# HOW DID JAPAN CATCH-UP WITH THE WEST? SOME IMPLICATIONS OF RECENT REVISIONS TO JAPAN'S HISTORICAL GROWTH RECORD

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*Abstract:* This paper uses recently revised data on Japanese GDP to analyse the process by which Japan caught-up with the West. The new historical national accounts suggest that Japan was more than one-third richer in 1874 than suggested by Maddison, and that the Meiji period growth built on earlier development. We show that (1) despite trend GDP per capita growth during the Tokugawa shogunate, the catching-up process only started after 1890 with respect to Britain, and after World War 1 with respect to the United States and many European nations (2) although catching up was driven by the dynamic productivity performance of Japanese manufacturing, Japanese success in exporting manufactured goods was just as much driven by limiting the growth of real wages (3) despite claims that Japan was following a distinctive Asian path of labour-intensive industrialisation, capital played an important role in the catching-up process.

# I. INTRODUCTION

Recent developments in historical national accounting for Japan suggest that earlier work exaggerated the growth rate during the period 1868-1955, so that Japan at the time of the Meiji Restoration was richer than has generally been characterised in the comparative economic history literature (Fukao et al., 2015; Settsu et al., 2016). This work is consistent with the findings of Bassino et al. (2019) that Japan also exhibited per capita income growth before the Meiji period, but at a rate that was slower than in western Europe, so that Japan continued to fall behind during the Tokugawa shogunate. Here, we use the revised historical national accounts to analyse the process by which Japan caught-up with the West.

First, we show that the catching-up process started some time after the Meiji restoration, with the timing depending on the economy with which Japan is being compared. Although the Japanese economy was the most dynamic Asian economy during the Tokugawa Shogunate, it was growing more slowly than Britain, the nineteenth century per capita income leader. Japan began to narrow the gap with Britain only after 1890. However, since the United States and a number of West European nations were catching-up with Britain before World War 1, Japan's catching-up process with the West more generally was delayed until after 1914. Furthermore, given the catastrophic collapse of Japan across World War 2, Pilat (1994) has argued that Japanese catching-up only really began after 1945.

Second, a sectoral analysis of comparative productivity performance clearly highlights mining and manufacturing industry as the key sector in Japanese catching-up. However, an analysis of comparative unit labour costs reveals that Japan achieved

competitive success as an exporter of manufactured goods not simply by catching-up in labour productivity, but by holding down real wage growth so as to enjoy a unit labour cost advantage.

Third, a levels accounting exercise reveals an important role for capital in Japan's catching-up, which casts doubt on the idea of Japan following a distinctive Asian path of labour-intensive industrialisation (Hayami and Tsubouchi, 1989; Sugihara, 2007). Japan had low levels of capital intensity in the late nineteenth century mainly because it was relatively poor, just as European economies had low levels of capital intensity in the early stages of industrialisation, consistent with the literature on the adoption of appropriate technology for given factor prices (Habakkuk, 1962; Acemoglu, 2002). However, that does not mean that Japan caught up simply by slavishly copying the West, since Japan came to play a leading role in the development of modern flexible production technology (Broadberry, 1994; Freeman, 1987).

## II. RECENT DEVELOPMENTS IN JAPANESE HISTORICAL NATIONAL ACCOUNTING

Amongst economic historians and economists, Angus Maddison has had a major influence on the perception of Japan as an extremely backward economy at the time of the Meiji Restoration in 1868. Maddison's (2010) methodology was to establish Japan's position relative to the rest of the world by expressing GDP per capita in 1990 international dollars. This was done by making use of the Income Comparisons Project (ICP) for 1990, which converted nominal GDP per capita in individual country currencies to the same units by comparing prices across countries, to establish purchasing power parities (PPPs). Once these benchmarks were established, they could

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be projected forwards and backwards to other years using indices of real GDP per capita for each country. Using this approach, Maddison established the position of Japan relative to other economies.

However, there were a number of weaknesses in the time series used by Maddison (2010) to project Japanese GDP per capita back from 1990 to 1874, as set out in Fukao et al. (2015), and Settsu et al. (2016). First, Settsu et al. (2016) have revised downwards Japanese GDP per capita growth in constant prices during the period 1940-1955, by using volume data rather than deflated value data at a time of rationing, hyperinflation and black markets. Second, Fukao et al. (2015) have revised downwards real GDP per capita growth during the period 1890-1940 by improving the estimates of value added relative to gross output. Third, for the period 1874-1890, rather than extending the growth rate for the period 1885-1890 back to 1874, as Maddison did, Fukao et al. (2015) have used data from a reconstruction of GDP in 1874, which again has the effect of revising downwards the growth of real GDP per capita between 1874 and 1890. Projecting back from 1990 to 1874 with a significantly lower growth rate results in a level of GDP per capita in 1874 that is 34 per cent higher than suggested by Maddison.

Table 1 sets out Maddison's (2010) estimates of Japanese GDP per capita for the period 1600-2008, together with the revised estimates.[1] Figure 1 shows graphically the growing cumulative effect of the revisions on the backwards projection from 1990 to 1874. The effect is already clearly visible by 1940, when the revised estimates put

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[1] The Maddison Project 2020 version (Bolt and van Zanden, 2020) uses the revised estimates but presents the data in terms of 2011 international dollars, while we continue to work in 1990 international dollars for comparability with most existing long run historical studies.

Japan 7 per cent richer than Maddison's data. The slower growth between 1890 and 1940 then means that Japan was 15 per cent richer than suggested by Maddison in 1890. The biggest change, however, arises over the period 1874-1890, when the adjustment for value added results in Japan being 34 per cent richer than suggested by Maddison in 1874. These revisions have a dramatic effect on Japan's position relative to the European peripheral economies for which data are available in Table 2. [2] With Maddison's data, Japan ranks 13th out of the 15 countries, with only Albania and Yugoslavia in the Balkans being poorer. Using the revised estimate, by contrast, Japan ranks a respectable 7th out of the 15.

Projections back further in time from 1874 were rather more speculative in Maddison's (2010) dataset, but new estimates have been produced recently by Bassino et al. (2019), based on contemporary data processed within a historical national accounting framework. These new estimates are included in Table 1 for the period 1600 to 1874, a period which is now widely seen as one characterised by positive per capita income growth in Japan. Figure 2 shows the revised estimates and Maddison's data in graphical form. Although the gap between the two series increased very little between 1600 and 1874, the pattern of growth between the endpoints was quite different. Whereas Maddison saw fairly steady growth between 1600 and 1800, followed by stagnation during the first half of the nineteenth century, Bassino et al. (2019) see stagnation between 1600 and 1721, followed by steady growth during the later Tokugawa period.

## II. WHEN DID THE CATCHING-UP PROCESS BEGIN?

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[2] Maddison's (2010) data are presented on the basis of post-World War 2 boundaries.

Although much of the literature on Japanese economic growth treats the Meiji restoration of 1868 as a key institutional change, ushering in a period of modern economic growth which has lasted to the present, this was not the start of the process of catching-up on the West (Ohkawa and Rosovsky, 1973; Pilat; 1994). Table 3 presents the revised estimates of Japan's GDP per capita from Table 1 compared with the United Kingdom and the United States, the global per capita income leaders in the nineteenth and twentieth centuries, respectively, and 12 West European nations, taken from Maddison (2010). The data for the United Kingdom before 1874 have been reported in Table 3 on a Great Britain basis, as Ireland was considerably poorer than the rest of the United Kingdom but formed a relatively large share of the total UK population before the mass migration following the Great Famine of the 1840s. The first point to note is that despite positive Japanese per capita income growth during the Tokugawa shogunate, Japan was growing more slowly than Great Britain, the nineteenth century per capita income leader, and therefore fell further behind. Second this falling behind continued after the Meiji restoration of 1868, until Japan began to catch up with the United Kingdom after 1890.

Third, however, much of the rest of Western Europe, and the United States were catching up with Britain during the second half of the nineteenth century and the early twentieth, so that Japan's catching up with the West more generally was delayed until after World War 1. Fourth, the impact of World War 2 needs to be considered. Given the catastrophic collapse of Japan across the war, Pilat (1994) has argued that Japanese catching up only really began after 1945. However, this seems too heavily influenced by the comparison with the United States, which experienced a wholly exceptional growth path between 1870 and 1950, at first catching-up on the United Kingdom, and

then forging ahead during the first half of the twentieth century, but with a major interruption to the process during the Great Depression of the 1930s, when the UK briefly regained per capita income leadership. Compared with the US, Japan was in roughly the same position in the late 1930s as in the 1870s, and much worse off in the 1950s. Compared with the UK and Western Europe as a whole, however, Japan was substantially better off in the late 1930s than in the 1870s, and no worse off in the 1950s.

## III. WHICH SECTORS WERE THE KEY DRIVERS OF CATCHING-UP?

To answer the question of which sectors were the key drivers of Japanese catching-up, it is necessary to assemble time series of output and employment in Japan and the United Kingdom on a sectoral basis and establish comparative levels of labour productivity in each sector.

