

3

Iron Town Cluster: Yawata, its Glory, Decline and Rebirth

Mitsuhiro Kagami

1. INTRODUCTION

Basic questions in this paper are why a certain location is attractive to firms while others are not and why firms form industrial agglomerations. To find answers to these questions traditional heavy industries are focused upon because these industries have long histories that possibly can provide some traceable factors to help explain industrial cluster formation.

The iron and steel industry has a long history in developed countries because of its initial and substantial role in the industrialization process. In Japan one of the first state-owned steel mills was established at Yawata in Kitakyushu City in 1901. Since then the city and the mill (Yawata Works) have shared their fortune together, i.e. rise, glory, fall, and rebirth. By observing this process common factors appertaining to industrial cluster formation can be considered.

The US steel city of Pittsburgh, where the US Steel Corporation was established in the same year as Yawata Works, is briefly examined in order to draw comparisons. In comparing the two cities and steel companies some common as well as different conclusions are realized.

In this chapter, first, Kitakyushu City, which has been home to both heavy and chemical industry clusters from the initial industrial development stage

in Japan, is introduced. The city's destiny has been closely interwoven to changes in the iron and steel industry, including redevelopment and revitalization programs that in recent decades have brought about a bright new future for the city. The more than 100-year history of Yawata Works, which highlights many important facets of Japan's industrialization process, is examined in the third section. The fourth section explains redevelopment projects and new businesses in Kitakyushu City after the steel industry declined. The comparison with Pittsburgh is undertaken in the fifth section and interesting similarities as well as differences with Kitakyushu City are mentioned. Finally, concluding remarks follow.

2. KITAKYUSHU CITY: HEAVY INDUSTRY CLUSTER

Kitakyushu City is recognized as a heavy and chemical industry cluster because of its foundation based on iron and coal.

2.1. Iron and Coal Nexus Cluster

Since the Edo era the Chikuho area produced coal. Production at the Chikuho coalfields peaked at 20.5 million tons in 1940 (see Table 3.1). A state-owned iron and steel mill was established at Yawata (presently called Yawata Works) in 1901 mainly owing to its proximity to the coalfields. Indeed, at first the Yawata Works had its own coalfields at Futase. As a consequence of this coal and iron nexus many industries such as chemicals, metal, machinery, machine tools, cement, sheet glass, railway, shipping, power generation, and banking developed. Although the central role of coal ended during the 1950s being substituted by petroleum, heavy and chemical industries remained in the Kokura and Moji areas, now called Kitakyushu City (see Figure 3.1).

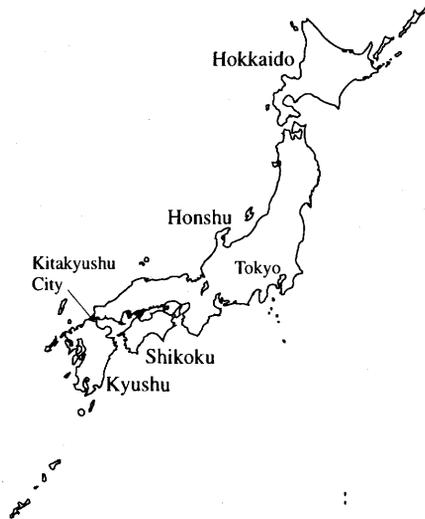
The city's population peaked at 1,068,415 in 1979 but has since declined to around 1.02 million in 1995. The population of Fukuoka City, its neighbor and main rival, passed that of Kitakyushu City in 1980 and reached 1.29 million in 1995. The workforce living in Kitakyushu City peaked at 566,000 in 1965 but decreased to 501,000 in 1995. This decline in the workforce is closely related to the evolution of the iron and steel industry because Yawata Works is seen as the guardian of Kitakyushu City.

Today, many well-known companies such as Yaskawa Electric Co. (robots and electronic products), TOTO Ltd. (bath, kitchen, wash, and restroom products), Mitsui Hightech (plastic molds), Shabondama Soap (soap), Zenrin

Table 3.1: Coal Production at Chikuho Coalfields

Year	Japan (thousand tons)	Chikuho (thousand tons)	Its share (%)
1885	1,293.6	236.0	18.2
1890	2,628.3	787.6	30.0
1895	4,772.7	2,136.6	44.8
1900	7,471.7	4,017.5	53.8
1905	11,637.2	5,804.1	49.9
1910	15,681.3	7,811.0	49.8
1915	20,490.7	8,769.6	42.8
1920	29,245.4	11,689.7	40.0
1925	31,459.4	12,746.8	40.5
1930	31,366.0	11,467.5	36.6
1935	37,762.0	14,988.0	39.7
1940	56,313.0	20,490.0	36.4
1945	22,334.5	7,177.5	32.1
1950	39,330.0	12,757.0	32.4
1955	42.5	12.8	30.1
1960	52.6	13.6	25.9
1965	50.1	8.5	17.0
1970	38.3	4.4	11.5

Source: Kitakyushu City [1998]. *Industrial History of Kitakyushu City* (in Japanese).

Figure 3.1: Map of Japan

Co. (residence maps and maps for car navigation), and Sankyu Co. (transport) are located in this area. Moreover, Nissan Motor Co. and Hitachi Metals have their roots here in the Tobata Foundry established by Yoshisuke Aikawa, founder of the Nissan Konzern, in 1910.

Why did Kitakyushu City form this industrial cluster? A simple explanation comes from the classic Marshallian trinity of external economies. First of all, the area was well endowed with natural resources such as coalfields and harbors — coal being essential for making steel, while steel has strong forward linkages for other manufacturing industries as an input. Production of coal and steel was supported by steady demand due to government-led modernization and catch-up policies. Local governments were also keen to foster manufacturing industries and knowledge spillover worked as industries agglomerated. Moreover, large-scale capital goods industries such as the iron and steel industry have by themselves scale merits. This meant that the agglomerated area as a whole could benefit from increasing returns to scale. Thus, this area enjoyed good industrial performance in terms of employment, especially, during the 1960s (see Table 3.2).

Why has this area faced difficulties? From the fifties onwards various factors conspired to change Kitakyushu's status. Yawata Iron & Steel Co. decided to disperse operations by constructing giant new steel mills closer to other areas of demand (for example, Hikari, Sakai and Kimitsu, i.e. 'distance matters') and many skilled workers were relocated away from Yawata Works to those new production centers. The decline of the coal industry due to substitution by petroleum also delivered a blow to the region. Moreover, external diseconomies such as pollution and environmental destruction also created centrifugal forces, particularly during the 1970s. Finally, overall declines in demand caused by the two oil shocks and severe competition in steel production from newly industrialized countries such as Korea and Brazil accelerated the process.

2.2. Restructuring toward New Businesses

As iron and steel production in Kitakyushu waned, mainly due to construction of new mills elsewhere and severe pollution, the city had to find a way to reform its industrial structure particularly from the 1980s on. To this end, four routes to the future were outlined: (1) knowledge intensive industries; (2) pollution-free ecological approaches; (3) international distribution center; and (4) agglomeration of automotive industries.

