Inequality, Poverty, and Growth in Japan, 1850-1955

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Abstract  
What role did international differences in income distribution play in the Great divergence between Asia and Europe that took place in the early modern period, and in the divergence within Asia that occurred in the 19th and 20th century? Provincial level information for early 19th century Japan suggests that both personal income inequality and the prevalence of poverty were low in Japan, by the international standards of the time, before the opening of the country to international trade in the late 1850s (Saito 2010). The aim of this paper is to provide a quantitative assessment of Saito’s hypothesis. We investigate levels and variations in regional and personal inequality in Japan before 1955 using new estimates, at the level of the present-day 47 prefectures, of per capita GDP, personal inequality, and poverty headcount. Our study spans over a century, starting before the full opening to international trade and ending with the post-WWII recovery leading to the high-speed growth of the 1950s and 1960s.

JEL classification: I3, N15, N35, N95, O47, 053  
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Introduction

What role did international differences in income distribution play in the Great divergence between Asia and Europe that took place in the early modern period, and in the divergence within Asia that took place in the 19th and 20th century? The country level estimates of extraction ratio (ER) calculated by Milanovic, Lindert and Williamson (2010) for benchmark years on the basis on information for the Gini of income distribution points to inequality levels, adjusted for differences in living standards, being lower in European countries than in the rest of the world until the early 20th century. The two main non-Western exceptions were China in 1880, although at a very low level of per capita GDP (around 540 USD of 1990), and Japan in 1886, with an average income per head well above subsistence level (916 USD).\footnote{Reported in Maddison (2010).} Provincial level information for early 19th century Japan (Nishikawa 1987) suggests that both personal income inequality and the prevalence of poverty were particularly low in that country, by the international standards of the time, before the opening to international trade in the late 1850s. This led Osamu Saito to speculate that the Gini of income inequality that was below 40 in 1886 according to Minami (1995a, 1995b), may have been around 35 in around 1860 and at a similar level during the first half of the 19th century (Saito 2008, 258).

Although based on snapshots, these measures resonate with two streams of theoretical and empirical research on the relationship between inequality and economic development. The first one is related to the Kuznets curve in personal and regional income distribution that has been observed in most countries during the historical process of economic development. The identification of a non-monotonic evolution of income distribution in 19th and early 20th century Europe and North America (Kuznets 1955; Easterlin 1960; Williamson 1965) led to investigate its early modern origin for the leading European countries (Lindert and Williamson 1982, 1983, 1985, Lindert 1986; van Zanden 1995) and the pattern of income distribution during the pre-industrial period and the early phase of catch-up of late-industrialising European countries, in particular Italy and Spain (Rossi, Toniolo, Vecchi...
2001; Felice 2005, 2011; Prados de la Escosura 2008). Already available results for Japan indicate that this country experienced a similar process (Minami 1995a, 1995b; Fukao et al. 2015).

The second stream of research, also initiated by Kuznets, was aimed at providing a theoretical framework for analysing a possible causal relation between inequality and growth (e.g. Person and Tabellini 1994; Li and Zou 1998; Aghion, Caroli, Garcia-Penalosa 1999), along with some attempts to provide empirical evidence of a negative/positive effect (and eventually non-monotonous effects) based on recent country level data (e.g. Person and Tabellini 1994; Li and Zou 1998; Barro 2000). The limitations of this type of empirical exercise have been clearly identified: unobserved country level variables, particularly institutions, and differences in the level of income are likely to play a major role, even if the sample is restricted to OECD countries (Atkinson and Brandolini 2000). In addition, the relevance of results based on average is questionable, especially in terms of policy implications if economic growth does not significantly reduce poverty (Ravaillon 2001).

The aim of this paper is to provide a quantitative assessment of Saito’s hypothesis of low inequality and poverty in early 19th century. We investigate levels and variations in regional and personal inequality in Japan before 1955 using new estimates, at the level of the present-day 47 prefectures, for three indicators: per capita GDP, personal inequality, and poverty headcount. Our study covers over a century, starting before the full opening to international trade and ending with the post-WWII recovery leading to the high-speed growth of the 1950s and 1960s.

