# MEIJI JAPAN: A UNIQUE TECHNOLOGICAL EXPERIENCE?

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*The period following the Meiji Restoration in Japan (1868) was one characterised by technological and industrial advancement. In this essay, Alexander David Brown, asks where credit is due for this progress. He contends that much of the growth that was experienced was a result of the solid socio-economic base inherited by the Meiji system from the Tokugawa regime which preceded it.*

## Introduction

The restoration of the Emperor of Japan's powers to rule his country symbolised the end of the feudal Tokugawa period and the beginning of what was known as the Meiji (Enlightened) Restoration. Like many other Asian nations, Japan had been forced to sign unequal treaties with the encroaching Western powers because of their superiority in military technology. The new Meiji state was determined to change this situation by catching up on the West economically and militarily. Thus, the Meiji Restoration (1868 – 1914) saw major reforms in nearly all aspects of the Japanese economy. The subsequent industrial revolution, in the words of Lehmann, can be "seen in terms of internal responses to external stimuli" (1988: 190-191). An essential facet of Japan's economic transformation was the apparent increase in technological capabilities that allowed the economy to rapidly industrialise. In this paper, I shall identify the sources of this technological diffusion and analyse the speed at which it disseminated through the Japanese economy. Specifically I will critique much of the current thinking on the Japanese technology experience in the late nineteenth and early twentieth centuries, and offer other explanations for such developments.

Technological progress can be defined as "changes in any of the elements that produce either new products or new processes for producing old ones" (Howe 1999: 236). The basic pattern of technological innovation is the advent of major

product innovation that leads to a continuous stream of process innovations.[1] This process continues until catch-up is achieved with the pioneer of existing technological capabilities. To understand Japan's technological progress we must measure it by analysing its development over time, identify technological progress in different sectors of the economy and lastly place this information within an international context. The simplest way to look at technological diffusion is to list new products as they come into use, and further, to identify time lags between the introductions of these technologies. Another way to look at technological progress is to study the trend of physical output per worker. Specifically for Japan, technological progress was at first a process of 'catching up.' Therefore, an extremely useful measure of progress would be foreign trade measures of import-substitution.

In looking at the period 1868-1915 we are essentially studying the economic development phase that Simon Kuznets defined as 'modern economic growth.' A major condition of this phase is the "application of modern scientific thought and technology to industry" (Kelley & Williamson 1974: 17). Lehmann outlines the factors that allowed for Japanese industrialisation which can be seen sequentially i.e. political revolution leading to institutional reform, increased role of the state, development of infrastructure and then the impact/diffusion of Western technology (1988). While the diffusion of technology has been intensively studied in recent years, authors such as Saxonhouse argue that a detailed analysis of the nature of institutions in relation to the transition of technological knowledge is needed if we are to further understand this process (1974). This is extremely significant in Meiji Japan where political institutions played a major role in determining the new states' technological diffusion experience.

## Meiji State Interventionism

Howe states that national technology policy operates within three spheres (1999). Firstly, education, research and development. Secondly; defence and national security. Thirdly, commercial sectors where public involvement is needed because private investment is inadequate. An important clarification however must be made when analysing Japanese technological diffusion. Meiji government technology policy must be divided into 'strategic' and 'commercial' elements. Howe believes that the former was born out of the need for national

[1] Product innovation creates demand and expands the economy through linkages between new/old productive structures. Process innovation reduces costs of existing goods and creates domestic and international competitiveness.

defence and clearly separated from the latter that was governed by economic priorities. In the strategic realm the state intervened directly while in the commercial realm, the government provided infrastructure and assisted companies in order that they could "survive the lengthy learning process needed to make technologies competitive" (Howe 1999: 246).

The Meiji government instigated a policy of import substitution known as *kokusanka*, literally meaning 'converting to domestic production.' This was to be achieved through the acquisition of Western technologies and expertise. These acquisitions would inevitably lead to technological diversification in industry with a view to creating export competitiveness. In addition, to achieve increased technological absorption into the economy, the government needed to improve the basic infrastructure of human capital and create an inseparable bond between the public and private sectors. This bond would become the long-term tradition of the Japanese economic experience following the Meiji Restoration.