Not only the steel industry but also other industries in the Kitakyushu

Table 3.2: Industrial Census, Kitakyushu City

Year	Establishment (units)	Employment (persons)	Wage and Salary (millions of yen)	Shipping Amount (millions of yen)
1963	2,195	135,241	276,105.6	931,217.2
1964	2,100	132,757	304,406.3	1,120,039.5
1965	2,075	129,605	306,414.4	1,102,192.2
1966	2,266	128,676	311,083.6	1,149,882.6
1967	2,197	128,586	339,066.5	1,363,010.5
1968	2,169	126,104	357,976.6	1,455,917.3
1969	2,450	130,292	389,268.1	1,579,173.6
1970	2,412	127,520	407,565.7	1,816,969.6
1971	2,365	124,546	435,560.6	1,958,642.4
1972	2,748	124,552	450,637.4	1,843,852.4
1973	2,681	123,409	470,819.0	1,880,770.7
1974	2,635	120,197	484,789.3	2,052,461.3
1975	2,819	119,270	496,579.3	2,013,763.8
1976	2,703	112,626	471,214.2	2,002,179.5
1977	2,646	105,969	460,093.6	2,162,477.1
1978	2,772	102,803	440,469.1	2,100,592.1
1979	2,647	100,547	439,968.5	2,154,458.4
1980	2,607	95,150	433,825.6	2,311,633.7
1981	2,082	94,890	436,300.5	2,372,680.2
1982	2,011	92,699	421,262.3	2,353,587.3
1983	2,849	93,138	421,873.5	2,193,276.1
1984	1,927	89,205	432,443.1	2,300,296.8
1985	2,689	89,140	427,218.9	2,435,895.1
1986	1,973	88,530	432,829.9	2,253,570.8
1987	1,880	84,051	407,578.8	2,085,577.7
1988	2,743	82,789	410,029.0	2,226,352.1
1989	1,847	81,908	415,218.7	2,257,812.9
1990	2,724	83,238	397,218.4	2,298,857.3
1991	1,929	84,484	406,684.8	2,455,126.8
1992	1,873	82,393	394,051.5	2,353,984.3
1993	2,668	82,676	391,705.9	2,216,965.2
1994	1,745	76,515	388,969.1	2,125,055.7
1995	2,502	75,932	385,514.7	2,185,270.6
1996	1,640	72,539	407,608.7	2,235,219.2
1997	1,731	72,862	389,907.9	2,315,964.9

Note 1: "Employment" indicates that permanent employees + individual entrepreneurs with family employees.

2: "Wage and Salary" indicates that wages and salaries at constant prices (CPI: 1995 = 100).

3: "Shipping Amount" at constant prices (WPI: 1995 = 100).

Source: Industrial Census, various issues.

area had accumulated industrial and managerial knowledge from agglomeration that could be utilized for creating new ideas and businesses. Realizing that research and development (R&D) activities were essential, the city government emphasized R&D and technical assistance and invited universities as well as research institutes from private companies to locate there. Successful examples of this policy were the establishment of the Kitakyushu International Techno-cooperative Association (KITA) in 1980, Techno-parks and the Technocenter in 1990, and the plan for the development of the Kitakyushu Academic Research Promotion City in 1996.

Yawata Works paid enormous amounts of money for environmental protection, especially, during the 1970s and both Yawata Works and the city government promoted forestation of old factory areas (brownfields) and the city itself. In addition, recycling of industrial waste, particularly, plastics and office automation (OA) machinery was intensely targeted, and the city allocated reclaimed land for this purpose. The declaration of Kitakyushu City as an 'eco-town' or ecology town was announced in 1997.

This new approach extends value chains from normal production and sales to recycling and rebuilding activities, i.e. including both 'artery' and 'vein' industries and hence increases new business opportunities.

Owing to its geographical position Kitakyushu has historically had contacts with Korea, China, and East Asian countries. Taking advantage of its good position regarding sea routes the city launched a major container port plan, called the Hibikinada Hub Port Initiative in 1996 in order to contribute to international logistics and benefit from China's emergence as a world economic power.

Lastly, this area is now attracting the automotive industry. Nissan expanded its Kanda factory in the vicinity of Kitakyushu City and Toyota opened the new Kyushu plant near Fukuoka City during the 1990s. These moves influenced parts and component makers to transfer their factories to this area. These centripetal developments are explained by the existence of an accumulated technology base and a high industrial knowledge and skill-based workforce in the region. Good port facilities — easy delivery of parts and components and shipping out of final products — are another advantage. Indeed, the very centrifugal forces that had convinced Yawata Iron and Steel Co. to downsize in Kitakyushu in favor of locating new mills in Honshu (central Japan) were viewed in reverse by the recent automakers. Because Honshu (see again Figure 3.1) is congested in terms of transport cost and labor shortages, the auto industry decided to move into the Kyushu area. Recent IT developments supported this tendency as information can

be easily exchanged between the headquarters and local plants through Internet conferencing.

3. HISTORY OF YAWATA WORKS

The modern history of Kitakyushu City and Yawata Works are inseparable because the two have walked hand in hand for over 100 years. Indeed, the company's evolution and decline has mapped out the City's destiny so it is worthwhile here to sketch out the company's history.

3.1. Yawata Works

In 1970 two giant steel makers, Yawata Iron and Steel Co. and Fuji Iron and Steel Co. merged to create Nippon Steel Corporation (NSC). As of April 2002 NSC has 25,229 employees, capital of 419,524 million yen (approximately 3.5 billion US dollars), and sales of 1,681,406 million yen (14.0 billion US dollars). NSC has 10 plants in Japan: Muroran Works, Kamaishi Works, Tokyo Works, Kimitsu Works, Nagoya Works, Sakai Works, Hirohata Works, Hikari Works, Oita Works, and Yawata Works (Yawata Works [2002]). Except for Kamaishi, Yawata Works has the longest history because it started as a state-owned iron and steel company in 1901.

In 2001 Yawata Works in Kitakyushu City produced 3.21 million tons of crude steel, 3.55 million tons of steel products, and had 3,703 employees. Its products include hot rolled sheet, electrical sheet, cold rolled sheet, hot-dip-galvanized sheet, electro-galvanized sheet, alsheet, terne sheet, tinplate, tin-free steel, spiral pipe, rail, sheet pile, shape, and stainless steel plate. Yawata Works used 5,257 thousand tons of imported iron ore with 3,142 thousand tons of imported coking coal to produce crude steel. About 60% of iron ore and 58% of coal came from Australia. Yawata Works consists of two sites: Tobata and Yawata. At the Tobata site, one blast furnace is working to produce hot rolled sheets, cold rolled sheets, coated sheets and spiral pipes. Stainless heavy plates, rails, steel sheet piles and shapes, and electrical steel sheets are produced at the Yawata site. At its peak in the mid-1960s Yawata Works produced 9 million tons of crude steel, and employed around 43,000.

3.2. Selection of the Factory Site

When the Meiji Government decided to construct a state-owned iron and steel enterprise, four factors were considered: (1) defense reasons; (2) proximity to raw materials; (3) port and its facilities; and (4) laborers. Iron and steel production was very important for industrialization under the slogan ‘strengthen wealth and military power.’ Thus, the factory should be safe from military attack. And, as steel production needs coal and iron ore, the factory should be near those supplies. If materials were to come from foreign countries, a good port was necessary. Moreover a port was also required to ship steel products for domestic as well as foreign demand. Lastly, production needs skillful workers from an abundant labor pool. Fulfilling these conditions three candidates were chosen: Sakamura in Hiroshima Prefecture, Moji in Fukuoka Prefecture, and Yawata in Fukuoka Prefecture (Nippon Steel Corporation [2001]).