This approach of inequality as it relates to Japan’s path of development is motivated by the observation of the Japanese economy embarking in the last decades of the 19th century in a decisive process of technological and institutional innovation which lead to a shift to industrialisation, in contrast to other Asian countries that experienced this process at a similar scale only in the post-WWII period. We can distinguish two types of interpretations not mutually exclusive of the Japanese ‘economic miracle’ of the late 19th century. The first one emphasizes the discontinuities, in particular the dismantlement of external and internal barriers and therefore Ricardian gains from trade. The first impetus came from the full opening of the country to international trade in the second half of the 19th century (following

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2 A comparable process took place in the first decades of the 20th century, albeit on a smaller scale, in Shanghai where the diffusion of Japanese technologies played a critical role, particularly in the textile industry, and in Korea and Manchuria in the 1930s, where the industrialisation process largely resulted from the imposition of Japanese colonial rule.
the treaties of 1858), and was amplified by the positive effects of institutional changes breaking internal barriers as a result of the Meiji restoration/revolution (1868).

The second interpretation stresses that Japan was already on an upward trajectory before 1850, with a Smithian growth process resulting from the diffusion of best practices in the cottage industry nation-wide, and that favourable preconditions existed for further economic development (Saito 2008). One of these propitious preconditions was the distinctive pattern of income distribution in Tokugawa and early Meiji Japan3: “all poor but no paupers” (Saito 2010). As equality is conducive, among other things, to human capital accumulation and the diffusion of best practices, the Japanese experience of early industrialisation can regarded as a legacy of economic and social conditions in the early 19th century.

Section 1 discusses evidence from top income shares and their regional distribution. Section 2 estimates the process of regional convergence, adjusted for taking into account the inequality possibility frontier (Milanovic 2006), and measures personal inequality at the national level using information on height distribution. Section 3 generates prefecture-level measures of personal Gini and poverty headcount, and investigates causal links between poverty and growth. Section 4 concludes by proposing an interpretation of the causes of the initial low level of inequality in Japan, and of the changes identified between 1850 and 1940.

1. Top income shares at the national and regional level

Although there is a general consensus regarding the low degree of regional and personal inequality in post-WWII Japan, the picture that emerges from the different indicators available for the late 19th and early 20th century does not seem entirely consistent. According to Gini coefficients of personal income estimated by Minami (1995a, 1995b), inequality was on a rising trend in Japan between the 1880s and the 1930s. However, the share of top incomes (top 1%) in total national income calculated by Moriguchi and Saez (2008) was rather stable in the first decades of the 20th century, fluctuating in a range between 16 and 20%. These differences in trend may be due to the rising share of relatively high but below the top 1% incomes, or changes at the medium and lower levels of the distribution.

3 The Tokugawa period spans 1603 to 1868, and the Meiji era 1868 to 1912; early Meiji refers here to the period before the start of heavy industrialisation of the 1890s.
Our study is concerned with the entire distribution, across households but also across regions, and also with changes in absolute poverty. From this viewpoint, it is worth considering how changes in the share of the top 1% should be adjusted for taking into account above subsistence GDP, but also the implication of the regional concentration of top incomes.

Estimates of the share of top incomes, the top 0.1%, 0.5-0.1%, and 1-0.5% were expressed by Moriguchi and Saez relative to total national income. But this information can be easily rearranged as a share of Japanese income above subsistence level (Table 1, bottom line). In doing so, we adopt the analytical framework of the inequality possibility frontier, as defined by Milanovic (2006) to assess the share of total income that can be effectively extracted without affecting the productivity of lower income workers and their dependents, and therefore the sustainability of the extraction of a large share of total output by an economic or political elite, through the payment for factors other than labour or through taxation. We present an alternative measure of the share of top incomes with above subsistence GDP as denominator, instead of GDP. This calculation affects the timing of the peak of inequality that is 1909 instead of 1925. An additional implication is that a continuous declining trend is now observed during the three decades prior to 1940, which seems consistent with the relative decline of influence of the kinship-based rent-seeking zaibatsu combines that had close connections with the political establishment during the early phase of economic development (in particular Mitsubishi, Mitsui and Sumitomo), and the emergence in the first decades of the 20th century of new business groups originating from new ventures in emerging high tech sectors of the early 20th century.