### 1. Japanese time series

Until recently, most accounts of Japanese economic performance since the Meiji restoration have relied heavily on the estimates of output and employment in the multi-volume *Estimates of Long-Term Economic Statistics of Japan Since 1868,* edited by Kazushi Ohkawa, Miyohei Shinohara and Mataji Umemura (henceforth referred to as LTES). In particular, most writers have drawn heavily on the volumes on national income and manpower (Ohkawa et al., 1974; Umemura et al., 1988), supplemented with additional information from Ohkawa and Rosovsky (1973), the *Historical Statistics of Japan* produced by the Japanese Statistics Bureau and the *Annual Report on National Accounts* prepared by the Economic and Social Research Institute, Cabinet Office.

As noted in the previous section, however, we have used the new estimates of GDP from Fukao et al. (2015) and Settsu et al. (2016), which have revised the growth rate downwards substantially for the period before 1955, thus raising the level of GDP per capita for the pre-World War 1 period. In the case of employment data for the period 1885-1940, we also make use of the new estimates provided by Fukao et al. (2015). Using results of Saito and Settsu (2007), they revised by-employment data of the LTES. Table A1 in the Appendix presents the output, employment and labour productivity data for the whole economy and for the five main sectors, agriculture, mining and manufacturing, construction, facilitating industry and commerce-services, together with a detailed listing of sources. It should be noted that agriculture includes forestry and fishing as well as farming, facilitating industry combines transport and communications with gas, electricity and water, and commerce-services includes distribution, finance, government and other services. Japan's boundaries have remained almost unchanged throughout the period.

The output and employment data from the Appendix can be used to calculate indices of labour productivity by major sector. From these indices it is possible to calculate the average annual growth rates of labour productivity by sector, which are presented here in Table 4. From the late nineteenth century until the end of World War 1, a fairly rapid overall labour productivity growth rate was driven by mining/manufacturing and facilitating industry as Japan embarked on a process of modernisation following the Meiji restoration. The period between 1920 and 1955 was characterised by much slower labour productivity growth in all sectors. Japan returned to rapid labour productivity growth between 1955 and 1990, this time with truly spectacular performance in mining/manufacturing and facilitating industry during the

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period between 1955 and 1973. The fading miracle of the 1970s and 1980s was followed by a period of much slower labour productivity growth after 1990, but with mining/manufacturing and facilitating industry continuing to record the fastest labour productivity growth.

We would emphasise the following three points from this preliminary analysis of labour productivity growth in Japan. First, the fastest growth occurred in mining/manufacturing and facilitating industry. Second, labour productivity grew more slowly in agriculture than in the economy as a whole throughout the period 1891-1973. Since agriculture still accounted for over 40 per cent of Japanese employment as late as 1955, this sector can be seen as acting as a major drag on the economy until very recently. Third, labour productivity growth in Japan can best be characterised as following a roller-coaster pattern, with an initial growth spurt before 1920 followed by slower growth between 1920 and 1955, before the dramatic postwar episode of catching up and an equally dramatic deceleration since 1973. Ohkawa and Rosovsky's (1973) attempt to describe Japanese growth as a process of continuous trend acceleration, based on an analysis of output rather than per capita income or productivity, and dependent on a careful choice of benchmark years, seems to obscure as much as it illuminates, even before the slowdown of the 1970s.

## 2. UK time series

The UK time series are taken largely from the historical national accounts of Feinstein (1972), updated with output estimates from the *UK National Accounts* produced by the Office for National Statistics and employment data from O'Mahony (1999) and the EU KLEMS database (O'Mahony and Timmer, 2009). Again, the series are presented in

the Appendix, together with full details of the data sources. The territory covered refers to the United Kingdom of Great Britain and the whole of Ireland before 1920, but Great Britain and Northern Ireland after 1920. In contrast to Broadberry (1998), where the output and employment data were both spliced at 1920, following the procedures of Maddison (1995) to provide continuous series within the current boundaries of the United Kingdom, in this study both the output and employment series change with the secession of Southern Ireland. This is more in keeping with the approach to boundary changes adopted by Maddison (2003) for his later work on non-European countries such as India, and by Broadberry and Klein (2012) for Europe, although it does not make a lot of difference for the UK case. As in the Japanese case, the output and employment series can be combined to derive indices of labour productivity, from which the labour productivity growth rates shown in Table 2 are calculated. A stronger case could be made for trend acceleration of labour productivity growth in the period to 1973 for the United Kingdom than for Japan.

UK labour productivity growth before 1920 was fastest in mining/manufacturing and facilitating industry and slowest in agriculture. The period 1920-1955 saw an increase in the labour productivity growth rate in all sectors apart from commerce-services, which exhibited stagnation of productivity. After World War 2, rapid labour productivity growth continued in agriculture, mining/manufacturing and facilitating industry.

Having examined labour productivity growth in each country in isolation, we can now put the two together to shed light on the patterns of differential labour productivity growth performance. Part C of Table 4 subtracts UK labour productivity

growth from Japanese labour productivity growth; a positive number here indicates that Japan was catching-up, while a negative number indicates falling behind. The first conclusion, which can be gleaned from the final column, is thus that Japan was catching up with the United Kingdom until 1990, but the process stalled between 1920 and 1955 and went decisively into reverse after 1990. The second conclusion is that the periods of rapid Japanese catching-up were driven largely by developments in mining/manufacturing and facilitating industry, although commerce-services also played an important role after 1955. By and large, then, Japan fits the stereotypical Asian pattern of industry-led catching-up, in contrast to the exceptional case of service-led development in India (Broadberry and Gupta, 2010).

## 3. A benchmark for 1997

The labour productivity data for Japan and the United Kingdom from the Appendix can be combined to provide trends in comparative labour productivity for each sector in index number form. To pin down the comparative labour productivity level, we use a benchmark for 1997, presented in Table 5 and derived from the EU KLEMS database (O'Mahony and Timmer, 2009). The benchmark is estimated from data on nominal value added per person engaged in each country, compared at sector-specific price ratios, adjusted for purchasing power parity (PPP). This is necessary because the exchange rate cannot be assumed to be a perfect guide to differences in prices between two countries, especially at the level of individual goods and services, or particular sectors. For example, a country with a comparative advantage in agriculture may expect to have relatively cheap food, while a country with a comparative advantage in manufacturing may expect to have relatively cheap industrial goods, although we may expect the effects of trade to moderate such tendencies.

Note that the overall PPP in 1997 was £1 = 326.2 yen, at a time when the exchange rate was £1=198.1 yen, suggesting a significantly overvalued Japanese yen. Note also that the scale of the deviation from PPP was dramatically higher in agriculture and correspondingly lower in mining and manufacturing, consistent with most assessments of Japan's comparative advantage, with manufactured goods relatively cheap and foodstuffs relatively expensive. Labour productivity was particularly low in Japanese agriculture, consistent with the findings of other international comparative studies (Pilat, 1994; O'Mahony, 1999)

**4. Comparative labour productivity levels by sector**

Table 6 provides a breakdown of Japan/UK comparative labour productivity levels by sector. The first point to note is that mining and manufacturing has led the catching-up process, a result that can be seen most clearly in Figure 3. Japan/UK comparative labour productivity in mining and manufacturing was initially below the average for the economy as a whole in 1891 but was broadly in line with the whole economy level during the interwar period. From the 1950s to 1990, Japan/UK comparative labour productivity in mining and manufacturing became increasingly above the average for the economy as a whole, thus leading the overall catching up process. After 1990, however, the comparative labour productivity performance of Japan's mining and manufacturing sector has been more volatile than the economy as a whole, as Japanese catching-up has stalled.

A second finding is that Japanese agriculture has moved from an above average comparative labour productivity performance before World War 1 to a dramatically

worse than average performance since World War 2. This seems to be associated with the slow movement of labour away from agriculture in a highly protected sector. Third, comparative labour productivity performance in construction and in facilitating industry exhibits a pattern of long cycles with high amplitude, suggestive of inverse swings in infrastructure investment in the two countries. Fourth, although Japanese commerce-services showed no trend improvement in their comparative labour productivity performance before World War 2, their position has improved more or less in line with the economy as a whole since 1955.

It is worth contrasting these findings with those of Pilat's (1994) Japan/US comparative study. Although Pilat (1994: 130) found that manufacturing played an important role in Japanese catching-up on the United States after World War 2, his findings for the pre-World War 2 period suggested a much less important role for manufacturing. Indeed, any prewar catching-up in mining and manufacturing was largely confined to the 1930s, when the Great Depression hit the United States much harder than Japan. Agriculture also showed no catching up compared with the United States before World War 2, so to the extent that catching up occurred between the 1880s and the 1930s, it was largely confined to other sectors, comprising construction, facilitating industry and commerce-services. However, care must be taken in interpreting these findings, because of the unusual experience of the United States, which was itself catching-up on the United Kingdom in the late nineteenth century and forging ahead during the first half of the twentieth. Measured against Britain and other European economies, Japan experienced a strong phase of catching up between the 1880s and the early 1920s, driven by developments in manufacturing. This helped to lay the foundations of the post-1955 catching-up growth.

