JAPAN AND THE GREAT DIVERGENCE, 730-1874

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Abstract: Despite being the first Asian economy to achieve modern economic growth, Japan has received relatively little attention in the Great Divergence debate. New estimates suggest that although the level of GDP per capita remained below the level of northwest Europe throughout the period 730-1874, Japan experienced positive trend growth before 1868, in contrast to the negative trend growth experienced in China and India, leading to a Little Divergence within Asia. However, growth in Japan remained slower than in northwest Europe so that Japan continued to fall behind until after the institutional reforms of the early Meiji period. The Great Divergence thus occurred as the most dynamic part of Asia fell behind the most dynamic part of Europe.

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1. INTRODUCTION

Before the publication of Angus Maddison's (2001), *The World Economy: A Millennial Perspective,* most accounts of economic growth before the nineteenth century were largely qualitative. Although Maddison's estimates have been influential, they were based largely on conjecture rather than built up from contemporary data. Maddison himself was well aware that many parts of Europe and Asia during the medieval and early modern periods were quite literate and numerate, and left behind an abundance of documents containing information that could be turned into estimates of population and economic activity. Indeed, in an edited collection from the World Economic History Congress in Milan, Maddison and van der Wee (1994) provided some preliminary studies in historical national accounting that went back to 1086 in England, to 1500 in Flanders and Brabant and to 1580 in Spain (Snooks, 1994; Blomme and van der Wee, 1994; Yun, 1994). However, these studies were only very loosely incorporated into Maddison (2001: 244-265), where many of the GDP per capita estimates before 1500 are around $400 in 1990 international prices, connected up to the 1820 estimates using assumed growth rates based on a reading of the qualitative literature. The figure of $400 is seen as subsistence income, based on the assumption that most people existed at the World Bank poverty level of $1 per day (in 1990 prices), with a small rich elite pulling up the average from $365. It is important to understand that Maddison intended his estimates for the pre-modern period to be a starting point and indeed encouraged other scholars to engage in historical national accounting using contemporary data, with a view to improving his estimates, just as he had already done for the modern period in a remarkable stream of publications from Maddison (1982) to Maddison (1995).

Maddison's pathbreaking study has stimulated much progress in historical national accounting for medieval and early modern Europe, with annual estimates now available back as far as 1300 for Britain, the Netherlands, Italy, Spain, Sweden and France and back to 1500 for Portugal and Germany (Broadberry et al., 2015a; van Zanden and van Leeuwen, 2012; Malanima, 2011; Álvarez-Nogal and Prados de la Escosura, 2013; Schön and Kranz, 2012; Krantz, 2017; Ridolfi, 2017; Pfister, 2015; Palma and Reis, 2017). For Asia, progress has been rather slower, as there is less of a tradition of collecting data and processing it within an economic framework on which to build. Nevertheless studies have now appeared for China and India based on contemporary data, showing substantial differences from Maddison's (2001) conjectures (Broadberry et al., 2018; Xu et al., 2017; Broadberry et al., 2015b). Japan, Asia's most successful economy, has been missing from this new database.

In this paper, we provide the first estimates based on contemporary data of long term growth for Japan over the period 730-1874. These estimates have important implications for the debate over the Great Divergence of productivity and living standards between Europe and Asia. Following the claim of Pomeranz (2000) that China did not fall behind the West until after 1800, most attention on the Asian side has been focused on China, with a smaller amount of literature devoted to the case of India, following the work of Parthasarathi (1998; 2011). However, a similar debate had in fact taken place over the position of Japan nearly two decades earlier, following the work of Hanley (1983; 1986). Hanley (1983) argued that Japanese living standards were as high as in the West until the nineteenth century. Furthermore, the case for Japan as the most likely Asian economy to be on a par with Europe in the early modern period is given credence by the fact that Japan was the first Asian economy to make the transition to modern economic growth in Asia after the Meiji Restoration of 1868, and went on to catch up with Western levels of per capita GDP in the twentieth century while China and India fell further behind. Although Hanley's (1983) claim of Japanese parity with the West until the nineteenth century was quickly criticised by Yasuba (1986) before fading from view, the idea of Japan following an exceptional path within Asia, sharing many characteristics with the European path, was already firmly established within the economic history literature and has remained strong (Smith, 1959; Dore, 1965; Nakamura, 1966; Hayami et al., 1999). Indeed, the later volumes of the *Cambridge Economic History of Europe* even went so far as to include separate chapters on Japan in providing a comprehensive overview of "European" development (Mathias and Postan, 1978; Mathias and Pollard, 1989). Adding Japan to the database means that for the first time, we can examine quantitatively the underlying differences between China, India and Japan which may help to shed light on why Japan caught up with Europe in the twentieth century, while India and China lagged behind.

The results presented here suggest that Japan experienced substantial GDP per capita growth before 1868, thus providing a firm base for the first Asian transition to modern economic growth following the Meiji restoration of that year. Inevitably, with the current state of knowledge, the estimates lack precision. There are undoubtedly fewer sources for Asian economies than for European economies such as Britain and the Netherlands. Furthermore, those sources that are available have been subjected to less critical scrutiny by economic historians. To deal with this uncertainty, we provide data reliability assessments and sensitivity analysis. Here, we build upon the subjective error margins approach used by Farris (2006; 2009a) for Japanese population and agricultural output. This approach has also been used in historical national accounting studies for other countries (Feinstein and Thomas 2002; van Zanden and van Leeuwen, 2012; Broadberry et al., 2018). We also consider the robustness of our main findings to alternative scenarios.

The central estimates suggest Malthusian fluctuations in Japan during the ancient period, with positive per capita income growth during periods of falling population and negative per capita income growth during periods of rising population. This was followed by positive trend growth of per capita income in Japan between 1280 and 1874, with most of the growth occurring in two phases, between 1450 and 1600 during the medieval period, and after 1721 during the Tokugawa period. Although there is a qualitative literature to support the idea of late medieval growth, the width of the error bands during the medieval period suggests caution should be exercised until further quantitative evidence becomes available to confirm this finding (Nagahara, 1981; Farris, 2006). For the Tokugawa period, however, the case for trend growth is stronger since it is based upon a much larger amount of contemporary quantitative information as well as an extensive qualitative literature that supports this interpretation (Nakamura, 1968; Hayami et al., 2004). Although our estimates suggest that Japan was improving its relative position within Asia during the Tokugawa period, growth in Japan remained slower than in northwest Europe. As a result, Japan continued to fall behind the leading European economies until after the Meiji Restoration. The Great Divergence thus occurred as the most dynamic part of Asia fell behind the most dynamic part of Europe.

2. POPULATION

Historical demographic data allow the estimation of total population for Japan back to around 730. The data in Table 1 are taken from a number of sources that have been cross-checked and made consistent, covering the ancient, medieval and Tokugawa periods (Saito and Takashima, 2017a; 2017b). Due to the limited availability of primary sources for premodern Japan, it is not possible to construct an annual series, so data are provided for a number of benchmark years. For the ancient period (710-1192), data are presented for 730, 950 and 1150, while for the medieval period (1192-1600), the benchmark years are 1280 and 1450. For the Tokugawa period (1600-1868), data are provided for 1600, 1721, 1804 and 1846. These estimates are linked up to a benchmark for 1874, early in the Meiji period (1868-1912). Here we provide a brief description of the sources and methods for the estimation of the population benchmarks, with further details set out in the Appendix.

2.1 Ancient period

For the ancient period, the estimates of Farris (2009a) are derived ultimately from information on the number and average size of villages (for the year 730) or the cultivated area together with the amount of land needed to provide sufficient food to support a person (for the years 950 and 1150). For 730, Farris reworks the estimates of Sawada (1927) and Kamata (1984), based on the number of *gō* (villages or administrative units consisting of 50 households) in *Rissho zanpen*, an ancient penal statute compiled in the first half of the eighth century (Kondo, 1969). The number of villages is multiplied by the number of people living in an average village in the first half of the eighth century, supplemented by an allowance for urban dwellers and slaves. This yields a range of 5.8 to 6.4 million for the population in 730, shown in Table 1.

For 950, Farris (2009a: 23-24) reworks the figures of Kito (1983), who based his population estimates on the cultivated area from *Wamyōshō*, an ancient Japanese encyclopaedia compiled in the first half of the tenth century (Kyoto Daigaku Bungakubu Kokugogaku Kokubungaku Kenkyūshitsu, 1968), and information on the amount of land required to support one person in the mid-tenth century. This yields the maximum figure of 5.6 million in Table 1. For the minimum figure of 4.4 million in 950, Farris (2009a: 4, 24) used information from a Tōdaiji monk Chonen, who arrived at the Chinese court in 983 with documents showing the number of administrative villages.

Farris (2009a: 24-26) also provides a range for the population of Japan in 1150. His starting point is again the work of Kito (1983), who based his estimates on the cultivated area recorded in *Shūgaishō*, an old Japanese encyclopaedia compiled in the early medieval period (Iyanaga, 1980). Because there is uncertainty over whether or not the cultivated area includes all land that was actually in cultivation or just rice paddies, Farris provides a range of between 5.5 and 6.3 million for the population in 1150.

Table 1 also includes some alternative estimates from Kito (1996; 2000) covering the years 725, 900 and 1150. Although it would be possible to argue that they have been superseded by the estimates of Farris, which reworked the same basic information under different assumptions, they are included here since they fall outside the range given by Farris. Note that encompassing Kito's alternative estimates would increase the error range for 730 and 950 from ±5% to 12% to around ±17% to 18%. We will return to the issue of error margins later in the paper when considering the robustness of our results.

2.2 Medieval period

For the medieval period, the estimates are also taken from the work of Farris (2006). For 1280, a link to the cultivated area in the ancient period is established using a sample of land registers and combined with information on the amount of land per person needed to support life (Farris, 2006: 22-26). For 1450, the population is estimated by establishing the number of soldiers, applying a ratio of soldiers to the rural population and making an allowance for the urban population (Farris, 2006: 95-98). This figure is then cross-checked against Osamu Saito's extrapolation back from the first national census estimate of 1721 (Farris, 2006: 98-100; Saito and Takashima, 2017a). Again, Farris provides a range of estimates for 1280 and 1450, which are shown in Table 1.

2.3 Tokugawa and early Meiji periods

For the Tokugawa period, the population data for 1600 are taken from Saito and Takashima (2017a), again projected back from the census figure for 1721. The estimates for 1804 and 1846 are based on further national surveys, reworked by Kito (1996). For the early Meiji period, the 1874 level is taken from Fukao *et al.* (2015). Farris (2006) provides an error range of around ±5% for most years before 1600, but with a higher range of ±12% for 950. Because the population figures for the Tokugawa and early Meiji periods are rooted in national surveys, the maximum and minimum figures have also been set at 5% above and below the benchmark estimates.

2.4 Overview of population growth

To be credible, estimates of population must also produce reasonable average annual rates of growth between benchmark years, so Table 1 also provides data on the annual rate of growth of population in panel B. Over the entire period 730-1874, Japanese population grew at a relatively modest annual rate of 0.15 per cent using our main series, or 0.18 per cent using the alternative series for the ancient period. However, much of the population growth was concentrated in the period 1280-1721, with periods of much slower growth before 1280 and again after 1721.

The stagnation of the population between 730 and 1280 is easily understood in the context of a high frequency of famines, which kept mortality rates high (Saito, 2015: 215). The strong population growth from 1280 is consistent with the decline in the frequency of famines from one every three years in the ancient period to one every four years during the medieval period (Saito, 2015: 216). Also, with the failure of the Mongol invasion from China in the late thirteenth century preserving Japan’s isolation from the Eurasian mainland, Japan avoided the major population decline that hit China and most European countries with the arrival of the

Black Death in the mid-fourteenth century (McNeil, 1976). Although population growth may have been expected to slow down between 1450 and 1600 because of the conflict of the Warring States Period, Saito (2015) notes that this effect was offset by a further decline in the frequency of famines to one every eight years, as a result of an increase in direct control of the land by feudal lords, making it easier to respond to harvest failures (Saito and Takashima, 2017a).

Turning to the slower population growth after 1721, Saito (2015: 214) notes that despite the continued downward trend in the number of famines per century, Japan could not escape from disasters completely, and the Tenmei famine of the 1780s and the Tenpō famine of the 1830s took their toll. This shows up here in the absolute fall in the population level between 1721 and 1804, and a positive rate of population growth between 1804 and 1874 that remained well below the peak growth of the early Tokugawa period. It should nevertheless be noted that population continued to increase in western Japan, where proto-industry and agriculture continued to prosper. The population decline was thus driven by trends in eastern Japan, which fell behind the proto-industrialising western parts of the country and was hit by famines as a result of cold weather and economic stagnation (Hayami and Kito, 2004: 221-222).

3. AGRICULTURAL OUTPUT FROM THE SUPPLY SIDE

Agricultural output can be estimated directly from the supply side, using data on crops harvested or the amount of land used for crop production multiplied by crop yields. This can then be cross-checked against estimates of the demand for food derived indirectly from data on population, wages and prices. Starting with the supply-side estimates, the precise method of estimation varies by period. For the ancient and medieval periods, agricultural output is derived from data on the amount of arable land in use, multiplied by estimates of the productivity of land. For the period 1600-1874, by contrast, the most reliable data are for total production and land use, with land productivity derived from these two series. Here we provide a brief guide to the construction of the supply side estimates for the ancient, medieval and Tokugawa periods, with further details included in the Appendix.

3.1 Ancient period

For the ancient period, under the *Ritsuryō* legal code, which treated people and land as public property, all persons were recorded in a family register and land was distributed to farmers on the basis of the size and the composition of the household in terms of age, sex and social status. Farmers cultivated their allotted fields (*kubunden*) and paid land tax to the government in the form of rice, together with various poll taxes. To maintain the system, the allotment of land was revised, in principle, every six years. Sufficient data have survived from this period to allow the estimation of agricultural output from the amount of arable land in use, multiplied by the productivity of land for the benchmark years 730 during the Nara period, and 950 and 1150 during the early and late Heian periods, respectively.

