

The European Industrial Economy and the Endogenous Development in Asia

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1. Introduction

The author is not a historian of science and technology but a student mainly observing socio-economic aspects of technology transfer in the less developed countries today. However, as we shall see soon, the present situation of the less developed world has its origin in the period with which this conference is mainly concerned. In this context a student of contemporary technological problems may have something relevant to say about this period. The theme of this conference reminds me of a paragraph of Professor Celso Furtade, the influential Latin American economist.

The advent of an industrial nucleus in eighteenth century Europe disrupted the world economy of the time and eventually conditioned later economic development in almost every region in the world. The action of that powerful dynamic nucleus proceeded to operate in three directions.¹

This sentence most adequately characterizes the period which we are going to discuss in this conference: namely 1780 to 1880. It was an age in which a powerful industrial nucleus emerged in Britain right at the beginning, enlarging its frontiers around the globe, and eventually covering the entire surface of the earth near the end. The transfer of science and technology of this period was certainly related to the action of this powerful nucleus.

Professor Furtade stresses that this action proceeded to operate in three directions: the first was towards the European economy itself where the disorganization of the pre-capitalistic artisan economy and organization of the capitalistic economy proceeded in parallel. The second was towards sparsely

¹ Furtade, Celso *Development and Underdevelopment* (California 1964) 127.

populated regions such as North America, Australia, etc., where “the development was not basically different from the process of development of Europe itself, of which it formed a part”. In both directions we can observe many examples of transfers of science and technology. It will be the third direction, however, in which the members of this conference are mostly interested because Japan and Asian countries are to be found in this direction.

The third line of expansion of the European industrial economy was towards already inhabited regions, some of which were densely populated, whose old economic systems were of various, but invariably pre-capitalistic, types. The contacts between the vigorous capitalistic economies and these regions of long-standing habitation did not occur in a uniform manner. ...The result, however, was almost always to create hybrid structures, part tending to behave as a capitalistic system, part perpetuating the feature of the previously existing system. The phenomenon of underdevelopment today is precisely a matter of this type of dualistic economy.

Here Professor Furtade is referring to the origin of the underdeveloped world today. Though his concern is mainly Latin America, members of this conference should feel that his words are equally valid to Asian countries of the period of our concern. Surely the phenomenon of underdevelopment in Asia today has its origin in its encounter with the frontier of the European industrial economy in this period. However, there remains something worrying about this last sentence. That is the case of Japan.

Japan was densely populated when it came in contact with the European industrial economy. Its socio-economic system was of a pre-capitalistic type: feudalism which was described in a contemporary French journal as follows “on trouverait reproduire la constitution du royaume de France sous les premiers Capetiens”.² It developed a dualistic economy under the impact from the West in which the traditional and modern (or Westernized) sectors developed in parallel. Technology supporting this development was distinct in its hybrid nature. All these are exactly in accordance with Professor Furtade's description of his “dualistic economy”. Nevertheless, with regard to Japan, this dualistic economy was not a cause of underdevelopment today but a starting point of its industrialization and economic growth. Why was it possible? Why and where did the difference between Japan and other less developed countries come from? These are the main concerns of this paper.

These questions came to the author when he gave Mexican students a series of lectures on the rise of modern technology in Japan, in 1983. At that time, the

² Duchesne de Bellecourt, C. ‘La Chine et le Japon a l’Exposition Universelle’, in *Revue de Deux Mondes* (1 aout 1867) 722.

author acquired for the first time a view point which saw Japanese development as being unlike others in different parts of the world in the nineteenth century, developing through dynamic interaction between a regional traditional economy and the action of the European industrial nucleus and found that Japan's development was extremely peculiar. Since that time these questions have been ones of concern to the author.

However, in order to define the problem in a clearer form, it will be necessary to confirm in more detail the peculiar points of Japan's reaction against the frontier of European industrial economy in comparison to other Asian or Latin American countries. Let us start with describing briefly how Japan reacted against it, focusing on its technological activities.

2. Technology Transfer To Japan 1840 to 1890

After the Opium War

The first reaction was the movement of rich and strong 'han' towards an expansion in Western style armaments. The Saga Han started this soon after hearing the news that China had been defeated in the Opium War, and Satsuma followed immediately thereafter. Many han joined them after facing the menace of Kurofune (Western 'Black Ships'). The target of the movement was to acquire "Guns and Sails" (preferably steam ships) for the fight against Western fleets. "Between 1850 and 1868 there had been at least 11 (eleven!!) sites, where the construction of reverberatory furnace actually started; three further sites have only reached the planning stage, another plan is—due to the lack of written sources—doubtful" writes Dr. Pauer with regard to cannon casting.³ As for shipbuilding there had been sixteen plans for the construction of shipyards including the two by the Bakufu (government).

The extraordinary feature of all attempts, before 1857, was the fact that all the work involved was carried out in strict accordance with directions found in a few Dutch books, though the construction of the Bakufu's shipyard in Nagasaki, which started in this year, was carried out under the guidance of a Dutch engineer. It was indeed a movement of technology transfer from Holland to Japan; carried out, however, with only the help of books and little direct guidance from Dutch engineers. It is not surprising that such endeavors should have resulted in many failures. Consequently the movement began to decline as early

³ Pauer, Erich 'Japan's Industrial Apprenticeship: A Case Study on the Initiative Role of the Reverberatory Furnace for the Japanese Industrial Revolution', paper presented to the Japanologist Conference on Technology Transfer, Transformation and Development: The Japanese Experience (Tokyo April 20-23, 1981) 4.

as around 1855. It may be termed a miracle, however, that over 200 iron cannons and a small steam boat could be successfully constructed through this movement.

A Dutch naval officer observed this Japanese version of the steamboat in March of 1858. A steam engine made with brass was settled in a small traditional Japanese flat bottom ship. The ship was propelled by paddle wheels powered by this engine. Because of bad machine work, steam was leaking from many parts of the engine. He estimated that its actual power would be barely two or three horse power while the size of cylinder suggested that the designed power was about twelve. "However, who among us can construct a steam engine without any experience of seeing the real steam engine, only with the aid of a very simple drawing? Considering this I couldn't help admiring the extraordinary talent of the men who made this engine," he wrote.⁴ His words suffice to express the extraordinary nature of this movement.