In 1896 the government finally decided on Yawata as the mill site because (1) Yawata is situated at the inside of Dokai Bay which is deeply cut into the land and so difficult to attack; (2) the proximity of the Chikuhō coalfields, one of the country’s largest in those days; (3) the port facilities could be utilized and easily expanded; and (4) a large available industrially trained workforce due to the nearness of the coalfields and other existing businesses. At first the use of iron ore from Akatani in Niigata Prefecture was planned but this was soon canceled owing to delays in mining development and instead ore from Daye along the Yangtze River in China was imported. Regarding coal, the Futase, Miike, and Takashima mines in the Chikuhō area supplied coking coals. The first blast furnace at Higashida was blown in 1901, starting the first integrated iron and steel works in Japan.

Technologies, especially, blast furnace technologies came from Germany. Yawata Works invited German engineers and technicians to set up and kindle the first blast furnace. It was said that the salary of one of the technical advisers was double that of Japan’s prime minister. Several Japanese workers were also sent to Oberhausen to learn steel making technologies as well as maintenance skills.¹

Because of the government’s push to industrialize the country and strengthen military power demand for iron and steel was very strong. The Russo-Japanese War (1904-05) also gave impetus to this demand. Yawata Works had three consecutive expansion plans: first, in 1906; then in 1911; and finally in 1917. Completion of the sixth blast furnace at Higashida in

Table 3.3: Brief History of Yawata Works

Year	Events at Yawata and Tobata sites	Related issues	
1897	Yawata village was officially chosen as a public steel mill site.		
1901	The first blast furnace at Yawata (Higashida) started operation.	US Steel was established.	
1905	The second blast furnace at Yawata (Higashida) started operation.		
1906	First expansion plan		
1909	The third blast furnace at Yawata (Higashida) started operation.		
1911	Second expansion plan (steel products 300,000 t/year).		
1914	The fourth blast furnace at Yawata (Higashida) started operation.		
1917	Third expansion plan (steel products 650,000 t/year).		
1918	The fifth blast furnace at Yawata (Higashida) started operation.		
1921	The sixth blast furnace at Yawata (Higashida) started operation.		
1924	The third blast furnace at Tobata started operation.		
1930	The first blast furnace at Yawata (Kukioka) started operation.		
1933	The second blast furnace at Yawata (Kukioka) started operation.		
1934	Six steel companies including Yawata Works were merged to form Japan Steel Co. (up to 1950).		
1937	The third blast furnace at Yawata (Kukioka) started operation.		
1938	The fourth blast furnace at Yawata (Kukioka) started operation. This furnace was domestically produced with capacity of 1,000 t/day.		Pacific War 1941-45
1947	Reproduction started.		
1948	Production Five-year Plan		

(continued)

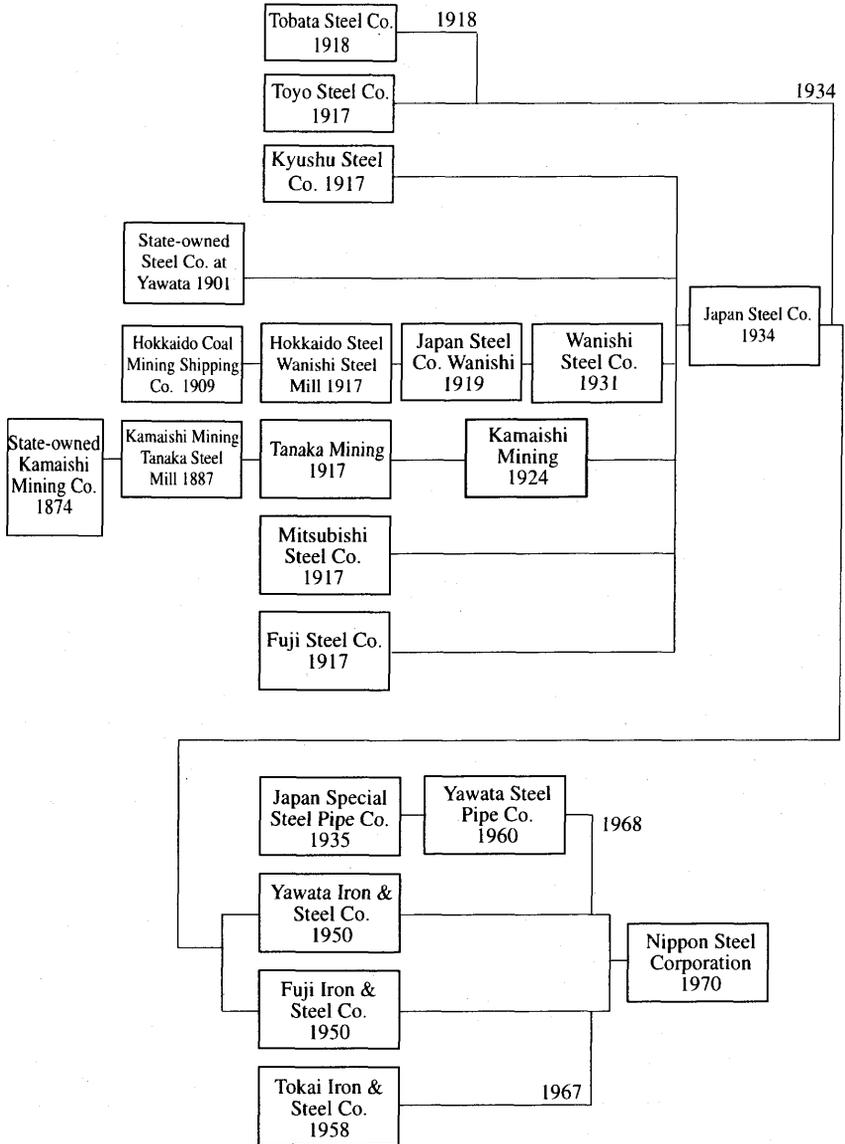
Year	Events at Yawata and Tobata sites	Related issues
1950	Japan Steel Co. was dissolved into four private companies including Yawata Iron & Steel Co. Ltd. The second blast furnace at Yawata (Kukioka) kindled. The fourth blast furnace at Yawata (Higashida) kindled. Modernization Plan for Production Facilities	Korean War 1950-53
1951 1955	The first blast furnace at Yawata (Higashida) kindled.	Hikari Works of Yawata Works began operation.
1959	The new first blast furnace (integrated iron and steel production) at Tobata kindled, scrapping two old ones.	
1960	The second blast furnace (1,500 t/day) at Tobata kindled.	
1961	IBM computers 7,070 and 1,401 were introduced.	Sakai Works of Yawata Works began operation.
1962	The third blast furnace (2,000 t/day) at Tobata kindled.	First blast furnace kindled at Usiminas (Brazil).
1963		Kitakyushu City was born.
1966		Kasumigaseki bldg. (36F) was built.
1967		Malayawata (Malaysia)'s blast furnace kindled.
1968	Pollution Control Committee formed.	Kimitsu's first blast furnace kindled. Announced voluntary export restraints of steel against the US.
1969	Production Master Plan. Yawata Works recorded 100 million tons of pig iron.	Kimitsu's second blast furnace kindled.
1970	Yawata and Fuji were merged to form Nippon Steel Corporation (NSC).	
1972	First and sixth blast furnaces at Yawata (Higashida) extinguished. The fourth blast furnace at Tobata kindled. Tobata strip mill recorded 10 million tons of cold-rolled steel sheet in terms of accumulated figure from the start of operation.	
1973	Factory Forestation Agreement with Kitakyushu City concluded. Thick plate on-line system was introduced. Japan's crude steel production recorded 120,017,000 tons.	First oil shock. First blast furnace of Pohang Steel (Korea) kindled.