Table 1 around here

There remained however, until the mid-1940s, a small group of extremely wealthy households that can be identified in Who’s Who type Japanese publications reporting individual data for the amount of tax, place of residence, and main sources of income. Yazawa (2004) processed this source for measuring the average taxable income of the top 5,000 taxpayers, who accounted for 0.04 of the total number of households. He also provides information on two other groups of households, which we could label as medium and lower income groups (5.55 and 94.41% of the total number of households respectively), and their average taxable income. Although the information is broadly consistent with that based on

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4 Shinshiroku 紳士録 [Yearbook of gentlemen].
the top 1% calculated by Moriguchi and Saez, it appears that what were labelled as medium income households, had in fact a taxable income that was only a small fraction of the average of the top 5,000, and only 4.5 times that of the average for lower income households.

Yazawa (2004, 54) also provides information on the number of households by prefecture. Out of 5,000 individuals, 2,009 where resident in Tokyo, 1,262 in Osaka, 502 in Hyogo prefecture (where Kobe is the capital city), 314 in Aichi (with Nagoya as the capital city), and 179 in Kanagawa (with Yokohama as the capital city). This high degree of geographic concentration implies that personal inequality in Japan was closely related to regional inequality. Out of a total 47 Japanese prefectures, 26 had no resident who was part of the top 5,000, and among the 21 prefectures with at least one resident, the share of total income of the wealthiest households in total prefectural GDP\(^5\) was in a range between 0.17% (Nara prefecture, with 3 households) and 9.07% (in Tokyo); the share in total number of households at the prefecture level was in range between 0.05‰ (Saitama prefecture) and 1.56‰ (in Tokyo). Regional averages of taxable income were however less dispersed, in a range between 30,113 yen in Ibaraki, and 67,692 yen in Tokyo.

Table 2 around here

For a complementary assessment of the magnitude of the income gap between the highest levels of the distribution and the rest of the population, and of a possible variation in this gap over time, we can rely on alternative indicators of wellbeing such as the average height of these respective populations. A sizeable difference in average height between the social elite and the average level of the population is observed in most historical societies characterized by a certain degree of social stratification. In the case of pre-war Japan, we can compare the national average for students, aged 16, 18, or 20, almost exclusively drawn from respectable backgrounds, and the average height of military conscripts.\(^6\) On average, the students aged 20 were 3 cm around taller than the conscripts measured at the same age for any given year of birth between 1882 and 1917 (no data available before and after these dates for either students or conscripts).

But, at around 160 cm in the mid-1880s, the average height of the Japanese upper class was significantly lower, by 3 to 5 cm, than the national average of southern European

\(^5\) Prefectural GDP estimates in current yen for 1935 used as proxy for prefectural income in 1936.

\(^6\) Sources: Ministry of Education for students; original sources for conscripts are described by Bassino (2006).
countries. Japanese members of the elite were also shorter than the average estimated by Morgan (2004) for northern and eastern China (Morgan 2008) –166 and 167 cm respectively, although China has a much lower per capita GDP; and a rather similar genetic pool, in the case of northern and eastern China (Cavalli-Sforza, Menozzi, and Piazza, 1994; 230-231).

The mean height of the Japanese elite was even lower that the average for south China whose population had experienced a drastic decline in stature in the 1850s as a result of the massive warfare and destructions of the Taiping rebellion (Morgan 2008).

The low stature of the Japanese was not due to a higher exposure to disease. Japan had a comparatively low infant mortality and high life expectancy in the second half of the 19th century, by the standards of the time. At around 40 years, it was only slightly lower than the British and Italian levels (Johansson and Mosk 1986), while it was less than 30 years in China. This high level of life expectancy implies low levels of infant mortality and a high rate of access to public health services, which are critical aspects of wellbeing in pre-industrial societies.

2. Trends in regional and personal inequality at the national level

In this section, we identify trends in regional inequality using new estimates of prefecture level GDP (47 prefectures) for the benchmark years 1874, 1890, 1909, 1925, 1935, and 1940 (Fukao et al. 2015) along with official GDP statistics for the post-war period; we also estimate the relationship between regional per capita GDP and the average height of conscripts, and generate yearly series of national level personal Gini derived from the height distribution of Japanese conscripts born between 1872 and 1921.