For the Nara period, the arable land area is calculated separately for paddy and non-paddy fields. The paddy field area is obtained from the number of *gō* (villages or administrative units consisting of 50 households) multiplied by an estimate of the paddy field area per *gō*. The number of *gō* is taken from *Rissho zanpen* in Koten Hozonkai (1934), an ancient penal code. The paddy field area per *gō* is taken from the breakdown of the paddy field area of the 14 *gō* in the *Sagami no kuni fukoso koekichō [Books of trade and household taxes in Sagami Province]* in Kunaichō (1988) for the year 735. The non-paddy field area is obtained from the share of non-paddy fields in the total landholdings of *Gufukuji* and *Horyuji* temples. Land productivity is also calculated separately for paddy and non-paddy fields based on contemporary legal and land-related documents. The allocation of paddy fields followed a legal formula known as *shichibun-hō*, according to which land tracts were divided into high, medium, low, and very low grades, allotted in seven parts based on the formula 1:2:2:2. *The Ordinances of Engi [Engi-shiki]* (Kuroita, 2011b), give productivity figures on these grades of land. The productivity of non-paddy land relative to paddy land is obtained from the relative price of the two types of land. *Engi-shiki* (Kuroita, 2011b) records an average ratio of 0.64 for the relative price of non-paddy fields. Table 2 shows the range of values for the arable land area, land productivity and agricultural output for paddy and non-paddy fields in the Nara period. Figures in parentheses are the average values which serve as our benchmark estimates, with the range providing error margins, as with the population data.

For the Heian period, the arable land area is again calculated separately for paddy and non-paddy fields. The paddy field area is recorded in the various volumes of *Wamyōshō* for the early Heian period and the various volumes of *Shūgaishō* for the late Heian period. Research by Iyanaga (1980) suggests that the paddy field area recorded in these sources provides a good reflection of the situation in the early and late Heian periods. The non-paddy field area is estimated from the non-paddy share of landholdings in land documents for individual temples and shrines (Takeuchi, 1964-76). Land productivity in paddy fields is derived from legal and land documents available in Kuroita (2011a; 2011b) for the early Heian period and Takeuchi (1964-76) for the late Heian period. For non-paddy fields in the Heian period, land productivity is derived using information on the price of non-paddy fields relative to the price of paddy fields, as for the Nara period (Takeuchi, 1964-76). Note that the increase in the share of non-paddy fields from just under 20 per cent in the Nara period to around 40 per cent in the Heian period led to a fall in overall land productivity of around 15 per cent, since paddy fields were around 75 per cent more productive.

The data for the early and late Heian periods are again set out in Table 2. The figures in parentheses in Table 2 represent our benchmark estimates, with the degree of uncertainty indicated by the ranges in each column. A number of adjustments have been made to the raw data to make them comparable with the data from other periods. First, the data in the original sources are given in Nara units, which must be converted to Tokugawa units, with 1 Nara *chō* equal to 1.2 Tokugawa *chō* and 1 Nara *koku* equal to 2.5 Tokugawa *koku*. Second, the arable land area must be adjusted to allow for fallowed and abandoned land. This share is estimated separately for paddy and non-paddy fields from contemporary land documents, and indicates that around 40 per cent of arable land in the ancient period was not cultivated (Takeuchi, 1964-76). The land productivity estimates have been increased by the same proportion, leaving output as implied by the unadjusted data.

3.2 Medieval period

For the medieval period, the absence of a unified government, in contrast to the *Ritsuryō* system of the ancient period, means that there is more limited availability of systematic data on the cultivated area and land productivity. Here, we have made use of the work of Farris (2006: 263), who derived total arable land by multiplying the population by estimates of arable land per capita obtained from primary sources. These estimates are then multiplied by grain yields from the same sources to yield agricultural output. However, it should be noted that although data are available on all three elements of population, arable land per capita and land productivity for 1450, for 1280 we lack data on arable land per capita. Farris filled in this gap by assuming that arable output per capita was the same in both years, so that arable land per capita declined as land productivity increased.

We have reworked Farris's figures to incorporate additional information on land productivity from the work of Nishitani (2015), who estimated the productivity of paddy fields in villages of the Kinai region (around Kyoto) between the fourteenth and sixteenth centuries. Allowance is made for the fact that land productivity was higher than average in the Kinai region when estimating land productivity for Japan as a whole.[1] Table 3 summarises the more detailed information provided in the Appendix, setting out the benchmark estimates of arable land, land productivity and agricultural output. Additional information is provided on population to highlight the fact that Farris derived his 1280 figure for arable land per capita by assuming that arable output per capita was the same in both years. It will therefore be particularly important for this period to cross-check the supply-side results with the demand-side estimates obtained in section 4.

3.3 Tokugawa and early Meiji periods

For the Tokugawa period from 1600 the most reliable data are for total agricultural production and land use, with land productivity derived from these two series. Under the *kokudaka* system of the Tokugawa shogunate, lands were valued for taxation purposes in terms of their capacity for producing rice, expressed in *koku*, with one *koku* approximately equal to 150 kg. Here, we extend the approach of Nakamura (1968), who established the reliability of output benchmarks in the Shōhō period (1644-1648) and in the early years of the Meiji period (1877-79). Nakamura also made innovative use of the number of land improvement projects recorded in the *History of Civil Engineering Works* as a variable to interpolate agricultural output in a number of intervening periods. However, whereas Nakamura (1968) worked at the level of

[1] Given that land productivity in medieval Kyoto and its surrounding area was concentrated in the range from 10 to 16 *to/tan*, we assume that the average land productivity in Japan as a whole fell in the range from 7 to 10 *koku/chō* (see Appendix Tables A10 and A11).

Japan as a whole, we recalculate the output changes at the level of 14 regions, using the same 1644 benchmark, but a slightly different 1874 benchmark from Naimushō Kangyōryō (1875) *Meiji 7-nen fuken bussan-hyō* [Tables of Prefectural Products, Meiji 7]. A further adjustment is needed to bring the official figures of arable output into line with the output of the primary sector as a whole in the early Meiji period, as calculated by Fukao et al. (2015). This involves both correcting for the under-recording of arable output in the official statistics and allowing for other primary production, including livestock, forestry and fisheries.

The arable land area is estimated for the key benchmark years using official statistical sources for 1874 and a nationwide cadastral survey for 1721. For other years, a large number of county and village level cadastral surveys are available for use in interpolation. As with the agricultural output data, a correction factor is applied to the official data to bring them into line with the post-1874 estimates from Umemura et al. (1966). Table 4 provides the benchmark estimates for the Tokugawa and early Meiji periods, keeping a clear distinction between agricultural output and primary sector output.

3.4 Overview of the agricultural output estimates from the supply side

The benchmark estimates of Japanese agricultural production for the whole period 730-1874 are set out in summary form in Table 5. The arable land area is given in the first column, while the second column shows agricultural land productivity. The third column gives agricultural production in 1,000 *koku*, while the fourth column gives the series for agricultural production per head, obtained by dividing agricultural production by the average population series from Table 1. The fifth column presents the agricultural production per head data in index number form, based on 1874=100.

Using these benchmark estimates, agricultural production grew at an annual rate of 0.21 per cent between 730 and 1874, with more than four-fifths of the growth coming from an extension of the arable area, and the other one-fifth from rising land productivity. However, most of the output growth was needed merely to keep up with the increasing population, with the period before the nineteenth century characterized by Malthusian fluctuations. Per capita agricultural output tended to increase when population was declining or growing only slowly, but then tended to fall back in periods of rapid population growth. The Pearson correlation coefficient between the growth of agricultural output per head from panel B of Table 5 and population growth from panel B of Table 1 is strongly negative, at -0.49. During the nineteenth century, however, growth of agricultural output per head was accompanied by positive population growth, as Japan began to break free from the Malthusian trap. Alternative scenarios, making use of error margins, will be used later to assess the robustness of these findings.

4. AGRICULTURAL OUTPUT FROM THE DEMAND SIDE

An alternative way of estimating agricultural output is to infer it from a demand function for food, using known trends in wages and prices. This approach can be traced back at least as far as the work of Crafts (1985), who calculated the path of agricultural output in Britain during the Industrial Revolution with income and price elasticities derived from the experience of later developing countries. The approach was developed further by Allen (2000) using consumer theory. Allen (2000: 13-14) starts with the identity:

$$Q^A = rcN \qquad (1)$$

where Q^A is real agricultural output, r is the ratio of production to consumption, c is consumption per head and N is population. Real agricultural consumption per head is assumed to be a function of its own price in real terms (P^A/P), the price of non-agricultural goods and services in real terms (P^{NA}/P), and real income per head (y). Assuming a log-linear specification, we have:

$$\ln c = \alpha_0 + \alpha_1 \ln(P^A / P) + \alpha_2 \ln(P^{NA} / P) + \beta \ln y \qquad (2)$$

where α_1 and α_2 are the own-price and cross-price elasticities of demand, β is the income elasticity of demand and α_0 is a constant. Consumer theory requires that the own-price, cross-price and income elasticities should sum to zero, which sets tight constraints on the plausible values, particularly given the accumulated evidence on elasticities in developing countries (Deaton and Muellbauer, 1980: 15-16, 60-82).[2]

4.1 Real wages and the demand for food in Japan

For early modern Europe, Allen (2000: 14) works with an own-price elasticity of -0.6 and a cross-price elasticity of 0.1, which constrains the income elasticity to be 0.5. Allen also assumes that agricultural consumption is equal to agricultural production. For the case of Japan, where more limited information is available, we implement a restricted version using the rice wage (the daily wage divided by the price of rice) for unskilled labourers and an assumed income elasticity of 0.5.[3] One way to justify this would be if the cross-price elasticity is zero and real income is the wage divided by the overall price level. The demand function then becomes:

$$\ln c = \alpha_0 + \alpha_1 ln(P^A/P) + \beta \ln(W/P) \qquad (3)$$

[2] Although this approach is widely applied to peasant economies on the assumption that a bad harvest in the market sector also affects the non-market sector, it should be noted that the behaviour of crop prices potentially affects the income of commercial farmers differently. However, for the period 1885-1913, when data on all agricultural incomes are available, agricultural wages were highly correlated with other agricultural incomes (Fukao et al., 2017, Appendix Table 2).

[3] Many studies of developing economies in different eras find an income elasticity of demand for food in the range between 0.4 and 0.6 (Allen, 2000; Bouis, 1994; Deaton and Muellbauer, 1980; Malanima, 2011).

The own-price elasticity must then equal the negative of the real wage elasticity ($\alpha_1 = -\beta$), so that:

$$\ln c = \alpha_0 - \beta ln(P^A/P) + \beta \ln(W/P) \quad (4)$$

But then the overall price level used to deflate the wage cancels out with the overall price level used to deflate the grain price, leaving a single term in the grain wage:

$$\ln c = \alpha_0 + \beta ln(W/P^A) \quad (5)$$

The rice wage is taken from Bassino *et al.* (2010) and Bassino and Ma (2005), and plotted on an annual basis in Figure 1, together with the per capita agricultural demand derived using the demand approach. The data are drawn largely from the Kinai region, which includes Kyoto and Osaka, but there is scattered evidence from other regions to suggest that the rice wage series assembled here reflects national trends.

For the period 1260-1600, rice wages in Kyoto were constructed using information on nominal wages and the price of rice expressed in copper coins, or from wages paid directly in rice. The nominal wage series was based on wage rates for benchmark years collected by Endo (1956) and Tanaka (2007) and on individual contracts reported by Rekihaku (2009). Wages are available for a number of different occupations, including carpenters, blacksmiths, dyers, needle makers, transportation workers and urban service workers. A common feature of the wage data for the different occupations is a clustering of nominal wages at levels of 10, 50 and 100 copper coins per day, throughout the whole period. This constancy over long periods of time is also a feature of money wage series in medieval and early modern Europe (Phelps Brown and Hopkins, 1956; Allen, 2001). These clusters at 10, 50 and 100 copper coins per day are interpreted as corresponding to different skill levels, with the 10 copper coin level taken as the unskilled day wage, paid mainly to urban service workers, transportation workers and the unskilled helpers of craftsmen. Skilled wages were paid to a much smaller share of the population, so that unskilled wages are likely to provide a better indicator of average incomes. Throughout the entire period, with the daily nominal wage rate for unskilled workers fixed at 10 copper coins, the rice wage varied with changes in rice prices. Rice prices in copper coins were reported in Momose (1959), Rekihaku (2009), and Kyoto Daigaku Kinsei Bukkashi Kenkyūkai (1962). Out of 1,733 price observations in Kyoto Daigaku Kinsei Bukkashi Kenkyūkai, 863 state a region, and of these 699 are from the Kinai region, which includes Kyoto and Osaka. Of the remaining 163 price quotes which state a region, 69 are from Chugoku, 40 from Kanto, 38 from Hokuriku, 6 from Chubu, 6 from Sanyo and 5 from Kyushu. These data suggest that rice prices were about 20 per cent lower outside the Kinai region, which would have countered any advantage from higher money wages around Kyoto.