(continued)

Year	Events at Yawata and Tobata sites	Related issues
1976	Reconsideration of the Production Master Plan including production reduction and concentration into the Tobata area.	
1977	Seamless pipe production started.	
1978	All blast furnaces at the Yawata area extinguished. Two blast furnace system (first and fourth at Tobata) was established.	Agreed to assist the construction of Shanghai Baoshan Steel Co.
1979		Second oil shock.
1984	Accumulated pig iron production reached 200 million tons.	
1985		Plaza Accord (Yen appreciation).
1986	The lowest production of crude steel (25.5 million tons) by NSC was recorded.	
1987	Mid-term Management Plan (24 million t/y by NSC against 90 million tons of all Japan's crude steel production. Regarding blast furnace, one at Yawata, two at Nagoya, three at Kimitsu, and two at Oita while closing Sakai and Hirohata).	
1988	The fourth blast furnace extinguished only one remained at Tobata.	
1990	New strip mill producing cold-rolled steel sheet started operation. Theme park 'Space World' was opened.	
1995	All products got ISO 9,000 series.	
1997	Accumulated seamless pipe production reached 10 million tons. Accumulated pig iron production reached 250 million tons.	City started 'Kitakyushu Eco-town project.'
1998	Nishi-nihon (West Japan) PET Bottle Recycle Co. started operation. The first blast furnace at Tobata was closed and the fourth operation restarted after renovation.	
1999	Obtained ISO 14,001.	
2000	Nishi-nihon (West Japan) Auto Recycle Co. started operation.	
2001	New cold rolling mill for electrical steel sheets began operation. Withdrew from seamless pipe production.	Alliance with Sumitomo Metals and Nisshin Steel for stainless steel.
2002	Joint-venture with Shanghai Baoshan Steel announced, producing steel sheets for automobile in China. Waste plastics recycling facility began operation.	NSC with Sumitomo Metals and KOBELCO in terms of stock and management.

Source: Compiled from Nippon Steel Co. [2001]. *Beyond Century: One Hundred Years of the Yawata Works*, and its CD-ROM.

Figure 3.2: Evolution of Major Steel Companies in Japan



Note: In addition to Nippon Steel Corporation, there exist Kobe Steel Ltd. (KOBELCO), Sumitomo Metal Industries Ltd., JFE (Kawasaki Steel Co. and NKK Corporation), and Nisshin Steel Co. in 2002.

Source: As for Table 3.3.

1921 was one of the highlights of the third expansion plan (see Table 3.3).

However, the Great Depression in 1929 seriously affected world economies and iced demand for iron and steel. Private iron and steel companies faced severe difficulties and finally in 1934 Yawata Works and five other companies merged creating the Japan Steel Corporation (Figure 3.2). Yawata Works itself recorded the highest crude steel production of 250,000 tons per year at Higashida in 1935.

World War II devastated the Japanese economy. The first US air raid targeted Yawata in 1944 and severely damaged Yawata Works. Japan had to reconstruct its economy from ashes after defeat in 1945.

3.3. Success and Japan's Economic Rise

Along the General Headquarters (GHQ) guidance, Japan's large companies (*zaibatsu*) were divided or dissolved. Japan Steel Co. was also divided into four private companies. Thus, Yawata Iron & Steel Co. was reborn in 1950. The government took a short-cut policy to quickly reconstruct its economy due to severe shortages in coal, the so-called 'slope production method' or 'two-sector priority production method.' That is the strengthening of the coal and steel industries were given priority. All available economic resources were earmarked for the two industries. Imported petroleum was preferentially forwarded to the iron and steel industry whose subsequent output was channeled into the coal industry. Next the increased production of coal was preferentially re-circulated back to iron and steel. This priority treatment of the two industries resulted in output surplus that later went to other industries (Kagami [2001]).

The Korean War in 1950-53 vitalized Japan's economy through special war procurements and maintenance purposes, especially, for iron and steel. Because of its proximity to the Korean Peninsula, Kitakyushu worked as a base for this war-related demand. This economic buoyancy accelerated expansion and modernization of Yawata Works' facilities. The Production Modernization Plan started in 1950. Old facilities were scrapped and new ones installed. This plan continued until 1955 extending the original plan for two more years. In 1957 construction of a brand new integrated iron and steel mill started at the Tobata site on reclaimed land with modern port facilities. The first new blast furnace at Tobata started operation in 1959, replacing two old ones.

During the 1950s, the government pushed 'targeted' industries by providing tax and lending incentives. These were called 'industrial policies.'

Such industries as iron and steel, coal, shipbuilding, synthetic fiber, and chemical fertilizer were chosen as targeted industries.

Prime Minister Hayato Ikeda launched the 'Doubling National Income Plan 1961-70' in 1960 and the government set an objective for trade liberalization as shown in the 'Outline Program for Liberalization of Trade and Foreign Exchange' approved in the same year. The acceptance of obligations under Article 8 of the IMF and entry into the OECD in 1964 finally committed Japan to keep an open international economic system.²

Japan experienced handsome growth rates in this period. The average annual rate of growth of real GDP recorded 9% between 1961 and 1972. While industrial structure widened as well as deepened and exports expanded. For example, in 1964, the Tokaido Shin-kansen (bullet train) started operation; the Tokyo Metropolitan Highway opened; and the Tokyo Olympic Games were held. The first high-rise office building (36 stories) was constructed in the central part of Tokyo in 1967, called Kasumigaseki Building, for which Yawata Works provided H-shaped bar steel that effectively absorbed earthquake trembles.

Yawata Works recorded crude steel shipments at 100 million tons in 1965. In order to respond to increased demand for iron and steel, especially, in the largest demand area, i.e. Tokyo Metropolitan area and its vicinity, Yawata Works decided to construct a mammoth steel mill at Kimitsu in Chiba Prefecture in 1967. Two blast furnaces were constructed by 1969, making Kimitsu Works the most newly equipped iron and steel mill in the world. Almost half of the workers at Kimitsu came from Yawata Works.

In 1970 Nippon Steel Corporation (NSC) was born combining two giant companies, Yawata Iron & Steel Co. and Fuji Iron & Steel Co. albeit facing some opposition, particularly, from the Fair Trade Commission side (see again Figure 3.2). It was said that the iron and steel industry enjoyed its most prosperous period between 1965 and 1980 with global supremacy in terms of cost and quality. However, some negative characteristics had already started to appear to cloud its glory.

3.4. Decline and its Factors

Factors which negatively affected iron and steel production are summarized into three: (1) demand shift caused by oil price hikes, so-called oil shocks; (2) trade friction due to Japan's over-presence in international markets; and (3) environmental destruction because of rapid and large-scale industrialization.

The first oil shock in 1973 was a memorable year for Japan. The economy fell into minus growth in 1974 for the first time in postwar history. Such energy-intensive industries as iron and steel, nonferrous metal, chemicals and paper and pulp declined to the point of depression while the automotive and electronics industries barely survived due to their relatively light energy requirements and in-house efforts to save/substitute energy. The second oil shock in 1979 further accelerated energy saving and energy substitution technologies. For example, the automotive and electronics industries required lighter materials such as aluminum and plastics instead of iron and steel. Demand was irrevocably changed due to these oil shocks.

Japan's crude steel production peaked in 1973 reaching 120 million tons. Production never again exceeded this peak although it remained around the 100 million ton mark up to 2000 (see Table 3.4).