This action was based on the long tradition of Rangaku (Dutch learning) During the Edo period when Japan was isolated from the world, the Japanese studied Western science through Dutch books and made various scientific apparatus. For example, the Wimshurst influence machine, microscopes, the telegraph, etc., were made mainly according to descriptions available in those books. When they faced the urgent need for cannons and steamboats for the battle against the West, all they could do was to follow this traditional procedure of Rangaku: that is, at first to acquire a textbook through the Dutch trading house in Nagasaki; then to carry out a collaborated translation of it into Japanese; and finally to construct the object through trial and error according to the description found in the books. For cannon casting, Ulrich Huguenin's *Het Gietvezen in s'Rijks Ijzer-Geschutgieterij, te Luik* (1826) was used and for steamboat building, G. J. Verdam's *Volledige Verhandeling over de Stoomwerktuigen* (1832) was the text. The fact that three different translations prevailed for the former testified to the large scale of the movement.

Japanese historians have long disputed the importance of this movement to later development. Some estimate it highly as a precursor of later military-biased heavy industry while others emphasize its feudal nature and consequently see a break between it and later capitalistic development. The author's view is to place importance on the epistemological process accompanying to this movement. Firstly through this movement many samurai recognized the difference between the manufacture of a copied instrument and that of laboratory work but to make the latter was an industrial activity. For instance samurai of the Satsuma Han

⁴ Kattendyke, W. D. *Uittreksel uit het dagboek van W.J.C. Ridder H. v. Kattendyke gedurende zijn verblijf in Japan in 1857, 1858 en 1859* (sGravenhage 1860). This citation is from the Japanese translation of this book *Nagasaki Kaigun Densyūsho no Hibi* (Tokyo 1964) 96.

knew nothing about machining an engine block. Their brass engine was finished exclusively by file and chisel. Afterwards they saw the engine room of a Dutch warship of which the engine power was 400h.p. and recognized the huge gap between an industrially produced marine engine and their hand made brass engine. They returned to Satsuma and reported that it seemed to be impossible to manufacture a workable steam engine without machine tools.⁵ In this way they gradually became aware of what sort of activities existed behind the amazing armaments of Western fleets.

Secondly the movement consumed enormous financial resources. The Satsuma Han gave up its plan for building fifteen warships as early as in 1855. The main reason was exhaustion of the treasury. Many han faced the same problem. This experience attracted their attention to another factor behind the armament of Western fleets: that is, the wealth of the nation. Some samurai of Satsuma began to talk about the relation between the wealth and the strength of a nation by the early 1860's.⁶

It was the recognition of these two facts which propelled many samurai to go to Europe in the 1860's and to confirm with their own eyes the actual socio-economic conditions there. And they saw that the wealth of Western nations was being produced by an industrialized economy.

One important difference between Japan of the time and less developed countries today seems, to the author, to be that Japan had a relatively larger number of leaders who knew through their experience what was industry. Between 1862 and 1868 a minimum of two hundred samurai visited Europe or the U.S.A. and studied or observed industrial activities there.⁷ Many industrial leaders of the early Meiji period were included among them, for instance, Shibusawa Eiichi, Godai Tomoatsu, Ito Hirobumi, Yamao Yozo, Ito Masaru, and Enomoto Takeaki, among others.

After the Opening of the Ports

The second reaction, in 1859, which started with the opening of the ports was necessarily economic while the first was military or techno-political. Exports

⁵ *Shidan Sokkiroku* No. 40.

⁶ For instance, a letter to Shimazu Tadayoshi (the lord of Satsuma) from Godai Tomoatsu in 1864. Editing Board of the Shimazu Family, ed. *Satsuhan Kaigun-shi* (A History of the Satsuma Navy) 2 (1928) 867-90.

⁷ The late Professor Yoshida wrote "their number is estimated to have reached 500" in Yoshida Mitsukuni *Nippon to Chūgoku* [Japan and China] (Tokyo 1989) 23. Perhaps this can be considered the maximum estimate. We adopt here, as a minimum estimate, the number in a list compiled by Professor Ishizuki in the appendix of Ishizuki Minoru *Kindai Nippon no Kaigai Ryūgaku-shi* [A History of Japanese Students Studying Abroad] (Tokyo, 1992).

of silk and tea grew rapidly. Western merchants urgently demanded these because of the silk worm epidemic in Europe and the civil war in China which had previously been supplying them to Europe. The share of silk surpassed 50% of Japan's total exports until the Meiji Restoration. The increasing exports were accompanied by an increase in imports. Cotton and wool textiles, and refined sugar were major items.

This is a very common pattern. For instance, Professor Furtade writes of the Latin American experience where the impact of European industrial economy first caused a rapid development of export-oriented primary industries, closely connected with demand from the Western industrial nucleus; and then a correspondingly large increase in imports of manufactured consumer goods from the West.⁸ His words are quite applicable to Japan, though in the later development of Japan and Latin America a remarkable difference grew as we shall see later.

The rapidly increasing silk export was accompanied by another important event which affected later development. That was a serious shortage of silk yarn and consequently a large increase in its price in the domestic market. The local silk textile industry was greatly damaged, although some weavers did begin experimenting with the use of imported thin cotton yarn as a substitute for silk at this time. In addition, the American Civil War broke out in 1860. A resultant world shortage of raw cotton stimulated exports from Japan, and caused a shortage of cotton yarn in the local market. This damaged the local cotton textile industry and at the same time produced the experience of using imported cotton yarn to cotton weavers. Technologically the experience of these weavers had large implications for later development as we shall see in the next section.

Although the period between the opening of the ports and the Meiji Restoration was a mere eight years, a rough scheme for later economic development was determined during this time. After the Restoration, however, the new government took its industrial policy in a different direction. That is, towards the way represented by the *Kôbushô-jigyô* (government enterprises). It established the *Kôbushô* (Ministry of Public Works) in 1870 and began establishing many government enterprises with the help of technology transfer from the West. The work included the construction of railways, the telegraph network, light houses, two shipyards, several manufacturing plants for iron, machinery, and glass, the exploitation of ten mines (gold, silver, iron, coal, and oil) and the establishment of a technical college. Other governmental departments

⁸ Furtade, *Celso Op. cit.*, 134-5.

such as the Ministry of Finance, the Ministry of Home Affairs, the Army and the Navy also managed manufacturing plants.

