THE FORMATION OF HEAVY INDUSTRY

——One of the Processes of Industrialization in the Meiji Period——

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I

The aim of this short paper is to draw attention to a number of problems connected with industrialization[1] in Japan by means of a consideration of the process of the establishment of heavy industry.

The words 'heavy industry' are a common-sense term, but among the industries which are designated by this term the production-goods producing industries and the armaments industries differ completely in respect to their significance for economic development. However that may be, the fact of the matter is that in Japan, in the course of the process of transplanting modern industry at the hands of the state which took place after the Meiji Restoration, the nurturing of heavy industry

1 The term "industrial modernization" may be broadly rendered as meaning the "industrial revolution." The words "industrial revolution" are used in a variety of senses, but in this case they are used in the sense of the establishment of the factory system in the cotton spinning industry, or, in other words, the establishment of a mechanized cotton spinning industry. In passing we may give the following outline account of the pre-history of the industrial revolution in Japan.

We may roughly describe the process of the modernization of industry in Japan as having proceeded along two courses—the reorganization of traditional industries and the transplantation of industries from the advanced countries. The former includes the type exemplified in the cotton industry, in which some degree of improvement had been effected before the Meiji Restoration in the latter years of the Tokugawa régime, and later during the first years of the Meiji period, while later again the industry continued its development in association with machinery and technology imported from the advanced countries, the type exemplified in the pottery and brewing industries, which did not undertake any special form of modernization, particularly modernization along western European lines, but transformed themselves into traditional local industries, and the type intermediate between these two exemplified in the silk-reeling and raw-silk industry, in which modernization took the form of gradualistic and partial improvement. Among these, cotton and silk were the principal exporting industries.

We may describe the transplanted industries as being industries such as the military industries (arms and explosives), the iron and steel industry, the glass industry and the cement industry which had practically no traditional foundations but were directly imported from abroad.

was forcibly carried out with the military sector, headed by the armaments industry, as the centre. That is to say, the military industries have an overwhelming significance in relation to heavy industry and the chemical industries among those government-run factories and mines which the government operated under its own management during the early Meiji period.[1] Rather than this it would be no exaggeration to say that all factory industry was built with a military significance (See Table 1).

In the 1880's the government factories and mines were sold off to private enterprise at the time of a change in government financial policy (See Table 1). In these cases it was important that the branches of industry producing armaments and naval vessels remained under government management as military arsenals, and the fact was that not only did these arsenals become an important form of state capital thereafter, but there was firmly established that order in which the military industries of the Army and Navy were carried on with the military arsenals as their axis. What is more, these factories and mines were sold off to the privileged political merchants of the time at prices which were merely nominal and under conditions which were absurdly easy.[2] Thus the selling-off of these factories and mines became an important occasion for the formation of the so-called *Zaibatsu* or financial cliques.[3] Further, even after these factories and mines had been sold off, they were accorded generous protection by means of subsidies and in other ways.

However, there are a number of different evaluations of the significance of this "selling-off of the factories." It is of course true that, from the point of view of the whole, this may be taken to mean that the process of the formation of the basis for capitalism in Japan had been more or less completed, but we cannot declare completely that

1 The government operated factories may be divided into those which had been operated by the Shogunate or the great fiefs in the latter years of the Tokugawa régime with the help of machinery and technology imported from the advanced countries and which were taken over and enlarged by the Meiji government after the Restoration, and those which were set up on an entirely new basis by the new government after the Restoration. With one or two exceptions, all the mines which had been operated by the Shogunate or the fiefs in the period of the Tokugawa régime were taken over and operated by the new government.

2 The "political merchants" mentioned here were privileged merchants having special relations with important figures in the Meiji government.

3 The greatest characteristic of the *Zaibatsu* was their control by family groups associated with the traditional family system. These *Zaibatsu* were isolationists both in regard to funds and in regard to personnel, and particularly in the cases of the Mitsui, Mitsubishi and Sumitomo *Zaibatsu* they carried on diversified business in all fields of the economy, in banking, mines, industry, foreign trade, warehousing, insurance, etc.

Table 1. GOVERNMENT OPERATED FACTORIES IN

Factory	Establishment
The Tokyo Artillery Arsenal	Established in 1868 by taking over the Shogunate's Sekiguchi factory.
The Ōsaka Artillery Arsenal	Established in 1870 by taking over the Shogunate's Nagasaki factory and other establishments.
The Itabashi Explosives Factory	Completed 1876.
The Takinokami Explosives Factory	Taken over from the Kagoshima fief in 1870.
The Iwahana Explosives Factory	Established 1882.
The Meguro Explosives Factory	Established 1885.
The Yokosuka Shipbuilding Yard	Established 1868 by taking over the Shogunate's Yokosuka Iron Works.
The Navy Arsenal	Established 1874.
The Yokohama Factory	Established 1868 by taking over the Shogunate's Yokohama Iron Works.
The Nagasaki Shipbuilding Yard	Established 1868 by taking over the Shogunate's Nagasaki Iron Works (later called Nagasaki Seisakusho, Nagasaki Kōsaku Bun-kyoku).
The Hyōgo Shipbuilding Yard	Established by moving plant from the Kashū Factory, purchased 1873.
The Ishikawajima Shipbuilding Yard	Established 1868 by taking over the Shogunate's yard.
The Uraga Shipbuilding Yard	Established 1868 by taking over the Shogunate's yard.
The Akabane Kōsaku Bun-kyoku	Established 1881 with iron producing equipment of the Saga fief as basis, and at first called the Akabane Iron Works.
The Fukagawa Kōsaku Bun-kyoku	Started operation in 1875, a continuation of a Saga fief establishment, producing cement.
The Shinagawa Glass Manufacturing Plant	Set up in 1876.