In order to assess regional inequality, we would ideally rely on national accounts reconstructed on the income side. This could be possible, in principle, by collecting and processing for the 47 prefectures the same data sources used by Moriguchi and Saez at the national level. However, income estimates based on these sources would result in an

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7 Evidence for the early 19th century indicates that life expectancy was close in a range between 35 and 40 year in rural Japan. The low Japanese stature was largely due to cultural norms in food consumption, in particular a very low level of animal protein intake until the turn of the century, and possibly the relative price structure of food and non-food items (the price of superior foodstuffs relative to the price of services was extremely high in 19th century Japan).
underestimation of the level of prefectural income in the poorest regions due to underreporting by the tax authorities of income related to a sizeable share of agricultural activities, and probably also of a large part of informal services.

We have to acknowledge that the gap between GDP estimated in a production approach and in an income approach may be sizeable. The breakdown by source of income classified by economic sector suggests that part of their income originated from activities in manufacturing and services activities that were perhaps localised outside their region of residence. Among the 5,000 top incomes, only 32 originating mainly from the primary sector (0.6%), 1,231 from the secondary sector (24.6%, almost exclusively manufacturing), and 3,386 from the tertiary sector (67.7%), out of which 1,526 from wholesale and retail trade activities (30.5%) and 1,080 from finance and insurance (21.6%), while 351 (7.0%), had no occupation, implying that they drew their income from the ownership of assets (Yazawa 2004, Table 1-6, 61). But the total income of the top 5,000 taxpayers accounted for only 2.3% of total taxable income (Table 2); such a level of approximation appears therefore acceptable.

Figure 1 presents an overview of regional differences in per capita GDP for the benchmark years 1874, 1909, and 1940. Although average income was well below 1,000 USD in most prefectures in 1874, it was close or above that level in 1909, and close to or above 1,500 dollars in around three quarters of the prefectures by 1940. Estimation results for the conditional convergence model presented in Table 3 show that economic development lifted income levels by a process of regional convergence in which the growth rate of the poorest prefectures overtook that in the richest prefectures during the three sub-periods corresponding to our benchmark years, 1874-1890, 1890-1909, 1909-1925, 1925-1940 (16, 19, 16, and 15 years respectively), although the explanatory power of the model declines sharply after 1909.

Figure 1 and Table 3 around here

Figure 2 measures changes in regional inequality between 1850-1955 as the coefficient of variation of average income for the 47 present-day prefectures (the administrative divisions were stabilized in the 1880s) and 14 macro-regions. The CV is also measured after adjustment, i.e. the level above subsistence (regional average per capita GDP in USD minus subsistence level of 1 USD per day, or 365 USD per capita year). Our findings

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8 There were only 46 prefectures in 1950 and 1955 because Okinawa was under US military administration.
show that regional inequality was comparatively low in Japan in the 19th century, remained rather stable in the first decades of the 20th century, and declined less between 1940 and 1955 than suggested by the data used by Barro and Sala-i-Martin (1992), the trend exhibiting an inverted W shaped curve (Atkinson 2007).

Since there is no consensus on the trend in personal income distribution at the national level before 1940, it is worth considering alternative methods for generating time series of personal inequality. The strong relationship between height and income, both in terms of average levels in a given population and of difference in their distribution across regions and/or countries, allow the calculation of proximate values of Gini based on the coefficient variation for height. Recent estimates presented by van Zanden et al. (2014) of the relationship between income and height Gini for different regions of the world covering the period from 1820 to the present indicate that time series of Gini of personal distribution can be generated using a linear transformation of the coefficient of variation of height.

In the Japanese case, estimates of Gini personal income at the prefecture level are unavailable before the 1950s. We can however, as a second best, estimate personal inequality using height distribution if a strong relation between height and GDP exists. We investigate the relationship between prefecture level average GDP and average height (year of birth) for a panel of 47 prefectures with 3 years of observations: 1874, 1890, and 1909. The results are presented in Table 4 with 4 specifications: log-log and semi-log, OLS and prefecture fixed effects (FE), and in all cases with year dummies. The results point constantly toward significant coefficients for GDP per capita and the time dummies in all four specifications of the estimation.