These government enterprises have been highly estimated as a model of technology transfer in late comer countries by some historians.⁹ The main line of this argument was that the Meiji government took leadership in establishing many plants by intensive technology imports from the West, and after having assimilated imported technology, sold these plants to private entrepreneurs cheaply, successfully establishing the core of the private modern (i.e., Westernized) sector in a capital scarce country with no technological background.

However, the author is suspicious of this argument. Let us imagine that such large scale and comprehensive public works were to be carried out in a less developed country today. It is clear that this would result in a large financial deficit as well as current account imbalances, and consequently serious inflation. Did the Meiji government have anything like a magic wand to escape from such a situation? Not at all. It suffered just such a large deficit in finance and current balance, and resultant inflation.

The situation was far worse for the Meiji government. With the abolition of the feudal system most samurai lost their livelihood. A great amount of money was needed to pension them off and for war expenditure against their rebellions while the real income from land taxes, which was the government's main financial resource, was decreasing annually through inflation.

As early as 1877, leaders were beginning to discuss the abolition of Kôbushô. In December of this year Okubo Toshimichi wrote *Gyôseikaikaku Kengensho* (A Proposal for the Reform of Public Administration). He stressed that if they continued with the present administration policies for some years there surely would remain evils accumulated during these years, and therefore that they should proceed to the next step after having eliminated the already accumulating evils of these past years.

Now nearly ten years has passed since the Restoration. It is the time to eliminate the evil of ten years and reform our system. ... However, what was the evil of ten years? It is the lack of financial resources. This is the final cause of every disease. At the Restoration, we thought that the help of foreign advisors was inevitable for achieving our urgent tasks and hired them. Laws, educational systems, army and navy, agriculture, manufacture, reclamation, and other plans, there were no new enterprises established without the advice of foreigners.

However, there was of course no reason why these foreigners have to be deeply concerned about our poor financial situation.

9 For instance, see Smith, Thomas C. *Political Change and Industrial Development in Japan: Government Enterprise, 1868-1880* (Stanford 1955).

Their only concern is to show their talent in magnificent works, most of which were arbitrarily borrowed from models in the advanced and civilized countries. We could say that their works were but a mere transplantation of superficial features of Europe.

Reflecting deliberately on the appropriateness of their works to actual conditions of Japan, we cannot help concluding that they are a sort of vanity far inappropriate to our present situation; too many undertakings for poor financial resources.¹⁰

This can be seen as an honest confession of their estimate of *Kôbushô-jigyô*. Okubo's proposals were; dismissal of all foreign advisors, a merger of *Kôbushô* and *Naimushô* (Ministry of Home Affairs), a radical rationalization of government organization and a large personnel cut.

While Okubo's tragic assassination deprived him of an opportunity to carry out this policy himself, the government took the course he directed. It dismissed foreign advisors successively. In 1880 the sale of government enterprises except arsenals was decided and the *Kôbushô* was abolished in 1885. If we admire the leadership of the Meiji government, we should certainly appreciate the actions shown by them in this drastic revision of policy.

After the Revision of Policy

The revised policies featured three principles: first, less and less expenditure, second, no foreign participation, and third, trade balance recovery. This last was succeeded from the policy of the first decade. The trend in the balance of trade was very simple. It was black before the Restoration and red after it. The accumulated deficit was reaching a dangerous limit towards the end of the 1870's. The main causes of this trend were the stagnation of silk export on the one hand, and a large increase in selected imports, especially cotton yarn, on the other.

The government appointed Matsukata Masayoshi to be Minister of Finance in 1880. He adopted a strict retrenchment policy and at the same time made every effort to decrease imports and to increase exports. Japanese historians are still in dispute about the merits and demerits of his policy. It caused a serious deflation lasting until 1885 and occasioned great damage to local industries. On the other hand, efforts for the promotion of exports oriented, necessarily, the attention of administrators towards the traditional sector, for exportable products did not exist in the Westernized (modern) sector except for a small amount of coal. Silk yarn, silk worm eggs, tea, textiles, lacquer ware, ceramics, straw mats, braided cords, dried sea foods, etc., everything which had a possibility of export became a target for promotion. Because of the principle of less expenditure, the government

¹⁰ *Okubo Toshimichi Monjo* [Documents of Okubo Toshimichi] 7: 445-9.

necessarily relied on cheap information services excluding expensive technology imports as far as it possibly could. It energetically organized meetings for the exchange of technical know-how, expositions of local commodities, seminars on new techniques, etc.

It was not that plant imports were excluded completely. Another target of the policy was the import-substitution of cotton yarn. The main lines of the policy were as follows. The government imported equipment for ten cotton spinning mills of equal size (2000 mule spindles per mill). They were sold to competent entrepreneurs, in cotton-cultivating regions, who paid for them over a period of ten years with no interest. In addition, various measures were designed for financially supporting entrepreneurs who were willing to enter the spinning industry. Though this policy put more importance on private entrepreneurs' initiative than that of the first decade, it nevertheless failed utterly. All transplanted mills suffered from lack of maintenance as well as management skills, low operation rates, high capital output ratio, low product quality and consequently horrid business performance. All these are common in technology transfers to less developed countries today.¹¹

Thus new policies also involved many failures. Nevertheless, roughly speaking, the principle of less expenditure hampered the government from intervening too excessively in private sector activities and as a result liberated the latent energy of private capital. A good example was the construction of railways.

The government monopolized both railway construction and management in the first decade. Private entrepreneurs were allowed to enter the railway business in the second decade. Though construction was carried out by the government, many lines were delivered to private companies after their completion. This policy enabled government to cover its lack of finance with private capital and accelerated the construction of railways. In 1880 the total kilométrage of Japan's railways was a mere 123km. After the first entry of private capital in 1883, total kilométrage surpassed 2,000km by 1890 and reached 6,480km in 1900.¹² The introduction of private capital was truly successful. Progress in railway construction connected local industries to large city markets and exporting ports, thus triggering their development. Together with the growth of local economies more and more private capital was invested in local railway lines. This process played an important role in economic growth after the deflation.

¹¹ Nakaoka, Tetsuro 'The Transfer of Cotton Manufacturing Technology from Britain to Japan', in Jeremy, David J. ed. *International Technology Transfer: Europe, Japan and the USA, 1700-1914* (1991) 181-98.

¹² Tetsudōin, ed. *Honpō Tetsudō no Shakai oyobi Keizai ni oyoboseru Eikyō* [Effects of Railways on the Economy and Society of Japan] 1 (1915) 62.