Source: Compiled from Ministry of Finance, *Kōbushō Enkaku Hōkoku* 工部省沿革報*shi—Zōsen-hen* 明治工業史—造船編 (A History of Industry in the Meiji Period

industry in general had developed sufficiently to be able to stand on its own feet, with the special exception of the military industries, and in particular, that non-government capital had been accumulated to a sufficient degree. Attention is frequently drawn to the fact that this was a reorganization carried out so that the government might concentrate its operation in the directly military branch of industry. In the last analysis,

THE EARLY MEIJI PERIOD (Heavy-Chemical Industry)

Sold Off	Sold Off To	Notes
		At first called the Heikishi.
		At first called the Ōsaka Heikishi. Was in charge of the branch arsenals at Kagoshima and Wakayama, and the gun factory at Hagi.
		Under the Tokyo Artillery Arsenal.
		Under the Army Ministry.
		Under the Navy Ministry. After 1893 under the Army Ministry.
		At first under the Ministry of Works. In 1872 was transferred to the Navy Ministry, and became a Naval Arsenal.
		Leased in 1879 to become the Ishikawaguchi Factory, Yokohama.
1887	Mitsubishi	Leased to Mitsubishi in 1884.
1886	Kawasaki Shōzō	Sealed off in 1876. Later revised as the privately operated Hirano Shipbuilding Yard.
		Sealed off. Later revived as the privately operated Uraga Dock.
		Manufacture of iron and all types of machinery. Under the Ministry of Works. Abolished 1883.
1884	Asanuma Shinichirō and Nishimura Katsuzō.	Under the Ministry of Works. This enterprise, which took ¥93,276 to set on foot, was sold off for ¥73,862, payable in annual instalments over 25 years.
1885	Nishimura Katsuzō.	Under the Ministry of Works. This enterprise, which took ¥189,632 to set on foot, was sold off for ¥79,950, payable in annual instalments over 55 years.

告 (Report on the Ministry of Works), Tokyo, 1889; Kōgakukai 工學會, *Meiji Kōgyō*—Shipbuiding), Tokyo, 1952.

the historical significance of the selling-off of the factories may be considered, as we have noted above, to have consisted chiefly in the fact that the factories were sold off by the government to political merchants and formed the basis of the *Zaibatsu* or financial cliques.

Further, the selling-off of the factories had the significance of an epoch-making "change of formation" of industry in the history of Japanese

capitalism. After the selling-off of the factories it was the general principle that manufacturing and mining developed with private enterprises as their centre, leaving in government hands only a part of the military industries which it was thought impossible to entrust to private interests, at least at that stage.[1] Viewed from another standpoint, this means that Japan had now passed beyond the first stage in the development of a backward country, the stage in which manufacturing and mining are modernized with government operated factories and mines as their centre.

However, as we have noted above, Japanese heavy industry took a special form in that it was transplanted at government initiative in advance of the industrial revolution centred on the cotton industry, but although the transplanting of industry in the early Meiji period had its own peculiar significance it may nevertheless be described as being of an emergency character, and it was not until the period of the Russo-Japanese War (1904–1905) that the basis of heavy industry in Japan was firmly established. In comparison with the cloth producing sector, in particular, the cotton industry, this development took place at least ten years later. That is to say, the firm establishment of the basis of heavy industry took place approximately ten years after the completion of the industrial revolution centred on the cotton industry.

In the thirty years following the Meiji Restoration, up to 1897, only the armaments producing branches of heavy industry, centred on the Army and Navy arsenals, were prominent (for example, the Murata rifle of 1885, the establishment of the Kamaishi Cast Iron Works for the production of armaments for the Army in 1890, and the invention of the Shimose explosive in 1888), while the metallurgical and machine tools industries, which are the most basic of the production goods industries, were not only unable to stand on their own feet, but were completely behind the times. Table 2 shows imports and exports of machinery in the Mid-Meiji period. Thus, at this period armaments and railway rolling-stock were being produced chiefly by government operated factories, against the background of an overwhelming dependence on foreign imports on the part of the production-goods industries we have mentioned above (especially the machine tools industry). It is particularly worthy of note that the proportion of government operated factories is markedly

1 The sector of industry directly producing armaments for the Army and Navy remained under government operation as the arsenals, and continued in this condition up to the time of the Second World War. We may add that the Yawata Iron Works, which began operation in 1901 as the biggest plant of its kind in the Orient, was started under government operation, and so remained until the 1930's.

large. Further, among these government operated factories the proportion occupied by machine-using factories is overwhelmingly large. Thus, in 1890 there were 27 government operated factories, accounting for 56% of the total number of factories, 75% of total horse-power, and 88% of the total number of employees, while among armaments factories government operated factories accounted for 40% of the total number of factories, 74% of total horse-power, and 54% of the total number of employees.

Table 2. IMPORTS AND EXPORTS OF MACHINERY IN THE MID-MEIJI PERIOD

	Exports (¥10,000)	Imports (¥10,000)	Of which Textile Machinery	Imported Shipping (¥10,000)
1887	—	220	12	52
1892	6	358	35	43
1897	22	2,297	540	823
1902	86	1,321	70	148

Source: T. Tsuchiya, *Sangyō-shi* 産業史 (A History of Industry), Tokyo, Tōyōkeizai-shimpō-sha, 1944, p. 239.