Another negative factor was Japan's participation in the world economy. Capital liberalization, which began in 1967, finally reached full liberalization in July 1972. Coupled with the yen appreciation that followed the collapse of the Smithsonian monetary system in 1971 (so-called 'Nixon shock'), Japan's foreign direct investment expanded four times between 1971 and 1973, reaching 3.5 billion US dollars. Japan's participation in the international economy in terms of both trade and investment created new problems: trade friction and/or trade imbalances with other countries. For example, the US claimed that the Japanese textile and iron and steel industries dumped products below fair market value.

Japanese steel exports to the US increased rapidly from 4.5 million tons in 1967 to nearly 7 million tons in 1968. In response to US criticism, Japan carried out 'voluntary export restraints (VER)' from 1969 to 1974. Later, the US imposed the 'trigger price' system³ on steel imports from Japan in 1978.

Negative aspects of industrialization were also taken into account. Rapid industrialization during the 1960s led to increased levels of pollution and environmental destruction. By the late 1960s, problems such as smog and water pollution (for instance, the so-called 'Minamata disease' caused by mercury poisoning at Minamata Bay in Kumamoto Prefecture) forced the government to acknowledge and address these external diseconomies.

Accordingly, the government announced the Basic Act for the Prevention of Public Nuisances in 1967 to fight against pollution and other negative effects of industrialization. Related laws and ordinances were soon passed and addressed problems such as water pollution (1966), noise pollution (1968), and air pollution (1968).

Table 3.4: Crude Steel Production and Employees of Yawata Works

(Unit: Thousand tons, Persons)

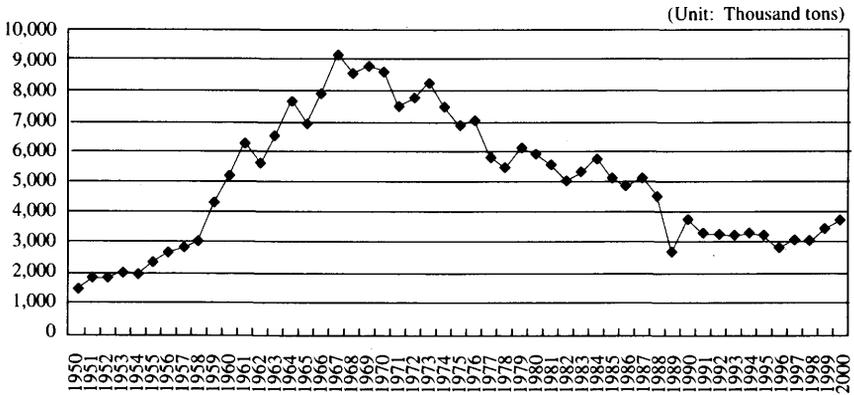
Year	Japan	Nippon Steel Co.	Yawata Works	Employees of Yawata Works
1950	5,298	2,335	1,466	35,038
1951	6,782	3,136	1,816	37,087
1952	6,912	3,165	1,815	36,729
1953	8,033	3,474	1,999	35,431
1954	7,875	3,492	1,929	34,578
1955	9,791	4,247	2,361	33,697
1956	11,678	4,785	2,673	33,237
1957	12,309	4,946	2,822	33,524
1958	12,773	5,372	3,064	33,988
1959	18,247	7,341	4,336	37,027
1960	23,161	8,889	5,197	37,326
1961	29,399	11,141	6,271	39,893
1962	27,250	10,064	5,602	42,220
1963	34,080	12,091	6,523	43,666
1964	40,532	14,381	7,689	39,677
1965	41,296	14,917	6,889	37,705
1966	51,898	18,678	7,943	36,235
1967	63,777	22,734	9,166	34,577
1968	68,987	24,400	8,587	32,486
1969	87,026	31,098	8,794	30,030
1970	92,406	32,982	8,651	27,624
1971	88,441	29,971	7,496	26,364
1972	102,972	35,369	7,757	24,917
1973	120,017	40,989	8,301	23,757
1974	114,035	36,899	7,490	22,847
1975	101,613	32,293	6,887	21,575
1976	108,326	34,394	7,047	20,554
1977	100,646	31,655	5,869	19,932
1978	105,059	31,994	5,470	19,116
1979	113,010	33,582	6,152	18,207
1980	107,386	31,683	5,967	17,202
1981	103,029	29,970	5,585	16,404
1982	96,299	27,050	5,104	16,267
1983	100,200	27,727	5,374	15,885
1984	106,470	29,596	5,835	14,905
1985	103,758	27,980	5,161	14,692
1986	96,379	25,566	4,917	13,797
1987	101,877	27,142	5,259	13,547
1988	105,656	28,217	4,608	12,261
1989	108,139	28,361	2,738	11,373
1990	111,710	28,992	3,852	10,472
1991	105,853	27,686	3,361	9,958
1992	98,937	25,319	3,351	9,838
1993	97,095	25,122	3,311	9,586
1994	101,363	26,564	3,383	9,199
1995	100,023	26,172	3,307	8,195
1996	100,793	25,705	2,911	7,292
1997	102,800	26,618	3,191	6,180
1998	90,979	23,200	3,132	4,900
1999	97,999	25,620	3,570	4,351
2000	106,901	27,838	3,799	3,873

Source: As for Table 3.3.

3.4.1. Response of Yawata Works

As far as Yawata Works is concerned, crude steel production had a declining tendency after the 1960s. Ten-year average crude steel production of Yawata Works increased from 2.4 million tons in the 1950s to 7.3 million tons in the 1960s but decreased to 7.1 million tons in the 1970s, 5.1 million tons in the 1980s, and went further down to 3.3 million tons in the 1990s⁴ (see Figure 3.3). Actually, the maximum production was recorded in 1967 at 9,166 thousand tons and since then it gradually decreased. The lowest point was 2,738 thousand tons in 1989. The last couple of years of the century showed a slight upward trend to 3,799 thousand tons in 2000.

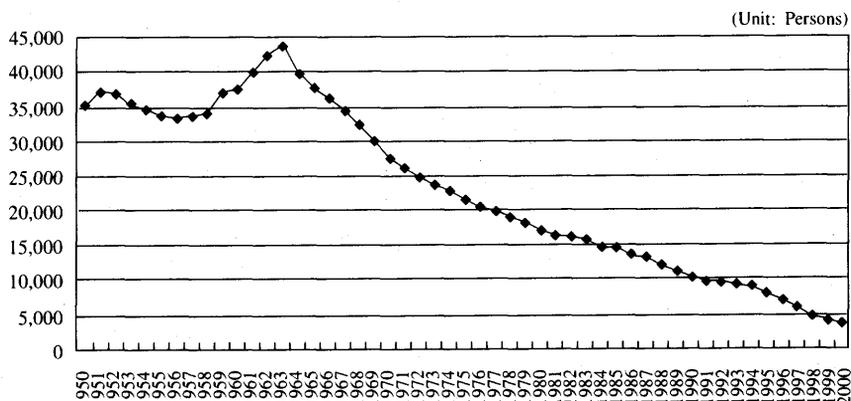
Figure 3.3: Crude Steel Production of Yawata Works, 1950-2000



Source: As for Table 3.3.