## 5. The structure of economic activity

To fully understand the contributions of the five main sectors to comparative productivity performance, it is necessary to track their shares in economic activity as well as their comparative productivity levels. Table 7 shows the percentage distribution of employment by major sectors for selected years. The sectoral composition of economic activity was clearly very different in the two countries for much of the period. Compared even with other developed economies, Britain already by the late nineteenth century devoted a very small share of the labour force to agriculture. Thus, for example, while both Germany and the United States had approximately 43 per cent of the labour force tied up in agriculture in 1891, the figure was under 16 per cent in the United Kingdom (Lebergott, 1966: 119; Hoffmann, 1965: 205; Feinstein, 1972: T131). For Japan, the agricultural share of the labour force was almost 62 per cent in 1890, and was still over 41 per cent as late as 1955. Although these figures are somewhat lower than those suggested by Ohkawa (1957: 245), who made no allowance for the by-employment of agricultural workers in the industrial sector, this still represents a very high commitment of resources to an inherently low value added sector, a point emphasised by Hayashi and Prescott (2008). Combined with the slower productivity growth in agriculture compared with the whole economy, this meant that agriculture held back Japanese economic growth for much of the period since the Meiji Restoration.

A second striking finding from Table 7 is that despite the fact that Japan currently has a much larger share of its labour force employed in mining and manufacturing than Britain, at its industrial peak between the wars Britain had a much

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larger share of its labour force in mining and manufacturing. A third point to note from Table 7 is that the commerce-services sector has seen the fastest growth of employment in both countries, but the growth has been much more dramatic in Japan than in Britain due to the later shift away from agriculture.


## 6. Cross-checking the results

A number of studies have questioned the use of time series projections from a single benchmark over long periods of time, the methodology used here in Table 6. Ward and Devereux (2003) suggest that the further one projects from the original benchmark, the bigger the discrepancy between time series projections using GDP per head in constant prices and cross-sectional benchmarks based on nominal GDP per head converted at PPPs, because of index number problems. The issue is the subject of debate between Broadberry (2003) and Ward and Devereux (2004). In fact, however, Broadberry (1993) had already suggested the use of additional benchmarks to provide cross-checks in a study of comparative productivity in manufacturing, while Broadberry (1997a; 1997b; 1998; 2006) applied the method to full sectoral productivity comparisons over the period 1870-1990 for the United Kingdom with the United States and Germany, and found broad agreement between the benchmarks and time series evidence for those countries. Broadberry and Irwin (2006; 2007) find similar agreement between time series projections and benchmarks for the United Kingdom compared with the United States in the nineteenth century and the United Kingdom compared with Australia over the period 1861-1948. More recently, Broadberry and Gupta (2010) have applied the same methodology to an Anglo-Indian comparison between 1870 and 2000.

To provide a cross-check on our time series projections from 1997, we would ideally like to estimate a second benchmark for a pre-war year such as 1935. To do this, we need to estimate a set of sectoral PPPs. Table 8 provides a PPP for manufacturing industry in 1935, based on factory gate prices derived from production census sources.[3] The overall PPP for manufacturing in 1935 was £1 = 12.46 yen, at a time when the market exchange rate was £1 = 17.14 yen (Kinyu Kenkyukai, 1937). The industrial price level was thus substantially cheaper in Japan than in the United Kingdom. However, it has not been possible to apply this methodology to agriculture because of the extremely different structures of the agricultural sector in the two countries, with Japanese agriculture dominated by rice, which was not grown in the UK at all, and with UK farming dominated by the production of livestock products such as meat and dairy produce, which were much less widely produced or consumed in Japan. We have therefore chosen to construct a PPP for the whole economy based on consumer prices and expenditure weights, as in Fukao et al. (2007). The results in Table 9 suggest an expenditure PPP of £1 = 8.36 yen, consistent with a substantially lower Japanese price level overall than in industry. The low overall price level in Japan can be explained partly by the low prices of the basic foodstuffs consumed by the Japanese, including rice, fish and vegetables, but also by the low cost of many labour-intensive services as a result of low wages in Japan.

Table 10 then uses these PPPs to calculate comparative Japan/UK GDP per employee levels for the whole economy and for mining and manufacturing in 1935, as

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[3] Value added weights are available for the six main manufacturing sectors, but within each sector it is necessary to aggregate using gross output weights. This procedure has been used widely since the work of Paige and Bombach (1959), although value added weights are normally available at a lower level of aggregation. Although Fremdling et al. (2007) compared British and German manufacturing productivity in the mid-1930s using double deflated value added, it made almost no difference at the level of total manufacturing.

a cross-check on the time series projections in Table 6. Nominal GDP and employment data are obtained from the standard historical national accounting sources for the United Kingdom and the new estimates for Japan (Feinstein, 1972; Fukao et al. 2015). These are then compared using the PPPs from Tables 8 and 9. For the economy as a whole, the comparative benchmark obtained in this way in Table 10 suggests Japanese labour productivity in 1935 at 35.0 per cent of the UK level, which is close to the time series projection in Table 6 of 33.1 per cent. For industry, the comparative benchmark suggests that Japanese labour productivity was 42.4 per cent of the UK level, which is even closer to the 41.5 per cent suggested by the time series projection in Table 6. Both error margins fall well within the 10 per cent range, and given the enormously rapid growth and the dramatic structural change exhibited by the Japanese economy between 1935 and 1997, it would be unrealistic to expect a closer degree of agreement between the benchmarks and time series projections.

## IV. HOW DID JAPAN BECOME COMPETITIVE ON WORLD MARKETS?

Industrial labour productivity was substantially lower in Japan than in Britain before the 1970s. However, Japan managed to achieve success in export markets despite this productivity gap. The shares of world exports in manufacturing are shown in Table 11. The high share of the UK in the 1880s reflects the fact that the first industrial revolution occurred in Britain, and this share was bound to shrink as other countries industrialised. The low share of Japan in the nineteenth century reflects both the low level of development and the lack of openness to trade before the Meiji Restoration. Britain lost out not just to Japan during the pre-World War 2 period, but also to the United States and Germany (Broadberry and Burhop, 2010). Between the early 1950s and 1973, Japan continued to gain world market share while UK market share declined. However,

the process of Japan gaining world market share stalled between 1973 and 1979 and then went into reverse as other East Asian economies developed.

One way of shedding light on the ability of Japan to take market share from the United Kingdom despite having lower labour productivity until the 1970s is to consider the offsetting effect of low wages, which affected unit labour costs. Here, we follow Broadberry and Burhop (2010) in calculating comparative unit labour costs. However, the extent of inflation in Japan across World War 2 makes it difficult to use a single index, so in Tables 12 and 13 we provide separate series for the pre- and post-World War 2 periods. In Table 12, data on nominal wages and producer prices for both countries are indexed on 1935 for the pre-World War 2 period and 1997 for the post-World War 2 period. The own product real wage clearly grew more rapidly in Japan than in the United Kingdom both before and after World War 2.

Part A of Table 13 combines the pre-World War 2 industrial real wage data from Table 12 with the labour productivity data for mining and manufacturing from Table 6 to estimate comparative unit labour costs. The comparative own product real wage in index number form in the third column of Table 13A, based on 1935=100, is converted to a UK=100 basis in the fourth column using a benchmark estimate of comparative own product real wages for 1935. The average Japanese wage of 375 yen was 22.34 per cent of the average UK wage of £134.71 when converted at the industrial PPP of £1 = 12.46 yen from Table 8. Projecting back to 1901, Japan's real wage was just 11.1 per cent of the UK level, while projecting forward to 1935, it had risen to 22.3 per cent of the UK level. Throughout this period, Japan was able to gain market share at the expense of the United Kingdom because although labour productivity remained

much lower in Japan than in the UK, Japanese real wages were lower by an even larger amount, so that Japanese unit labour costs in industry fluctuated around two-thirds of the UK level until the 1930s. During the interwar period, the Japanese cotton textile industry, in particular, posed a major threat in Britain's main export markets (Broadberry and Marrison, 2002).

Part B of Table 13 takes the story into the postwar period. The index of comparative real wages based on 1997=100 in the third column is converted to a UK=100 basis using a benchmark estimate of comparative own product real wages for 1997. The average Japanese industrial wage of 5,298,942 yen was 85.2 per cent of the average UK industrial wage of £23,922.26 when converted at the PPP of £1 = 259.9 yen from Table 5. Although labour productivity was substantially lower in Japan than in the UK in the early postwar period, wages were lower by a greater margin, so that Japan had substantially lower unit labour costs at around half the UK level, even lower than during the 1930s. By the 1970s, however, the growth of real wages in Japan was outpacing the growth of labour productivity, so that Japan's unit labour cost advantage returned to the pre-1929 level, and by the 1990s had virtually disappeared. However, faster real wage growth in the UK during the 1990s and 2000s allowed Japan to regain a unit labour cost advantage despite faster productivity growth in the UK. Japan thus avoided the sharp loss of export market share that hit UK industry, but it was lower wage economies such as China that dramatically improved their competitive position in world markets.

**V. WHAT WAS THE ROLE OF CAPITAL?**

In this section, we investigate the role of capital in Japan's catching-up. This is of particular interest because of suggestions in the literature that Japan followed a distinctive Asian path of labour intensive industrialisation. The idea can be traced back to the work of Hayami (1967) who coined the phrase "industrious revolution" to describe Japanese growth before the Meiji Restoration. Hayami and Tsubouchi(1989) generalised the idea to an East Asian industrious revolution, based on rice cultivation, which was seen as the basis of an alternative to western capital-intensive industrialisation. This idea has been emphasised more recently in the work of Sugihara (2007). However, the phrase "industrious revolution" has also been applied by de Vries (1994) to growth in Europe before the "industrial revolution", which suggests that rather than being a distinctive Asian path of labour intensive industrialisation, it may simply reflect appropriate factor proportions given relative factor prices at low levels of per capita GDP (abundant cheap labour and scarce expensive capital). This latter interpretation would be strengthened to the extent that Japan's post-1868 catching-up on the West was accompanied by convergence in levels of capital intensity.