For the period 1600-1743, unskilled wage rates in copper coins were obtained from a data series for Osaka, which is available for the whole period 1600-1780 (Miyamoto, 1963). For the post-1743 period, rice wages are also available for Kyoto, based on a collection of retail prices of rice sold and labour compensation paid by the Kyoto branch of the trading house Mitsui (Mitsui Bunko 1981). The Osaka wages were substantially lower than in Kyoto, but this, taken together with their stability over long periods, indicates that an in-kind component of rice was not included. The Osaka wages were thus adjusted upwards to the Kyoto level by assuming that the in-kind component in Osaka was 0.8 *shō* (1.8 litres per *shō*, and 1.5 kg in the case of husked rice). This adjustment factor was obtained by comparing the Osaka wage series for the period 1743-1870 with the series for Kyoto covering the period 1743-1762 and 1791-1870. The pre-1720 rice price series was generated by projecting backwards the Kyoto Mitsui series, assuming the same yearly variation as for wholesale prices in Osaka for 1700-1742 and 1763-1790, Hiroshima 1620-1700 (Iwahashi, 1981) and Osaka 1600-1650 (Kimura 1987). There is evidence to suggest that the trend of real wages in this series from the Kinai region reflected the national trend. Oyaizu (2006) collected micro-data on unskilled wages covering most regions of Japan from the mid-eighteenth century, which suggest that wages in the Kinai region were no higher than in the rest of the country. Regional rice prices are available on an annual basis for sixteen markets during 1720-1857, and indicate that rice prices in western and central Japan were closely integrated with the two main markets of Osaka and Edo (Iwahashi, 1981; Yamasaki, 1983). Although the small markets of eastern Japan were less well integrated, the majority of the population lived in western and central Japan (Miyamoto, 1985: 155).

The daily unskilled rice wage has been converted to an annual basis on the assumption of 250 days worked per year and is presented in Figure 1 in terms of *koku*, for comparison with the agricultural demand per head. A *koku* was intended to be sufficient to feed one person for a year, providing around 150 kilograms of rice, or 0.41 kg per day, which provided just over 2,000 kilocalories. The rice wage remained relatively stable between 1260/69 and 1450/59, before roughly doubling to 1550/59 and then slipping back, but remaining on a higher plateau than before 1450/59. Agricultural demand per head has been derived from the unskilled rice wage on the assumption of an income elasticity of demand of 0.5. The level of agricultural demand per head in *koku* has been calibrated using the supply side estimate for the 1840s of 1.76 *koku*. At this point in the late Tokugawa era, the demand for food consumed around 60 per cent of the annual wage, but the proportion averaged around 80 per cent during the medieval period. As we shall see in section 5, these proportions are broadly in line with changes in the share of the primary sector in total output.

One possible shortcoming of the above approach is that the demand for food has been derived using only wage income, but in a largely agricultural society, land rent must also have been an important component of income. However, a number of observations can be made to suggest that this was not likely to have been a major issue in the Japanese case. For the medieval period, Nishitani (2017) argues on the basis of a detailed study of village data that the ratio between land rent and the income of the cultivator was stable (at around 1) over time. During the Tokugawa period, some of the land rent was replaced by increased taxes for use as payment of a rental income to the Samurai class, and thus continued to be consumed (Schreurs, 2016). Furthermore, for the period 1885-1913, when data on all agricultural incomes are available, agricultural wages and land rents are highly correlated, with a correlation coefficient of 0.89 (Fukao et al., 2017, Appendix Table 2).

4.2 Agricultural output: supply and demand

A comparison between agricultural output per capita estimated from both the supply and demand sides is given in Figure 2. The supply-side estimates cover a long span of time, but at a relatively low frequency, while the demand-side estimates are available at a higher frequency, but for a shorter period of time. Both supply and demand estimates suggest a similar increase in agricultural output per capita between the late-thirteenth and mid-nineteenth centuries. Both estimates also show an increase between 1450 and 1600, followed by a decline during the seventeenth century and a return to growth in the eighteenth century.

As with the population series, we adopt the subjective error margins approach of Feinstein and Thomas (2002) to deal with uncertainty over the accuracy of the agricultural output data. The error margins for some of the individual components of agricultural supply and demand are higher, but the degree of agreement between the two series is reassuring.

5. SECONDARY AND TERTIARY OUTPUT

5.1 Urbanisation and non-agricultural production

A number of authors have used the share of the population living in towns as a measure of the growth of the non-agricultural sector. This approach began with Wrigley (1985), and has recently been combined with the demand approach to agriculture to provide indirect estimates of GDP in a number of European countries during the early modern period (Malanima, 2011; Álvarez-Nogal and Prados de la Escosura, 2013; Schön and Krantz, 2012). With the path of agricultural output (Q^A) derived using equations (1) and (2), overall output (Q) is derived as:

$$Q = \frac{Q^A}{1-\left(Q^{NA}/Q\right)} \qquad (6)$$

where the share of non-agricultural output in total output (Q^{NA}/Q) is proxied by the urbanisation rate. The approach can be made less crude by making an allowance for higher productivity in the non-agricultural sector, so that (Q^{NA}/Q) increases more than proportionally with the urbanisation rate.

However, as Saito and Takashima (2016) point out, there is a major problem with applying this method to Japan, because the urbanisation rate declined during the late Tokugawa period, which is widely seen as the key period of proto-industrial growth. Data on the Japanese urban population are shown in Table 6. The definition of urbanisation chosen here is the number of people living in settlements of at least 10,000, in line with the work of de Vries (1984) on Europe. The data on the size of individual towns were derived from historical sources compiled by local governments in Japan. The urban population share remained relatively stable at around 2 or 3 per cent until the mid-fifteenth century, when it increased substantially, particularly at the beginning of the Tokugawa shogunate. However, the urbanisation rate then remained on a plateau during the seventeenth and eighteenth centuries before declining during the nineteenth century. The sharp increase in the level of urbanisation at the beginning of the Tokugawa period was the result of the introduction of the *Bakuhan* system, which was based on a principle of separation between peasants in the countryside and warriors in towns, with merchants and artisans also being required to reside in towns (Iwahashi, 2004: 88-89). However, the separation between peasants and the commercial classes was less strictly enforced than that between peasants and the warriors, allowing the growth of proto-industry in the countryside (Shimbo and Hasegawa, 2004).

5.2 Allowing for proto-industry

Under the circumstances outlined above, a crude estimation of non-agricultural production using the urbanisation rate would miss the expansion of cottage industry in the rural industrious revolution highlighted by Hayami (1967). The solution proposed by Saito and Takashima (2016) is to allow secondary and tertiary output to vary with population density as well as the urbanisation rate, with the weights for these two factors derived from pooled regional data for the years 1874, 1890 and 1909. Population density continued to rise during the late Tokugawa period while the urbanisation rate declined, as can be seen in Table 6.

Using data from Fukao *et al*. (2015), Saito and Takashima (2016) run separate regressions for the secondary and tertiary sectors, with the same right hand side variables allowed to have different effects on the secondary and tertiary sector shares. The secondary sector share variable (*Sshare*) is defined as the proportion of secondary sector output in the sum of primary and secondary sector output, and the regression is run with the dependent variable in logit form to deal with the skewness of the distribution:

$$ln\left(\frac{Sshare}{1-Sshare}\right) = \alpha_0 + \alpha_1 lnD + \alpha_2 ln\left(\frac{U}{1-U}\right) + \alpha_3 M + \alpha_4 YR1 + \alpha_5 YR2 + \varepsilon \qquad (7)$$

Here, *D* is population density, *U* is the urbanisation rate (also entered in logit form), *M* is a dummy variable for modernised prefectures (confined to Tokyo and Osaka in 1874 and 1890, but with the addition of Aichi and Fukuoka in 1909), *YR1* and *YR2* are year dummies for 1890 and 1909 respectively, and ε is a stochastic error term. The tertiary sector share variable (*Tshare*) is defined as the proportion of tertiary sector output in the sum of primary and tertiary sector output, and the regression is again run with the dependent variable in logit form to deal with the skewness of the distribution:

$$ln\left(\frac{Tshare}{1-Tshare}\right) = \alpha_0 + \alpha_1 lnD + \alpha_2 ln\left(\frac{U}{1-U}\right) + \alpha_3 M + \alpha_4 YR1 + \alpha_5 YR2 + \varepsilon \qquad (8)$$

The right hand side variables are the same as in equation (7), but the coefficients are allowed to take different values in the two sectors.

Saito and Takashima (2016) employ four different models for their regression analysis: a simple pooling regression model, a pooling regression model with prefectural population weights, a fixed effects model and a random effects model. The model selection test results indicate that the random effects model is preferred, so these results are presented here in Table 7. The key explanatory variables are the population density and the urbanisation rate. The population density is measured in terms of the number of persons per *chō* in each prefecture, while the urbanisation rate is the number of people living in settlements of more than 10,000 persons in a prefecture divided by the total population of that prefecture. These variables are respectively log and logit transformed. A dummy for modernised prefectures is added, as well as year dummies for 1890 and 1909.

The random effects regression results for equations (7) and (8) in Table 7 yield a number of interesting findings. First, both population density and urbanisation were significant determinants of both secondary and tertiary sector activity. Second, however, the population density effect was comparatively more important for the secondary sector, while the urbanisation effect was comparatively more important for the tertiary sector.[4]

The coefficients from Table 7 can be used together with national level data on population density and the urbanisation rate to estimate secondary and tertiary sector output from the data on primary sector output in Table 8.[5] Our benchmark estimates apply the coefficients on population density as well as the urbanisation rate for the whole period. However, we also consider an alternative scenario where the density effect is applied only after 1600, as it was first noted in the context of the Tokugawa era, and it could be argued that population density would need to cross a threshold before having a significant effect. Primary sector output is first derived from agricultural output in Table 5 by making an allowance for forestry and fisheries. For this, the agricultural output data have been increased by 18.5 per cent, in line with the ratio of forestry and fisheries to agriculture in 1874.

Secondary and tertiary sector real outputs in 1,000 *koku* are shown in Table 8A, together with primary sector output. Table 8C provides the growth rates of GDP and its sectoral components over a number of sub-periods. Over the whole period 730-1874, and also in each sub-period, primary output, which was dominated by agriculture, was the slowest growing sector. Secondary output grew a little bit faster than primary output, but tertiary output was the fastest growing sector over the period as a whole. Nevertheless, secondary output was the

[4] The coefficient on the population density term was almost 4 times as large as the coefficient on the urbanisation term in the secondary sector equation, but was less than twice as large in the tertiary sector equation.

[5] The significance of the year dummies raises issues about the precision of the estimates of secondary and tertiary output. It is possible that the 1890 and 1909 dummies were needed because of institutional reforms during the Meiji period, but without further data it would not be possible to verify this.

fastest growing sector over the period 1721-1874, the key period of proto-industrialisation. As a result of these trends, we see in Table 8B that the primary sector's share of output in rice equivalent terms declined from a peak of 86.7 per cent in 950 to 59.5 per cent by 1874. Over the same period, the secondary sector increased its share from 5.3 to 12.3 per cent and the tertiary sector share more than tripled from 8.1 to 28.2 per cent.

The key variables contributing to the derivation of the outputs of the secondary and tertiary sectors are the urbanisation rate and population density, which ultimately rely heavily on the population estimates. One possibility would therefore be to assume that the error margins are the same as for the population series. However, when considering alternative scenarios to the benchmark estimates in sections 6 and 7, we will also consider the possibility that the population density effect applies only to the period from 1600. Before then, population density may have been too low to stimulate the proto-industrialisation highlighted by Hayami (1967) during the Tokugawa period, so we consider also GDP on the basis of setting the density coefficients to zero before 1600. This has the effect of raising GDP before 1600 relative to the benchmark estimates presented in Table 8.[6]

6. JAPANESE GDP PER CAPITA

6.1 Benchmark estimates

Our benchmark estimates of Japanese GDP per capita are shown in level form in Table 9A, and in annual growth rate form in Table 9B. The levels data are shown in terms of *koku*,

[6] When the population density effect applies to the whole period, moving forwards in time from 1600 means growing population density, which raises secondary and tertiary shares and hence per capita income. However, moving backwards in time from 1600 means falling population density, which lowers secondary and tertiary shares and hence per capita incomes. If the population density effect is switched off before 1600, then the falling population density moving backwards in time no longer reduces per capita income. Hence per capita income before 1600 is higher than it was when the population density effect applied to the whole period.

combining the benchmark estimates for GDP from Table 8 with the benchmark estimates for population from Table 1. Using this series, Japanese GDP per capita grew at an annual rate of 0.09 per cent between 730 and 1874, cumulating to an increase of living standards by a factor of 2.7.

During the ancient period, the patterns of GDP per capita growth in Table 9 and population growth in Table 1 are consistent with the Malthusian model. Rising living standards occurred between 730 and 950 as population declined, while the return to population expansion between 950 and 1280 coincided with negative economic growth. From a low point in 1280, however, GDP per capita growth was persistent over the observed intervals.[7] As a result, the transition to modern economic growth following the Meiji restoration of 1868 can be seen as building upon earlier episodes of growth, particularly between 1450 and 1600 in the medieval period and after 1721 during the Tokugawa period.

On its own, the very slow growth of GDP per capita between 1280 and 1450 in Table 9 may at first sight seem to indicate poor economic performance. However, it needs to be considered against the relatively high rate of population growth in Table 1, which on the basis of earlier experience may reasonably have been expected to lead to negative GDP per capita growth. During this period, there was clear development of a commercialised economy with the creation of new markets and towns, improved transportation and monetisation, as well as the growth of large cities (Harada, 1942; Sakaehara, 1992; Niki, 1997; 2002). Associated with this growing commercialisation were a number of improvements in agriculture, including the

[7] However, it seems likely from the higher frequency data on the rice wage in Figure 1 that short periods of shrinking or negative per capita growth continued to occur (Broadberry and Wallis, 2017).

use of more and better tools, the wider use of livestock, the application of fertilisers, the expansion of double-cropping, the introduction of high-yielding Champa rice and improvements in irrigation, facilitated by better organisation within self-governing villages (Farris, 2006: 129-139; Nishitani et al., 2017b). These improvements all occurred against a background of changes in the manorial system, with the development of a more direct form of management of the land by feudal lords. Traditionally, the land was controlled by scattered organisations such as temples, shrines, and aristocrats, who were based mainly in the central area, with multiple layers of management below the proprietor (Nishitani et al., 2017a). This important institutional change, which began during the fourteenth century, only came to full fruition during the later Warring States period. It nevertheless helped to sustain the average productivity of land during the late medieval period as the cultivated area expanded to meet the food demands of the growing population (Table 5). Also linked to the growing commercialisation were advances in tools and techniques in industry, which grew faster than agriculture (Table 8). Farris (2006: 149-150) points to improvements in carpentry, salt production and ceramics.