This development in the heavy industry sector after 1897, especially that centred on the military industries, was occasioned by the expansion of armaments which took place after the Sino-Japanese War of 1894–1895 (a regular Army of 150,000 with a war-time strength of 600,000, and a Navy of 200,000 tons). Railway building, too, had a military significance. Further, the funds distributed for this purpose were derived from the indemnity of ¥365,000,000 which Japan received as a result of her victory in the Sino-Japanese war. The fact that the industrial revolution in the heavy industry sector was occasioned in the manner described above made decisive the military character of the structure of Japanese industry. Let us now take a general view of each of the sectors of industry.

II

In the iron and steel industry the starting of the government operated Yawata Iron Works in 1901 is an index of the establishment of industrial capitalism over the whole field of heavy industry.

In the first years of the Meiji period the iron and steel industry was centred on the Kamaishi Mine and the plant attached to it. The Kamaishi Mine was transferred from the management of Ono Zenuemon to government operation in 1874, and steps were taken to modernize

the mine by engaging the services of seven English engineers, but this was a failure because of excessively high costs (¥31.20 as against ¥27.50 for imported pig iron). Later, in 1884, the mine was sold off and came under the management of Tanaka Chōbei. Four new steel-lined coal-extruding blast-furnaces were set up and in 1897 the annual production had reached 4,290,000 *kan* (16,100 tons), while in 1890 it was proved that the cast iron produced as raw material for Army ammunition was of a quality superior to that of the Italian Gregorini cast iron which had hitherto been taken as a model.

In addition to Kamaishi, steel plant was also set up and run under government management for arms production at the Tsukiji Naval Arsenal (where in 1882 a Krupp-type crucible steel-making plant was completed, the first western-type steel-making plant in Japan), the Ōsaka Army Arsenal (1890), the Yokosuka Naval Arsenal (1896), the Kure Temporary Steel Plant (1895) and the Tokyo Artillery Arsenal (1896). Later these government operated plants performed the function of supplying raw iron and steel to privately run plants.

In 1891, however, shortly before the Sino-Japanese War, a bill for the establishment of steel plant under the control of the Navy Ministry (of an annual capacity of 30,000 tons) was put before the second session of the Imperial Diet by the Matsukata cabinet. This proposal aimed at producing raw material for the armaments used by naval vessels and especially at breaking free from dependence on foreign sources of supply, with a particular view to avoiding the ill effects of a stoppage of steel imports during war-time, and envisaged the establishment of model plant at a number of locations all over Japan. The bill was rejected by the lower house, but the government later set up a Committee for the Investigation of Steel-Producing Undertakings (at first under the Cabinet, and later under the Ministry of Agriculture and Commerce). The Committee reported in favour of the establishment of government operated plant, and the establishment of such plant was carried one step further towards realization by the setting up of the Temporary Committee for Iron and Steel Production Undertakings in 1893. In this matter the House of Peers was extremely positive, but with the Sino-Japanese War the drive to establish iron and steel plant became all the more active, and at the eighth session of the Imperial Diet in 1895 it was proposed by the lower house that government operated iron and steel manufacturing plant should be established, as a result of which a Committee for the Investigation of Iron and Steel Undertakings was set up and concrete surveys carried out, so that at the ninth session of the Imperial Diet in

1896 the second Itō cabinet (with Enomoto Takeaki as Minister for Agriculture and Commerce) successfully proposed a bill providing for continuous expenditure of approximately ¥4,000,000 over the four years 1896 to 1899 for the purposes of establishing government operated iron and steel producing plant. It was expected that the primary task of this plant would be that of producing steel for use in armaments manufacture, production of steel for general use taking second place, and it was intended to begin with small-scale production and expand gradually, the annual target production being set for the meantime at 60,000 tons. In March, 1896, the official regulations for government iron and steel manufacturing plant were promulgated and the site for the establishment of the plant was fixed at Yawata Village in Onga County, Fukuoka Prefecture. Work began in 1897 with the annual target figures changed to 90,000 tons because of the expansion of armaments following the Sino-Japanese War, and German engineers were specially engaged for the setting up of the plant. Later supplementary finance was made available under the budget, so that the aggregate construction costs of the plant reached the figure of approximately ¥10,000,000. In February, 1901, the smelting furnace was lit for the first time, and in the autumn of the same year the starting of production was inaugurated. We may note that in the domestic production figures for this year the Yawata Iron Works accounted for 53% of the pig iron and 82% of the rolled steel, thus attaining at once a position of overwhelming superiority.

A very important matter in these events was the conclusion of a contract for the importation of Chinese Ta Ya iron ore in 1899 before the plant began operation. At first it had been intended to rely on supplies of ore from Japanese mines such as the Kamaishi and Akaya mines, but this was now changed, and thereafter Japanese iron and steel manufacture remained dependent on Ta Ya ore. In this way the foundations of iron and steel manufacture in Japan were laid on the occasion of the Sino-Japanese War and with military ends in view by the establishment of government operated plant having the north Kyūshū coalfield as its hinterland, facing Korea and China on the continent, and using Ta Ya iron ore as its raw material. Thereafter the Yawata Iron Works was repeatedly expanded, but iron and steel manufacture in Japan suffered from weaknesses in its raw materials from the very start, and it is of particular importance that it was dependent on Chinese supplies of iron ore and coal. At all events it is of extreme importance that iron and steel manufacture in Japan set out with military aims and in association with imperialistic expansion and rule.