As expected, the coefficient is negative for the time dummies 1874 and 1890 (1909 is the omitted year), which indicates a positive time trend that can be understood as resulting from improvement in public health that is not explained by prefectural GDP but rather by the diffusion of best practices throughout the country (e.g. training of midwives), local

9 See also the study by Moradi and Baten (2005) dealing with inequality in sub-Saharan Africa, and Baten and Mumme for the relation between inequality, measured using height and income Gini, and civil war.
10 Conscription ended in 1945, i.e. year of birth 1925, but the information is unavailable after 1921. In a sensitivity analysis, the relation was also estimated with the inclusion of the year 1925 in the panel (GDP in 1925 and average height in 1921 used as proxy for 1925; the results are similar to those presented in Table 4.
expenditures aimed at providing public health services that were funded by the central government, and other possible explanatory variables, in particular the improvement of hygiene resulting from public investment in primary education not necessarily affected by differences across regions and changes over time of per capita GDP.

Table 4 around here

The calculation of the CV of height for a given year is based on information for the number of individuals for each height interval at the country level.\footnote{The CV can be also calculated at the prefecture-level since information is available for all years between 1892 and 1936 (years of measurement); since the conscripts were measured at age 20, the years of birth are from 1872 to 1916.} The formula used for the calculation is:

\[
CV_t = \sqrt{\frac{1}{n} \sum_{i=1}^{n} N_{it} \left( \frac{H_i}{H_{mt}} - 1 \right)^2}
\]  

\(CV_t\) is the coefficient of variation in year \(t\) (for a given prefecture), \(N_{it}\) denotes the share of the population in each interval \(i\) in year \(t\), \(H_i\) the median height in each interval, and \(H_{mt}\) the median height of the entire cohort in year \(t\).

We can then convert the CV into height Gini estimates used as proxy for income Gini. For that purpose, we use the linear transformation formula estimated by van Zanden et al. (2014) with country level data for 1820-1929 using a FE specification.\footnote{Information presented in the online appendix of the paper. An alternative specification, obtained by the authors with the same dataset but in OLS estimation is \(Gini_{it} = 8.52 + 10.64*CV_{it}\). The results are obviously similar in terms of trend but the level of the estimated Gini is somehow higher with this second specification (see appendix 3).}

\[
Gini_{it} = 9.19 + 8.71*CV_{it}
\]  

The measure, expressed in percentage, obtained for the 1890 national level height Gini in (42.2) is almost identical to the figure estimated by Minami (1995a, 1995b) for 1886 on the basis of income distribution data (39.5), which is the reference used by Milanovic,
Lindert, and Williamson (2010, Table 2) for calculating the extraction ratio in late 19th century Japan. For 1850, we adopt the figure of 35 in 1860 proposed by Saito (2008, 158), as a conjecture based on information for the domain of Choshu, in present-day Yamaguchi prefecture, in the first half of the 19th century, and some less detailed information for other areas. We can now estimate the Inequality Possibility Frontier (IPF) and extraction ratio (ER) in 1850 and 1874 as the ratio of actual Gini to IPF (in %), as in Milanovic, Lindert and Williamson (2010), with the same figure for subsistence level (300 USD per capita per year). Table 5 reports the results showing that, for all benchmark years between 1850 and 1955, with an ER of 56.4 for 1850, for a Gini of 35 and an IPF of 62 in 1850, Japan is in the lower range of ER values in the sample of countries presented by Milanovic, Lindert and Williamson (2010). This indicates that Japan was characterised by a low degree of personal inequality before the opening to international trade in the late 1850s. Inequality increased between 1850 and 1874, which can be understood as a consequence of the opening to international trade, but declined during the first low-tech industrialisation of early Meiji. Since we identified in the first part of this section a trend of regional inequality following a M-shaped curve, it is worth investigating the combined effects of rising regional inequality and declining personal inequality. For that purpose, we estimate personal inequality at the prefecture level.

Table 5 around here

3. Prefecture level personal Gini and poverty headcount, and economic growth in Meiji Japan

In this section, we derive levels of and trends in personal income distribution at the regional level from 1874 to 1921 from the distribution of height, using the same method as in the previous section. Since the height Gini is a measure of biological welfare, it may significantly deviate from the income distribution in prefectures with the highest average per capita GDP. The magnitude of the deviation can be assessed by comparing the figures for year 1909 (a low point in personal inequality at the national level) with estimates of income Gini in 1936 calculated for 21 prefectures on the basis of top income (Yazawa 2004). In order to assess the severity of deprivation among the poorest segments of the population in each prefecture, we generate also estimates poverty headcount using the coefficients of the height
equation presented in Table 4. Finally, we use this prefecture level dataset to uncover causal relationship between inequality and growth.