The above information seems to indicate a strong vibrant government actively engaged in the economy. However in reality the truth was much more complex. Choi points out that while the Meiji government was actively involved in the economy, quantitatively this involvement was not particularly significant (Choi). Government expenditure (excluding transfer payments) is estimated at only 8.4% of GNP between 1878 and 1882, 15% between 1898 and 1902, and 17.6% between 1908 and 1912. With the obvious exceptions of the Chinese and Russian conflicts, the Meiji government's current and capital expenditures (including military spending) lay between 7-11% of gross national expenditure (Crawcour 1997). This is particularly low if one follows the hypothesis that public spending financed the technological innovation/industrialisation of the Meiji period.

The capital investment that the Meiji administration engaged in was also not universally successful. As we see the Meiji government failed to build and operate two large blast furnaces at Kamaishi despite a 2.5 million yen investment beginning in 1874 plus technical advice from British specialists (Yamamura 1977). In the 1880s, the government began to sell off its mines and factories to private entrepreneurs. Significantly it did not sell its munitions works which suggests that state's interest in industrialisation ended with the production of military equipment. Tipton states that the sale of mines and factories by the state for relatively low prices reflects the privileged position of the purchasers and the factories' inherent lack of commercial success (1981). I would argue that this is not the whole truth – the Meiji administration sold the factories off cheaply because it was principally concerned with military production and not industrialisation per se.

The specific economic policies of the Meiji government reinforce the hypothesis that public investment was primarily focused in the military sector to

the detriment of the private. In the inflationary period during the 1870s landowners used their extra incomes to invest in rural industries, especially those producing western consumer goods. While this is in keeping with the government's policy of '*kokusanka*' or import-substitution the very same government denounced them, saying "The manufacture of these contributed but little to national power" (Tipton 1981: 143). The Meiji government responded to the inflationary period by adopting a policy of deflation advocated by Matsukata Masayoshi (Finance Minister from 1881). This deflation redirected investment from rural consumer goods (that were import-substituting) towards public military spending that led to increased importing. From the late 1870s to the early 1880s military expenditure increased by 50% indicating the pre-eminence of the 'strategic' realm of Meiji economic policy.

The inherent current running through Meiji economic policy is this; technological innovation and industrialisation had little to do with the creation of economic priorities. Meiji economic policy was almost purely political. Howe somewhat reinforces this assertion (1999). He states that while the metallurgical, mechanical and electrical engineering skills required for the strategic realm spilled into the commercial, much of the benefit of this, did not materialise until the 1920s and 1930s and some not until after World War II, indicating a lack of political force in insuring technological diffusion into the commercial economy. The above leads one to conclude that the division of strategic and commercial realms in technology policy was more than a simple administrative allocation.

Nakamura argues that the Meiji Restoration signalled the transferral of income from a high-consuming ruling class; the samurai (warriors) and daimyo (nobility) to a new group of lower-consuming landowners. This was achieved through a lower Meiji land tax that was accented by a high inflation rate that eroded their tax burdens. Subsequently there was a greater income distribution among a class of Japanese society that had a larger MPS[1]. Through this, we can move away from the hypothesis that Meiji technological innovation and subsequent industrialisation was a direct representation of state intervention in the economy. Instead, we see the more organic development of industrialisation within Japan, challenging the more traditional viewpoint of intense public-private cooperation in the economy that is certainly a feature of the Japanese economy today.

[1] Marginal Propensity to Save

## Technological Diffusion

"The most important lesson of Meiji public finance is that rapid economic growth and rapid militarization of the economy are fundamentally incompatible."