The principle of self help did not mean that Japan abandoned efforts to acquire technology from the West. It only meant the replacement of expensive plant imports with cheap and practical instrument imports, and expensive foreign technical advisers with cheaper Japanese ones. Japan continued to send students to the West after the Restoration. They included two important groups: one was skilled craftsmen dispatched by local governments, the other was graduate students from higher educational institutions for science and engineering established after the Restoration—namely Kôbu Daigakkô (The Imperial Technical College) and the Faculty of Natural Science, Tokyo University. The former brought back to Japan practical devices immediately applicable to traditional handicraft manufactures. The latter matriculated at British or German universities, generally earning high marks, and replaced foreign advisers after their return to Japan. We cannot say that they were more skilled than foreigners. However, they could at least give their guidance in Japanese and display more understanding of local conditions.

Having gone through the most difficult years, the Japanese economy entered into a period of sustained economic growth after 1886. Economists regard this year as the starting point of Japan's modern economic growth.¹³ Aspects of this sustained growth were truly peculiar among less developed countries of that time. We shall examine them in the following section.

3. Technological Aspects of Japan's Modern Economic Growth

The Leading Role of the Traditional Sector

First the author would like to stress the importance of the traditional sector in Japan's modern economic growth. Since the classical work written by Professor Ohkawa Kazushi was published this fact has been widely accepted regarding the economy as a whole.¹⁴ However, as for the manufacturing sector, growth was accompanied by a strikingly rapid rise of the modern spinning industry, and therefore the idea arose that this time was the true Japanese Industrial Revolution. This line of argument attributes economic growth mainly to the modern sector and inclines to regard the traditional sector as a mere remnant of the feudal economy. Therefore we need to point out that at least at the early stage of economic growth the weight of the traditional sector was overwhelming and actually played a leading role.

¹³ In this paper the author often uses "modern" in the same meaning as "Westernized", but here "modern economic growth" is used purely as an economic term.

¹⁴ Ohkawa Kazushi *Differential Structure and Agriculture: Essays on Dualistic Growth* (Tokyo 1972).

Though reliable data were hardly available for the early years, Professor Nakamura Takafusa estimates that the traditional sector's share in output of manufactures was over 95% around the start of the growth period, gradually decreasing with time, reaching about 40% by World War I.¹⁵ Professor Sydney Crawcour roughly estimates that it was "nearly three-quarters in the 1880's", then fell to "about one-half around the Russo Japanese War" and "about one-third by World War I. ... This estimate of the importance of traditional industry as a producer of manufactures is probably conservative" he adds.¹⁶ At any rate, these researchers agree that traditional factors played a leading role in the early stage of modern economic growth.

The development of traditional manufacturing industries already started with the opening of the ports. Not only the silk reeling industry, but ceramics, lacquer ware, and other handicrafts manufacturing began more or less export-oriented changes. After the abolishment of the feudal system the development of the textile industry started. Perhaps the abolition of many feudal restrictions on jobs as well as people's dress had triggered weavers' latent energy on the supply side and people's desires for clothing on the demand side. Technologically, imported cotton yarn stimulated development. As previously described above, weavers had experience using imported cotton yarn soon after the opening of the ports and found that cotton yarn spun mechanically on the spinning frame had quite different characteristics from local hand spun yarn. Weavers applied those characteristics of imported cotton yarn both to create various types of new textiles and at the same time to improve productivity of the weaving processes. Rapidly increasing imports of cotton yarn after the Restoration *inter alia* testified to the development of the traditional textile industry depending on imported cotton yarn.¹⁷ Though this industry was oriented towards the domestic market, Matsukata's export promotion policy added many new items to export-oriented traditional manufacturing, for instance, the processing of sea foods, knitting mats, braiding cords, etc.

Transferred Western technology played an important role in this rise of traditional industries. This process is often explained by saying that the Japanese modified imported technology to adapt it to Japanese local conditions and succeeded in incorporating it into the local economy. However, this explanation

¹⁵ Nakamura Takafusa *Nippon Keizai* [The Japanese Economy] (Tokyo 1980) 86.

¹⁶ Duus, Peter, ed. *The Cambridge History of Japan* 6 (Cambridge 1988) 416.

¹⁷ As for the relation between imported cotton yarn and the development of the textile industry, see Nakaoka Tetsuro *Op. cit.*, and 'The Role of Domestic Technical Innovation in Foreign Technology Transfer: The Case of the Japanese Cotton Textile Industry', *Osaka City University Economic Review* 18 (1982) 45-62; Nakamura Satoru *Meiji Ishin no Kisokôzô* [The Infra-structure of the Meiji Restoration] (Tokyo 1968) Ch. 5.

seems to be too simplistic and impersonal to cover the whole process. The actual process was a more dynamic social transformation in which the traditional industries reacted to exogenous factors and developed themselves through numerous failures and successes. For instance, as we have seen above, not only Western imported cotton yarn (embodying Western technology) but also the abolition of feudalism played a crucial role in the development of the traditional textile industry. While imported yarn enabled creation of new textiles, imported dye stuff was often used by local dyers without any chemical knowledge causing innumerable troubles, resulting in serious damage to local textile industries. However, this damage gave the Japanese a strong stimulus to learn chemical science. In the growth process of this industry, from 1886, Japanese chemists, who had returned from the West, played an important role. Such dynamic interaction of exogenous and endogenous factors was a common but remarkable aspect of the development of all traditional manufacturing industries.

Perhaps a far more remarkable aspect of the development was a change occurring in the mode of production. Most manufacturing was based on small scale household industry. Silk reeling, cotton spinning, cotton weaving, braiding cords, etc., were relying on peasant sidelines, while silk weaving, lacquer ware, ceramics, etc., were jobs of urban craftsmen. The production process was generally organized by wholesale dealers employing more or less a 'putting out' system. Along with the development of the each industry a certain type of factory production system appeared, and through a period of competition with the traditional production mode, eventually established its existence in the industry around World War I. Here we adopt the example of the silk reeling industry, which has been most intensively investigated, and briefly look at the process of its industrial transformation.

The Case of the Silk Reeling Industry

Table 1 shows the remarkable growth of this industry during the early stage of Japan's modern economic growth. This development started with the opening of ports, relying on traditional technology and production mode. Japanese silk yarn however was unable to acquire a good reputation in the international market, due partly to a difference in quality due to technology differences, and partly because of a lack cottage industry product homogeneity.