Figure 3 presents the result of the calculation of height Gini for the lowest, highest (excluding Okinawa), and median prefecture levels. The archipelago of Okinawa is clearly an outlier with extremely high initial level of inequality that could be partly explained by the fact that this prefecture was (and still is) an outlier also in terms of average height. Inequality in Okinawa follows a downward trend, by with apparently erratic fluctuations probably due to the effects of crop failures induced by climate anomalies. At a very low level of biological wellbeing, nutritional hardships experienced between gestation and age 20 are likely to have an irreversible effect in terms of stunting, particularly during the growth spurt of adolescence.

A negative concave relationship between average height and the CV of height is identified by Blum (2013) in an international comparison of country level data for the 19th and 20th century. However, in the Japanese case, the relation identified here using prefecture level data exhibits a negative mildly convex one. The fact that the dispersion of height Gini across prefectures drastically declined during the last decade on the 19th century, while prefecture level capita GDP was still low by international standards, suggests that the declining trend in Gini reflected a genuine improvement in biological wellbeing. Furthermore, in the prefectures with the lowest height inequality, the Gini declined only slightly between 1874 and 1910 but a significant rise in average height occurred. This implies that the remaining height dispersion in these prefectures was mostly due to genetic factors, with a distribution that can be regarded as homogenous across regions since the differences in the genetic pool within Japan are negligible (Cavalli-Sforza, Menozzi, and Piazza, 1994; 230-231)).

Figure 4 presents the prefecture height Gini estimates for three benchmark years: 1874, 1890, and 1909. The initial situation in 1874 is characterised by a strong East-West gradient, with inequality levels particularly low in the Tohoku (north-eastern Japan) and high in the prefectures of western Honshu Island (with the exception of Tottori and Hiroshima), and in Shikoku Island. The regional convergence of height Gini, in 1909, towards the lower levels observed in 1874, and even below in some cases (such as Okayama and Fukuoka), is particularly impressive for western Japan. We should remember, however, that the height Gini is a measure of wellbeing that does not necessarily reflect the extent of income
inequality. Estimates for 1936 calculated at the prefecture level for 21 prefectures on the basis of top income (Yazawa 2004) are in a range between 12 (Nara) and 47 (Tokyo), with a median value of 32. The Gini is lower in prefectures with a small number of residents who were members of the top 5,000 among Japanese taxpayers but with a wide dispersion between 12 and 40 for prefectures with a number of top taxpayers under 20 at the prefecture level. Nevertheless, this dispersion suggests that the height Gini can be regarded as an acceptable proxy of the income Gini for the 27 rural prefectures with no residents among the Japanese top income, that were also the poorest prefectures.

Figure 4 around here

The prefecture level poverty headcount can provide a more accurate picture of the conditions of the residents in the lower range of the income distribution. The level of poverty headcount, expressed in percentage of the population, is estimated using height thresholds generated by injecting the coefficients of the height regression reported in Table 4. The height thresholds used for calculating the poverty headcount (% of conscripts below the height threshold) are estimated with the conventional figure of $1 a day for threshold of per capita GDP, but we also calculated with thresholds of $0.75 and $2 a day (see appendix 2).

Our preferred specification is in semi-log with prefecture FE ((4) in Table 4) allowing to take into account specific local conditions such as higher risk of exposure to tropical diseases in the south-western region and to communicable diseases in highly urbanized areas, and with a semi-log form because of height’s normal distribution across a population; although regional averages are not necessarily distributed, the distribution of this indicator also tends toward normality in the Japanese case. A major advantage of the fourth specification is also the low level of the coefficient for the intercept. As a sensitivity analysis, we also estimated poverty headcount with 1 dollar a day in semi-log, but without prefecture FE. The share of the population with this specification is around twice as high as with prefecture FE, but with a similar pattern of regional variance.