Thereafter the Japanese iron and steel manufacturing industry underwent rapid development which extended from the beginning of the Meiji period into the first years of the Taishō period, development marked by the beginning of the first whole-process steel manufacture in Japan at the Kamaishi Iron Works in 1903, the beginning of thick plate manufacture at the Yawata Iron Works in 1904, the beginning of production for the first expanded target figures of 180,000 tons at the Yawata Iron Works and the beginning of thin plate manufacture at the same works in 1909, the establishment of the Wanishi Iron Works and the Japan Steel Works, and the beginning of operation at Sumitomo Cast Steel in 1910, the establishment of the Kōbe Steel Works and the Honkeiko Iron Company in 1911, the establishment of the Japan Steel Pipe Company in 1912, the beginning of production for the third expanded target figures of 750,000 tons at the Yawata Iron Works in 1916, the beginning of operation at the Kenjiho Iron Works in 1918, and the beginning of operation at the Anzan Iron Works in 1919. What we must note here is the overwhelming importance of military considerations (for example, the rolled steel delivered to the Army and Navy in 1916 by the Yawata Iron Works amounted to 22% of its production by weight, and 31% by price), the firm establishment of an independent basis of operation by the securing of bases in colonial territories on the continent, such as Manchuria and Korea (Honkeiko, Kenjiho, Anzan, etc., as mentioned above), and the forcible effecting of government policies of protection (the removal of customs duties on imports of raw iron and steel ores in 1901, the lowering of customs duties on iron and steel in 1906, the establishment of the Iron and Steel Industry Survey in 1915, and the passing of the Law for the Encouragement of the Iron and Steel Industry in 1917).

Concrete figures showing the development of the iron and steel industry during this period are as follows. First, the increase in the production of pig iron and steel from the Mid-Meiji period up to the early Taishō period, as shown in Table 3, is very striking. Again, the state of exports and imports is shown in Table 4. The degree of self-sufficiency increased rapidly between 1910 and 1920. Thus in the case of pig iron (including alloys) the average degree of self-sufficiency was 45% over the years 1905–1911, 60% over the years 1906–1910, and 56% over the years 1911–1915, while in the case of steel and rolled steel the figures were 16%, 25%, and 38% respectively. It is particularly worthy of note that domestic production of pig iron overtook imports during the Russo-Japanese War (1904–1905). The fact that steel and

Table 3. PRODUCTION OF IRON AND STEEL, 1893–1917

(Unit: tons)

	Pig Iron	Rolled Steel (including special steel)
1893	17,283	808
1894	16,074	1,208
1895	18,126	1,064
1896	24,663	1,192
1897	26,877	1,080
1898	22,480	1,100
1899	20,752	908
1900	23,303	970
1901	56,834	6,033
1902	39,604	31,034
1903	30,623	39,788
1904	67,897	59,945
1905	80,367	71,127
1906	141,279	69,375
1907	140,073	90,579
1908	145,823	99,255
1909	164,244	102,982
1910	188,018	167,967
1911	203,067	191,700
1912	237,755	219,714
1913	240,363	254,952
1914	300,221	282,516
1915	317,748	342,870
1916	388,691	384,025
1917	489,252	529,614

Source: Ministry of Commerce and Industry, *Seitetsu Shiryō* 製鐵資料 (Source Material on Iron and Steel Manufacture), Tokyo, 1936.

Table 4. EXPORTS AND IMPORTS OF IRON AND STEEL FROM THE MID-MEIJI PERIOD TO THE EARLY TAISHŌ PERIOD

(Unit: 1,000 tons)

	Domestic Production		Imports	
	Pig Iron and Alloys	Steel and Rolled Steel	Pig Iron and Alloys	Steel and Rolled Steel
1877	—	8	2	14
1887	—	15	6	59
1892	17	1	12	36
1897	26	1	44	207
1901–5	55	42	66	215
1906–10	158	106	105	325
1911–15	262	258	209	422

Source: Compiled from T. Tsuchiya, *A History of Industry in the Meiji Period*, p. 309.

rolled steel lagged behind pig iron (this characteristic was continued into the 1930's and 1940's) is a weak point in Japanese iron and steel manufacture, but nevertheless the increase in production in this branch of industry was also conspicuous, and if the average of the years 1901–1905 is taken as 100 the figure for 1911–1915 is 614.

We may summarize the above by saying that Japanese iron and steel manufacture embarked on the way to firm establishment with the epoch-making beginning of production at the Yawata Iron Works in 1901, but it was characteristic of the industry that it was always subject to restrictions imposed by the demands of military considerations, that it rested on the foundations of the military rule of colonial territories such as Manchuria and Korea (particularly in its dependence on the continent for supplies of iron and steel ores and coal, and in obtaining colonial manufactured pig iron and steel), that the iron and steel branches of the industry developed disproportionately, that state capital occupied a dominating position in it, and that right up to the Taishō period self-sufficiency was far from attained, either in the case of pig iron or in that of steel. However, it is a mistake to stress only the military character of the industry, and we must accord due recognition to its connexions with general industry, to its purely economic significance.

The machine and shipbuilding industries also established themselves on firm foundations in the latter part of the Meiji period, during the Sino-Japanese and Russo-Japanese wars, but in this case the branch of the industry producing prime movers, especially ship's engines, developed disproportionately in comparison with the branch of the industry producing work-machines. In these industries the shipbuilding and engine manufacturing branches developed first, growing along the lines laid down by the military sector, particularly by naval expansion, while in the work-machines branch the production of textile machinery, which is directly connected with the consumer-goods producing sector, was markedly backward in comparison with the production of machine tools used in shipbuilding, engine manufacture and armaments manufacture. This mode of development was literally of an inverted character, and in such cases as textile machinery, a form of machinery which has the most basic significance, Japan was dependent on machinery imported from England right down to 1910 and thereafter.