Several reasons are given for this decrease in Yawata's position. First, NSC diversified production sites opening new mills near marketing areas. For example, Hikari Works near Hiroshima was opened in 1955 and between 1954 and 1969 around 1,270 personnel were transferred to that site from Yawata Works. In Sakai Works near Osaka (1961), about 2,940 personnel were moved between 1960 and 1969. The largest move however took place at Kimitsu Works near Tokyo (1965), accounting for 4,173 personnel being transferred between 1964 and 1975. Therefore, the share of Yawata Works in total NSC production declined from more than 55% during the 1950s to around 13% during the 1990s.

Employment figures show more dramatic drops. In its peak year (1963) Yawata Works employed 43,666 but since that time the number decreased

Figure 3.4: Number of Employees at Yawata Works, 1950-2000

Source: As for Table 3.3

drastically falling to 3,873 in 2000 (see Figure 3.4). This radical shift in the fortunes of Yawata is explained by changes in production site location as mentioned above and the company's efforts to increase labor productivity but a general decline in demand for iron and steel also played a part.

However, yet another reason was that NSC's competitors both in and outside of Japan gained ground. Iron and steel makers such as Kawasaki Steel Corporation, Kobe Steel Ltd., NKK Corporation, Sumitomo Metal Industries Ltd., and Nisshin Steel Co. gradually expanded production capacity and encroached on the traditional leader. NSC now accounts for around 26% of crude steel production in Japan as compared with more than 45% in the glory years.

It is also a little ironic that NSC assisted in the establishment of iron and steel mills in developing countries in the past as some of the fledgling firms that NSC helped get started are now serious competitors in the world market. The Japanese government set up a joint venture to establish USIMINAS (Minas Gerais Steel Mill) in Brazil and NSC played a major role in its establishment in terms of technology and management at the beginning of the 1960s. In the cases of Malayawata in Malaysia, Pohang Steel in Korea, and Shanghai Baoshan Steel in China, NSC also assisted in setting up blast furnaces and training workers. As a result, especially, Pohang Steel has become one of the world largest iron and steel producers.

Consequently, all blast furnaces in the Yawata area are extinguished. Yawata Works had to concentrate its iron and steel making divisions into the Tobata area, keeping two blast furnaces in operation in 1978. By 1988

only one blast furnace remained in operation, symbolizing the near-death of a town that now lives in its past glory.

3.4.2. *Environmental Protection*

During the 1950s and 1960s, black smoke and dirty drainage were symbols of an iron town. People suffered from asthma because of photochemical smog and insomnia or hearing difficulties because of noise. Owing to national as well as city government regulations against such pollution and environmental destruction, Yawata was forced to adopt several measures. For example, it attached smoke extraction apparatus for desulfurization of soot and smoke.

The company was required to spend heavily on environmental protection due to its noise and industrial waste emissions. In the peak year (1974) it spent 21,260 million yen (approximately 177 million US dollars) for such protective measures as clean air (18,320 million yen), anti-noise devices (2,390 million yen), and clean water (550 million yen). The accumulated amount between 1963 and 2000 reached 92,999 million yen (approximately 775 million US dollars) (air 69,463 million yen or 74.7%; water 16,314 million yen or 17.5%; and noise 7,222 million yen or 7.8%) (NSC [2001]).

In 1973 Yawata Works concluded a Factory Forestation Agreement with Kitakyushu City. Since then Yawata Works has planted trees and flowers in factory yards and expanded park areas to promote a clean and comfortable atmosphere.

4. REVIVAL OF THE CITY

After the bubble economy burst a lengthy recession covered Japan in the 1990s. Many local governments faced difficulties, suffering from severe fiscal deficits. Municipal governments also had to tackle these difficulties and create new development plans for future prosperity. Although total demand for iron and steel did not decrease Yawata Works faced severe complications in order to survive and new ideas and breakthroughs were desperately needed.

4.1. Role of the City Government

The Kitakyushu City government created new ideas and plans to challenge these difficulties under Mayor Koichi Sueyoshi (1987-present). They are

summarized as follows (Kitakyushu City [1998]):

- Kitakyushu Technoparks and Technocenter (1990)
- New Kitakyushu International Airport (starting construction in 1994 and finishing in 2005)
- Plan for Kitakyushu Academic Research Promotion City (1996)
- Hibikinada Hub Port Initiative (1996)
- Asia-Pacific Import Mart (AIM) and Kitakyushu International Distribution (KID) Center (1996)
- Kitakyushu Eco-town Project (1997)
- Special Free Zone for International Distribution (2002)

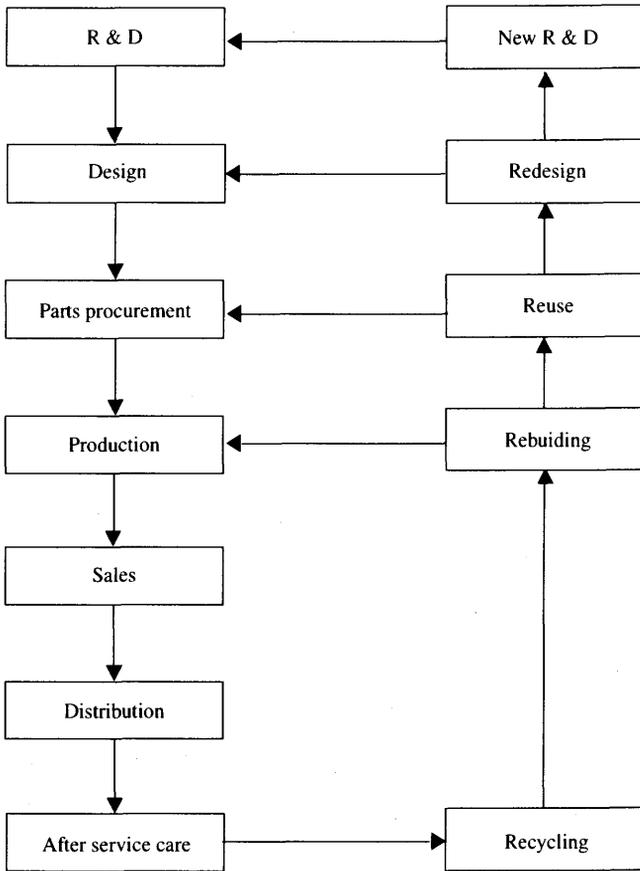
Among them, the Hibikinada Hub Port Initiative and Kitakyushu Eco-town Project seem very important.

The port of Kitakyushu (Moji, Shin-Moji, Wakamatsu, etc.) handled 86 million tons of cargo including both foreign and domestic trade (export + import) in 2001 according to Kitakyushu Port and Harbor Bureau [2002], ranking it seventh in Japan (Chiba, Nagoya, Yokohama, Kawasaki, Mizushima, and Osaka). Container cargo volume was 387 thousand TEU in 2001. Principal trading partners for container cargo were China (42%), Taiwan (20%), Korea (15%), Hong Kong (5%), and Thailand (3%).

Because of the heavy trade with neighboring countries the city decided in 1996 to construct a large-scale container port, Hibikinada, which has a 43 ha container yard on reclaimed land (total 2,000ha). Port facilities if completed in 2003 include two berths with a depth of 15m and two berths with a depth of 10m, accommodating handling capacity of 500,000 TEU.

Kitakyushu Eco-town Project⁵ started in 1997 is a recycling cluster which includes the recycle, reuse and rebuilding of PET bottles, electronic machines (personal computers, printers, copy machines, electric home appliances, etc.), and automobiles on reclaimed land. This is described as 'vein industries' as against 'artery industries' that are used in normal industrial activities. At present the project covers a 41ha area where around 30 firms and research institutions participate. For example, the capacity of the auto recycle shop is 1,500 cars per month and that for electrical home appliances 4,000 goods per day. The second development phase expands the area to 100ha.

