than 80 percent of clusters involve partnerships with such public institutions. On the contrary, forming a partnership with a university is relatively rare for the firm in a cluster. Only11 percent of the clusters are involved in partnerships with universities. When a firm in a cluster form alliances with other firms, its partners are likely to be small- and medium-sized firms rather than large firms. Indeed, in the majority of clusters are partnerships formed among SMEs, but only 5 percent of them involve large firms as partners.

Table 6. *Alliance Partner Within Cluster, by Industry (response rate in percentage)*

	Number of clusters in sample	*Public Research and Testing Institution*	*University*	*Small and medium firm*	*Large firm*
Foods	16	75.0	18.8	31.3	0.0
Textile and clothing	35	60.0	5.7	60.0	5.7
Wooden product and furniture	18	44.4	11.1	55.6	0.0
Stone, clay, and glass	21	57.1	9.5	47.6	9.5
Machinery	18	83.3	16.7	44.4	11.1
Miscellaneous	19	47.4	10.5	52.6	0.0
Total	127	60.6	11.0	50.4	4.7

Source: SMEA (1997), Table 54.

In sum, the evidence suggests that public institutions such as prefecture testing and research centers and technical centers play an important role in facilitating inter-firm cooperation between firms in a localized industry. Joint R&D efforts and technological alliances serve as the most commonly used vehicles for access to new technology and other assets in Japan's clusters. Acquiring or augmenting technological assets and other assets through capital participation and joint venture is unlikely in Japanese cluster.

5. Cluster Performance

The analysis has thus far focused on the structural features of Japan's clusters. This section attempts to shed some light on some issues of cluster performance.

Firm Exit in Cluster

Do all the firms in Japan's clusters perform equally well and survive in their markets? In other words, how frequently do firms in clusters exit? Entry into and exit from industry have been used extensively in the previous empirical literature of industrial organization to infer the extent of competitive performance of industry. Do firms in clusters face more volatile or more stable environment? While there is no published data available to answer this question for Japan, the SMEA survey provides some statistics that can be used to shed some preliminary light on this issue. The survey shows the number of exits of firms that belong to clusters during the three-year period of 1994–96 without making any reference on their entry dates. By using these data and an estimate of average number of firms in clusters presented in Table 2 of this paper, Table 7 presents an estimate of exit rate for seven manufacturing industries in Japan.

Table 7. *Number of Exits and Exit Rate, by Industry (1994–96)*

Industry	*Exits/cluster*	*Firms/cluster*	*Exits/firms in cluster*
Food processing	1.79	82	0.022
Textile	15.37	241	0.064
Clothing	8.22	208	0.040
Wood product and furniture	2.48	102	0.024
Clay, stone, and glass product	2.75	125	0.022
Machinery	2.68	128	0.021
Miscellaneous	2.67	111	0.024
Total	7.00	145	0.048

Source: The author's estimate based on Table 12 in SMEA (1997).

The first column of Table 7 shows the number of exits per cluster by industry. The most distinctive pattern that emerges from this is that the numbers of exits in textile (15.37) and clothing (8.22) are among the highest. The numbers of exits for other industries are more comparable ranging between 1.79 and 2.75.

Since the number of exits presented in the first column is not adjusted for the total number of firms in clusters, the third column shows the exit rate, defined as the number of exits divided by the number of firms in a typical cluster (column 2). The pattern of exit rate is virtually the same as that of the unadjusted number of exits in column 1. The exit rate for textile is the highest with 6.4 percent followed by that for clothing with 4.0 percent. The exit rates for the rest of the sample are again comparable ranging between 2.1 percent and 2.4 percent.

The relatively high exit rate for the textile and clothing industries is presumably explained by the recent increase in international competition in these markets. Significant recent increases in imports of textile and clothing in Japan from her neighboring Asian countries injected competitive pressure and restrained domestic prices for these goods (Yamawaki 1992). Facing such competitive pressure, some of the Japanese firms in these markets were forced to exit from their markets.