The data for the net capital stock at constant prices and the share of capital in income at current prices are presented in Appendix Table A3. Over the whole period, they are not available broken down by sector, and are therefore presented at the level of the aggregate economy. Table 14 shows how Japan caught up with the UK in terms of capital intensity as well as labour productivity. During the late nineteenth century, Japan's capital per employee was little more than 10 per cent of the UK level, but had reached 25 to 30 per cent of the UK level by the 1920s and 30 to 35 per cent by the 1930s. After World War 2, Japan entered a phase of rapid capital-deepening from the 1950s so that by the 1990s capital per employee was higher in Japan than in the United

Kingdom. Table 14 also shows the implications of this for comparative total factor productivity (TFP). Although capital intensity was much lower in Japan than in the UK in 1891, it was not sufficiently low to explain much of the labour productivity gap between the two nations, so that comparative TFP was generally less than half the UK level before World War 2. During the 1970s and 1980s, however, as Japan caught up in terms of capital intensity, comparative TFP became about the same as comparative labour productivity.

Table 15 examines the role of capital intensity in Japanese catching-up in another way by utilising the growth accounting identity:

$$g_{Y/L} = \alpha g_{K/L} + g_{TFP} \qquad\qquad (1)$$

where $g_{Y/L}$ is the growth rate of output per employee, $g_{K/L}$ is the growth rate of capital per employee, $g_{TFP}$ is the growth rate of total factor productivity and α is the share of capital in income. Labour productivity growth can be decomposed into the parts due to capital deepening ($\alpha g_{K/L}$) and improving efficiency ($g_{TFP}$). Capital deepening played an important role in explaining labour productivity growth in both countries, but the proportion of labour productivity growth explained by capital deepening was greater in Japan than in the UK in three of the five periods. Part C of Table 15 analyses the catching-up process by subtracting UK growth rates from Japanese growth rates. The second and third columns therefore reveal the contributions of differential rates of capital deepening and TFP growth to Japanese catching–up. The positive contribution of capital deepening in all five periods indicates that this factor strongly favoured Japanese catching-up growth. Furthermore, the continued positive contribution of capital deepening since 1973 indicates that the stalling of Japan's catching-up process has been due mainly to problems of efficiency rather than failure to accumulate capital.

These are relatively crude calculations of TFP which do not take account of the quality of the capital stock or the labour force, but such adjustments would be likely to decrease rather than increase the contribution of TFP. The conclusion that the adoption of increasingly capital-intensive production methods helped Japan to catch-up is therefore secure. This is not to suggest that Japan caught-up merely by slavishly copying the West. Indeed, there is a large literature that emphasises differences in factor proportions amongst western countries, the need to adopt appropriate technology for given factor prices, and the impact on subsequent technical progress (Habakkuk, 1962; David, 1975; Broadberry, 1997c; Acemoglu, 2002). Within this framework, Japan can be seen as playing a leading role in the development of modern flexible production technology (Broadberry, 1994; Freeman, 1987; Oliver and Wilkinson, 1988). Nevertheless, it is important to recognise that there are limits to the variation in capital intensity consistent with high living standards, and that Japan would not have caught up without increasing capital intensity to western levels (Allen, 2012).


## VI. CONCLUSIONS

Although Japan was the most dynamic Asian economy during the Tokugawa Shogunate, it was still growing more slowly than Britain, the nineteenth century per capita income leader, until after the Meiji Restoration. The process of catching-up with the West began only after 1890 with respect to the United Kingdom, the nineteenth century productivity leader, and after World War 1 with respect to the United States and many European nations.

A sectoral analysis of comparative labour productivity performance highlights industry as the key sector in Japanese catching-up, with a particularly dynamic performance in manufacturing. However, Japanese export success in world markets, beginning with cotton textiles during the interwar period and moving on to shipbuilding, motor vehicles and consumer electronics in the postwar period, was driven not simply by catching-up in labour productivity, but also through holding down real wage growth so as to achieve low unit labour costs.

Finally, it is shown that capital played an important role in Japanese catching-up. As well as indicating a slower pace of catching-up in total factor productivity than in labour productivity, this finding casts doubt on the idea that Japan followed a distinctive Asian path of labour-intensive industrialisation. Although capital intensity was low when Japan was poor, it was also low in European economies at similar levels of GDP per capita. And by the time that Japan had caught up with the West, capital intensity was also at Western levels.

**TABLE 1: Revised estimates of Japanese GDP per capita, 1600-2008 (1990 international dollars)**

|  | Revised estimates | Maddison estimates |
|---|---|---|
| 1600 | 667 | 520 |
| 1721 | 675 | 570 |
| 1804 | 828 | 669 |
| 1846 | 903 | 679 |
| 1874 | 1,013 | 756 |
| 1890 | 1,166 | 1,012 |
| 1909 | 1,467 | 1,301 |
| 1925 | 2,147 | 1,885 |
| 1935 | 2,406 | 2,120 |
| 1940 | 3,071 | 2,874 |
| 1955 | 2,771 | 2,771 |
| 1970 | 9,714 | 9,714 |
| 1990 | 18,789 | 18,789 |
| 2008 | 22,816 | 22,816 |

Sources: Revised estimates: 1600-1874: Bassino et al. (2019); 1874-2008: Fukao et al. (2015); Settsu et al. (2016); Maddison estimates: Maddison (2010).

**TABLE 2: GDP per capita in Japan compared with the European periphery in 1870 (1990 international dollars)**

|  | $ 1990 |  | $ 1990 |
|---|---|---|---|
| Japan (Maddison) | 737 |  |  |
| Japan (revised estimate) | 988 |  |  |
|  |  | Albania | 446 |
| Greece | 880 | Bulgaria | 840 |
| Portugal | 975 | Czechoslovakia | 1,164 |
| Spain | 1,207 | Hungary | 1,092 |
|  |  | Poland | 946 |
| Finland | 1,140 | Romania | 931 |
| Norway | 1,360 | Yugoslavia | 599 |
| Sweden | 1,359 | Russia | 943 |

Source: Maddison (2010).

**TABLE 3: GDP per capita in Japan as a percentage of Western nations, 1846-2008**

|      | Japan/GB | Japan/UK | Japan/US | Japan/W.Euro |
|------|----------|----------|----------|--------------|
| 1600 | 67.0     |          |          |              |
| 1721 | 45.6     |          |          |              |
| 1804 | 43.1     |          |          |              |
| 1846 | 32.6     |          |          |              |
| 1874 | 26.1     | 29.9     | 41.4     | 44.5         |
| 1890 |          | 29.1     | 34.4     | 44.3         |
| 1909 |          | 32.5     | 29.2     | 43.5         |
| 1925 |          | 41.7     | 34.2     | 54.3         |
| 1935 |          | 41.4     | 44.0     | 59.3         |
| 1940 |          | 44.8     | 43.8     | 61.5         |
| 1955 |          | 35.2     | 25.4     | 44.1         |
| 1970 |          | 90.2     | 64.6     | 88.9         |
| 1990 |          | 114.4    | 81.0     | 111.9        |
| 2008 |          | 96.1     | 73.2     | 102.6        |

Source: Japan: Table 1; GB: Broadberry et al. (2015); UK, US, Western Europe: Maddison (2010).

**TABLE 4: Average annual growth rates of output per employee (% per year)**

**A. Japan**

|  | Agric | Mining/ manuf | Constr. | Facilitating industry | Commerce- Services | GDP |
|---|---|---|---|---|---|---|
| 1891-1920 | 1.91 | 3.99 | 2.75 | 7.13 | 0.71 | 2.48 |
| 1920-1955 | -0.09 | 2.65 | 2.71 | 2.54 | -0.22 | 1.29 |
| 1955-1973 | 4.29 | 9.36 | 5.33 | 7.57 | 4.47 | 7.33 |
| 1973-1990 | 2.87 | 2.95 | 0.52 | 3.26 | 2.12 | 3.36 |
| 1990-2007 | 1.09 | 2.34 | -2.31 | 1.92 | 0.53 | 1.07 |

**B. United Kingdom**

|  | Agric | Mining/ manuf | Constr. | Facilitating industry | Commerce- Services | GDP |
|---|---|---|---|---|---|---|
| 1891-1920 | 0.05 | 0.39 | 0.23 | 0.62 | 0.36 | 0.46 |
| 1920-1955 | 2.75 | 2.13 | 1.30 | 2.27 | 0.00 | 1.23 |
| 1955-1973 | 5.94 | 3.04 | 1.34 | 4.03 | 1.36 | 2.42 |
| 1973-1990 | 3.40 | 3.43 | 0.86 | 2.60 | 0.46 | 1.73 |
| 1990-2007 | 2.22 | 3.31 | 1.32 | 4.46 | 1.48 | 2.08 |

**C. Japan – United Kingdom**

|  | Agric | Mining/ manuf | Constr. | Facilitating industry | Commerce- Services | GDP |
|---|---|---|---|---|---|---|
| 1891-1920 | 1.85 | 3.59 | 2.52 | 6.51 | 0.35 | 2.02 |
| 1920-1955 | -2.84 | 0.52 | 1.41 | 0.27 | -0.21 | 0.06 |
| 1955-1973 | -1.65 | 6.32 | 3.99 | 3.54 | 3.10 | 4.91 |
| 1973-1990 | -0.53 | -0.48 | -0.35 | 0.66 | 1.66 | 1.63 |
| 1990-2007 | -1.13 | -0.97 | -3.64 | -2.54 | -0.95 | -1.01 |

Source: Derived from Appendix Tables A1, A2.