(Oshima 1965:281)

Mijamoto et al. reveal that the industries that expanded quickly in the Meiji period were not those firms that had imported western technology (1965). Traditional industries such as silk reeling and tea making were more important. As they argue, western technology was not transplanted intact into Japan, rather such innovation was an "adaptation of foreign technologies to domestic conditions" (Mijamoto et al. 1965: 18). **A** good example of this would be the spread of silk-reeling tools with gears in the Tokugawa and early Meiji periods. Post World War I can be treated as a separate phase in Meiji economic experience. From the Great War onwards, the private sector, though still relatively small, became "self sustaining and began to provide the momentum for further growth" (Crawcour 1997: 56). Okhawa, as an exponent of the 'Japanese model' of economic growth credits Japan with maintaining concurrent growth in both agriculture and industry. Crawcour argues however, that before World War I this industrial growth took place only in the traditional sector (1997).[2] This is evidenced in an 1884 survey of nongovernmental factories that revealed that of 1,981 firms, 1,237 were located in rural villages. One third of all 'factories' had no more than five workers and only 176 had more than fifty.

To understand Meiji Japan's technological dissemination process, we must look specifically at how military concerns and activities within the Japanese economy achieved this. Yamamura argues that Japan's 'strong army' policy and her wars against China (1895) and Russia (1905) led to the establishment of military arsenals and shipyards that acted as "highly effective centres for the absorption and dissemination of Western technologies and skills" (Yamamura 1977: 113). Japan's military activities also created demand for smaller private firms' products in shipbuilding, machinery etc. that allowed for the continuation of technological production and therefore innovation.

The most important role of Japan's military arsenals and shipyards was in aiding non-military firms and factories. From the 1870s and 1880s the Osaka arsenal produced steam engines, lathes, wood planes, grinding machines, gears etc. for private firms. The navy's Tsukyi arsenal provided the Ishikawjima Shipyard (est. 1876) with technical assistance, three-year interest credit, real estate etc., which allowed the shipyard to produce boilers for textile factories, stone crushers,

[2] The traditional sector is typically defined as a 'factory' with five workers or less.

iron bridges etc. by 1885. By 1907, Japan had some 150,000 workers who were qualified in industrial employment and who were essential in increasing the "technological capabilities of Japanese industry" (Yamamura 1977: 126). Between 1907 and 1910, we see the exodus of some 25,000 workers from Japan's military arsenals. Undoubtedly these workers moved into the private sector to fill the rapid labour demand of newly established industries. Through this, we can see how the dissemination of technological knowledge was not necessarily a state-regulated act. Therefore the subsequent link between public military production and private industrialisation, was not a state sponsored economic policy but the result of an organic transfer of capital, labour and technological knowledge between the two.

An excellent and direct way to look at technological absorption levels in the Japanese economy for this period is to trace the time lag between the invention of new technologies and their introduction into the Japanese economy.

**Table 1: Japanese-European Technology Gaps in Metallurgy, 1858-1909**

| Technique | European innovation | Japanese adoption | Gaps |
|---|---|---|---|
| Charcoal-fired furnace | 1700 | 1858 | 160+ |
| Coke-fired furnace | 1717 | 1894 | 177 |
| Crucible steel | 1740 | 1882 | 142 |
| Reverberatory furnace | 1766 | 1850-2 | 86 |
| Puddling method | 1784 | 1875 | 91 |
| Hot power bellows | 1828 | 1875 | 47 |
| Air-blown steel converter | 1856 | 1901 | 45 |
| Open hearth process | 1863 | 1890 | 27 |
| Stassano electric arc furnace | 1899 | 1909 | 10 |

Source: Howe 1999, 249

Table 1 shows a general trend of decreasing time-gaps between Western invention and Japanese absorption. This information could certainly show that Meiji industrial development was not significant before World War I and therefore technological diffusion into the economy was lacking in this time period because of the dearth of active public involvement in the 'commercial' sector. This must of course be qualified by the fact that trade/transport networks greatly improved throughout this period thus allowing for more efficient technology transfers.

The organic transfer of technology into the post-World War I economy can be seen in the table below. The average growth rate for the private sector

between 1908 and 1938 was 6.71% with labour productivity growing by 4.4%. More than half of this productivity was due to technological progress.