Building on this wave of development, GDP per capita growth accelerated during the period 1450-1600, while population growth remained high (Tables 1 and 9). During this Warring States period, the system of direct control of the land by feudal lords, which had begun during the fourteenth century, spread widely as more feudal lords established a governance structure to avoid the collapse of their domains under the pressures of conflict (Nagahara, 1981). Within this institutional framework, agriculture benefited from the further diffusion and refinement of the improvements introduced in the early medieval period, documented on a regional basis by Farris (2006: 222-230), so that land productivity increased together with the expansion of the cultivated area (Table 5). Industry also saw a number of important developments, including the rapid growth of cotton cloth manufacturing, the construction of large stone castles and a boom in mining and metallurgy encompassing precious metals as well as the iron needed for the production of weapons (Farris, 2006: 242-244).[8] The fastest growing sector was services (Table 8), with growing commercialisation at home as the feudal lords sought to secure food, weapons, uniforms and other supplies. There was also commercial expansion overseas, particularly through trade with China, with Portuguese merchants acting as middlemen after the suspension of friendly relations between China and Japan in 1547 (Farris, 2009b: 180-181). This rapid growth of commercial activity was associated with a sharp increase in the urban share of the population (Table 6).

As in the early medieval period, the very slow growth of GDP per capita during the early Tokugawa period (1600-1721) needs to be considered against the backdrop of rapid population growth, this time at an annual rate of 0.51 per cent, substantially higher than in any comparably long period between 730 and 1874. Rather than viewing the slow per capita GDP growth on its own as a disappointing economic performance, the ability of the early Tokugawa economy to avoid a Malthusian collapse of living standards during pre-modern Japan's peak period of population growth should thus be seen as a success, helping to pave the way for the transition to modern economic growth after the Meiji restoration. This is better reflected in the high growth rate of GDP in Table 8, driven particularly by the expansion of tertiary output. An important driver of this growth was the expansion of the newly built castle towns following the redistribution of domains among feudal lords after the Battle of Sekigahara in 1600. As a result, samurai were forced to live in their castle towns and the commercial and service industries that

[8] It should of course be borne in mind that within the national accounting framework an increase in the production of weapons may increase GDP without increasing welfare (Kuznets, 1945).

catered for the consumption of the samurai prospered. Other changes encouraging the growth of the commercial sector included the unification of the currency system, standardisation of units of measurement, transport improvements such as the establishment of a national road system linking the whole country and developments in coastal transport, as well as the introduction of the *murauke* system of village-wide collective responsibility for tax payment (Miyamoto, 2004: 56-82; Iwahashi, 2004: 96-98; Hayami, 2015: 57-58; Arimoto, 2006).

The later Tokugawa period (1721-1874) saw a return to positive GDP per capita growth, but with relatively little population growth, so this is best seen as the final period of laying the foundations for modern economic growth achieved after the Meiji restoration. As argued by Saito and Takashima (2016), growth was driven during this period by the emergence of rural-centred development under the proto-industrial economy. Output growth in the secondary and tertiary sectors was particularly strong during the period 1846-1874, most likely reflecting the stimulus provided by the re-opening of Japan to trade with the western world via treaty ports during the 1850s.

6.2 Sensitivity analysis

There is, however, inevitably a degree of uncertainty around these estimates, so it is important to take account of the error margins that have been noted in earlier sections describing the construction of the component series, and which are pulled together here in Table 10. The pioneer of the subjective error margins approach was Bowley (1911-12), and it was subsequently taken up in the construction of historical national accounts by Chapman (1953) and Feinstein (1972) for the case of Britain and by Perkins (1969) for the case of China. Feinstein and Thomas (2002) provide a more recent statement of the case for the use of subjective error margins. In this approach, series are assigned reliability grades corresponding to error bands. Following Feinstein (1972: 21), for firm figures (grade A), the margin of error around the reported series is judged to be ± less than 5%. For good estimates (grade B), the margin of error is ± 5% to 15%, while for rough estimates (grade C) the margin of error is ± 15% to 25% and for conjectures (grade D) it is ± more than 25%. The subjective margins of error are then assumed to be held with 95 percent confidence, so that the average margin of error can be interpreted as two standard errors. Perkins (1969: 216) suggested an 80 percent confidence interval would be more appropriate for the less well documented Chinese case, although the statistical basis for either of these assumptions is somewhat tenuous.

The arable land estimates are assessed in Table 10B as rough estimates (grade C) during the ancient and medieval periods, based on the subjective error margins provided in the Appendix. The land productivity estimates are assessed as conjectures (grade D) in the ancient period, rough estimates (grade C) for the medieval period and good estimates (grade B) for the Tokugawa period. Agricultural output is thus graded as D in the ancient period, rising to C in the medieval period and B for the Tokugawa period, when agricultural output was directly recorded at the time. The secondary and tertiary sector estimates are highly dependent on the population data, which affect both the urbanisation rate and population density, so it might be expected that the grades for these sectors would be the same as for the population series. However, given the uncertainty over the timing of the population density effect discussed earlier, we have assigned grade C to the medieval as well as the ancient period and grade B rather than grade A to the Tokugawa era. Given the dominance of agriculture, the reliability grades for GDP and GDP per capita follow those of agricultural output. Note that the population series is assessed as grade C for the ancient period, thus encompassing Kito's alternative estimates in Table 1.

The sensitivity of Japanese GDP to perturbations of the component series is assessed in Table 10C. The table shows the percentage increase (decrease) in GDP in response to an increase (decrease) in each series by an amount equal to the average margin of error during each period.[9] The arable land series is grade C for the ancient period, which gives an average error of ± 20 per cent. Perturbing the arable land by ± 20 per cent results in a change in GDP of ± 17.3 per cent. GDP remains almost as sensitive to an average error perturbation to the arable land area in the medieval period, but much less so in the Tokugawa period, as a result of a decline in the size of the average error and a reduction of the share of agriculture in overall economic activity. GDP is even more sensitive to a perturbation in land productivity during the ancient period. However, perturbations to secondary and tertiary output have much less effect on GDP largely because of the dominance of the primary sector in economic activity, particularly during the ancient and medieval periods.

6.3 Different scenarios

How robust is the picture of rising GDP per capita that has been painted here, given the error margins and sensitivity analysis presented in Table 10? Table 11 sets out a number of different scenarios alongside the benchmark estimates. The high and low estimates are derived on the basis of ± one average error for the GDP per capita series using the reliability assessments from Table 10, i.e ± 40% for the ancient period, ± 20% for the medieval period and ± 10% for the Tokugawa era. The "alternative" estimates are based on the assumption that population density affected the secondary and tertiary sector outputs only from 1600 onwards. The figures are presented in terms of 1990 international dollars, derived from Maddison (2010), but

[9] To the extent that one is willing to accept the statistical interpretation that the error margins are held with 95 per cent confidence, this is equal to approximately 2 standard errors.

incorporating some important revisions as set out in Fukao *et al.* (2015), which will be discussed in the next section.

With the benchmark estimates, Japanese GDP per capita increased by a factor of 2.7 between 730 and 1874, or an annual rate of 0.09 per cent. Using the high estimates, GDP per capita increased by a smaller factor of 2.5, which translates to a growth rate of 0.08 per cent, while using the low estimates, GDP per capita increased by a larger factor of 3.0, or a growth rate of 0.1 per cent. If secondary and tertiary sector outputs are calculated on the assumption that the population density effects were significant only after 1600, then GDP per capita increased by a factor of 2.3, or an annual growth rate of 0.07 per cent. The general pattern of positive trend growth in Japan is therefore quite robust to all these different scenarios. Even starting with the high estimate in 730 and ending with the low estimate in 1874 leads to a 73 per cent increase of GDP per capita, or an average annual growth rate of 0.05 per cent.

7. IMPLICATIONS FOR THE GREAT DIVERGENCE DEBATE

7.1 An Anglo-Japanese comparison

To pin down the timing and extent of the Great Divergence, we need to compare GDP per capita in Japan with Britain, where the transition to modern economic growth first occurred, and place the Anglo-Japanese comparison within its wider Europe-Asia context. Here, we project back from an estimate of GDP per capita in the late nineteenth century, expressed in 1990 international dollars, but with some important adjustments that improve on the 1874 value used by Maddison (2010). Maddison's (2010) figure for Japanese GDP per capita in 1874 was obtained by projecting back from a 1990 benchmark expressed at purchasing power parity in 1990 international dollars. However, we make three important adjustments to the GDP per capita growth series used by Maddison to project back from 1990 to 1874. 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 substantially higher level of GDP per capita in 1874 than suggested by Maddison.

Whereas Maddison worked with the territory of the United Kingdom, Broadberry et al. (2015a) provide a series for Great Britain covering the period 1700-1870 and England for the period 1270-1700. They note that even in the Middle Ages, British levels of GDP per capita were well above $400 in 1990 international prices. The figure of $400, or a little more than a dollar a day, is usually taken as the measure of bare bones subsistence, and is observed for many poor countries in the twentieth century. Broadberry *et al.* (2015a) note that GDP per capita figures of well above $400 have been found for a number of west European countries in the late Middle Ages (van Zanden and van Leeuwen, 2012; Malanima, 2011; Alvarez-Nogal and Prados de la Escosura, 2013). Broadberry *et al.* (2015b) also find early modern India well above bare bones subsistence, while Broadberry *et al.* (2018) present estimates showing Chinese GDP per capita as the highest in the world during the eleventh century. Since Japan was the first Asian economy to achieve modern economic growth, it is of particular interest to establish Japan's position in the Great Divergence.

Table 12 shows that, using the benchmark estimates, GDP per capita in Japan in 1280 was 81.3 per cent of the British level. Applying the error margins from Table 10, this produces a range of 65.0 to 97.6 per cent. However, following the Black Death of the mid-fourteenth century, which wiped out around a third of the British population immediately and more than half by the mid-fifteenth century, British GDP per capita increased sharply. A similar increase in GDP per capita and in the real wage occurred across much of Europe, where the Black Death also sharply reduced the population. However, the Black Death did not reach Japan and there was accordingly no similar increase in GDP per capita there. Hence by 1450, Japanese GDP per capita was only around half the British level. The gap narrowed between 1450 and 1600, with Japan at around 60 per cent of the British level by the beginning of the seventeenth century. However, a surge of economic growth in Britain from the middle of the seventeenth century further widened the gap and Japan's per capita GDP was only around a quarter of the British level by the early Meiji period. Even taking account of the error ranges, the relative decline of Japan over the period since 1280, and particularly since 1600 is very clear.

The finding that Japanese GDP per capita in 1280 was already below the British level is interesting, since the two countries had similar levels of urbanisation at this time, and urbanisation is often used as an indicator of prosperity. One way of understanding this would be to see two counterbalancing forces at work. First, it seems likely that Japan had a more sophisticated urban culture than Britain (Farris, 2006: 81, 151-153; Rozman, 1973, 13-58; Astill, 2000: 46-49). Second, however, offsetting this first effect was the fact that Britain had an unusually large share of its agricultural sector devoted to high value added livestock farming (Broadberry *et al*., 2015a: 118). Although this did not produce more kilocalories than the minimum required for the population to work and reproduce, it did allow a varied diet, including meat, dairy produce and ale as well as the more basic grain products such as bread and oatmeal. Given the importance of agriculture at the time, it is this effect which dominated, making per capita GDP higher in Britain than in Japan.

Another interesting finding from the benchmark estimates concerns the relatively modest increase in per capita agricultural output, despite the approximate doubling of per capita GDP between 1280 and 1874. This contrast between trends in the per capita availability of food and overall output, which can be seen clearly in Figure 3, reminds us that before the mid-nineteenth century, the fruits of economic development came mainly through the greater availability of manufactured goods and services rather than through greater consumption of food.

7.2 Japan in the Great Divergence

The comparison with Britain is revealing. However, Britain was a relatively poor part of Europe in the eleventh century and a relatively rich part by the nineteenth century, as can be seen in the estimates of GDP per capita for a sample of European and Asian countries presented in Table 13. Before the Black Death struck in 1348, per capita incomes were substantially higher in Italy and Spain than in Britain and the Netherlands (Broadberry *et al.*, 2015a; van Zanden and van Leeuwen, 2012; Malanima, 2011; Álvarez-Nogal and Prados de la Escosura, 2013). There then followed a substantial reversal of fortunes between the North Sea area and Mediterranean Europe, so that by 1800, per capita incomes were substantially higher in Britain and the Netherlands than in Italy and Spain. This "Little Divergence" occurred alongside the "Great Divergence" between Europe and Asia.

Similarly, there are good reasons to believe that Japan was a relatively poor part of Asia in the eleventh century, but had transformed itself into the most dynamic part of the continent by the nineteenth century, making the transition to modern economic growth during the Meiji period. Indeed, there is a substantial literature on the global economic leadership of China during the Northern Song and Ming dynasties, followed by decline during the Qing dynasty (Needham, 1954; Wittfogel, 1957; Elvin, 1973; Huang, 1985). Recent estimates of GDP per capita for China, also included in Table 13, are consistent with this interpretation (Broadberry et al., 2018). Like China, India experienced declining GDP per capita from the Mughal peak under Akbar, circa 1600 (Broadberry *et al.*, 2015b). Japan did not experience a sustained decline in the way that both China and India did. This is in line with the strand of literature that has seen Japan as following an exceptional path within Asia, sharing many characteristics with the European path.