Unfortunately, this paper is unable to answer the question of whether Japanese firms in clusters are more likely to survive than those outside clusters because of the unavailability of exit rates comparable between these two samples of firms. Comparison of performance between insiders and outsiders is needed in future research. In recent years, an increasing number of empirical studies in industrial organization have examined patters of *gross* entry and exit for many industrialized countries and their link to firm and industry performances. Similar empirical research for Japan is indeed needed urgently.

The finding in Table 7, however, implies that not all the firms in a cluster perform equally well and survive when faced with international competition. While clusters may provide firms that belong to them with common cluster-specific and region-specific advantages, such advantages may be offset by firm-specific disadvantages. As the estimate of exit rate for textile and clothing suggests, some inefficient firms in the cluster, albeit small, are forced to exit. Thus, clustering does not necessarily guarantee that all the firms benefit equally from it, but each firm's firm-specific resource and capability instead may play a more important role in shaping the firm's viability in the industry.

Agglomeration and Regional Economic Growth

Does the presence of cluster in a region increase its economic growth? Does agglomeration of economic activities in a region create externalities and improve productivity? Despite the importance of these questions, empirical research that provides evidence to answer these questions is quite scarce at least in Japan. An exception is the statistical study by Morikawa (1997) that examined the relationships between various measures of regional economic performance and agglomeration during the period of 1975–91 in Japan. By using data sample at the level of prefecture, Morikawa estimated equations that explain regional economic growth by the extent of agglomeration of general economic activity, the presence of general machinery industry in the region, initial economic condition of the region, and policy variables.

His regression result shows that regional shipment growth is positively related to a proxy for agglomeration measured by manufacturing shipment per geographic area. On the contrary, he finds that real labor productivity growth in the region is not statistically related to the proxies for agglomeration measured by population density and regional GDP per geographic area. On the basis of this finding, he concludes that agglomeration of general economic activity is more likely to help expand the size of regional economy, but it is less likely to help increase labor productivity growth.

More interestingly, his work finds that the strong presence of general machinery industry in the region significantly increases the region's productivity growth. This finding is consistent with the hypothesis that the presence of machinery industry in the region creates externalities and helps augment productivity growth of other industries in the region. This result further provides statistical evidence that is consistent with the anecdotal evidence in Section 3 of this paper, confirming that the existence of supporting and related industries are likely to create cluster-specific advantage.

6. Conclusions

This paper has provided an overview of the evolution and structure of industrial clusters in Japan. The emergence of Japan's clusters is related to several factors: historical circumstances, prior existence of large manufacturers, prior existence of supporting industries, prior existence of related industries in neighboring geographic areas, reduction in transportation costs, regional government policy, and technology transfer. Japan's industrial clusters generate advantages by supporting large numbers of suppliers with specialized capabilities and by organizing market structures that encourage inter-firm linkages and facilitate the transmission of knowledge among firms.

This list of drivers and advantages of industry localization is quite consistent with lists derived from the experiences in the United States and Europe. Aside from the difference in historical circumstances, the distinctively Japanese element lies in the ways in which Japanese firms organize their business activities and the local governments promote local clusters. The extensive use of subcontracting; the hierarchical relationship between manufacturers and multiple layers of suppliers; the small size of suppliers; the importance of on-the-job-training; the low degree of labor mobility of skilled workers between firms; the preference for internal labor markets to external labor markets to allocate human resources; the establishment of various public testing, research, and technical centers by the local governments; the existence of various institutions such as trade associations, business associations, and wholesalers associations; and the roles such institutions play in facilitating the communication between firms in a cluster, are all important characteristics of Japan's industrial organization that distinguish Japan's industrial clusters from those in other countries such as in the United States.

Among the advantages identified in the paper, that created by the existence of specialized suppliers in a localized industry is considered the most important element in creating agglomeration economies. A supplier's skills and capabilities complement other suppliers' skills and capabilities, which in turn complement manufacturers' skills and capabilities. Through such a network, firms develop the skills

specific to a cluster. The case analysis of this paper finds that firms develop and accumulate such skills over time, which in turn become important assets that often determine the cluster's evolution path.