**Table 2: The rate of growth of private industry and the contribution of technical progress to increases in labour productivity, 1908-1938 (% per annum)**

| | Growth rate of Industry | Growth rate of labour productivity | Technical progress[4] | Share[3] |
|---|---|---|---|---|
| 1908-10 | 5.41 | 3.85 | .44 | 12% |
| 1911-20 | 7.85 | 4.65 | 1.55 | 32% |
| 1921-30 | 5.03 | 4.1 | 2.96 | 62% |
| 1931-38 | 7.86 | 4.69 | 3.42 | 85% |
| Average | 6.71 | 4.4 | 2.38 | 54% |

Source: Howe 1999: 248.

The evidence above is somewhat qualified by table 3.The organic shift of technological innovation from the public sector to the private can be evidenced by the employment of foreign specialists in Japan between 1870s and 1880s. In this table, we see how there is a shift between an economy where the public sector dominates the employment of foreign specialists in the 1870s to a gradual loss to the private sector over the 1880s and 1890s. This occurs *before* the transition of the Meiji economy into fully-fledged industrialisation but it could represent a time lag between an initial organic shift and the realised benefits (in terms of technological diffusion) of such a shift as I have discussed in Section 2.

[3] Share of technical progress.
[4] Contribution of technical progress to labour productivity.

**Table 3: Foreign experts hired in Japan, 1870-1900**

| | 1870s | 1880s | 1890s | 1870-90 |
|---|---|---|---|---|
| Science Teaching | 1,300 | 1,698 | 3,556 | 6,564 |
| | (72.8) | (40.8) | (17.6) | (34.5) |
| Engineering | 2,210 | 2,613 | 2,070 | 6,983 |
| | (58.6) | (19.6) | (6.8) | (28.2) |
| Business | 593 | 897 | 566 | 2,056 |
| | (76.4) | (53.6) | (44.7) | (57.7) |
| Other | 1,698 | 1,244 | 277 | 3,219 |
| | (39.2) | (8) | (6.5) | (24.7) |
| Total | 5,801 | 6,453 | 6,479 | 18,732 |
| | (57.9) | (27.8) | (16) | (33.1) |

Note: Data in brackets are % hired by public sector.
Source: Howe 1999:258

If indeed, the hypothesis is correct and the Meiji technological experience was the result of an organic shift of technological capabilities into the private sector rather than the result of direct public participation, then that organic process was particularly successful. In column 1 of Table 4, we see that the average labour productivity in industry rose from 155.7 to 420.4 for the period 1887 – 1915. In line with the evidence above labour productivity shows the most significant increases following the turn of the century.

**Table 4: Labour Productivity and Per Capita Output**

| Year | A[5] | B[6] |
|---|---|---|
| 1887 | 155.7 | 92.3 |
| 1891 | 159.8 | 100.3 |
| 1895 | 188.1 | 107.1 |
| 1899 | 228.6 | 114.5 |
| 1903 | 237.2 | 125.7 |
| 1907 | 304.4 | 119.4 |
| 1911 | 365.5 | 132.0 |
| 1915 | 420.4 | 149.6 |

Source: Kelley & Williamson 1974: 232.

## Re-evaluating Tokugawa Japan

Shigeki and other Japanese Marxists such as Inocie Kiyoshi and Horie Eiichi were perhaps the first academics to re-revaluate the Tokugawa and Meiji periods (Shigeki 1951). They argued that by the time Japan had opened up the Western influences in the twilight of the Tokugawa shogunate, the country already possessed a socio-economic environment that was conducive to growth. Subsequently there continued to be much academic controversy surrounding Japan's industrialisation. Ohkawa and Rosovsky argued that technology dissemination was effectively blocked by the Bakuhan land-system of the Tokugawa shogunate that changed with the advent of the Meiji Restoration and the opening up of Japan to foreign influences. Nakamura however challenges this assertion, stating that agricultural yields during the Meiji were overestimated (in order to avoid higher levels of taxation) and therefore Meiji productivity was less than spectacular relative to the Tokugawa period, with increases of about 1% per annum (Choi 1971). Choi reinforces Nakamura's argument, stating that the Bakuhan system diffused rather than inhibited technology, thereby increasing agricultural output and widening the scope for industrialisation.

In line with this, Kelley & Williamson ask whether the apparent stagnation of the Tokugawa period mask the real contributions it made to the economic development of the Meiji period (1974). The creation of a labour force that could utilise new technologies efficiently requires high literacy rates and general educational standards. As I will discuss, these were present in Tokugawa

[5] Average labour productivity in industry.
[6] Average labour productivity in agriculture.