Although the level of per capita income remained much lower in Japan than in northwest Europe throughout the period considered here, there are also similarities between the two regions in the rates of change. In Europe, British and Dutch per capita incomes showed an upward trend from the late medieval period while economies in the rest of the continent stagnated or declined, bringing about a European Little Divergence. In Asia, Japanese per capita incomes trended upwards from the medieval period while the rest of the continent stagnated or declined, bringing about an Asian Little Divergence. Of course, the similarities between Britain and the North Sea area should not be overstated; Japan was starting from a much lower level of GDP per capita than Britain and the Netherlands, and the trend growth was also significantly slower in Japan. The transition to modern economic growth thus occurred first in the North Sea area in the form of the British Industrial Revolution, which then spread fairly quickly to other high income parts of Europe. Within Asia, as Japan was improving its position relative to China and India, however, it was also falling further behind

Britain until the Meiji restoration of 1868 and the institutional reforms which ushered in Asia's first case of modern economic growth.

Finally, it is worth noting the differences arising from the use of contemporary data compared with Maddison's reliance on conjecture controlled by the largely qualitative literature. Panel B of Table 13 reports Maddison's (2010) estimates of GDP per capita in 1990 international dollars over the same period. Maddison reports fewer data points, but it is nevertheless clear that there are significant differences. First, notice that all the studies of European economies based on the systematic use of contemporary data indicate a much higher level of GDP per capita in the medieval period than Maddison's conjectures. Maddison's series refers to the territory of the United Kingdom, which includes Ireland as well as Great Britain, but this can account for only a very small part of the difference between Maddison's conjecture that the British lived at bare bones subsistence of $400 in 1000 and the figure of $723 in 1086 derived from the Domesday survey. Furthermore, Maddison's conjecture that the British economy grew at the same rate between 1500 and 1700 as between 1700 and 1830 produces a much lower figure for per capita GDP in 1500 than Broadberry et al.'s (2015) figure based on direct estimation from output data. Similarly, Maddison's conjectures for the Netherlands, Italy and Spain result in substantially lower levels of GDP per capita in the medieval period. Second, Maddison's estimates for Asia suggest a relatively modest economic performance in the medieval and early modern periods, with China's per capita GDP peaking at $600. By contrast, the studies based on contemporary data suggest China achieving a per capita GDP of more than $1,000 in peak years during both the Northern Song and Ming dynasties, and India with a per capita income of almost $700 at the time of Akbar. For the case of Japan, the GDP per capita series from this study remains above Maddison's series throughout the period 1000-1874. The largest difference with Maddison's estimates can be seen in the Tokugawa and early Meiji periods, as a result of the revisions to the Japanese GDP series by Fukao et al. (2015) and Settsu et al. (2016).

8. CONCLUSIONS

This paper provides estimates of Japanese GDP per capita for the period 730-1874, constructed from the output side, using methods developed for the estimation of GDP per capita in medieval and early modern Europe, but amended to suit Japanese circumstances and data. Our estimates for the agricultural sector are built up from direct estimates of arable land use and land productivity, and checked against trends in agricultural demand derived from the grain wages of unskilled labourers. Activity in the secondary and tertiary sectors is quantified using techniques developed originally in the context of Europe, but again amended to suit Japanese circumstances and data availability. As well as linking the growth of non-agricultural output to the urbanisation ratio, a role is identified for population density during the proto-industrial phase of the Tokugawa period.

The resulting estimates, which are subjected to reliability assessments and sensitivity analysis, suggest that Japan experienced substantial per capita income growth before 1868, which provided a foundation for the transition to modern economic growth after the Meiji Restoration. The central estimates are consistent with Malthusian fluctuations during the ancient period, between 730 and 1280, with a negative relationship between population and per capita income levels. After 1280, the central estimates suggest positive trend growth of per capita income, with growth concentrated in two periods, 1450-1600 and after 1721. However, the wider error bands during the medieval period mean that this early phase of growth is less secure than the Tokugawa period growth. This is not to suggest that Japan would have made that transition to modern economic growth without the institutional reforms of the Meiji period.

It does, however, link to an earlier literature emphasising Japan's exceptional path within Asia, sharing many characteristics with the European path. But since Japan started at a lower level than Britain and grew more slowly until the Meiji Restoration, the Great Divergence occurred as the most dynamic part of Asia fell behind the most dynamic part of Europe.

TABLE 1: Total population of Japan, 730-1874

A. Level in millions

Year	Average population	Minimum	Maximum	Alternative estimates
730	6.1	5.8	6.4	4.5
950	5.0	4.4	5.6	6.4
1150	5.9	5.5	6.3	6.8
1280	6.0	5.7	6.2	
1450	10.1	9.6	10.5	
1600	17.0	16.2	17.8	
1721	31.3	29.7	32.9	
1804	30.7	29.2	32.2	
1846	32.2	30.6	33.8	
1874	34.5	32.8	36.2	

B. Annual growth rates (% per year)

Years	Average population	Alternative estimates
730-950	-0.09	0.16
950-1150	0.08	0.03
1150-1280	0.01	-0.10
1280-1450	0.31	
1450-1600	0.35	
1600-1721	0.51	
1721-1804	-0.02	
1804-1846	0.12	
1846-1874	0.25	
730-1280	0.00	0.05
1280-1721	0.38	0.38
1721-1874	0.06	0.06
730-1874	0.15	0.18

Sources and notes: Main series: 730–1600: Farris (2006, 2009a), Saito and Takashima (2017a). 1721–1846: Kito (1996; 2000). 1874: Fukao et al. (2015). Alternative estimates for 730–1150: Kito (1996; 2000). For 730 and 950 we show Kito's estimates for 725 and 900, respectively. Estimates for all years exclude Ezochi and Ryūkyū (present-day Hokkaido and Okinawa prefectures). The population for 1874 including Hokkaido and Okinawa was 34.8 million.

TABLE 2: Estimated arable land, land productivity, and agricultural output in the ancient period, 730-1150

	Arable land (1,000 *chō*)			Land productivity (*koku*/*chō*)		Agricultural output (1,000 *koku*)		
	Paddy	Non-paddy	Total	Paddy	Non-paddy	Paddy	Non-paddy	Total
Nara period	458-590	39-192	497-782	7.94-12.64	4.88-7.82	3,639–7,465	191–1,501	3,830–8,966
(730)	(524)	(116)	(640)	(10.29)	(6.35)	(5,397)	(734)	(6,130)
Early Heian period	591-633	218-613	809-1,246	5.83-14.59	3.12-7.82	3,451–9,234	682–4,796	4,133–14,030
(950)	(612)	(416)	(1,028)	(10.21)	(5.47)	(6,252)	(2,276)	(8,527)
Late Heian period	639-705	353-522	992-1,227	6.29-13.68	3.62-7.82	4,024–9,640	1,275–4,079	5,299–13,719
(1150)	(672)	(438)	(1,109)	(9.98)	(5.72)	(6,711)	(2,500)	(9,211)

Notes and sources: Appendix Table A9B. All figures are expressed in Tokugawa units. Figures in parentheses are average values. The arable land area and land productivity have been adjusted for fallowed and abandoned land. For further details, see text and appendix.

TABLE 3: Estimated arable land, land productivity, and agricultural output in the medieval period

	Arable land (1,000 *chō*)	Land productivity (*koku*/*chō*)	Agricultural output (1,000 *koku*)	Population (millions)	Agricultural output per head (*koku*)
1280	1,276	6.49	8,278	6.0	1.39
1450	1,621	8.60	13,938	10.1	1.39

Sources and notes: Appendix Table A22. All figures are in Tokugawa units. For further details, see text and appendix.

TABLE 4: Estimates of arable land, land productivity, agricultural output, and primary sector output in the Tokugawa and early Meiji periods, 1600-1874

	Arable land (1,000 *chō*)	Land productivity (*koku*/*chō*)	Agricultural output (1,000 *koku*)	Primary sector output (1,000 *koku*)
1600	2,497	10.36	25,879	30,678
1721	3,249	12.67	41,173	48,808
1804	3,892	12.74	49,604	58,803
1846	4,265	13.26	56,571	67,062
1874	4,533	14.31	64,861	76,351

Sources and notes: Agricultural output for 1600–1846 is calculated using the share of forestry- and fishery-sector output in total output in early Meiji Japan taken from Fukao et al. (2015). Hokkaido and Okinawa are included in 1874. All figures are in Tokugawa units. For further details, see text and appendix.

TABLE 5: Japanese agricultural production, 730-1874: the benchmark estimates

A. Levels

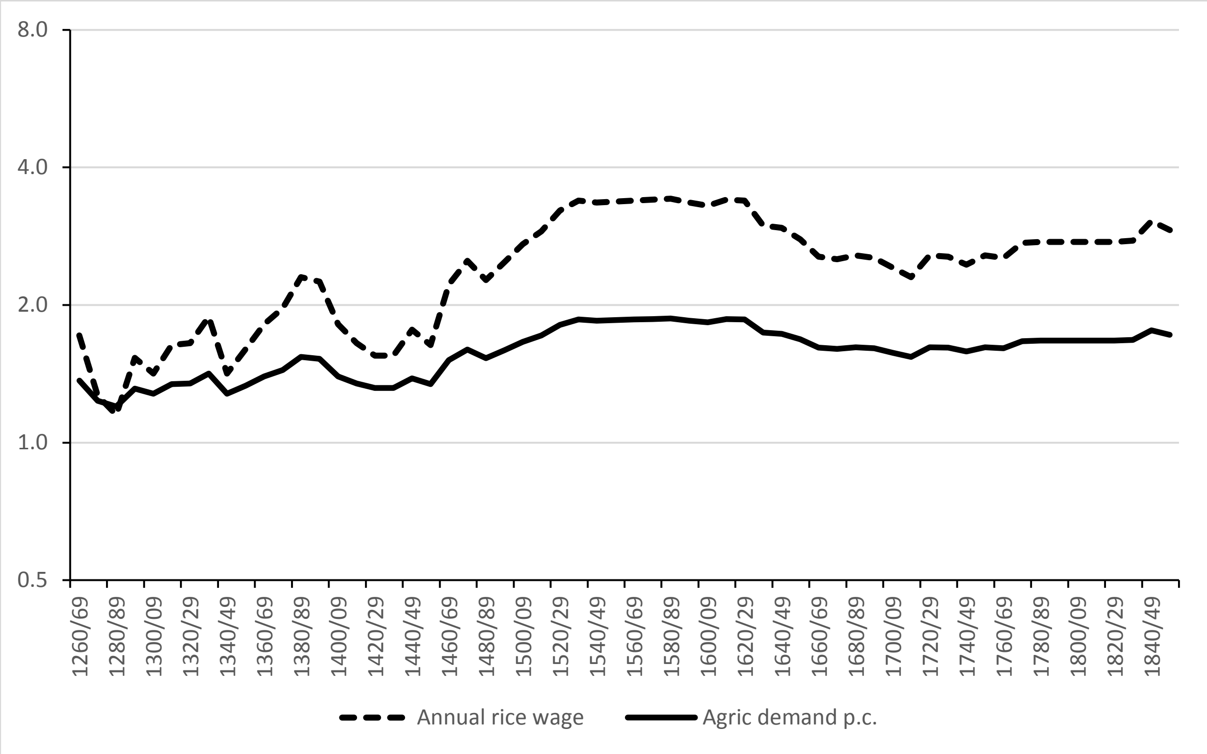
	Arable land (1000 *chō*)	Land productivity (*koku*/*chō*)	Agricultural output (1000 *koku*)	Agricultural output per head (*koku*)	Agricultural output per head (1874=100)
730	640	9.58	6,130	1.00	54.0
950	1,028	8.30	8,527	1.71	91.6
1150	1,109	8.31	9,211	1.56	83.9
1280	1,276	6.49	8,278	1.39	74.7
1450	1,621	8.60	13,938	1.39	74.5
1600	2,497	10.36	25,879	1.52	81.8
1721	3,249	12.67	41,173	1.32	70.7
1804	3,892	12.74	49,604	1.62	86.8
1846	4,265	13.26	56,571	1.76	94.3
1874	4,533	14.31	64,861	1.86	100.0

B. Annual growth rates (% per year

	Arable land	Land productivity	Agricultural output	Agricultural output per head
730-950	0.22	-0.07	0.15	0.24
950-1150	0.04	0.00	0.04	-0.04
1150-1280	0.11	-0.19	-0.08	-0.09
1280-1450	0.14	0.17	0.31	0.00
1450-1600	0.29	0.12	0.41	0.06
1600-1721	0.22	0.17	0.38	-0.12
1721-1804	0.22	0.01	0.22	0.25
1804-1846	0.22	0.10	0.31	0.20
1846-1874	0.22	0.27	0.49	0.21
730-1280	0.13	-0.07	0.05	0.06
1280-1721	0.21	0.15	0.36	-0.01
1721-1874	0.22	0.08	0.30	0.23
730-1874	0.17	0.04	0.21	0.05