Considering first the case of shipbuilding, the main axis of this branch of industry was the construction of naval vessels (80% of the total tonnage built in Japan during the 10 years following the Russo-Japanese War consisted of naval vessels), and in particular this was

occasioned by armaments expansion consequent upon the Sino-Japanese and Russo-Japanese wars. Further, the naval arsenals occupied a leading position in this branch of industry. Among the private enterprises, Ishikawajima, Kawasaki, Ōsaka Tekkō, and the Nagasaki shipyards undertook the construction of large-size naval vessels, but it is worthy of note that not only did they receive orders from the service ministries but also had their installations commandeered by them (for example, during the Sino-Japanese War the installations at the Ishikawajima shipyards were commandeered by the Naval Arsenal), and that they were covered by government protection embodied in the Law for the Encouragement of Shipbuilding of 1896. Another important fact was that the arsenals and private manufacturers purchased manufacturing rights from foreign companies in respect to engine manufacture (for example, the Mitsubishi shipyard at Nagasaki purchased the right to manufacture turbines from the English firm of Parsons in 1904, and the Kawasaki shipyard purchased the right to manufacture the American Curtis turbine in 1907). In this way by the end of the Meiji period government and private shipyards were approaching world levels in the construction of large-size first-class naval and mercantile vessels, complete with engines.

The following is an account of the naval and mercantile vessels, and their engines, built in Japan from the year 1887:

1887 First naval vessel built by private enterprise. (The Chōkai, at the Ishikawajima Shipyard.)

1889 The Kamogawa Maru built at the Kawasaki Shipyard.

1892 Beginning of manufacture of cast steel engines for naval vessels at the Yokosuka Naval Arsenal.

1893 Imperial order for the encouragement of the manufacture of mirrors.

1896 Law for the Encouragement of Shipbuilding passed.

1897 First ship built under the Law for the Encouragement of Shipbuilding, the Iyo Maru, launched at the Kawasaki Shipyard. Invention of the Miyahara-type boiler.

1898 The epoch-making Hitachi Maru completed at the Nagasaki Shipyard. (Two 2,000 h.p. triple expansion engines, steam pressure 200 psi.)

1901 300 h.p. Miyahara-type water tube boilers manufactured at Shibaura Manufacturing Plant. The Taitei Maru completed at the Nagasaki Shipyard. (First ship fitted with forced draft system.)

1902 The Wakamatsu Maru and Daiya Maru completed at the Nagasaki Shipyard. (First vessels fitted with quadruple expansion engine.) Lightship ordered by China launched at the Kawasaki Shipyard. (First vessel built for a foreign country.) The naval vessel Hashidate refitted with Miyahara-type boilers.

1903 The epoch-making fast vessel Nikkō Maru completed at the Nagasaki Shipyard. Invention of the Ikeda-type water tube boiler.

1904 Nagasaki acquired manufacturing rights in respect to Parsons' turbines. (Beginning of turbine manufacture for marine and land use.) The Niitaka

and Otowa completed at the Yokosuka Shipyard, and the Tsushima at the Kure Shipyard. (All fitted with new type boilers.)

1905 Work begun at the Yokosuka Shipyard on the Satsuma, the biggest battleship in the world. The Mitsubishi Kōbe Shipyard began operation.

1907 The Kawasaki Shipyard acquired manufacturing rights in respect to the Curtis turbine.

1908 The Tenyō Maru, Chiyō Maru and Sakura Maru completed at the Nagasaki Shipyard. (Fitted with Parsons' turbines.) The naval vessel Mogami (fitted with Parsons' turbines) launched.

1909 The Kiyō Maru launched at the Nagasaki Shipyard. (Fitted with the latest large-type aft engines.) The naval vessel Ibuki (fitted with Curtis turbines) completed at the Kure Shipyard.

1910 The Satsuma completed at the Yokosuka Shipyard. The Shunyō Maru (a large turbine-driven vessel) completed at the Nagasaki Shipyard.

1913 Beginning of the manufacture of the Takuma-type boiler. The Anyō Maru (the first Japanese-built vessel fitted with geared turbines) launched at the Nagasaki Shipyard.

1914 The naval vessel Kirishima reconstructed with Ro-gō-type boilers.

1915 Beginning of the shipbuilding boom.

1916 The naval vessel Ise launched at the Kawasaki Shipyard (thoroughgoing practical utilization of the Ro-gō-Kampon-type boiler). The Mitsubishi Kōbe Shipyard acquired manufacturing rights in respect to the Ljungeström turbine.

1917 The Navy 8-4 Plan. The Destroyer Ekaze launched geared turbines.

1918 The Tenryū (a large naval vessel fitted with geared turbines) launched at the Yokosuka Shipyard.

1919 New record in shipping tonnage.

1920 The battleship Nagato completed at the Kure Shipyard.

As will be clear from the above, by the end of the nineteenth century and the beginning of the twentieth, shipbuilding and engine manufacture had literally caught up with world levels, and had even reached the stage of surpassing them. Particularly representative in the above account are the building of the Satsuma (the biggest battleship in the world) and the Ibuki (which together with the Aki was fitted with Curtis rotary steam engines, and has been described as "epoch-making in the history of world naval shipbuilding"), and the invention of the Miyahara-type boiler and the Takuma-type boiler. However, as we see in this instance, the military character of the development which took place, centred as it was on the construction of naval vessels, was always of particular importance.