**TABLE 5: Comparative Japan/UK GDP per employee by sector, 1997**

|  | Agric, forestry, fisheries | Mining, manuf | Constr- uction | Facili -tating industry | Commerce, Services | GDP |
|---|---|---|---|---|---|---|
| Japan (000 yen) | 1,992.0 | 8,575.5 | 5,812.8 | 10,920.6 | 7,825.7 | 7,580.6 |
| UK (£ 000) | 18.7 | 37.0 | 22.2 | 42.4 | 23.6 | 26.8 |
| PPP (yen per £) | 723.0 | 259.9 | 282.6 | 320.6 | 347.5 | 326.2 |
| Japan/UK (UK=100) | 14.7 | 89.3 | 92.7 | 80.4 | 95.5 | 86.7 |

Sources and notes: Derived from EU KLEMS database (O'Mahony and Timmer, 2009). The market exchange rate for 1997 was £1 = 198.1 yen.

**TABLE 6: Comparative Japan/UK labour productivity by sector (UK=100)**

|         | Agric, forestry, fisheries | Mining, manuf | Constr-uction | Facili-tating industry | Commerce, Services | GDP |
|---------|------|------|-------|-------|-------|------|
| 1890/91 | 34.9 | 10.7 | 24.4  | 7.3   | 43.3  | 18.5 |
| 1901    | 41.2 |      |       |       |       | 21.2 |
| 1911    | 44.3 | 20.8 | 53.3  | 36.1  | 44.1  | 23.8 |
| 1920    | 58.0 | 30.9 | 51.7  | 48.0  | 48.3  | 31.0 |
| 1929    | 41.3 | 37.3 | 35.2  | 71.1  | 52.5  | 33.7 |
| 1935    | 35.9 | 41.5 | 59.5  | 78.1  | 43.0  | 33.4 |
| 1955    | 21.7 | 36.9 | 83.8  | 52.6  | 44.8  | 31.7 |
| 1960    | 22.5 | 47.0 | 98.0  | 69.1  | 48.5  | 38.3 |
| 1973    | 16.4 | 107.8| 167.7 | 96.1  | 77.1  | 73.6 |
| 1979    | 14.4 | 108.9| 166.1 | 91.9  | 86.8  | 82.0 |
| 1990    | 15.0 | 99.5 | 158.2 | 107.2 | 101.8 | 96.3 |
| 1997    | 14.7 | 89.3 | 92.7  | 80.4  | 95.5  | 86.7 |
| 2007    | 12.4 | 84.7 | 85.0  | 70.5  | 86.8  | 81.4 |

Source: Derived from the benchmark in Table 5 and the time series in Appendix Tables A1 and A2.

**TABLE 7: Labour force by sector (%)**

**A. Japan**

|      | Agric | Mining/ manuf | Constr. | Facilitating industry | Commerce-Services | Total |
|------|-------|---------------|---------|-----------------------|-------------------|-------|
| 1890 | 61.9  | 18.9          |         | 2.9                   | 16.3              | 100.0 |
| 1920 | 52.6  | 18.0          | 3.6     | 4.6                   | 21.3              | 100.0 |
| 1955 | 41.5  | 18.6          | 5.3     | 5.0                   | 29.6              | 100.0 |
| 1973 | 16.1  | 26.1          | 9.3     | 6.4                   | 42.1              | 100.0 |
| 1990 | 8.8   | 23.0          | 9.6     | 6.3                   | 52.3              | 100.0 |
| 2007 | 5.0   | 17.2          | 8.4     | 6.5                   | 62.8              | 100.0 |

**B. United Kingdom**

|      | Agric | Mining/ manuf | Constr. | Facilitating industry | Commerce-Services | Total |
|------|-------|---------------|---------|-----------------------|-------------------|-------|
| 1891 | 15.8  | 38.2          | 5.0     | 7.0                   | 34.0              | 100.0 |
| 1920 | 8.6   | 42.0          | 4.6     | 9.0                   | 35.8              | 100.0 |
| 1955 | 4.5   | 39.5          | 6.3     | 8.8                   | 40.9              | 100.0 |
| 1973 | 2.5   | 34.6          | 7.7     | 7.8                   | 47.4              | 100.0 |
| 1990 | 2.0   | 21.6          | 8.4     | 7.2                   | 60.8              | 100.0 |
| 2007 | 1.4   | 12.4          | 7.5     | 6.9                   | 71.9              | 100.0 |

Sources: See Appendix Tables A1 and A2.

**TABLE 8: A Japan/UK PPP for industry, 1935 (yen per £)**

|  | PPP (yen per £) | Japanese weights (%) | UK weights (%) |
|---|---|---|---|
| Chemicals & allied | 14.81 | 20.3 | 7.0 |
| Metals & engineering | 13.10 | 6.0 | 7.0 |
| Engineering | 9.70 | 18.6 | 27.3 |
| Textiles & clothing | 11.21 | 21.8 | 19.9 |
| Food, drink & tobacco | 16.52 | 15.1 | 17.7 |
| Other industry | 11.80 | 18.2 | 21.1 |
| Total industry | 12.46 | 100.0 | 100.0 |

Sources: Price and quantity information for PPPs from Statistics Bureau, Management and Coordination Agency (1988), Vol.2 and Board of Trade (1938). Value added weights from Fukao et al. (2015) and Business Statistics Office (1978). Within each of the six main manufacturing sectors, PPPs for individual matched products are aggregated using gross output weights. The market exchange rate in 1935 was £1 = 17.14 yen, from Kinyu Kenkyukai (1937).

**TABLE 9: A Japan/UK PPP for the whole economy, 1935**

|  | PPP (yen per £) | UK weights (%) | Japanese weights (% |
|---|---|---|---|
| Grain & bread | 12.16 | 4.1 | 16.4 |
| Meat | 12.53 | 9.9 | 1.1 |
| Fish | 2.47 | 0.9 | 3.4 |
| Milk & eggs | 10.51 | 5.1 | 1.0 |
| Sugar | 17.90 | 1.9 | 3.5 |
| Vegetables & fruit | 6.15 | 4.6 | 3.8 |
| Processed foods | 3.02 | 1.7 | 7.9 |
| Alcohol | 10.41 | 7.1 | 2.0 |
| Tea | 8.62 | 1.3 | 0.5 |
| Tobacco | 7.17 | 3.8 | 1.6 |
| *Total food* | 9.21 | 40.4 | 41.3 |
| Fuel & light | 16.22 | 4.3 | 4.8 |
| Clothing | 12.84 | 11.9 | 10.6 |
| Housing & furniture | 9.83 | 17.3 | 10.2 |
| Transport & communications | 4.24 | 7.6 | 2.1 |
| Health & hygiene | 2.83 | 9.1 | 7.7 |
| Education & entertainment | 6.36 | 9.4 | 23.4 |
| *Total expenditure* | 8.36 | 100.0 | 100.0 |

Sources and notes: UK consumer prices and expenditure weights were taken largely from Stone (1954) and Stone and Rowe (1966), with additional data on service sector wages from Chapman (1953) and on newspaper prices from Kaldor and Silverman (1948). Japanese consumer prices and expenditure weights were taken from Fukao et al. (2007). The market exchange rate in 1935 was £1 = 17.14 yen, from Kinyu Kenkyukai (1937).

**TABLE 10: Comparative Japan/UK GDP per employee benchmark, 1935**

|  | Mining/ manufacturing | Whole economy |
| --- | --- | --- |
| Japanese GDP per employee (yen) | 945.16 | 612.48 |
| UK GDP per employee (£) | 178.72 | 209.31 |
| PPP (yen per £) | 12.46 | 8.36 |
| Japan/UK GDP per employee (UK=100) | 42.4 | 35.0 |

Sources and notes: Japanese GDP at current prices and employment from Fukao et al. (2015). UK GDP and employment from Feinstein (1972). PPPs from Tables 8 and 9. The market exchange rate in 1935 was £1 = 17.14 yen, from Kinyu Kenkyukai (1937).

**TABLE 11: Shares of world exports of manufacturing (%)**

|  | UK | Japan | USA | Germany |
| --- | --- | --- | --- | --- |
| 1881-85 | 43.0 | 0.0 | 6.0 | 16.0 |
| 1899 | 34.5 | 1.6 | 12.1 | 16.6 |
| 1913 | 31.8 | 2.5 | 13.7 | 19.9 |
| 1929 | 23.8 | 4.1 | 21.7 | 15.5 |
| 1937 | 22.3 | 7.4 | 20.5 | 16.5 |
| 1950 | 24.6 | 3.4 | 26.6 | 7.0 |
| 1964 | 14.0 | 8.3 | 20.1 | 19.5 |
| 1973 | 9.1 | 13.1 | 15.1 | 22.3 |
| 1979 | 9.2 | 13.1 | 16.3 | 21.6 |
| 1999 | 6.9 | 12.2 | 17.8 | 14.2 |

Source: Broadberry (1994: 294; 2004: 64).