Table 1: Production and Export of Silk Yarn

Year	Production	Export
1883	457	365
1889-93 (annual average)	1,110	662
1899-03 (annual average)	1,924	1,110
1909-13 (annual average)	3,375	2,563

unit: thousand kwan

Source: Allen, G. C. *A Short Economic History of Modern Japan* (London 1981) 69.

Faced with a stagnation of silk exports after the Restoration, the government decided to introduce Western silk reeling technology together with the factory production system as an easy way to upgrade the quality of local silk yarn to an internationally competitive level. It employed Paul Brunat, a French specialist, as a technical advisor and established a model silk reeling mill with French technology at Tomioka in 1870. Around this time more three model mills, based on Italian technology, were established by Maebashi Han in Maebashi, Tokyo's Ono-gumi and Kôbushô. As is known well, these model mills did not diffuse into the local industry in their original form.¹⁸

The reason for this is clear. There was a deep gap between the economic operation of those mills and local manufacturers' capabilities, who relied largely on peasant manual labor. The required capital gap was especially enormous. Maebashi Mill was the smallest of the above four. The equipment for this mill was manufactured by local carpenters using wooden construction under the guidance of a foreign advisor. Even a mill of this size was far beyond the reach of rural reelers and appropriate only to the financial capability of a former han.

However, many local silk reelers visited those mills, observed the operation of Western reeling equipment and found that many reels working in a single working unit was rather similar to a Japanese traditional reeling apparatus called *Zaguri-ki*. Efforts to copy it immediately started. The reeling unit was basically traditional but some superior devices of Western origin were also adopted. The multi-axle driving mechanism was simplified using wooden construction, as far as possible, and constructed by local carpenters. The equipment was driven

¹⁸ In this section the following works were referred to: Okumura Shoji *Koban Kiito Watetsu* [Gold Coins, Silk Yarn and Old Japanese Iron] (Tokyo 1973); Ueyama Kazuo 'Silk Reeling Technology and the Formation of Kikaiguri', in Unno Fukuju, ed. *Gijutsu no Shakaishi* [A Social History of Technology] 3 (Tokyo 1982) 168-205; Suzuki Jun 'The Development of Boilers for Kikaiguri', *Shigaku-Zasshi* 101. 7 (1992) 33-61; Minami, R. & Makino, F. 'Technology Choices in the Silk Reeling Industry', in Minami, R. & Kiyokawa, Y., eds. *Nippon no Kôgyôka to Gijutsu Hatten* [Japan's Industrialization and Technological Progress] (Tokyo 1987) 41-63.

sometimes by human power and sometimes by water power. Cocoon processing equipment also was copied by local copper processing craftsmen simplifying it as far as possible. The earliest version of Japanized silk reeling equipment, whose rough design was borrowed from that of Tomioka Mill, appeared as early as in 1874.

The new reeling technology based on Japanized equipment was called *Kikaiguri* (mechanical reeling) as compared to traditional technology called *Zaguri*. *Kikaiguri* was hybrid in its nature in the sense that it retained appropriate parts of traditional technology and at the same time incorporated advanced elements of Western technology. The most impressive point of this technology was its exemplary capital saving nature. *Kikaiguri* equipment with 100 basins came at a total cost of 1,900 yen, while Tomioka's equipment, with 300 basins, cost 37,000 yen.¹⁹ Nevertheless it was still capital intensive compared to *Zaguri* technology. Even such cheap equipment was considered by average reelers to be too expensive though the selling price of *Kikaiguri* yarn in the export market was considerably higher than that of *Zaguri* yarn. Its diffusion therefore was rather slow. However, it was a very important change because it was a transitional form of the factory system born in the traditional industry.

Meanwhile, traditional technology had improved under the impact of the West. Brunat introduced know-how for the killing of silk worms, selecting, storing and cooking cocoons. Such know-how was directly applicable to traditional processes without any modification. There was a technical change in the reeling apparatus. In traditional *Zaguri-ki* weavers had to manually rotate a small reel onto which filaments from several cocoons were reeled, after having been combined together into a single thread. In the 1870's a pedal reeling apparatus was invented in which the small reel was driven by a foot pedal. This enabled workers to use their two hands exclusively for taking care of filaments and, as a result, improved the quality of silk yarn. Though productivity of this apparatus was lower than that of *Kikaiguri* equipment, peasants often organized village workshops and tried to raise productivity by the division of manual labor. Village workshops were effective for product homogenization. Some villages also bought pedal reeling apparatuses collectively and distributed them to peasants individually.

Advantages of *Zaguri* technology were often related to the rural socio-economic structure. Village (or community) workshops were an example. In most regions peasants combined crop cultivation, sericulture and silk reeling. This resulted in cheap wages and low cocoon costs, which constituted the basis of

¹⁹ Ueyama Kazuo *Op. cit.*, (1982) 183.

Zaguri competitiveness. Meetings designed to improve the quality of cocoons and silkworm eggs were also organized, sometimes at a community level and sometimes at a regional level. These developed into a large rural movement for technical learning and for diffusion of knowledge. Sustained by these efforts rooted in rural communities, Zaguri was overwhelming at the early stage.

However, along with the diffusion of modern engineering, Kikaiguri technology also gradually improved. For instance, at the early stage reelers used a cast iron boiler made by local craftsmen which was nothing but a large iron kettle. Soon, the transfer of modern mechanical engineering from Tokyo and Yokohama enabled local craftsmen to manufacture a simplified type of Cornish boiler. By 1886 a local craftsman in Nagano prefecture invented a new boiler which was actually a compound Cornish and Multitubular boiler. Adoption of this boiler improved heat control of processes and at the same time decreased fuel consumption dramatically.²⁰ Kikaiguri entrepreneurs also made every effort to develop an efficient work system, sometimes borrowing even from the Zaguri system.

Thus Kikaiguri and Zaguri developed concurrently in the 1880's. At the end of this decade, the share of Kikaiguri in the total output of the silk reeling industry was one third, with Zaguri still holding the larger share. Professor Minami Ryoshin has studied in detail the competition between the two technologies in that decade. Kikaiguri technology was superior with regard to labor productivity, selling prices of yarn and basic unit of cocoons. Zaguri technology was advantageous in wage rate, purchase prices of cocoons and low capital intensity. As a result the rate of return was almost the same for both technologies. However, hybrid Kikaiguri technology made its own technical progress. Towards the turn of the century performance of locally manufactured silk reeling equipment improved rapidly.²¹

In 1894 output from Kikaiguri factory production surpassed 50% for the first time. And in the first decade of this century, a rapid shift to Kikaiguri took place in most Zaguri silk reeling regions.