Table 5 shows the ratio between domestic shipbuilding and imports of shipping between the Meiji Restoration and 1915. It is noteworthy that after 1910 domestic building at length surpasses imports. Again, Table 6 shows the ratio between government and private enterprise naval construction. The arsenals, that is, state capital, occupy an overwhelming position, but it is worthy of note that after 1910 the proportion

Table 5. RATIO BETWEEN JAPANESE STEAM VESSELS BUILT IN JAPAN AND ABROAD BETWEEN THE BEGINNING OF THE MEIJI ERA AND THE BEGINNING OF THE TAISHŌ ERA (%)

	Built in Japan	Imported
1874–1884	26.4	73.6
1885–1895	19.4	80.6
1896–1905	31.1	68.9
1906–1915	60.1	39.9

Source: Koyama Hirotake 小山弘健, "Nihon Gunji Kōgyō Hattatsu-shi 日本軍事工業發達史 (A History of the Development of the Military Industries of Japan)," in *Nihon Sangyō Kikō Kenkyū* 日本産業機構研究 (Studies in the Mechanisms of Japanese Industry), Tokyo, Itō-shoten, 1943, p. 128.

Table 6. RATIO BETWEEN GOVERNMENT AND PRIVATE ENTERPRISE NAVAL CONSTRUCTION BETWEEN THE BEGINNING OF THE MEIJI ERA AND THE BEGINNING OF THE TAISHŌ ERA (%)

	Government	Private Enterprise
1874–1884	100.0	—
1885–1895	97.2	2.8
1896–1905	100.0	—
1906–1915	73.4	26.6

Source: H. Koyama, "Nihon Gunji Kōgyō Hattatsu-shi," p. 128.

built by private enterprise rises to 26.6%. Among the private shipyards the Mitsubishi yards at Nagasaki and Kōbe, and the Kawasaki yard at Kōbe possessed a particularly important significance. In particular the Mitsubishi yard at Nagasaki, along with the arsenals at Kure and Yokosuka, remained a great shipyard well up to world standards right up to the time of the Pacific War and built a number of important naval vessels, notably the battleship Musashi.

Steps were taken from an early date to ensure domestic production in the vehicle-building industry, particularly the building of railway rolling-stock, under the influence of protection and demands from the part of the Army. It is important that the Japanese vehicle-building industry developed along with the development of the railways and the military policies of protection and nurturing associated with them. Thus, as is shown in Table 7, domestically produced goods and passenger rolling-stock occupied an overwhelming proportion from an early date, but in the case of locomotives the situation is just the reverse (See Table 8). In the case of locomotives, the Steam Locomotive Manufacturing Company Limited was established in Ōsaka in 1896, the first Japanese factory specializing in locomotive rolling-stock, while in 1907 the Hyōgo factory of the Kawasaki Shipbuilding Company began producing locomo-

tives and both goods and passenger rolling-stock, but with the effecting of protection policies such as the imposition of a tariff on the importation of locomotives in 1911 and the adoption of a policy of domestic locomotive construction by the railway authorities the industry embarked on a course of rapid development. During this period the two companies mentioned above produced rolling-stock in imitation of that of England, Germany, and others of the advanced countries. In this way the degree of self-sufficiency had been pushed up to 26.4% by the end of the Meiji period (See Table 8).

Such branches of industry as the machine tools industry, like the textile machinery industry, were very backward when compared with shipbuilding or armaments manufacture, and in particular they were placed outside the framework of direct government protection. Consequently, these branches of industry remained overwhelmingly dependent on foreign countries up to the time of the Russo-Japanese War. The private enterprise machine tool industry was practically confined to the Ikegai Iron Works, established in 1889, followed, after the Sino-Japanese War, by the Niigata Iron Works, established in 1895, and the beginning of machine tool manufacture at the Shibaura Manufacturing Plant in 1895. However, the demands for arms and naval vessels resulting from the Russo-Japanese War naturally brought about an increased demand in relation to the machine tool industry, and even the mobilization of private enterprise machine factories was carried out. Thus in this industry, too, the government came to adopt a positive policy of protection. In this case the leading role performed by the Navy was particularly important. Next,

Table 7. SELF-SUFFICIENCY IN ROLLING-STOCK ON GOVERNMENT RAILWAYS IN THE LATER MEIJI PERIOD (Goods and Passenger Rolling-Stock) (%)

	Built in Japan	Imported
1887–1896	82.7	17.3
1897–1906	89.9	10.1
1907–1911	79.9	23.1

Source: H. Koyama, "Nihon Gunji Kōgyō Hattatsu-shi," p. 130.

Table 8. SELF-SUFFICIENCY IN RAILWAY LOCOMOTIVES IN THE LATER MEIJI PERIOD (%)

	Built in Japan	Imported
1888–1897	1.7	98.3
1898–1907	5.7	94.4
1908–1912	26.4	73.1

Source: H. Koyama, "Nihon Gunji Kōgyō Hattatsu-shi," p. 131.

in 1888 the Anglo-American eclectic-type lathe was successfully manufactured, and in 1889 the Ikegai Iron Works manufactured a lathe for use on its own premises, thus becoming the first machine tool manufacturer in Japan, while in 1905 the same firm successfully manufactured in its entirety the American Bradford-type lathe, and hereupon the Ikegai-type lathe was put on the market. Apart from the Ikegai and Niigata works there appeared such machine tool making firms as the Honda Iron Works (1906), the Inoue Iron Works (1907), the Hirao Iron Works (1907), the Hatsudōki Seizō Company (1908), the Arakawa Manufacturing Plant (1908), Tokyo Gas and Electricity Industries (1909), the Karatsu Iron Works (1909), the Dengyō-sha Company (1910), the Rokuroku Shōten Manufacturing Plant (1912), and the Hakuyō-sha Company (1912), while such firms as the Ōsumi Iron Works, the Kubota Iron Works, and the Wakayama Iron Works also began the manufacture of machine tools. In this way a beginning was made to ensuring the domestic production of lathes and other machine tools, and imports of lathes and other similar articles began to decline after reaching their peak in 1905, but self-sufficiency in this department of production was as yet far from attained. A particularly important point is that these machine tools developed through demand and demands emanating from the armaments industry, centred on the arsenals. In sum, the machine tools industry was more or less established on firm foundations between 1897 and the end of the Meiji period, but the military phase of the development of the industry was extremely characteristic, while the low level of the industry revealed in concentrated form the weaknesses of the Japanese industrial structure and may even be said to have exercised a restricting influence over the whole of Japanese capitalism. Further, the fact that no textile machinery was produced in Japan before 1910 shows the peculiar nature of the development of the machine industry in Japan.