**TABLE 12: Industrial wages and prices in Japan and the United Kingdom**

**A. Before World War 2 (1935=100)**

| | Japan | | | UK | | |
|---|---|---|---|---|---|---|
| | Nominal wage | Producer price | Own product real wage | Nominal wage | Producer price | Own product real wage |
| 1901 | 21.3 | 60.7 | 35.2 | 44.1 | 62.0 | 71.0 |
| 1911 | 32.8 | 79.1 | 41.4 | 46.3 | 66.8 | 69.3 |
| 1920 | 120.3 | 197.8 | 60.8 | 137.2 | 194.3 | 70.6 |
| 1929 | 128.3 | 121.2 | 105.8 | 101.0 | 110.7 | 91.3 |
| 1935 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

**B. After World War 2 (1997=100)**

| | Japan | | | UK | | |
|---|---|---|---|---|---|---|
| | Nominal wage | Producer price | Own product real wage | Nominal wage | Producer price | Own product real wage |
| 1955 | 3.2 | 51.4 | 6.3 | 2.4 | 8.0 | 30.1 |
| 1960 | 4.7 | 51.4 | 9.2 | 3.1 | 9.5 | 32.9 |
| 1973 | 26.8 | 65.1 | 41.2 | 8.8 | 16.6 | 53.1 |
| 1979 | 54.1 | 95.7 | 56.5 | 24.7 | 41.4 | 59.6 |
| 1990 | 87.6 | 105.2 | 83.3 | 70.6 | 87.3 | 80.8 |
| 1997 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| 2007 | 98.3 | 100.1 | 98.2 | 157.0 | 116.7 | 134.5 |

Sources: UK wages: Feinstein (1972; 1990); Chapman (1953); Department of Employment (1971); Department of Employment (various years), *British Labour Statistics*; EU KLEMS database (O'Mahony and Timmer, 2009). UK producer prices: Mitchell, (1988); Office for National Statistics (various years) *Monthly Digest of Statistics*; EU KLEMS database. Japanese wages: Minami and Ono (1978); Economic and Social Research Institute, Cabinet Office (n.d.), *Annual Report on National Accounts*; Japanese producer prices: Ohkawa et al. (1967); *Annual Report on National Accounts*.

**TABLE 13: Comparative Japan/UK unit labour costs in industry**

**A. Before World War 2**

| | (1935=100) | | | (UK=100) | | |
|---|---|---|---|---|---|---|
| | Japanese real wage | UK real wage | Japan/UK real wage | Japan/UK real wage | Japan/UK labour productivity | Japan/UK unit labour costs |
| 1901 | 35.2 | 71.0 | 49.5 | 11.1 | 16.6 | 66.6 |
| 1911 | 41.4 | 69.3 | 59.8 | 13.4 | 20.5 | 65.2 |
| 1920 | 60.8 | 70.6 | 86.2 | 19.2 | 31.4 | 61.3 |
| 1929 | | | 115.9 | | | |
| | 105.8 | 91.3 | | 25.9 | 35.5 | 73.0 |
| 1935 | 100.0 | 100.0 | 100.0 | 22.3 | 35.9 | 62.2 |

**B. After World War 2 (1997=100)**

| | (1997=100) | | | (UK=100) | | |
|---|---|---|---|---|---|---|
| | Japanese real wage | UK real wage | Japan/UK real wage | Japan/UK real wage | Japan/UK labour productivity | Japan/UK unit labour costs |
| 1955 | 6.3 | 30.1 | 20.8 | 17.7 | 36.9 | 48.1 |
| 1960 | 9.2 | 32.9 | 27.8 | 23.7 | 47.0 | 50.4 |
| 1973 | 41.2 | 53.1 | 77.7 | 66.2 | 107.8 | 61.4 |
| 1979 | 56.5 | 59.6 | 94.8 | 80.8 | 108.9 | 74.2 |
| 1990 | 83.3 | 80.8 | 103.0 | 87.8 | 99.5 | 88.2 |
| 1997 | 100.0 | 100.0 | 100.0 | 85.2 | 89.3 | 95.4 |
| 2007 | 98.2 | 134.5 | 73.0 | 62.2 | 84.7 | 73.4 |

Sources and notes: Real wages: Table 12, with benchmark levels in 1935 and 1997 discussed in the text. Labour productivity: Table 6. Comparative unit labour costs derived as the ratio of own product real wages to labour productivity.

**TABLE 14: Japan/UK comparative labour productivity (Y/L), capital intensity (K/L) and total factor productivity (TFP) (UK=100)**

|      | Comparative Y/L | Comparative K/L | Comparative TFP |
|------|-----------------|-----------------|-----------------|
| 1891 | 17.4            | 11.0            | 38.4            |
| 1901 | 21.2            | 13.2            | 45.7            |
| 1911 | 23.8            | 17.4            | 47.0            |
| 1920 | 31.0            | 25.6            | 49.7            |
| 1929 | 33.7            | 29.4            | 52.2            |
| 1935 | 33.4            | 32.7            | 51.0            |
| 1955 | 31.7            | 37.3            | 42.8            |
| 1960 | 38.3            | 43.5            | 47.4            |
| 1973 | 73.6            | 73.4            | 79.6            |
| 1979 | 82.0            | 83.3            | 86.1            |
| 1990 | 96.3            | 114.4           | 92.6            |
| 1997 | 86.7            | 115.0           | 82.7            |
| 2007 | 81.4            | 95.4            | 82.6            |

Sources and notes: Derived from Appendix Table A1-A3. The level of comparative labour productivity in the benchmark year of 1997 is taken from Table 5, while the level of comparative capital intensity is derived using the net capital stock for 1997 from *JIP Database* (Research Institute of Economy, Trade and Industry, 2013) for Japan and *UK National Accounts* (Office for National Statistics, 2000) for the UK, and the 1997 PPP for construction and manufacturing from the EU KLEMS data base (O'Mahony and Timmer, 2009). Comparative TFP is calculated using the geometric mean of Japanese and UK capital shares in income.

**TABLE 15: Accounting for labour productivity growth (% per year)**

**A. Japan**

|  | Labour productivity growth | Contributions of: | |
|  |  | Capital deepening | TFP growth |
| --- | --- | --- | --- |
| 1891-1920 | 2.50 | 1.42 | 1.08 |
| 1920-1955 | 1.31 | 0.61 | 0.70 |
| 1955-1973 | 7.48 | 2.80 | 4.68 |
| 1973-1990 | 3.39 | 1.40 | 1.99 |
| 1990-2007 | 1.20 | 0.81 | 0.39 |

**B. United Kingdom**

|  | Labour productivity growth | Contributions of: | |
|  |  | Capital deepening | TFP growth |
| --- | --- | --- | --- |
| 1891-1920 | 0.47 | 0.12 | 0.35 |
| 1920-1955 | 1.23 | 0.29 | 0.95 |
| 1955-1973 | 2.43 | 0.93 | 1.50 |
| 1973-1990 | 1.73 | 0.59 | 1.15 |
| 1990-2007 | 2.09 | 0.49 | 1.60 |

**C. Japan – United Kingdom**

|  | Labour productivity growth | Contributions of: | |
|  |  | Capital deepening | TFP growth |
| --- | --- | --- | --- |
| 1891-1920 | 2.03 | 1.29 | 0.74 |
| 1920-1955 | 0.07 | 0.32 | -0.25 |
| 1955-1973 | 5.05 | 1.88 | 3.17 |
| 1973-1990 | 1.65 | 0.81 | 0.84 |
| 1990-2007 | -0.89 | 0.32 | -1.21 |

Sources and notes: Derived from Appendix Table A1-A3. TFP growth is calculated using the geometric mean of the capital shares of income during each period.