The Points at Issue

The development cited above may remind the reader of the theory of "Proto-industrialization". Firstly, it was development caused from production activities for the non regional market (i.e., export-oriented); secondly, these production activities were rural manufactures relying on peasants' part time and

²⁰ Suzuki Jun *Op. cit.*, (1992) 47-8.

²¹ Minami, R. & Makino, F. *Op. cit.*, (1987).

activities; and thirdly, along with development, modes of production shifted from household production, under the putting out system to mechanized factory production. Though some small differences exist, this development is strongly reminiscent of the proto-industrialization process which occurred in Flanders.²²

This type of development was not restricted to the silk reeling industry. Many regional cotton textile industries followed a similar course. For instance there was a well developed cotton textile industry in south Osaka which depended on peasants' cottage industry and the putting out system before the Restoration. After the abolition of the feudal system it began to develop rapidly. It was not export-oriented but oriented to the domestic market outside the region. Along with the development a 'manu-factory' system based on local treadle looms began to emerge. And finally the advent of locally invented power looms accelerated a shift from the putting out system to the factory system in the decades between 1910 and 1930.²³

This development conforms to Marxist theory, which claims that the mode of production develops first from the putting out system, through the manu-factory to the 'machino-factory' system. As Japanese historians have been mostly influenced by the Marxist economic theory, they regarded these facts simply as a sign that the Japanese economy as well as the European developed equally under the same laws of world history, never feeling uncomfortable about the similarity between Japanese and European development. However, for those of us who tend to see Japanese development from a developing country comparative point of view, this similarity is very peculiar.

Latin American countries also developed export-oriented economies when they came into contact with the European industrial economy. Professor Furtade classifies them into three types: "(a) economies exporting temperate agricultural commodities; (b) economies exporting tropical agricultural commodities; (c) economies exporting mineral products". Exported commodities were all primary goods not manufactures. Argentina and Uruguay represent type (a) where large

²² Professor Saito Osamu summarizes characteristics of the process of proto-industrialization into the following three: i) production activity oriented not to inside the region but to the market outside the region; ii) production activities conducted as rural household manufacturing, which were often organized by urban dealers with the 'putting out system', and consequently characterized the transition to the second stage by a shift to the factory system; iii) commercial agriculture co-existed in the same regional economy, and usually this developed into the regional division of labour between rural industrial and large scale crop agricultural areas. In the Japanese case this third aspect seems to have been unclear. Saito Osamu 'The Theory of Proto-industrialization: Its Results and Prospects', in Yasuba, Y. & Saito, O., eds. *Puroto Kogyōka-ki no Keizai to Shakai* [The Economy and Society in the Period of Proto-industrialization] (Tokyo 1983) 13-35.

²³ Kajinishi Mitsuhaya *Nippon Kindai Mengyō no Seiritsu* [The Rise of the Modern Cotton Industry in Japan] (Tokyo 1950).

scale agriculture like that of the United States developed. Brazil, Colombia, Ecuador, Central America, etc., represent type (b) where "tropical products tended to remain in the framework of the traditional economies". Mexico, Chile, Peru, Bolivia, etc., represent type (c) where "small-scale mining operations of the artisan or quasi-artisan type were gradually replaced by large-scale production controlled by foreign capital and administered from abroad."²⁴ Nowhere did the Japanese type proto-industrialization process take place. This also holds true for other countries in Asia. Among less developed countries at that time, therefore, the Japanese type of development was exceptional indeed.

In the introduction of this paper, the author set forth the question, why did contact with the frontier of the European industrial economy only lead Japan to a course of industrialization and modernization while leading almost all of the other less developed countries to the 'development of underdevelopment'? The fact that only Japan went through the process of proto-industrialization provides the answer to this question. However, this answer is nothing but a transformation of the above question to another question. Why was Japan the only country to go through a process of proto-industrialization when meeting the frontier of the European industrial economy?

This question can be divided into a series of small questions. Was Japan already prepared for industrialization in the Edo period? Did the rice economy have a bearing on this development? Was it accidental or necessary that the contemporary European economy demanded Japanese manufactured goods which were just then appearing? Did the geographical position of Japan have a bearing on this development? What role did technology transfer play in this development? And so on.

The author has no desire to answer these questions in this paper. A long series of investigations will be needed to give exact replies to each question. Anticipating that the discussions at this conference will bring abundant insight for such investigation, the author only tries to introduce in the following section the opinions of three Japanese scholars which are keenly relevant to these questions.

4. Global Technology Transfer and Asian Development

Global Technology Transfer

Professor Kawakatsu Heita calls to our attention the coincidental nature of the product mix between the European industrial economy and the Japanese traditional economy. The European industrial economy demanded silk yarn and

²⁴ Furtade, Celso *Economic Development of Latin America* (Cambridge 1978) 47-49.

tea from Japan and wanted to sell cotton and wool textiles, and refined sugar to Japan. Manufacturing industries producing all these products already existed in Japan (with the one exception of wool), and they reacted vigorously to this demand and supply. Was it a coincidence? He insists that it was not.²⁵

It was from India that cotton textiles were introduced into Britain, largely in the late seventeenth century. The struggle between Britain and Holland for Indonesian spices was settled with the triumph of Holland. Up until that time, British merchants in India had been using Indian cotton textiles to pay for Indonesian spices. Being excluded from the spice trade they decided to export cotton textiles directly to Britain. The increasing stream of Indian cotton from the late seventeenth century adversely affected the local British textile industry, resulting in various countermeasures, and eventually stimulating the rise of the British cotton industry, which in turn triggered the emergence of the European industrial economy. Thus cotton textiles as well as the cotton industry were transferred from Asia to Europe through the historical interchange between East and West beginning with Vasco da Gama.²⁶

This pattern more or less holds for three other products: silk, tea, and sugar. They were originally Asian products. Though the process of introduction was different for each product, during the period from the late seventeenth to the eighteenth century they diffused widely in Western society and eventually were incorporated into the product mix of the European industrial economy. Kawakatsu emphasizes that these products were introduced into Japan before the closure of the country and that self-sufficient production was established during this latter period. That is, they were incorporated into the product mix of the Japanese traditional economy at nearly in the same time as they were in the European industrial economy.