This recycling idea is very interesting, as producers have begun to consider whole supply chains including goods in the post-consuming phase. This extended value chain enriches our notion of industry and produces new business opportunities. From now on consumer-products will be designed for reuse and/or recycling from the outset⁶ (see Figure 3.5).

Figure 3.5: Recycling: Extended Value Chains

4.2. New Businesses by Yawata Works

In the above-mentioned new projects, Yawata Works played a vital role by establishing wholly owned companies or joint ventures. The first Yawata Works project that diversified from steel making was a theme park. Yawata Works decided to transfer all iron and steel making divisions in the Higashida area to the Tobata area in 1978. The idle Higashida area was redeveloped for new urban recreation centers during the 1990s. Yawata Works had an agreement with NASA to construct a theme park on science and space, resulting in the birth of 'Space World' in 1990.

New businesses were set up one after another by Yawata Works, these included six engineering companies, two technical support companies, two vocational schools, two medical facilities, one supermarket, two travel service agencies, four telecommunications and broadcasting companies, one printing company, three estate companies, and six environmental and recycling companies, including the West Japan PET Bottle Recycle Co. (established in 1998) and West Japan Auto Recycle Co. (in 2000). In addition, Yawata Works sells electricity to Kyushu Electric Power Co. by using gas generated from the blast furnace at Tobata.

4.3. Automotive Cluster Island

Kyushu Island has gradually emerged as an automotive agglomeration because major automakers established their assembly plants in Kyushu or near Kyushu. Nissan first invested in Kanda Town just next to Kitakyushu City in 1976 and then expanded its assembly factory in 1992. Honda came to Otsu Town in Kumamoto Prefecture in 1976 assembling motorcycles. Mazda constructed its first assembly factory at Bofu in Yamaguchi Prefecture in 1982 and opened a second plant in 1992. Toyota came to Miyata Town in Fukuoka Prefecture in 1992. Daihatsu plans to start operations in Nakatsu in Oita Prefecture in 2004.

These developments created the incentive for parts and component makers to move into the area and an automotive cluster came into being. It is said that Nissan Kyushu Plant has 66 parts supply makers within Kyushu while Toyota Kyushu Plant has around 50 suppliers west of Hiroshima. Honda Kyushu has 53 suppliers in Kyushu and Mazda's Bofu plant has 28 suppliers in Yamaguchi Prefecture.

Accordingly, Yawata Works faced increased demand for high-tension thin plate steel from the automotive industry. As a result, Yawata Works set up a new cold strip mill and started operation in 1990.

5. COMPARISONS AND NEW DIRECTIONS

There are some similarities between Kitakyushu City and Pittsburgh in the US.⁷ Both cities thrived and declined with the iron and steel industry. Kitakyushu City has Nippon Steel Yawata Works while Pittsburgh has the US Steel Corporation. Both companies established their foundations respectively because of the proximity of materials, especially, coal: the Chikuho coalfields for Yawata Works and the Appalachia coalfields for US Steel.

Both cities suffered from heavy pollution and demand deterioration due to economic changes in the steel industry. Both cities are en route to restructuring. Thus, it is quite interesting to compare the two cities, once called 'smoke towns.'

5.1. Pittsburgh

The city is situated on a sandbank where the Allegheny and Monongahela rivers meet and form the Ohio River in the State of Pennsylvania. After the completion of the Pennsylvania Canal (1843) and the Pennsylvania Railway (1852), the city played the role as the gateway to the West. Many immigrants from Europe came to the city because the Civil War (1861-65) brought an instant boom to the city as special war demands for weapons and munitions appeared. Between 1870 and 1910 the coal and iron and steel industries thrived. The US Steel Corporation was founded in 1901 (the same year like Yawata Works). In the 1920s Pittsburgh was called the 'capital of the world' since it was recognized as a world leading manufacturing center with beautiful Victorian architecture and bustling streets.

World War I and II also stimulated the production of iron and steel and brought huge wealth to the steel industry. However, since the 1950s, the city had faced severe air and water pollution, resulting in it being known all over the US as 'smoke town.' Lots of mills and related plants bankrupted and closed due to the upsurge of steel imports from Europe and Asia since the 1970s. It was said that half the employees of the iron and steel industry were fired and many left the city.⁸

Confronting these problems, Pittsburgh City government adopted several measures including the 'Renaissance Project' (first period, 1945-1969; and second, 1978-1988). The first period emphasized three controls: control of smoke and smog, flood control, and sewage control. The second period put emphasis on redevelopment of old factory sites. Because the steel industry declined many empty mill and plant sites and railway yards were abandoned. Moreover, large tracts of land, polluted by industrial waste including slag, remained. The city undertook a policy to redevelop these areas, known as 'brownfields' as against 'greenfields.' The redevelopment of these brownfield sites included housing projects, construction of parks and recreation facilities, hotels, shopping malls as well as business and cultural centers.

Brownfield sites faced special difficulties because often the land was contaminated by industrial waste such as PCB and asbestos. To eradicate

poisonous materials or seal up the waste took time and money. The city, private companies and community groups tenaciously undertook to remedy this process.

Gradually, the city has recovered and revitalized business activities, particularly in high-tech industries such as information and telecommunications technologies, biotechnologies, and robotics. Now, Pittsburgh has more than 250 software companies employing about 25,000 and is recognized as one of the R&D centers in the US (CLAIR [2002]).

5.2. Changing Actors in Redevelopment

In the case of Pittsburgh, new approaches were adopted for redevelopment and revitalization programs. In particular, non-profit organizations (NPOs) played a vital role in the process. In the center of Pittsburgh there is a tower called 'NPO Tower' where around 60 NPOs are operating. Such NPOs as Sustainable Pittsburgh (environmental urban planning) and PPND (housing and community planning) enthusiastically participated in the redevelopment projects. From the beginning they participate in the discussion and actually gave ideas for urban planning and housing design to the municipal government. Recently NPOs have become more professional than before.

Moreover, Pittsburgh has wealthy foundations such as the Carnegie Foundation, the Heinz Endowment, and the Richard King Foundation that offer money for redevelopment. It is said that there are about 20 such foundations in Pittsburgh. Combined with the city government (Urban Redevelopment Agency of Pittsburgh or URAP), NPOs, and community groups, Pittsburgh has succeeded in revitalizing its industries to transform itself into a 'high-tech town.'

5.3. Differences between Kitakyushu City and Pittsburgh

There are three main differences between the two cities. First, Kitakyushu City is situated along the coastline while Pittsburgh is inland. In the redevelopment stage this difference created the growth difference. Kitakyushu City can expand its land by reclaiming the sea. Hence, Kitakyushu City has more options to develop other industries such as container ports, recycling towns, R&D centers, and even a new airport. Pittsburgh did not have spare land for new businesses to expand into as a result its population has shrunk to almost half that of the 1950s. Growth potential was limited by its location.

Second, Pittsburgh tended to foster more ICT-related high-tech industries together with universities such as Carnegie-Melon University and Pittsburgh University after the fall of the steel industry while Kitakyushu City stuck with manufacturing goods (*'monodukuri'* or making goods), by introducing recycling, reuse and rebuilding goods. Pittsburgh changed to become more service-oriented while Kitakyushu City, in a sense, extended *monodukuri* value chains including recycling along the lines of manufacturing. In comparison, Pittsburgh became a high-tech town while Kitakyushu City became an ecology town.