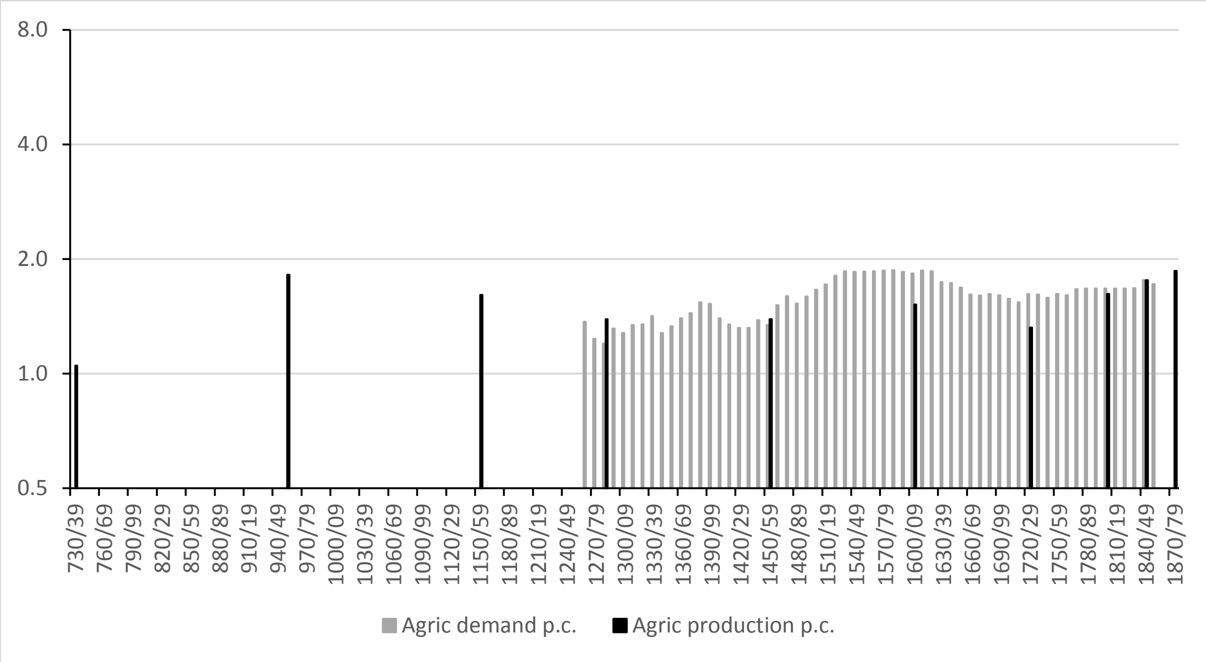
Sources and notes: All figures are in Tokugawa units. See discussion in the text and appendix.

FIGURE 1: Japanese unskilled rice wage and agricultural demand per capita, 1260/69-1850/59 (*koku*, log scale)



Sources and notes: Daily unskilled rice wage from Bassino *et al*. (2010), Bassino and Ma (2005): 1262-1583: constructed using information reported in Momose (1959), Rekihaku (2009), Kyoto Daigaku Kinsei Bukkashi Kenkyukai (1962), Endo (1956) and Tanaka (2007). 1600-1780: generated using information in Miyamoto, 1963), Iwahashi (1981) and (Kimura 1987). 1793-1862: derived from Mitsui (Mitsui Bunko 1981). Annual rice wage based on 250 days worked per year, and 150 kg per *koku*. See text for details. Agricultural demand per capita: see text.

FIGURE 2: Per capita supply of and demand for agricultural products, 730/39-1870/79 (*koku*)



Sources and notes: See text.

TABLE 6: Urban population and population density in Japan, 730-1873

	Urban population (1,000)	Total population (millions)	Urban share (%)	Population density (persons per *chō*)
730	124	6.1	2.0	0.21
950	135	5.0	2.7	0.17
1150	120	5.9	2.0	0.20
1280	208	6.0	3.5	0.21
1450	259	10.1	2.6	0.35
1600	1,088	17.0	6.4	0.59
1721	3,956	31.3	12.6	1.09
1804	3,936	30.7	12.8	1.06
1846	3,961	32.2	12.3	1.12
1874	3,588	34.5	10.4	1.20

Sources and notes: The urban population data for Japan excluding Ezochi and Ryūkyū (present-day Hokkaido and Okinawa) are taken from Kito (1996), Farris (2009a), and Saito and Takashima (2015; 2017b). They include persons living in settlements of at least 10,000 persons. The total population data are taken from Table 1. The land area of Japan excluding Hokkaido and Okinawa is 28.8 million *chō*.

TABLE 7: Determinants of sectoral shares: random effects regression results, 1874, 1890 and 1909

	Secondary sector	Tertiary sector
Population density (log)	0.460***	0.538***
	(4.65)	(6.97)
Urbanisation rate (logit)	0.122*	0.310***
	(1.92)	(6.26)
Prefectural dummy	0.775***	0.307**
	(3.84)	(1.96)
Year 1890 dummy	0.447***	0.388***
	(7.38)	(8.29)
Year 1909 dummy	0.743***	0.428***
	(10.11)	(7.52)
Constant	-1.557***	-0.319**
	(-8.48)	(-2.24)
No. of observations	135	135
No. of groups	45	45
Adjusted R^2	0.740	0.835

Sources and notes: Saito and Takashima (2016: 379).

TABLE 8: Japanese GDP by main output categories, 730-1874, benchmark estimates

A. Levels of GDP (1,000 *koku*)

	Primary output	Secondary output	Tertiary output	GDP
730	7,267	466	689	8,422
950	10,108	613	943	11,664
1150	10,919	690	1,017	12,626
1280	9,813	666	1,091	11,571
1450	16,523	1,374	2,209	20,106
1600	30,678	3,652	7,306	41,635
1721	48,808	8,434	20,361	77,603
1804	58,803	10,091	24,402	93,296
1846	67,062	11,698	28,140	106,900
1874	76,351	15,782	36,043	128,176

B. Sectoral shares of GDP (%)

	Primary output	Secondary output	Tertiary output	GDP
730	86.3	5.5	8.2	100.0
950	86.7	5.3	8.1	100.0
1150	86.5	5.5	8.1	100.0
1280	84.8	5.8	9.4	100.0
1450	82.2	6.8	11.0	100.0
1600	73.7	8.8	17.5	100.0
1721	62.9	10.9	26.2	100.0
1804	63.0	10.8	26.2	100.0
1846	62.7	10.9	26.3	100.0
1874	59.6	12.3	28.1	100.0

C. Growth rates of GDP (% per year)

	Primary output	Secondary output	Tertiary output	GDP
730-950	0.15	0.12	0.14	0.15
950-11500	0.04	0.06	0.04	0.04
1150-1280	-0.08	-0.03	0.05	-0.07
1280-1450	0.31	0.43	0.42	0.33
1450-1600	0.41	0.65	0.80	0.49
1600-1721	0.38	0.69	0.85	0.52
1721-1804	0.22	0.22	0.22	0.22
1804-1846	0.31	0.35	0.34	0.32
1846-1874	0.46	1.08	0.89	0.65
730-1280	0.05	0.06	0.08	0.06
1280-1721	0.36	0.58	0.67	0.43
1721-1874	0.29	0.41	0.37	0.33
730-1874	0.21	0.31	0.35	0.24

Sources and notes: Primary output is derived from agricultural output in Table 2, as explained in the text. Secondary and tertiary output before 1874 are derived using data on the urbanisation rate and population density together with the regression coefficient from Table 4, as described in the text.

TABLE 9: Japanese GDP per capita, 730-1874, benchmark estimates

A. Level of GDP per capita

	GDP (1,000 *koku*)	Population (million)	GDP per capita (*koku*)	GDP per capita (1874=100)
730	8,422	6.1	1.38	37.2
950	11,664	5.0	2.33	62.8
1150	12,626	5.9	2.14	57.6
1280	11,571	6.0	1.94	52.4
1450	20,106	10.1	2.00	53.9
1600	41,635	17.0	2.45	66.0
1721	77,603	31.3	2.48	66.8
1804	93,296	30.7	3.04	81.9
1846	106,900	32.2	3.32	89.4
1874	128,176	34.8	3.71	100.0

B. Annual growth rates of GDP per capita

	Growth rate (% per year)
730-950	0.24
950-1150	-0.04
1150-1280	-0.07
1280-1450	0.02
1450-1600	0.13
1600-1721	0.01
1721-1804	0.25
1804-1846	0.21
1846-1874	0.40
730-1280	0.06
1280-1721	0.06
1721-1874	0.26
730-1874	0.09

Sources and notes: GDP from Table 8, population from Table 1.

TABLE 10: Data reliability assessments and sensitivity analysis

A. Data reliability grades

Reliability grade	Margin of error	Average margin of error
A. Firm figures	± less than 5%	± 2.5%
B. Good figures	± 5% to 15%	± 10%
C. Rough estimates	± 15% to 25%	± 20%
D. Conjectures	± more than 25%	± 40%

B. Reliability assessments for Japanese data

	Ancient	Medieval	Tokugawa
Primary output			
Arable land	C	C	A
Land productivity	D	C	B
Rice wage		C	B
Agricultural output	D	C	B
Secondary & tertiary output			
Secondary output	C	C	B
Tertiary output	C	C	B
Aggregates			
GDP	D	C	B
Population	C	B	A
GDP per capita	D	C	B

C. Sensitivity analysis for Japanese GDP

	Ancient	Medieval	Tokugawa
Arable land	± 17.3%	± 16.7%	± 1.6%
Land productivity	± 35.2%	± 16.7%	± 6.5%
Secondary output	± 5.8%	± 1.3%	± 1.2%
Tertiary output	± 6.4%	± 2.0%	± 2.6%

Sources: error margins derived from the range of estimates produced from alternative sources and the volatility of the underlying data, as described in the text. The interpretation of the reliability grades is from Feinstein (1972: 21). Sensitivity analysis shows the percentage increase (decrease) in GDP in response to an increase (decrease) in each series by an amount equal to the average margin of error during each period.

TABLE 11: Different scenarios for Japanese GDP per capita ($1990)

	Benchmark estimates	High estimates	Low estimates	Alternative estimates
730	376	526	(300)	438
950	635	889	381	757
1150	583	816	350	680
1280	529	635	423	629
1450	545	654	436	614
1600	667	734	600	667
1721	675	743	608	675
1804	828	911	745	828
1846	903	993	813	903
1874	1,011	1,112	910	1,011

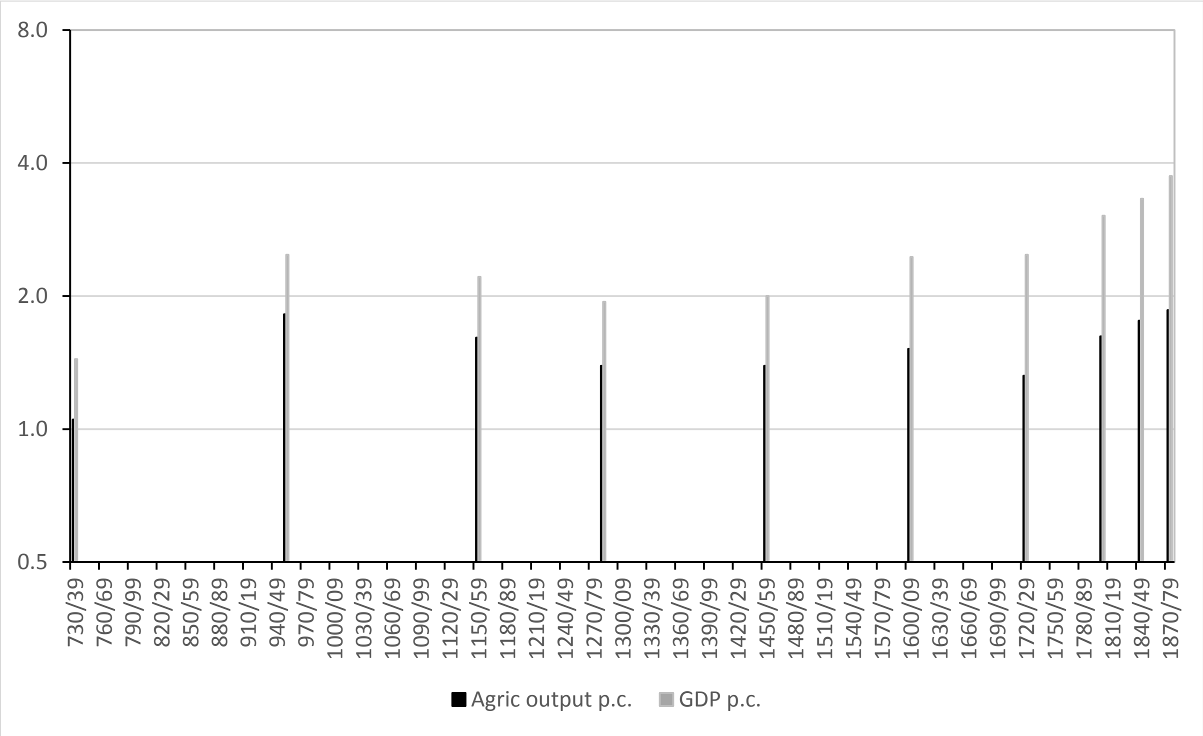
Sources and notes: Benchmark estimate from Table 9, converted to 1990 international dollars at 1874 from Fukao *et al.* (2015). Hokkaido and Okinawa are included in 1874. High and low estimates are calculated using ± one average error, based on the reliability assessments in Table 10. The low estimate of $300 for 730 is given in parentheses, since the figure of $226 suggested by a mechanical application of the error bands would be too low to sustain life. Alternative estimates are based on the assumption that population density affected the secondary and tertiary sector outputs only from 1600 onwards.