In short, he insists that what happened in Japan after the opening of the ports was an encounter of two economies: one strongly influenced by the transfer of products and technology from Asia to the West since Vasco da Gama, and the other by that from continental Asia to our eastern isolated islands. It was, therefore, not an accident but rather a necessary development that just those products that the contemporary European economy demanded were being manufactured in Japan, and that this demand stimulated the process of proto-industrialization in rural Japan.

²⁵ Kawakatsu Heita 'Outer Pressures and Intra-Asian Competitions to the Industrialization of Japan', in Hamashita, T. & Kawakatsu, H., eds. *Ajia Kōekiken to Nippon Kōgyōka: 1500-1900* [The Asian Trading Zone and Japan's Industrialization] (Tokyo 1991) 158-93.

²⁶ Kawakatsu Heita 'The Transfer of Cotton to the West,' *Waseda Seijikeizaigaku Zasshi* 270-2 (1982) 100-135.

Kawakatsu's proposition is still hypothetical and much future research will be required to confirm it. It is, however, at the very least suggestively relevant to our present discussion. He suggests that we consider the above issues in the long historical interchanges between East and West since Vasco da Gama. This is just what concerns us at this conference. Already in the first conference at Amsterdam & Leiden contributions of the East—Arabs, India and China—to the emergence of early modern science was one of critical issues in relation to Needham's "Grand Question".²⁷ The frontier of the European industrial economy brought to Asia Western science and technology. To a certain degree, this was the return of transformed Asian tradition. At the very least this is the case with technology.

In addition, interchanges existed between Asian countries. The flow of goods and information from China, for example, had a strong influence on the Asian economy in the period of our concern. For instance, Chinese sugar refining technology was established in the late sixteenth century. It was transferred to other Asian countries from the seventeenth to nineteenth centuries and contributed much to the development of the sugar industry in each country. These processes and their relation to later colonial sugar economies were studied by Professor Christian Daniels.²⁸ The frontier of the European industrial economy, coming to Asia, interacted with influences coming from Asian countries in this way and determined its specific development.

The above consideration seems to shed some light on the differences between Asian and Latin American development. A large flow of products from Latin America to Europe also existed from the time of Columbus. Being mainly primary products, however, they were less influential on the product mix of the European industrial economy, to say nothing of science and technology. In addition, there seems to have been less of an exchange of goods and technology between Latin American countries. Perhaps each country was tied too strongly to a suzerain country in Europe. These differences might have strongly conditioned the later development of Asia and Latin America. Asian development seems to have reflected far more strongly the cross-regional transfer of products and information inside Asia.

²⁷ Cohen, H. F. 'The Emergence of Early Science in Europe; with Remarks on Needham's "Grand Question," Including the Issues of the Cross-Cultural Transfer of Scientific Ideas', *Journal of the Japan-Netherlands Institute* 3 (Tokyo 1991) 9-31.

²⁸ Daniels, Christian 'Inter East Asian Trade and the Transfer of Production Technology in the Seventeenth and Eighteenth Centuries', in Hamashita & Kawakatsu, eds., *Op. cit.*, 70-101.

China and Holland in Japan

The above discussion can also be applied to Edo Japan. Though being relatively isolated from the world, it was not a period of complete isolation but one in which a strong cultural exchange with Asia as well as Europe existed. With regard to the flow of products, major exchanges existed to and from China, Korea and Holland. Along these interchanges of science, technology and culture can be perceived. Influences from Asia and Europe interacted with each other to develop a peculiar culture in this relative isolation.

The late Professor Yoshida Mitsukuni emphasized the fact that in this relative isolation Dutch influences were accepted following Japan's long tradition of learning from China and Korea.²⁹ Urban design, construction and architecture, weaving and dyeing, ceramics, lacquer ware, iron manufacture and other metallurgy; Japan acquired all this material culture through the guidance of immigrants from Korea and China. As for spiritual culture, Japan accepted also many essential things from abroad, for instance, Chinese characters, Buddhism, Confucianism, etc. This tradition is reflected in the attitude of the Japanese who expected high quality goods and superior culture coming from abroad, being eager to learn from foreign books as well as from foreign immigrants, sending many students overseas to China for advanced study, and making every effort to reproduce these superior products in Japan.

This attitude was applied to Dutch goods and books in the Edo period as well. "Scientific instruments such as telescopes, microscopes, and celestial globes; guns with flintlock, pistols, scarlet woolen cloth, Persian or Indian rugs, glasses, drugs, Western dogs and horses; all these things were imported through the Dutch trading house."³⁰ High officials of the Bakufu as well as the Daimyo competed keenly to obtain these things. "Ranpeki" (Dutch taste) which constituted the highest luxury of the upper class of the Edo period, was a modified version of the traditional worship of Chinese goods. And the Japanese eagerly studied Dutch books in order to discover the background of this amazing material culture. Unfortunately no guidance of Western immigrants was available because of the isolation policy. Therefore they developed the method of studying imported models with reference to the descriptions of translated Dutch books, then reconstructing these models.

Yoshida's proposal is important for understanding the role of Rangaku in the development of Japan. In the second section of this paper, we have described

²⁹ Yoshida Mitsukuni *Nippon to Chûgoku —Gijutsu to Kindaika* [Japan and China: Technology and Modernization] (Tokyo 1989).

³⁰ *Ibid.*, 21.

the samurai's behavior in acquiring Western style armament as "at first to acquire a textbook through the Dutch trading house in Nagasaki; then to carry out a collaborated translation of it into Japanese; and finally to construct the object, through trial and error, according to the description found in the book". This was the attitude long nurtured by Rangaku students during the Edo period but at the same time it was deeply rooted in the Japanese tradition of learning from Korea and China. This was the reason why Rangaku, which was the province of a small group throughout the whole Edo period, could play such an important role in Japan's later development. Once national attention was oriented towards the West, people accepted naturally the Rangaku method as appropriate for learning from the West. Searching for superior things, whether spiritual or material, in the West, importing books on them from the West, translating them into Japanese, studying them collectively, importing models, studying them with reference to descriptions found in the literature, and finally reproducing them in Japan: this was the intellectual attitude of the Japanese underlying the whole process of Japan's modernization (Westernization). We can perceive a strong heritage from Rangaku in this attitude.