**FIGURE 1: Japanese GDP per capita, 1874-2008 (1990 international dollars)**
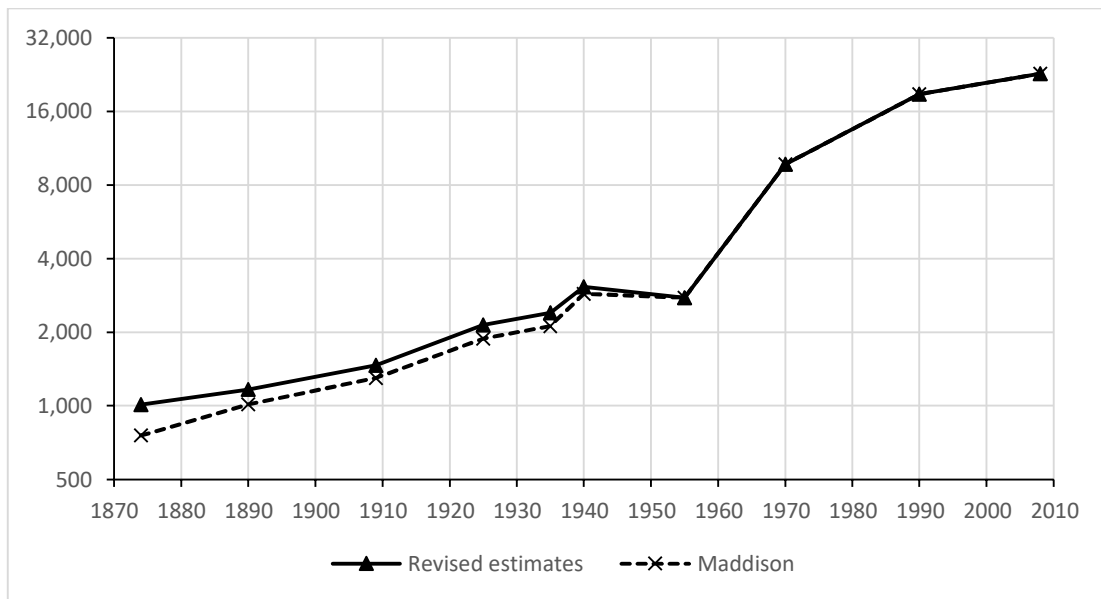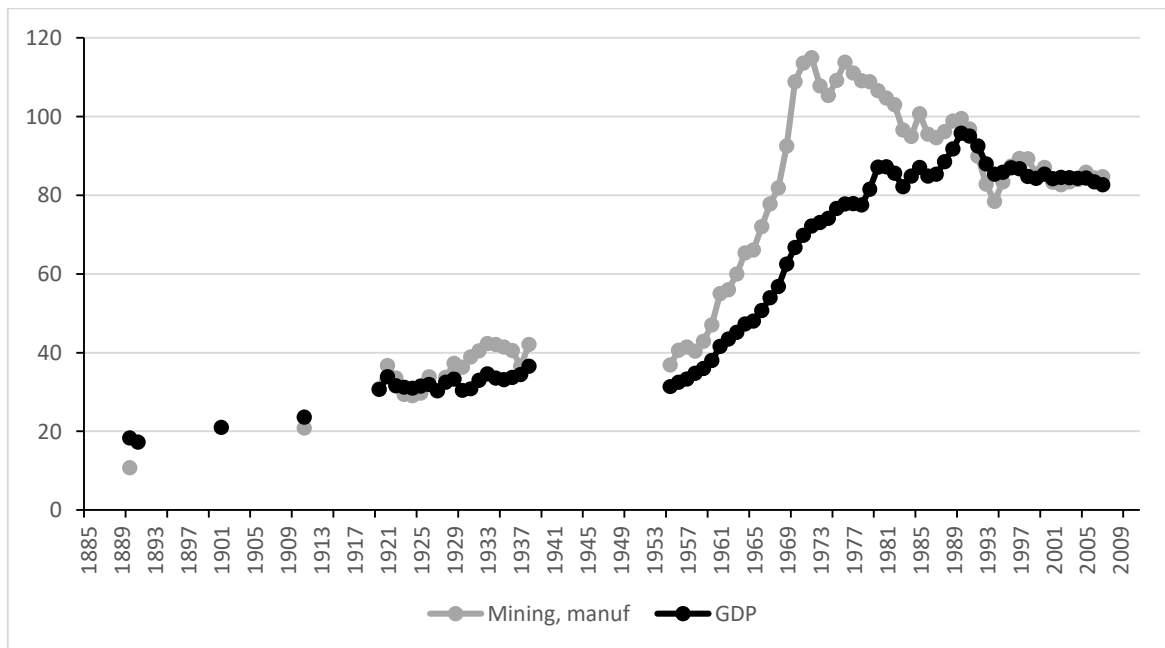


Source: Table 1.

**FIGURE 2: Japanese GDP per capita, 1600-1874 (1990 international dollars)**
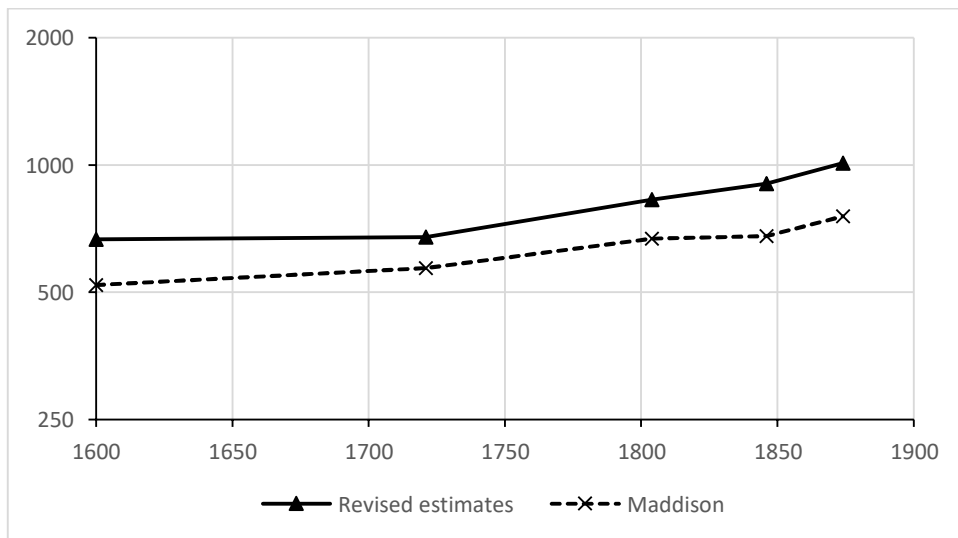


Source: Table 1.

**FIGURE 3: Comparative Japan/UK labour productivity (UK=100)**



Sources: See Table 6.

# APPENDIX: DATA AND SOURCES FOR TIME SERIES PROJECTIONS

**TABLE A1: Time series for Japanese output, employment and labour productivity by sector (1935=100)**

**A. Japanese output**

|      | Agric, forestry, fisheries | Mining, manuf | Constr-uction | Facili-tating industry | Commerce, Services | GDP |
|------|------|------|------|------|------|------|
| 1890 | 60.9 | 9.1 | 12.4 | 2.9 | 40.1 | 27.8 |
| 1901 | 73.3 | 14.6 | 19.9 | 8.0 | 51.0 | 36.4 |
| 1911 | 84.3 | 22.2 | 30.6 | 20.9 | 58.6 | 45.4 |
| 1920 | 102.4 | 39.9 | 33.9 | 43.1 | 75.7 | 62.8 |
| 1929 | 100.4 | 70.4 | 61.4 | 86.5 | 101.7 | 87.9 |
| 1935 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| 1955 | 116.8 | 153.9 | 192.8 | 168.8 | 145.2 | 146.7 |
| 1960 | 135.2 | 291.4 | 361.4 | 309.1 | 206.2 | 219.4 |
| 1973 | 133.9 | 1,493.3 | 1,176.8 | 1,114.4 | 628.1 | 726.9 |
| 1979 | 123.8 | 1,589.9 | 1,214.3 | 1,242.0 | 844.3 | 897.1 |
| 1990 | 134.9 | 2,465.8 | 1,520.6 | 2,163.3 | 1,274.2 | 1,457.4 |
| 1997 | 107.0 | 2,582.3 | 1,287.4 | 2,624.0 | 1,488.0 | 1,624.3 |
| 2007 | 93.3 | 2,745.9 | 896.1 | 3,075.5 | 1,678.2 | 1,789.6 |

**B. Japanese employment**

|      | Agric, forestry, fisheries | Mining, manuf | Constr-uction | Facili-tating industry | Commerce, Services | GDP |
|------|------|------|------|------|------|------|
| 1890 | 100.2 | 62.2 | 62.2 | 52.6 | 42.6 | 73.5 |
| 1901 | 102.9 | | | | | 78.1 |
| 1911 | 104.5 | 67.9 | 73.7 | 64.4 | 56.2 | 81.3 |
| 1920 | 99.8 | 84.7 | 75.3 | 98.3 | 65.0 | 86.1 |
| 1929 | 99.1 | 90.6 | 101.6 | 98.2 | 81.4 | 92.6 |
| 1935 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| 1955 | 117.3 | 130.8 | 168.1 | 159.8 | 134.5 | 128.5 |
| 1960 | 104.4 | 175.3 | 244.2 | 191.6 | 162.9 | 143.4 |
| 1973 | 63.1 | 253.7 | 403.1 | 283.9 | 264.9 | 178.2 |
| 1979 | 55.7 | 229.5 | 450.2 | 295.8 | 307.2 | 184.8 |
| 1990 | 39.3 | 255.6 | 477.3 | 319.2 | 376.4 | 203.7 |
| 1997 | 30.7 | 234.3 | 539.8 | 348.7 | 425.5 | 214.9 |
| 2007 | 22.6 | 192.1 | 418.6 | 328.5 | 453.3 | 208.7 |

**C. Japanese output per employee**

| | Agric, forestry, fisheries | Mining, manuf | Constr-uction | Facili-tating industry | Commerce, Services | GDP |
|---|---|---|---|---|---|---|
| 1890 | 60.8 | 14.6 | 19.9 | 5.6 | 94.2 | 37.8 |
| 1901 | | | | | | 46.6 |
| 1911 | 80.7 | 32.7 | 41.5 | 32.4 | 104.2 | 55.8 |
| 1920 | 102.6 | 47.1 | 45.0 | 43.9 | 116.4 | 72.9 |
| 1929 | 101.3 | 77.6 | 60.4 | 88.1 | 124.8 | 94.9 |
| 1935 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| 1955 | 99.5 | 117.6 | 114.7 | 105.6 | 108.0 | 114.1 |
| 1960 | 129.6 | 166.2 | 148.0 | 161.3 | 126.6 | 153.0 |
| 1973 | 212.1 | 588.7 | 292.0 | 392.6 | 237.1 | 408.0 |
| 1979 | 222.2 | 692.6 | 269.7 | 419.9 | 274.8 | 485.5 |
| 1990 | 343.1 | 964.7 | 318.6 | 677.8 | 338.5 | 715.4 |
| 1997 | 348.3 | 1,102.0 | 238.5 | 752.4 | 349.7 | 755.8 |
| 2007 | 412.4 | 1,429.2 | 214.0 | 936.1 | 370.2 | 857.4 |

**Sources**

*Output by sector*

1885-1940: Fukao et al. (2015).Interpolation between benchmark years using Ohkawa et al. (1974: Table 25).