TABLE 12: An Anglo-Japanese comparison of per capita GDP, 730-1874

	Japan p.c. GDP, benchmark estimates ($1990)	GB p.c. GDP ($1990)	Japan/GB p.c. GDP, benchmark estimates (GB=100)	Range for Japan/GB p.c. GDP (GB=100)
730	376			
950	635			
1150	583			
1280	529	651	81.3	65.0 - 97.6
1450	545	1,011	53.9	43.1 - 64.7
1600	667	1,077	61.9	55.7 – 68.1
1721	675	1,605	42.1	37.9 – 46.3
1804	828	2,080	39.8	35.8 – 43.8
1846	903	2,997	30.1	27.1 – 33.1
1874	1,011	4,191	24.1	21.7 – 26.5

Sources and notes: Japanese GDP per capita from Table 9, converted to 1990 international dollars at 1874 from Fukao *et al.* (2015).; GB GDP per capita from Broadberry *et al.* (2015a), benchmarked at 1850 using Maddison (2010), but adjusted from the territory of the United Kingdom to a Great Britain basis. Range calculated using the average error from the reliability assessment for Japanese GDP per capita in Table 10.

FIGURE 3: Japanese agricultural output and GDP per capita, 730/39-1870/79 (*koku*)



Sources and notes: Agricultural output per capita from Table 5; GDP per capita from Table 9.

TABLE 13: GDP per capita levels in Europe and Asia, 730-1870 (1990 international dollars)

A. Studies based on contemporary data

	GB	NL	Italy	Spain	Japan	China	India
730					376		
950					635		
980						853	
1020						1,006	
1050						967	
1086	723					878	
1120						863	
1150					583		
1280	651			897	529		
1300	724		1,466	889			
1348	745	674	1,327	957			
1400	1,045	958	1,570	822		1,032	
1450	1,011	1,102	1,657	827	545	990	
1500	1,068	1,141	1,408	826		858	
1570	1,096	1,372	1,325	919		885	
1600	1,077	1,825	1,224	876	667	865	682
1650	1,055	1,671	1,372	838			638
1700	1,563	1,849	1,344	817		1,103	622
1720	1,605	1,751	1,564	850	675	950	
1750	1,710	1,877	1,446	845		727	573
1800	2,080	1,974	1,327	893	828	614	569
1850	2,997	2,397	1,306	1,144	903	600	556
1870	3,856	2,849	1,470	1,486	1,011	618	526

B. Maddison

	UK	NL	Italy	Spain	Japan	China	India
1000	400	425	450	450	425	466	450
1500	714	761	1,100	661	500	600	550
1600	974	1,381	1,100	853	520	600	550
1700	1,250	2,130	1,100	853	570	600	550
1820	1,706	1,838	1,117	1,008	669	600	533
1850	2,330	2,371	1,350	1,079	679	600	533
1870	3,031	2,757	1,499	1,207	756	530	533

Sources: Part A: Britain: Broadberry *et al.* (2015a); Walker (2014); Netherlands: van Zanden and van Leuwen (2012); Italy: Malanima (2011); Spain: Álvarez-Nogal and Prados de la Escosura (2013); Japan: Table 11; China: Broadberry *et al.* (2018); India: Broadberry *et al.* (2015b). Part B: Maddison (2010).

REFERENCES

Allen, R.C. (2000), “Economic Structure and Agricultural Productivity in Europe, 1300-1800”, *European Review of Economic History*, 3, 1-25.

Allen, R.C. (2001), “The Great Divergence in European Wages and Prices from the Middle Ages to the First World War”, *Explorations in Economic History*, 38, 411-447.

Álvarez-Nogal, C. and Prados de la Escosura, L. (2013), “The Rise and Fall of Spain (1270-1850)”, *Economic History Review*, 66, 1-37.

Arimoto, Y. (2006), “Kaihatsu keizaigaku kara mita jichisonraku ron [Perspectives on Autonomous Village Theory: A View from Development Economics]”, *Nōgyōshi Kenkyū*, 40, 89-96.

Astill, G. (2000), “General Survey 600-1300”, I Palliser, D.M. (ed.), *The Cambridge Urban History of Britain, Volume I, 600-1540*, Cambridge: Cambridge University Press, 27-49.

Bassino, J.P., Fukao, K. and Takashima, M. (2010), “Grain Wages of Carpenters and Skill Premium in Kyoto, c. 1240-1600: A Comparison with Florence, London, Constantinople-Istanbul and Cairo”, Paper presented at Economic History Society Conference, University of Durham, http://www.ehs.org.uk/dotAsset/85e81444-8b65-4f60-b950-cc6dd0aaceb2.pdf

Bassino, J.-P. and Ma, D. (2005), “Japanese Unskilled Wages in International Perspective, 1741-1913”, *Research in Economic History*, 23, 229-248.

Blomme, J. and van der Wee, H. (1994), “The Belgian Economy in a Long-Term Historical Perspective: Economic Development in Flanders and Brabant, 1500-1812”, in Maddison, A. and van der Wee, H. (eds.), *Economic Growth and Structural Change: Comparative Approaches over the Long Run*, Milan: International Economic History Congress, 77-96.

Bouis, H.E. (1994), “The Effect of Income on Demand for Food in Poor Countries: Are our Food Consumption Databases Giving Us Reliable Estimates?”, *Journal of Development Economics*, 44, 199-226.

Bowley, Arthur L. (1911-12), “The Measurement of the Accuracy of an Average”, *Journal of the Royal Statistical Society*, 75, 77-88.

Broadberry, S. (2013), “Accounting for the Great Divergence”, Nuffield College, Oxford, https://www.nuffield.ox.ac.uk/people/sites/broadberry-research/.

Broadberry, S., Campbell, B., Klein, A., Overton, M. and van Leeuwen, B. (2015a), *British Economic Growth, 1270-1870*, Cambridge: Cambridge University Press.

Broadberry, S., Custodis, J. and Gupta, B. (2015b), “India and the Great Divergence: An Anglo-Indian Comparison of GDP per capita, 1600-1871”, *Explorations in Economic History*, 55, 58-75.

Broadberry, S. Guan, H. and Li, D. (2018), “China, Europe and the Great Divergence: A Study in Historical National Accounting”, *Journal of Economic History*, (forthcoming).

Broadberry, S. and Wallis, J. (2017), “Growing, Shrinking and Long Run Economic Performance: Historical Perspectives on Economic Development”, National Bureau of Economic Research Working Paper No. 23343, http://www.nber.org/papers/w23343

Chapman, Agatha L. (1953), *Wages and Salaries in the United Kingdom 1920-1938*, Cambridge: Cambridge University Press.

Crafts, N.F.R. (1985), *British Economic Growth during the Industrial Revolution*, Oxford: Oxford University Press.

Deaton, A. and Muellbauer, J. (1980), *Economics and Consumer Behaviour*, Cambridge; Cambridge University Press.

Dore, R. (1965), *Education in Tokugawa Japan*, London: Routledge & Kegan Paul.

Elvin, M. (1973), T*he Pattern of the Chinese Past*, Stanford CA: Stanford University Press.
Endo, M. (1956), *Shokunin no rekishi [History of Craftsmanship]*, Tokyo: Shibundō.
Farris, W. W. (2006), *Japan's Medieval Population: Famine, Fertility, and Warfare in a Transformative Age*, Honolulu: University of Hawai'i Press.
Farris, W. W. (2009a), *Daily Life and Demographics in Ancient Japan*, Ann Arbor, Michigan: Center for Japanese Studies, University of Michigan.
Farris, W.W. (2009b), *Japan to 1600: A Social and Economic History*, Honolulu: University of Hawai'i Press.
Feinstein, C.H. (1972), *National income, Expenditure and Output of the United Kingdom, 1855-1965*, Cambridge: Cambridge University Press.
Feinstein, C.H. and Thomas, M. (2002), "A Plea for Errors", *Historical Methods*, 35, 155-165.
Fukao, K., Bassino, J.-P., Makino, T., Paprzycki, R., Settsu, T., Takashima, M., and Tokui, J. (2015), *Regional Inequality and Industrial Structure in Japan: 1874-2008*, Tokyo: Maruzen Publishing.
Fukao, K., Settsu, T. and Nakabayashi, M. (2017), "Kanmatsu furoku: Seisan, bukka, shotoku no Suikei [Appendix: Estimation of Production, Prices, and Income]", in Fukao, K., Nakamura, N. and Nakabayashi, M. (eds.), *Kindai 1, Iwanami Kōza Nihon Keizai no Rekishi 3 [Iwanami Lecture Series on the History of the Japanese Economy], vol. 3, The Modern Period 1*, Iwanami Shoten, 273-288.
Hanley, S.B. (1983), "A High Standard of Living in Nineteenth-Century Japan: Fact or Fantasy?", *Journal of Economic History*, 43, 183-192.
Hanley, S.B. (1986), "Standard of Living in Nineteenth-Century Japan: Reply to Yasuba", *Journal of Economic History,* 46, 225-226.
Harada, T. (1942), *Chūsei ni okeru toshi no kenkyū [Study of Urban History in the Medieval Period]*, Tokyo: Kodansha.
Hayami, A. (1967), "Keizai shakai no seiritsu to sono tokushitsu [The Emergence of Economic Society and its Characteristics]", in Shakai-Keizaishi Gakkai (ed.), *Atarashii Edo Jidaizo wo Motomete*, Tokyo: Tōyō Keizai Shinpōsha.
Hayami, A. (2015), *Japan's Industrious Revolution: Economic and Social Transformations in the Early Modern Period*, Tokyo: Springer.
Hayami, A. and Kito, H. (2004), "Demography and Living Standards", in Hayami, A., Saito, S. and Toby, R.P. (eds.), *Emergence of Economic Society in Japan, 1600-1859,* Oxford: Oxford University Press, 213-246.
Hayami, A., Saito, S. and Toby, R.P. (eds.) (2004), *Emergence of Economic Society in Japan, 1600-1859,* Oxford: Oxford University Press.
Huang, P. (1985), *The Peasant Economy and Social Change in North China,* Stanford, CA: Stanford University Press.
Iwahashi, M. (1981), *Kinsei nihon bukkashi no kenkyū [Research on the History of Prices in Early Modern Japan]*, Tokyo: Ohara Shinsei Sha.
Iwahashi, M. (2004), "The Institutional Framework of the Tokugawa Economy", in A. Hayami, Saito, O. and Toby, R.P. (eds.), *Emergence of Economic Society in Japan, 1600-1859,* Oxford: Oxford University Press, 85-104.
Iyanaga, T. (1980), *Nihon kodai shakai keizaishi kenkyū [Study of Japanese ancient socio-economic history]*, Tokyo: Iwanami Shoten.
Kamata, M. (1984), 'Nihon kodai no jinkō ni tsuite [Population in Ancient Japan]', *Mokkan Kenkyū*, 6, 131-154.
Kimura, M. (1987), *La Revolución de los precios en la cuenca del pacífico, 1600-1650 [The Price Revolution in the Pacific Basin, 1600-1650]*, Ciudad de México: Universidad Nacional Autónoma de México, Facultad de Economía (data available in electronic

format on the file "Osaka 1600-1650", prepared by David Jacks, 2006, Global Price and Income History website
http://gpih.ucdavis.edu/Datafilelist.htm).
Kito, H. (1983), *Nihon nisen nen no jinkōshi [A Two Thousand Year History of the Japanese Population]*, Tokyo: PHP Kenkyujo.
Kito, H. (1996), "Meiji izen Nihon no chiiki jinkō [Japan's Population before the Meiji Period]", *Jōchi Keizai Ronshū [Jochi Economic Review]*, 41(1.2), 65-79.
Kito, H. (2000), *Jinkō kara mita Nihon no rekishi [Japanese History from a Demographic Perspective]*. Tokyo: Kodansha.
Kondo, H. (ed.), (1969), *Kaitei shiseki shūran, 27 [Collection of Historical Materials]*, Tokyo: Shiseki Shūran Kenkyūkai.
Koten Hozonkai (ed.), (1934), *Korissho zanpen [Fragments from the Penal Statutes]*, Tokyo: Koten Hozonkai.
Krantz, O. (2017), "Swedish GDP 1300-1560: A Tentative Estimate", Lund Papers in Economic History; No. 152, Department of Economic History, Lund University, http://portal.research.lu.se/portal/files/21081639/LUP_152.pdf.
Kunaichō Shōsōin Jimusho (ed.), (1988) *Shōsōin komonjo eiin shūsei 1 [Photographic Reproductions Collection of Ancient Documents in Shōsōin Treasure House, vol.1*, Tokyo: Yagi Shoten.
Kuroita, K. (2011a), *Ruijūu sandaikyaku and Kōnin kyakushō (Shintei zōho Kokushi taikei 25, Shinsōban) [Assorted Regulations from Three Reigns and Extracts of the Kōnin Regulations (The 25th volume of the Supplementary compendium of Japanese history, Newly Revised Edition)]*, Boulder: NetLibrary.
Kuroita, K. (2011b), *Enryaku kōkanshiki, Jōgan kōkanshiki, Engi kōkanshiki, Kōnin shiki, Engi shiki (Shintei zōho Kokushi taikei 26, Shinsōban) [Succession for the Ordinances of Enryaku, Succession for the Ordinances of Jōgan, Succession for the Ordinances of Engi, the Ordinances of Kōnin, and the Ordinances of Engi (The 26th volume of Supplementary compendium of Japanese history, Newly Revised Edition)*, Boulder: NetLibrary.
Kuznets, S. (1945), *National Product in Wartime*, New York: National Bureau of Economic Research.
Kyoto Daigaku Kinsei Bukkashi Kenkyūkai (KKB), ed. (1962), *15-17 Seiki ni okeru bukka hendō no kenkyū [Research on Price Fluctuations in the 15th to 17th Centuries]*, Kyoto: Tokushikai.
Kyoto Daigaku Bungakubu Kokugogaku Kokubungaku Kenkyūshitsu [Kyoto University Faculty of Letters] (ed.), (1968), *Shohon shūsei Wamyō-ruijūshō (Honbunhen) [Collections of Wamyō-ruijūshō (Text)]*, Kyoto: Rinsen Shoten.
McNeil, W.H. (1976), *Plagues and Peoples*, Garden City, NY: Anchor Press.
Maddison, A. (1982), *Phases of Capitalist Development*, Oxford: Oxford University Press.
Maddison, A. (1995), *Monitoring the World Economy, 1820-1992*, Paris: Organisation for Economic Cooperation and Development.
Maddison, A. (2001), *The World Economy: A Millennial Perspective*, Paris: Organisation for Economic Cooperation and Development.
Maddison, A. (2010), "Statistics on World Population, GDP and Per Capita GDP, 1-2008 AD", Groningen Growth and Development Centre,
http://www.ggdc.net/MADDISON/oriindex.htm.
Maddison, A. and van der Wee, H. (eds.), (1994), *Economic Growth and Structural Change: Comparative Approaches over the Long Run*, Milan: International Economic History Congress.