Though this attitude seems to have been not so adapted to creative works in science as compared to the European intellectual tradition, it was less discriminative against mechanical arts. Some Daimyo carried out mechanical arts by themselves. Shimazu Nariakira invented a spinning frame. His princess wove cotton textiles by herself and presented them to important visitors. Yamao Yozo, a samurai from the Chōshū Han and later Minister of Kōbushō, did not hesitate to work as an apprentice at a shipyard in Glasgow for the study of shipbuilding. Yamanobe Takeo, another samurai from the Tsuwano Han and later president of the Osaka Spinning Company, worked as an apprentice at a spinning mill in Manchester, and transferred skills to his company. Such behavior is amazing when we consider the fact that Tokugawa feudalism was under the strict discrimination of social classes which placed craftsmen at the second from the lowest. Perhaps this can be explained by the Rangaku tradition. Shimazu Nariakira was famous for his Ranpeki (Dutch taste). His taste for mechanical arts was inseparable from the elegant taste of the upper class. Dutch learning was also inseparable from it. In this tradition, pursuit of intellectual interests was always connected with reproduction of curious mechanical products from the West. This tradition was advantageous to Japan's industrialization.

Trade between Asian Countries

We have been stressing the importance of seeing Japan's development in the history of intercourse between the East and West and also between Asian

countries. Economically this means that we should pay more attention to intra-Asian trade. Dr. Sugihara Kaoru demonstrated that trade between Asian countries grew at a rate of 5.4% per annum from 1883 to 1913 while that between Europe and Asia grew at 3.2%.³¹ His analysis shows that the main constituents of intra-Asian trades were, cotton yarn, raw cotton and rice. Roughly speaking this growth was caused by the following: first, the modern (Western style) spinning industry emerged in India in the mid nineteenth century; second, a flow of cotton yarn from India to Japan stimulated the rise of the modern cotton spinning industry in Japan; third, the flow of cotton yarn from India and Japan to East Asian countries caused the development of local cotton textile industries; and along with these changes, certain Asian regions were specializing in staple agriculture or cotton cultivation and consequently the trade of rice and raw cotton increased.

Sugihara's findings teach us that it was not only the European industrial economy but the emerging Asian industrial economy which affected the later development of Japan. Asian countries began to influence each other through intra-Asian trade. Asian influences made a dynamic impact on Japan's development which in turn affected Asian development. We can confirm this by Japan's machinery trade to Asia which embodies nothing else but a transfer of technology.

In the third section, we referred to the traditional/Western hybrid nature of Kikaiguri equipment which made this machine appropriate for local conditions. Most machines invented by the Japanese in the Meiji period were of a similar nature. Some among them became important Japanese machinery exports to Asia. Perhaps what was appropriate for Japan was also appropriate for the rest Asia. For example, rickshaws occupied the top rank of early machinery exports. Their main destinations were Hong Kong, Singapore, Penang and Indian cities, towns which had developed through intra-Asian trade demonstrating perhaps a similarity in urban transportation conditions between them and Tokyo, Yokohama and Osaka.³² The invention of a noodle manufacturing machine is another example. From the turn of the century this machine was also actively exported to China and Korea, where noodles are much loved.³³ These exports, however, did not continue for long. With the advent of street cars in Singapore and other cities, the export of rickshaws declined rapidly. The Chinese soon began to manufacture

³¹ Sugihara Kaoru 'The Growth of Intra-Asian Trade and its Structure', *Shakai-Keizaishi-gaku* 51.1 (1985) 17-53.

³² Saito Toshihiko *Jinrikisha* [Rickshaws] (Tokyo 1979) 219-20.

³³ Furusawa Kiyoko 'The Role of a Failed Rural Machinery Manufacturer', in Nakaoka Tetsuro, ed. *Gijutsu Keisei no Kokusai Hikaku* [International Comparisons of Technological Capability Building] (Tokyo 1990) 230-267.

copied noodle-making machines. What was appropriate technology for Japanese mechanics was also appropriate for Chinese ones. Since they could easily copy the machine, its export declined rapidly. These declines motivated the infant Japanese machinery industry to develop other products and cultivate different fields. Many manufacturers tried to adapt. Some failed and disappeared, while others were successful in shifting, for instance, to machine tools or electrical machinery.

The above process suggests that hybrid technology or Japanized Western technology may have been more appropriate to other East Asian countries than original Western technology and that the transfer of such technology might have helped endogenous Asian development which in turn affected Japanese development. We can find many examples suggesting this, especially in the Asian textile industry of this period. Unfortunately, Japan's invasion of East Asia, beginning in the 1920's, stopped the full exploitation of possibilities for the mutually interactive development of East Asian countries.

Concluding Remarks

The author has been focusing on technological aspects of Japan's development in this paper. This is because he is a Japanese specializing in the study of modern technology transfer. His intention was to depict, through a history of Japanese development, the main aspects of a period in which both European and intra-Asian contact interacted dynamically, causing varied endogenous evolution or involution. Roughly speaking, we can say that it was a period in which the dynamic action of the European industrial nucleus proceeded to the East, operating on the traditional economies of Asian countries, integrating them into the European economy, and finally establishing colonial economies there. However, a closer look will reveal the more dynamic interaction of endogenous factors and exogenous impacts. Japan is a good example. Exogenous influence came not only from Europe, but also from China, India and Korea. European influence included some elements of Asian tradition earlier transferred to the West. Japanese endogenous factors also involved elements of Indian, Chinese, Korean, Spanish, Portuguese and Dutch traditions. The dynamic interaction between them all is reflected in Japan's development since the initial contact with the frontier of the European industrial economy. If we shift our view point to other Asian countries we find other types of dynamic interaction between endogenous and exogenous factors, resulting in each country's specific development.

Scientific and technology transfer was not a phenomenon isolated from such dynamic interaction. As we have seen in this paper, they were invariably

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transferred along with the flow of products, immigrants, or political influence, etc. In other words, the study of the transfer of science and technology between Europe and Asia, and also between Asian countries in this period, will disentangle the dynamic interaction of numerous factors.

The author expects that discussions in this conference will offer many leads to the understanding of Asian development today, while at the same time offering solutions to Needham's "Grand Question" of why modern science emerged only in Western Europe.