Japan. We see that a sophisticated irrigation system had been built in pre-Meiji Japan that had a direct impact on Meiji agricultural productivity and therefore Japan's subsequent industrialisation. Japan's agriculture was able to increase productivity in an institutional context of small farm size in contrast to the Western traditions of collectivisation, large holdings and economies of scale. The Bakufu's lands (Tenryo) were actually concentrated centres for economic activity and were spread across all of Japan. Thus, their geographical location actually supported rather than blocked the spread of technological knowledge. The presence of large urban populations in Edo, Osaka and Kyoto showed that a national economy existed within the Tokugawa shogunate since their large populations were ultimately clothed and fed by the rural population centres of the Bakuhan.

The link between technological diffusion and educational attainment is an important one. Japan's formal education system however was not a Meiji creation but rather a product of the Tokugawa period. As Howe states, by the beginning of the 19th century Japanese education comprised of temple (terakoya), shogunal, han and various private (shijuku) schools (1999). Between them, these various types of schools provided basic educational attainments but also more advanced teaching and training as well. While the feudal system of the Tokugawa shogunate was somewhat restricting it did not discourage literacy and learning male literacy stood at 40-50% in 1867 (Howe 1999). In addition, Tokugawa Japan had a fully established financial system that served trade and commerce and provided capital for handicraft production and loans for estates that were secured against future tax revenues. This system obviously contributed to the establishment of a national banking system so early in Japan's economic history.

In terms of diffusing newly arrived technology the Tokugawa shogunate provided a good base. During that period there were systems of 'in-house' training in merchant concerns and traditional crafts. Indeed Howe states that there was a massive continuity between the Tokugawa skill-base and that of the Meiji era. The Meiji administration in actuality, inherited much of its industrial base from the earlier Tokugawa shogunate and its establishment of new factories were intended to provide employment for displaced samurai, a political goal, which was not successful. Therefore an essential fact of technological diffusion in Meiji Japan was that it had already acquired the relevant social capabilities and traditional manufacturing disciplines required for industrialisation.

## Conclusion

By re-evaluating the physical and institutional contributions of Tokugawa Japan we discover that the economic capabilities of the Meiji period were less impressive than previously believed. Early Meiji growth was as much a product of the Tokugawa period as it was of the economic reforms of the Restoration. Through this the greater technological diffusion of the post-World War I period as a progression of an organic shift becomes much more significant. Early Meiji public involvement in technological diffusion therefore, was even more limited in scope and effect.

This assertion is reinforced by the apparent lack of will or failure on the part of the Meiji government to actively encourage technological diffusion into the private sector. The lack of Meiji industrial development before World War I was therefore a direct result of this public failure to be directly involved in the 'commercial' sector. This was primarily motivated by military/strategic considerations that dominated Meiji economic priorities. Meiji post-World War I industrial growth was affectively created through the organic transfer of labour, skills and capital from the public sector to the private without overt governmental support. This hypothesis challenges the more traditional viewpoint of intense public-private cooperation in the Meiji economy, something that would become the most recognisable feature of the Japanese economy in current times. It also brings the Japanese technological experience more into line with the Western experience of technological diffusion. Full technological innovation was never achieved through pure governmental intervention in the socio-economic structures of the West. Instead we see a more complex blend of interconnecting relationships between various private and public actors and this certainly seems to be the case in Meiji Japan.

While the government's technology policy may have turned Japan into an advanced industrialised nation, the dominance of military technological investment ensured lower standards of living and that may have contributed to the social and political troubles of the 1930s. Therefore Japan's technological dissemination experience offers stark lessons for developing nations today. The dominance of government in technological investment will inevitably be sullied by political considerations preventing purely economic priorities from allocating resources efficiently. Technological innovation and subsequent industrialisation cannot be primarily achieved through direct governmental intervention alone. The government's role must be to provide the basic institutional and physical infrastructure through which the private sector can absorb and utilize technology to achieve economic growth.

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