The armaments industry was one on which the government concentrated its protective and nurturing policies from the time of the Meiji Restoration, and in particular it was subject to direct protective and nurturing policies in the form of government operation of factories, or, in other words, state capital occupied an overwhelmingly predominant position in it. Further, the armaments industry grew disproportionately in comparison with other industries, and, as we have noted several times already, while no production of textile machinery took place in Japan until after 1910 and while such industries as the machine tool industry were markedly backward and producing at very low levels the armaments industry alone developed until it could be said to have reached world

levels. We may set out the principal indices of this development between the Mid-Meiji period and the first years of the Taishō period as follows. (Items relating to naval vessels mentioned previously have been omitted):

1880 Invention of the *Meiji 13* Murata rifle.
1881 Iwahana Explosives Factory starts operation.
1884 Regulations for Naval Shipyards promulgated.
1885 Meguro Naval Explosives Arsenal starts operation. Invention of the Naval Arsenal Steel Shell.
1886 Specification of the *Meiji 18* Murata rifle. (Issued to all garrisons.)
1887 Completion of the Trial Coastal Artillery at the Ōsaka Arsenal.
1888 Invention of the Shimose explosive.
1889 Work begun on the Kure Arsenal.
1890 Installation of a 200 kg. steel furnace at the Ōsaka Arsenal. Installation of a 5 ton horizontal Siemens-Martin furnace at the Yokosuka Arsenal. Work begun on the Sasebo Arsenal.
1891 Beginning of experimental manufacture of torpedoes at the Naval Arsenal. Promulgation of Regulations for the Naval Arsenal.
1892 Order placed with the Tokyo Arsenal by the Army Military of Australia. (First manufacture of foreign armaments.) Invention of the quick-firing steel shell at the Naval Arsenal. Beginning of manufacture of cast-steel naval engines at the Yokosuka Arsenal.
1893 Installation of precision engineering shops in the Tokyo and Ōsaka Arsenals.
1894 War-time production by Army and Navy Arsenals, private enterprise armaments factories, etc.
1895 Kure and Kokura Arsenals completed.
1896 Beginning of the manufacture of smokeless explosives at the Itabashi Factory.
1897 Specification of the *Meiji 30* infantry and cavalry rifle. Sasebo Arsenal completed. Beginning of picric acid manufacture at the Itabashi Factory.
1898 Specification of the *Meiji 31* quick-firing field/mountain gun. Manufacture of the *Meiji 30* rifle begun (Tokyo Arsenal).
1899 Establishment of the Shimose Explosives Factory.
1901 Opening of the Maizuru Arsenal.
1902 All forces equipped with the *Meiji 31* gun. Invention of the eight-inch quick-firing gun at the Kure Arsenal.
1903 All forces equipped with the *Meiji 30* rifle. Establishment of the Army Explosives Research Station.
1904 Establishment of the Atsuta Armaments Factory.
1905 Specification of the *Meiji 38* infantry rifle.
1907 Specification of the *Meiji 38* machine gun and field gun.
1911 Specification of the *Meiji 41* mountain gun, *Meiji 38* 12cm. howitzer, *Meiji 38* 15cm. howitzer, and *Meiji 38* 10cm. canet gun.
1915 Large arms orders received from Russia.
1918 Law for the Mobilization of War Industries passed. Establishment of the Army Aeronautical Research Station.

(In addition to the above items, enlargement, re-equipment and new installation of Army and Navy Arsenals occurred in practically every year.)

Thus, on grounds of political necessity everything was concentrated

in the armaments industries as being typical of modern large-scale industry, or, to express it differently, as being the material backing for the equipment, expansion and strengthening of a huge regular Army and Navy establishment under the Meiji government. It is no exaggeration to say that the industries of the Meiji period, and in particular the heavy industry sector, developed with the armaments industries as their basic axis. In particular, the invention of the Murata rifle and the invention of the Shimose explosive, together with the construction of first-class naval vessels, headed by the Satsuma, the biggest battleship in the world, by the shipbuilding and engineering industries, and the invention of the Miyahara- and Takuma-type boilers, are indeed an index of the attainment of world levels. However, the fact that these industries were completely out of balance and protuberant in relation to other branches of industry produced weaknesses not only in the Japanese industrial structure, but also in the military industries themselves.

The question of motive power is of decisive significance when we consider the industrial revolution. In general, steam power predominates over all other traditional forms of motive power during the period in which industrial capitalism establishes itself, and with the advance into the stage of the establishment of independent capital electric power takes its place along with steam power and at length secures the position of the modern form of motive power. The establishment of electric power causes a spectacular advance in the development of the chemical industry. In Japan, however, it was in 1896, when the country was passing through its industrial revolution after the Sino-Japanese War, that steam power came to predominate over all traditional forms of motive power (Watt's steam engine had been invented in 1781). Thus, out of 2,758 factories using power in 1895, 1,287, or 46%, were using steam, while out of 3,037 factories using power in 1896, 1,654, or 54%, were using steam. From the point of view of horse-power, these factories accounted for 87% of total horse-power in use. We may note in passing that it was after 1910 that electric power came on the scene in real earnest, that the switch-over from steam to electricity began in the first years of the Taishō period, and that it was during the First World War, between 1917 and 1919, that electric power came to predominate over steam.