Malanima, P. (2011), “The Long Decline of a Leading Economy: GDP in Central and Northern Italy, 1300-1913”, *European Review of Economic History*, 15, 169-219.

Mathias, P. and Pollard, S. (eds.) (1989), *The Cambridge Economic History of Europe, Volume 8: The Industrial Economies: The Development of Economic and Social Policies*, Cambridge: Cambridge University Press.

Mathias, P. and Postan, M.M. (eds.) (1978), *The Cambridge Economic History of Europe, Volume 7: The Industrial Economies: Capital, Labour and Enterprise, Part 2, The United States, Japan and Russia*, Cambridge: Cambridge University Press.

Mitsui Bunko. ed. (1981), *Kinsei kōki ni okeru shuyō bukka no dōtai [Trends of Major Prices in Early Modern Japan]*, Tokyo: Tokyo Daigaku Shuppankai.

Miyamoto M. ed. (1963), *Kinsei Osaka no bukka to rishi [Prices and Interest Rates in Early Modern Osaka]*, Tokyo: Sobunsha.

Miyamoto, M. (1985), “Edo jidai ni okeru bukka no chiiki hikaku to shijō keisei [Comparison of price levels and market formation in the Edo period]”, in Harada, T. and Miyamoto, M. (eds.), *Rekishi no Naka no Bukka, Zenkogyoka Shakai no Bukka to Hatten [Prices in History; Prices and Economic Development before the Industrialisation],* Tokyo: Dobunkan, 147-208.

Miyamoto, M. (2004), “Quantitative Aspects of Tokugawa Economy”, in Hayami, A., Saito, O. and Toby, R.P. (eds.), *Emergence of Economic Society in Japan, 1600-1859,* Oxford: Oxford University Press, 36-84.

Momose, K. (1959), “Muromachi jidai ni okeru beikahyō [Rice Price Tables for the Muromachi Period]”, *Shigaku Zasshi*, 66(1), 58-71.

Nagahara, K. (1981). “The Sengoku Daimyo and the Kandaka System”, in Hall, S., Nagahara, K., and Yamamura, K. (eds.), *Japan Before Tokugawa: Political Consolidation and Economic Growth, 1500 to 1650*, Princeton, N.J.: Princeton University Press, 27-63.

Naimusho Kangyōrō (Agency for the Promotion of Industry, Ministry of Home Affairs) ed. (1875) *Meiji 7-nen fuken bussan-hyō [Tables of Prefectural Products, Meiji 7]*, Tokyo: Naimusho Kangyoryo.

Nakamura, J.I. (1966), *Agricultural Production and the Economic Development of Japan, 1873-1922*, Princeton NJ: Princeton University Press.

Nakamura, S. (1968), *Meiji ishin no kiso kozō [The Basic Structure of the Meiji Restoration]*, Tokyo: Miraisha.

Needham, J. (1954), *Science and Civilization in China*, Volume 1, Cambridge: Cambridge University Press.

Niki, H. (1997). *Kūkan, ōyake, kyōdōtai, chusei toshi kara kinsei toshi he [Spatial, public, and community: from the medieval city to the pre-modern city]*, Tokyo: Aoki Shoten.

Niki, H. (2002). “Kodai chūsei nihon toshiron no riron to hōhō [Methods and theory of the discussion about urban history in the ancient and medieval period]”, in Niki. H. (ed.), *Toshi: zenkindai toshiron no shatei [City: the future of the study on urban history]*, Tokyo: Aoki Shoten, 9-25.

Nishitani, M. (2017), “Chūsei no nogyō kōzō [Agricultural Structure in the Medieval Period]”, in Fukao, K., Nakamura, N. and Nakabayashi, M. (eds.), *Chūsei, Iwanami Kōza Nihon Keizai no Rekishi 1 [Iwanami Lecture Series on the History of the Japanese Economy], vol. 1, The Medieval Period*, Tokyo: Iwanami Shoten, 148-177.

Nishitani, M. (2015), “Chūsei kōki ni okeru Yamashiro no kuni Kamikuse-shō no nōgyō seisan [Agricultural Production of the Kamikuze Manor in Yamashiro Province in the late Medieval Period]”, *Fukuoka Daigaku Jinbun Ronsō*, 47(3), 679-730.

Nishitani, M., Hayashima, D. and Nakabayasi, M. (2017a) “Seifu no Yakuwari (The Role of Government),” in Fukao, K., Nakamura, T. and Nakabayashi, M. (eds.), *Chūsei, Iwanami*

Kōza Nihon Keizai no Rekishi 1 [Iwanami Lecture Series on the History of the Japanese Economy], vol. 1, The Medieval Period, Tokyo: Iwanami Shoten, 23-33.

Nishitani, M., Kida, K. and Hayashima, D. (2017b) "Nōmin no Teijyū to Tochi no Shōken-ka (Settling Down of Farmers and Securitization of Land)," in Fukao, K., Nakamura, T. and Nakabayashi, M. (eds.), *Chūsei, Iwanami Kōza Nihon Keizai no Rekishi 1 [Iwanami Lecture Series on the History of Japanese Economy], vol. 1, The Medieval Period*, Tokyo: Tokyo: Iwanami Shoten, 147-233.

Oyaizu, N. (2006), *Kinsei chingin bukkashi shiryō [Documents for the history of early modern prices]*, Aichi: Seikosha.

Palma, N. and Reis, J. (2017), "From Convergence to Divergence: Portuguese Economic Growth, 1527-1850", unpublished manuscript, University of Manchester.

Parthasarathi, P. (1998), "Rethinking Wages and Competitiveness in the Eighteenth Century: Britain and South India", *Past and Present*, 158, 79-109.

Parthasarathi, P. (2011), *Why Europe grew Rich and Asian did not*, Cambridge: Cambridge University Press.

Perkins, D. H. (1969), *Agricultural development in China, 1368-1968*, Chicago: Aldine.

Pfister, U. (2011), "Economic Growth in Germany, 1500–1850", paper for the "Quantifying Long Run Economic Development" conference at the University of Warwick in Venice, March, 22–24,
https://www.wiwi.uni-muenster.de/wisoge/organisation/personen/pfister/forschung/Growth-Venice-2011.pdf.

Phelps Brown, H. and Hopkins, S.V. (1955), "Seven Centuries of Building Wages", *Economica*, 22, 195-206.

Pomeranz, K. (2000), *The Great Divergence: China, Europe, and the Making of the Modern World Economy*, Princeton: Princeton University Press.

Rekihaku [National Museum of Japanese History], wage and price data available in electronic format in August 2009, http://www.rekihaku.ac.jp/doc/t-db-index.html)

Ridolfi, L. (2016), "The French economy in the longue durée. A study on real wages, working days and economic performance from Louis IX to the Revolution (1250-1789), PhD thesis, IMT School for Advanced Studies, Lucca.

Rozman, G. (1973), *Urban Networks in Ch'ing China and Tokugawa Japan*, Princeton, New Jersey: Princeton University Press.

Saito, O. (2015) "Climate, Famine, and Population in Japanese History: A Long-Term Perspective", in Batten, B.L. and Brown, P.C. (eds.), *Environment and Society in the Japanese Islands*, Corvallis: Oregon State University Press, 213-229.

Saito, O. and Takashima, M. (2015), "Population, Urbanisation and Farm Output in Early Modern Japan, 1600-1874: A Review of Data and Benchmark Estimates", RCESR Discussion Paper Series, No. DP15-3.
https://hermes-ir.lib.hit-u.ac.jp/rs/handle/10086/27295

Saito, O. and Takashima, M. (2016), "Estimating the Shares of Secondary- and Tertiary-Sector Output in the Age of Early Modern Growth: The Case of Japan, 1600-1874", *European Review of Economic History*, 20(3), 368-386.

Saito, O. and Takashima, M. (2017a), Jinkō to toshika to shūgyō kōzō [Population, Urbanisation, and Employee], in Fukao, K., Nakamura, T. and Nakabayashi, M. (eds.), *Chūsei, Iwanami Kōza Nihon Keizai no Rekishi 1 [Iwanami Lecture Series on the History of the Japanese Economy], vol. 1, The Medieval Period*, Tokyo: Iwanami Shoten, 57-89.

Saito, O. and Takashima, M. (2017b), Jinkō to toshika, idō to shūgyō [Population and Urbanisation, Migration and Employee Structure], in Fukao, K., Nakamura, T. and Nakabayashi, M. (eds.), *Kinsei, Iwanami Kōza Nihon Keizai no Rekishi 2 [Iwanami*

Lecture Series on the History of the Japanese Economy], vol. 2, The Pre-modern Period, Tokyo: Iwanami Shoten, 61-104.

Sakaehara, T. (1992). *Nara jidai ryutsū keizaishi no kenkyū [Study on the economy of distribution in the Nara period]*, Tokyo: Hanawa Shobō.

Sawada, G. (1927), *Narachō jidai minsei keizai no sūteki kenkyū [Quantitative Study of Economy and Society in the Nara Period]*, Tokyo: Fuzanbo.

Schön, L. and Krantz, O. (2012), "The Swedish Economy in the Early Modern Period: Constructing Historical National Accounts", *European Review of Economic History*, 16, 529-549.

Schreurs, G. (2016), "Government Institutions and Economic Development in Tokugawa Japan: A Study of the Effects of Systems Competition", a paper presented at Economic and Social History Seminar, Centre for Global Economic History, Utrecht University, 10 November, 2016, available at http://www.cgeh.nl/fall-2016.

Settsu, T., Bassino, J.-P. and Fukao, K. (2016), "Meiji-ki keizai seichō no sai-kentō: sangyō kōzō, rōdō seisansei to chiikikan kakusa [Revisiting Economic Growth in Meiji Japan: Industrial Structure, Labour Productivity and Regional Inequality]", *Keizai Kenkyu [Economic Review]*, 67 (3), 193-214.

Shimbo, H. and Hasegawa, A. (2004), "The Dynamics of Market Economy and Production", in Hayami, A., Saito, O. and Toby, R.P. (eds.), *Emergence of Economic Society in Japan, 1600-1859*, Oxford: Oxford University Press, 159-191.

Smith, T.C. (1959), The Agrarian Origins of Modern Japan, Stanford CA: Stanford University Press.

Snooks, G.D. (1994), "The Dynamics of Very Long-Run Economic Change: England, 1000-2000", in Maddison, A. and van der Wee, H. (eds.), *Economic Growth and Structural Change: Comparative Approaches over the Long Run*, Milan: International Economic History Congress, 23-36.

Takeuchi, R. (ed.) (1964-76), *Heian ibun [Documents of the Heian Period]*, Tokyo: Tokyodō Shuppan.

Tanaka, K. (2007), "Kahei ryūtsū kara mita 16 seiki no Kyoto [Sixteenth Century Kyoto from the Perspective of Money Circulation]", in K. Suzuki, ed., *Kahei no chiikishi [The Regional History of Currency]*, Tokyo: Iwanami Shoten, 83-124.

Umemura, M., Yamada, S., Hayami, Y., Takamatsu, N., and Kumazaki, M. (1966), *Noringyō (Choki keizai tokei, 9) [Agriculture and Forestry (Long–Term Economic Statistics of Japan, Vol. 9)]*, Tokyo: Toyo Keizai.

de Vries, J. (1984), *European Urbanization, 1500-1800*, London: Methuen.

Walker, J. T. (2014), "National Income in Domesday England", in Allen, M. and Coffman, D. (eds.), *Money, Prices and Wages: Essays in Honour of Professor Nicholas Mayhew*, Basingstoke: Palgrave Macmillan, 24-50.

Wittfogel, K.A. (1957), *Oriental Despotism: A Comparative Study of Total Power*, New Haven CT: Yale University Press.

Wrigley, E.A. (1985), "Urban Growth and Agricultural Change: England and the Continent in the Early Modern Period", *Journal of Interdisciplinary History*, 15, 683-728.

Xu, Y., Shi, Z., van Leeuwen, B., Ni, Y., Zhang, Z. and Ma, Y. (2017), "Chinese national income, ca. 1661-1933", *Australian Economic History Review*, 57, 368-393.

Yamasaki, R. (1983), *Kinsei bukka shi kenkyū [Studies on Early Modern Price History],* Tōkyō: Ohara Shinseisha.

Yasuba, Y. (1986), Standard of Living in Japan before Industrialization: From What Level did Japan Begin? A Comment", *Journal of Economic History*, 46, 217-224.

Yun, B. (1994), "Proposals to Quantify Long-term Performance in the Kingdom of Castile, 1550-1800", in Maddison, A. and van der Wee, H. (eds.), *Economic Growth and*

Structural Change: Comparative Approaches over the Long Run, Milan: International Economic History Congress, 97-110.
van Zanden, J.L. and van Leeuwen, B. (2012), “Persistent but not Consistent: The Growth of National Income in Holland, 1347-1807”, *Explorations in Economic History*, 49, 119-130.