Third, a new actor emerged in the redevelopment stage in Pittsburgh, that is, NPOs. On the other hand, Kitakyushu City's redevelopment processes did not have such participation maybe because of underdevelopment of NPO and NGO activities in Japan. Such activities with rich participatory foundations cannot be found in Japan because of reasons mentioned above and taxation problems.⁹

6. CONCLUDING REMARKS

We raised the question as to why certain locations attract firms. And why firms agglomerate? Heavy industries as against high-tech or service industries were focused upon in this survey. Traditional heavy industries in Japanese are called *'juko-chodai'* (literally meaning heavy, thick, long, and large) and are now generally considered to be dinosaurs. However, the truth often lies in history and careful observation of these traditional industries show us some simple explanations as to why cluster forming occurs as well as to its adversity.

Several factors that attract firms, especially, the case of iron town clusters are summarized as follows:

- Existence of raw materials is essential. The iron and steel industry needs coal and iron ore, so mills are built near these resources.
- Well-organized infrastructure is needed such as railways, canals, highways, and ports. As the iron and steel industry sometimes needs to import foreign materials, a good port is necessary. This is also true for the shipping of products. In addition, stable supplies of electricity, gas and water are also indispensable.
- A large pool of quality labor is another factor to attract firms.
- A coal and iron nexus invites related industries such as chemicals, metals and machinery industries so that a heavy industry agglomeration is formed.

- Important crossing points in terms of roads, railways, telecommunications, and banking services are also incentive factors for encouraging other industries to come.
- Steel products and chemical materials are used as an input for other industries; i.e. forward linkages are strong while consumer durables such as the automotive industry have solid backward linkages. The steel industry thus does not need many subcontractors such as parts and component producers near its factory as the automotive industry does. This is the reason why iron clusters do not have many layers or supporting industries near their mills while car assembly makers have multiple layers of supporting industries forming an auto cluster.¹⁰
- Activities of Yawata Works shrank mainly due to the relocation or new mills constructed in areas other than Kitakyushu, in addition to demand shifts due to the two oil shocks and environmental destruction.
- New businesses emerged based on accumulated knowledge on steel making and pollution controls. The inclusion of recycling changed concepts of production (matching vein with artery industries) and created new businesses.
- The help of the city government is also essential. The municipal government provides tax and financial incentives and infrastructure supplies. Especially, the city government can create initiatives to redevelop and revitalize industries and the city itself after traditional industries have declined.
- It is interesting that automotive industries are moving into the area and this development will help to form another type of agglomeration different from the old one based on the iron and steel industry.

Two factors are worth mentioning. One is the notion of recycling. Kitakyushu City is emphasizing recycling, reuse and rebuilding of used or abandoned industrial products such as plastics, OA machines, electrical home appliances, and automotives. This is an extended value to the supply chain. Enterprises have to start producing products taking into account the recycling phase. This will change production styles from the beginning such as design and production processes using reused parts and components. This represents a new type of industrial agglomeration based on 'vein industries.'

The other important factor is the participation of NPOs in the decision-making processes of local governments. In this context Japan lags far behind partly because of the amateur status of NPOs and partly because of a

lack of understanding by public officials. Japan has to foster professional NPOs as well as upgrading public officers' recognition for NPOs. Moreover, contributions and donations should be flexibly treated in terms of taxation in order to promote foundation activities.

In sum, two forces have worked to foster the Kitakyushu City industrial cluster. The iron and steel industry is a classic case of the Marshallian trinity when the city expanded, i.e. linkages, thick markets and knowledge spillovers. The industry itself had scale merits. Thus, the city's agglomeration had both externalities and increasing returns. In the declining phase, external diseconomies such as environmental destruction worked in addition to the relocation of steel mills (transportation cost) and declines in demand. Decisions taken by firms' head offices on the location of new plants to be constructed in Japan, both in the case of the steel makers and the automakers, were influenced by these two forces, i.e. centripetal and centrifugal, however the conclusions reached could be said to be diametrically opposed. NSC building new mills closer to the market-demand area during the 1960s ('distance matters'), whereas the contemporary automakers have chosen to agglomerate in the Kyushu area mainly due to the IT Revolution ('distance is dead').

Lastly, city government initiatives to reclaim land and foster 'vein industries' are highly appreciated in the redevelopment stage because they will attract new industries.

Notes

- ¹ Those with excellent skills were later nominated as 'Shukurou,' a life long position to teach skills to other workers. Only seven were appointed to such a position in the factory's history.
- ² Except for free movements of capital that was prolonged until 1972 for out-flows and until 1992 for inflows.
- ³ This system set a minimum price for Japanese steel products, and when import prices went below the set price, the US Treasury Department would initiate an investigation into the matter.
- ⁴ Ten-year average crude steel production of Nippon Steel Corporation changed: 4.2 million tons in the 1950s; 16.8 million tons in the 1960s; 34.0 million tons in the 1970s; 28.3 million tons in the 1980s; and 26.1 million tons in the 1990s, also showing a declining trend after the 1970s.
- ⁵ This area was nominated by the Japanese government as a special recycling estate. Sixteen areas were nominated all over Japan.
- ⁶ It is said that the government will pass the Automotive Recycling Act in 2004.

- ⁷ Actually, both cities had an agreement called 'Kitakyushu/Pittsburgh Business Partnership Tie' in 1999.
- ⁸ The population of the city of Pittsburgh was 670,000 in 1950 and 335,000 in 2001.
- ⁹ Contributions and donations have partial or limited exemption in the tax calculation in Japan.
- ¹⁰ This type of cluster is sometimes called a '*jokamachi*' or an industrial castle town where a lord attracts many people to live surrounding his castle. Examples are Toyota in Toyota City and Mazda in Hiroshima City.

References

- CLAIR (Council of Local Authorities for International Relations), <http://www.clair.nippon-net.ne.jp/>.
- Corporation Recycle Tech [2002]. *Company Pamphlet* (in Japanese).
- Kagami, Mitsuhiro [2001]. "Japan's Development Model: Success or Failure?" Paper presented to the academic forum on 'El Modelo de Desarrollo Asiático: Relevancia para México,' organized by the Pacific Study Center, University of Guadalajara, Mexico on May 7-8.
- Kitakyushu City [1998]. *Industrial History of Kitakyushu City* (in Japanese).
- Kitakyushu City [2002]. *Kitakyushu Eco-Town Project* (in Japanese).
- Kitakyushu City, <http://www.city.kitakyushu.jp/>.
- Kitakyushu Port and Harbor Bureau [2002]. *Statistics of Port of Kitakyushu 2001*.
- Nippon Steel Corporation (NSC) [2001]. *Beyond Century: One Hundred Years of the Yawata Works* (in Japanese), and its CD-ROM.
- Nippon Steel Corporation, <http://www.nsc.co.jp/>.
- Nissan Kyushu Plant [2002]. *Plant Guide* (in Japanese).
- PPND (Pittsburgh Partnership for Neighborhood Development), <http://www.ppnd.org/>.
- TOTO Ltd. [2002]. *Annual Report 2002*.
- US Steel Corporation, <http://www.uss.com/>.
- Yaskawa Electric Co. [2002]. *Company Guide 2002* (in Japanese).
- Yawata Works [2002]. *Progress* (Company pamphlet).
- Zenrin Co., Ltd. [2002]. *Company Guide*.