III

In the above we have presented an outline of the process by which heavy industry became established in Japan. We may sum up by saying

that in the consumer goods industries, and in particular in the cloth producing industries, the cotton industry, comprising cotton growing, spinning and weaving, retained the leading position, and together with the silk industry, comprising sericulture, silk-reeling and silk-weaving, constituted the axis of these industries, and that whereas around the time of the Sino-Japanese War, or about 1897, the establishment of industrial capital, or in other words, the fulfilment of the industrial revolution, had been carried out, the production goods industries, tied up to such military industries as armaments manufacture, naval shipbuilding and explosives manufacture, had more or less established themselves around the time of the Russo-Japanese War, or about 1907, having the iron and steel, shipbuilding and machine tool industries as their axis.

Further, we may say that by this process there was established that pattern in Japan's industries under which the light industries and consumer goods industries developed with cotton and silk as their centre, while the heavy industries developed with shipbuilding and the the military industries as their centre. This pattern remained in being until a great change came about in the industrial structure of Japan as a result of the extraordinary development of the heavy and chemical industries after the Second World War.

We may now list the characteristic points in the process of the establishment of modern industry in Japan, centred as it was on heavy industry.

(1) Industries were developed with the help of direct and powerful government policies of protection. Further, state capital (particularly as represented in government operated factories and mines) occupied a large proportion of the whole.

(2) While the development of modernization was extremely rapid, development was inverted at many points, as well as being disproportionate. This point has been made in connexion with the specific instances in question, but we may note particularly that in the heavy industry sector it appears that the shipbuilding and military industries alone underwent extraordinary development while such industries as the machine tools industry remained markedly backward. As a result, in spite of the world-scale development of the shipbuilding and military industries, Japan's industrial structure was inevitably concentrated overwhelmingly in the light industries up to the period of the Second World War.

(3) There was a high degree of dependence on foreign supplies of raw materials, machine tools, etc., used by heavy industry. This long remained a weak point in Japanese industry.

(4) There was a wide distribution of medium and smaller industry, and these enterprises were much inferior to the large enterprises in matters of technology, equipment, etc. This condition persisted until after the Second World War in the form of the problem of the so-called "dual structure" of the Japanese economy, and it left behind it the tasks which were the most difficult that the Japanese economy had to solve.

(5) The phenomenon of premature concentration was produced. This was particularly marked in the case of such industries as the cotton spinning industry and shipbuilding, and in the cotton industry in particular a Spinner's League having the implications of a cartel was formed as early as 1883, only 15 years after the Meiji Restoration. This Spinner's League later played an important role in such matters as the curtailment of output.

(6) *Zaibatsu*, or financial cliques, were formed. Since this time the *Zaibatsu* have ruled economic circles in Japan, each *Zaibatsu* carrying on multifarious forms of business distributed over a wide field, and, apart from those enterprises which were carried on with state capital, enterprises affiliated to the *Zaibatsu* occupied positions of overwhelming dominance in the Japanese economy. Further, all of these *Zaibatsu* were under the control of family groups of the kind produced by the traditional family system, and their methods of making surveys of funds were such as to confine financial operations within narrow bounds. To view another aspect, the banks affiliated to the *Zaibatsu*, which occupied an overwhelming position in the Japanese banking world, were all banking organs serving the interests of the *Zaibatsu* to which they belonged.

(7) Japan enjoyed some advantages by being industrialized later than other countries. A representative example of this is the case of the Japanese cotton industry, particularly the machine cotton spinning industry, which was transplanted from England. As a result of this fact the very latest high-level cotton spinning machinery and technology were imported and the industry set out with this as the starting-line.

(8) In transplanting the modern industries of the advanced countries, Japan possessed sufficient capacity for response to make possible the fullest acceptance and development of these industries under the conditions peculiar to Japan. In this connexion there is the particular necessity of evaluating the legacy and foundations provided by the traditional industries from the period before the Meiji Restoration.

(9) In comparison with the rapid development of modernization in the industrial field, the agricultural sector remained static both in structure and in productive capacity, and this fact exercised a restricting influence

on the development of Japanese capitalism as a whole, including the industrial sector.

(10) Wage-rates which were low in the international scale persisted for a long time. This was closely related to the points made in paragraph (9), and in particular to the backward structure of agriculture, a structure which some have even thought fit to characterize as "semi-feudal," and to the condition of chronic poverty in the agricultural villages. In this way, as well as by the points made in paragraph (9), the "narrowness of the domestic market" was determined.

(11) Out of the relations mentioned in paragraphs (3), (9) and (10), Japan prematurely took steps to embark on expansion in quest of colonial territories overseas in her search for industrial raw materials and commodity markets, and this connected up with Imperialism. In the above the limitations to which Japanese industry was subject in the process of modernization are clearly apparent, but at the same time we must recognize that Japanese industry later underwent extraordinary development, and in particular we must recognize that the factors which led to the unprecedented economic growth after the Second World War were nurtured during the process of modernization. In considering these matters we must not fail to note that the demilitarization of Japan and the various policies for "democratization" which followed the Second World War had the effect of removing from the Japanese economy, and in particular from Japanese industry, those conditions which in the past had obstructed the development of industry in Japan.