1940-1955: Settsu et al. (2016).

1955-1973: Fukao and Makino (2021).

https://d-infra.ier.hit-u.ac.jp/Japanese/ltes/b000.html#07

1970-2007: Research Institute of Economy, Trade and Industry (2015) Japan industrial productivity Database 2015 (JIP Database 2015).

https://www.rieti.go.jp/jp/database/JIP2015/index.html

*Employment by sector*

1890: Fukao et al. (2015).

1906-1940: Fukao et al. (2017a: Appendix Table) (2017b: Appendix Table).

1955-1973: Fukao and Makino (2021)

https://d-infra.ier.hit-u.ac.jp/Japanese/ltes/b000.html#07

1970-2007: Research Institute of Economy, Trade and Industry (2015) Japan industrial productivity Database 2015 (JIP Database 2015).

https://www.rieti.go.jp/jp/database/JIP2015/index.html

**TABLE A2: UK time series for output, employment and labour productivity by sector (1935=100)**

**A. UK output**

|  | Agric, forestry, fisheries | Mining, manuf | Constr-uction | Facili-tating industry | Commerce, Services | GDP |
|---|---|---|---|---|---|---|
| 1891 | 120.2 | 49.4 | 35.7 | 37.9 | 62.9 | 57.2 |
| 1901 | 109.7 | 59.5 | 56.4 | 49.1 | 76.0 | 68.7 |
| 1911 | 114.7 | 70.4 | 41.8 | 64.7 | 89.5 | 79.8 |
| 1920 | 80.8 | 74.3 | 42.1 | 70.8 | 89.6 | 79.7 |
| 1929 | 96.7 | 90.2 | 90.5 | 95.8 | 91.9 | 91.6 |
| 1935 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| 1955 | 131.3 | 175.1 | 110.4 | 182.3 | 122.5 | 146.5 |
| 1960 | 153.4 | 197.5 | 128.9 | 207.7 | 137.3 | 165.6 |
| 1973 | 219.2 | 278.1 | 179.3 | 347.8 | 191.3 | 238.0 |
| 1979 | 226.5 | 293.4 | 160.3 | 383.3 | 213.1 | 253.7 |
| 1990 | 318.8 | 314.0 | 230.9 | 509.3 | 271.1 | 325.5 |
| 1997 | 311.1 | 346.1 | 224.2 | 691.0 | 317.3 | 375.2 |
| 2007 | 334.1 | 338.6 | 279.7 | 1,101.6 | 444.7 | 499.4 |

**B. UK employment**

|  | Agric, forestry, fisheries | Mining, manuf | Constr-uction | Facili-tating industry | Commerce, Services | GDP |
|---|---|---|---|---|---|---|
| 1891 | 192.0 | 87.6 | 73.6 | 63.5 | 67.2 | 83.1 |
| 1901 | 176.6 | 96.6 | 95.5 | 84.1 | 78.4 | 93.2 |
| 1911 | 175.2 | 108.0 | 90.3 | 92.3 | 88.1 | 101.8 |
| 1920 | 127.1 | 117.6 | 81.2 | 99.1 | 86.3 | 101.3 |
| 1929 | 109.6 | 104.4 | 88.6 | 99.1 | 89.8 | 97.2 |
| 1935 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| 1955 | 79.8 | 132.5 | 135.5 | 116.3 | 118.1 | 121.5 |
| 1960 | 74.1 | 134.7 | 143.4 | 114.1 | 122.1 | 123.9 |
| 1973 | 47.1 | 122.7 | 173.1 | 109.1 | 144.5 | 128.3 |
| 1979 | 40.8 | 111.2 | 165.9 | 107.5 | 156.4 | 128.1 |
| 1990 | 38.9 | 78.1 | 192.7 | 103.2 | 189.4 | 131.1 |
| 1997 | 36.5 | 67.6 | 146.4 | 94.6 | 201.3 | 128.7 |
| 2007 | 28.1 | 48.4 | 186.7 | 106.3 | 242.2 | 141.7 |

**C. UK output per employee**

|  | Agric, forestry, fisheries | Mining, manuf | Constr-uction | Facili-tating industry | Commerce, Services | GDP |
|---|---|---|---|---|---|---|
| 1891 | 62.6 | 56.4 | 48.5 | 59.7 | 93.7 | 68.8 |
| 1901 | 62.1 | 61.6 | 59.0 | 58.3 | 96.9 | 73.7 |
| 1911 | 65.5 | 65.2 | 46.3 | 70.1 | 101.6 | 78.4 |
| 1920 | 63.6 | 63.2 | 51.8 | 71.4 | 103.9 | 78.7 |
| 1929 | 88.2 | 86.4 | 102.1 | 96.7 | 102.4 | 94.2 |
| 1935 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| 1955 | 164.6 | 132.2 | 81.5 | 156.7 | 103.7 | 120.6 |
| 1960 | 207.1 | 146.6 | 89.9 | 182.1 | 112.4 | 133.7 |
| 1973 | 465.0 | 226.6 | 103.6 | 318.8 | 132.4 | 185.5 |
| 1979 | 554.8 | 264.0 | 96.6 | 356.5 | 136.3 | 198.0 |
| 1990 | 820.5 | 402.3 | 119.8 | 493.6 | 143.1 | 248.4 |
| 1997 | 851.3 | 511.9 | 153.1 | 730.4 | 157.6 | 291.6 |
| 2007 | 1,191.0 | 700.1 | 149.8 | 1,036.0 | 183.6 | 352.4 |

**Sources**
*Output by sector*
1891-1965: Feinstein (1972: Table 8). Weights for component parts of sectors from Feinstein (1972: 208).
1965-2007: Office for National Statistics (various years), *UK National Accounts*.

*Employment by sector*
1871-1965: Feinstein (1972: Tables 59, 60).
1965-1970: O'Mahony (1999).
1970-2007: EU KLEMS database (O'Mahony and Timmer, 2009).

*Territory*
Boundaries of the United Kingdom of Great Britain and Ireland before 1920, Great Britain and Northern Ireland after 1920.

**TABLE A3: Aggregate time series for capital stock and capital share of income**

| | Capital stock (1935=100) | | Capital share of income | |
| --- | --- | --- | --- | --- |
| | Japan | UK | Japan | UK |
| 1891 | 17.4 | 58.1 | 0.307 | 0.420 |
| 1901 | 24.6 | 72.6 | 0.346 | 0.420 |
| 1911 | 37.4 | 87.9 | 0.350 | 0.433 |
| 1920 | 62.3 | 93.6 | 0.379 | 0.318 |
| 1929 | 84.4 | 98.4 | 0.357 | 0.359 |
| 1935 | 100.0 | 100.0 | 0.415 | 0.342 |
| 1955 | 165.8 | 137.5 | 0.320 | 0.289 |
| 1960 | 267.4 | 173.6 | 0.226 | 0.294 |
| 1973 | 1,248.2 | 400.3 | 0.225 | 0.291 |
| 1979 | 1,697.9 | 461.5 | 0.246 | 0.282 |
| 1990 | 3,156.1 | 579.8 | 0.338 | 0.252 |
| 1997 | 4,141.7 | 794.4 | 0.378 | 0.303 |
| 2007 | 4,660.1 | 1,082.9 | 0.346 | 0.284 |

**Sources**
*Net fixed capital stock excluding dwellings*
Japan:
1885-1970: Fukao et al. (2019: Appendix Table)
1970-2007: Research Institute of Economy, Trade and Industry (2015) Japan industrial productivity Database 2015 (JIP Database 2015).
https://www.rieti.go.jp/jp/database/JIP2015/index.html

United Kingdom:
1891-1920: Feinstein (1988: Table XIII).
1920-1955: Feinstein (1972: Appendix Table 43).
1955-1970: UK Central Statistical Office (various years), *National Income and Expenditure*; UK Central Statistical Office (various years), *Capital Stocks, Capital Consumption and Non-Financial Balance Sheets*.
1970-2007: Volume indices from EU KLEMS database (O'Mahony and Timmer, 2009).

*Capital share of income*
Japan:
We calculated the capital share of income using background data of Fukao et al. (2021) as follows:

$$Capital\ Share = \frac{Capital\ Surplus}{Nominal\ GDP}$$
$$= \frac{Nominal\ GDP - Net\ Indirect\ Tax - Labour\ Cost}{Nominal\ GDP}$$

United Kingdom:
1891-1970: Feinstein (1972: Appendix Table 1) and Matthews et al. (1982: Table 6.1 and 6.3).
1970-2007: EU KLEMS database (O'Mahony and Timmer, 2009).

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