References

Asanuma, B., and T. Kikutani. 1992. "Risk Absorption in Japanese Subcontracting: A Microeconometric Study of the Automobile Industry." *Journal of the Japanese and International Economies* 6(March):1–29.

Audretsch, D. B. 1999. "The Economic Role of Small-and Medium-Sized Enterprises: The United States." Paper prepared for the World Bank Workshop on Small and Medium Enterprises, August 13–14 1999. World Bank, Washington, D.C.

Audretsch, D. B., and M. P. Feldman. 1996. "R&D Spillovers and the Geography of Innovation and Production." *American Economic Review* 86(June):630–40.

Head, K., J. Ries, and D. Swenson. 1995, "Agglomeration Benefits and Location Choice: Evidence from Japanese Manufacturing Investments in the United States." *Journal of International Economics* 38(May):223–47.

Ito, M., and S. Urata. 1997. "Chushokigyo to hushokigyo enjoseisaku (1): 3 sanchi no hikaku chosa (Small and Medium Enterprises and Policy Toward Them)." *Keizaigaku Ronshu* 63(10):1–20.

Ito, M., and S. Urata. 1998. "Chushokigyo to hushokigyo enjoseisaku (2): 3 sanchi no hikaku chosa (Small and Medium Enterprises and Policy Toward Them)," *Keizaigaku Ronshu* 64(4):49–73.

Jaffe, A., M. Trajtenberg, and R. Henderson. 1993. "Geographic Localization of Knowledge Spillovers as Evidence by Patent Citations." *Quarterly Journal of Economics* 63:577–98.

JICA. 1992, *Nihonno jibasangyo shinkoseisaku kenkyu* (Research on Japan's Policy Toward Regional Clusters). Tokyo: Japan International Cooperation Agency .

Koike, K. 1988. *Understanding Industrial Relations in Modern Japan*. New York: Macmillan.

Krugman, P. 1991. *Geography and Trade*. Cambridge, Mass.: MIT Press.

Marshall, A. 1920. *Principles of Economics*. New York: Macmillan.

MITI. 1996. "Sangyo shuseki fudoki (Industrial Localization)." An interim report. Ministry of International Trade and Industry, Tokyo.

Mishina, K. 1993. "Tombow Pencil Co., Ltd.." Harvard Business School Case, 9-692-011. Harvard University, Cambridge, Mass.

Morikawa, M. 1997. "Machinery Industry and Regional Economic Growth: Factors in the Economic Development of Japan's Prefectures." *Tsusankenkyu Review* 10(December):64–90. [In Japanese.]

Odagiri, H. 1992. *Growth Through Competition, Competition Through Growth: Strategic Management and the Economy in Japan*. New York: Oxford University Press.

People's Finance Corporation 1987. *Endaka de yureru jibasangyo (Regional Clusters Under the Appreciation of Yen)*. Tokyo: Small and Medium Enterprise Research Center.

People's Finance Corporation 1995, *Tenki wo mukaeta chiikikeizai: kawaru jibasangyo no yakuwari (Regional Economies Under Transition: Changing Roles of Regional Clusters)*. Tokyo: Small and Medium Enterprise Research Center.

Porter, M. 1998. "Clusters and the New Economics of Competition." *Harvard Business Review*. 76(November–December):77–90.

Porter, M. 1990. *The Competitive Advantage of Nations*. New York: Free Press.

SMEA. 1997. *Zenkoku no sanchi: heisei 8 nendo sanchi gaikyochosa kekka (Japan's Industrial Clusters: The 1996 Survey Result)*. Tokyo: Small and Medium Enterprise Agency.

Uekusa, M. 1987. "Industrial Organization." In K. Yamamura and Y. Yasuba, eds., *The Political Economy of Japan*, Vol. 1: *The Domestic Transformation*, Stanford, Calif.: Stanford University Press.

Yamawaki, H. 1992. "International Competition and Japan's Domestic Adjustments." In K. Anderson, ed., *New Silk Roads: East Asia and World Textile Markets*, Cambridge, U.K.: Cambridge University Press.