Figure 5 presents the result of the estimation of poverty headcount with the log-log specification, $1 a day income threshold, and prefecture FE. The two most notable features are, first, the contrast between the western part of the country with declining levels of poverty

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13 The height thresholds obtained with 365 $ per year are 1483 mm in 1874, 1499 in 1890, and 1514 mm in 1909.
headcount between 1874 and 1890, whereas the levels are rising in the eastern part during the same sub-period, second the general decline in poverty headcount throughout the country between 1890 and 1909. Overall, if we accept that the preferred specification is the more appropriate way to estimate the poverty headcount, the level for Japan as a whole appears extremely low in comparison with recent figures recorded in developing countries with the same level of per capita GPD (Deaton 2005; Reddy and Minoiu 2007).

Figure 5 around here

The final part of this section attempts to uncover causal relationships between inequality and growth using changes in prefecture level per capita GDP and inequality (measured using Gini coefficient of height) and poverty headcount. The first step of this investigation is to estimate prefecture level growth for different sub-periods in a conditional convergence framework with inequality and poverty additional independent variable. The results, presented in Table 6, point towards a discontinuous effect of inequality over time: no effect of inequality on growth between 1874 and 1890 (coefficient not significant, and anyway very small), positive and significant for growth between 1890 and 1909 (albeit with a low explanatory power of the equations (1) and (3), as indicated by the low adjusted R-squared), and negative and significant effect of the initial level of inequality or poverty on growth between 1909 and 1925. As expected, the coefficients for the initial level of period GDP are significant and negative in all three cases, but the coefficient is significant only in the period 1909-1925.

The second step of the investigation consists in estimating the determinant of inequality with changes in the height Gini and in the poverty headcount as dependant variables (the dependant variable is measured as the difference in log) in the sub-periods 1874-1890 and 1890-1909. For the third sub-period 1909-1925, it is impossible to test the same equations due to the lack of height data for 1925. The independent variables are the variation of prefecture level per capita GDP, and the initial Gini or the poverty headcount, along with a dummy taking the value 1 for the prefectures of western Japan and 0 otherwise. The results, presented in Table 6, indicate unambiguously that, in the first sub-period 1874-1890, the growth of per capita GDP resulted in a reduction of inequality and poverty. The

14 Data for 1921 were used as proxy, which resulted in non-significant coefficients for height Gini and poverty headcount.
results are robust to the inclusion of the initial level of per capita GDP in the equation, and of a dummy for western prefectures. In the third sub-period 1890-1909, this effect vanishes; we can only identify a negative relationship between the initial level of the Gini and the variation in this coefficient.

Table 6 and 7 around here

4. Conclusion

Our investigation of levels and trends of regional and personal inequality based on estimates of regional per capita GDP, height Gini, and poverty headcount confirms Saito’s hypothesis of low level of inequality and poverty in pre-industrial Japan, in 1874, with similar albeit tentative results for 1850, i.e. before the opening to international trade. Throughout the period studied, Japan remained a relatively egalitarian country experiencing a gradual process of regional convergence of per capita GDP, contraction of personal inequality at the regional and national level, and reduction of poverty headcount.

A causality running from economic growth to a reduction of both personal inequality and poverty in observed in 1874-1890, the first sub-period for which our dataset allows an estimation of the relationship. During the following sub-period, 1890-1909, corresponding to the initial phase of heavy industrialisation, the causality identified is from high initial inequality to high growth rate, in line with an interpretation that emphasizes the role of saving by the higher income households in the financing of capital-intensive industrial projects; but the overall explanatory power of the equation tested is low. The relation turns from positive to negative in the sub-period 1909-1925, i.e. low growth rate in prefectures with high initial level of inequality (with a higher explanatory power than for the previous sub-period).

These results suggest that the low level of inequality and poverty observed before 1874 or 1890, i.e. before the initial phase of Japanese industrialisation, was the consequence of an earlier rise in per capita GDP, during the last period of Tokugawa rule and/or during the decade of opening to international trade preceding the Meiji era. The fact that the national average of per capita GDP was already well above the level of other Asian countries in 1874, and also probably before 1850, implies that the country was already engaged in the early 19th century in a virtuous dynamics of human capital accumulation and human capital intensive economic development.
The most egalitarian prefectures in 1874 were not necessarily those with the highest height or the highest per capita GDP, which implies that local institutional and environmental conditions, and economic structures, influenced either per capital GDP or inequality, or both. When investigating the regional variance in 1874 or even 1890, it should be remembered that, before 1868, Japan was fragmented in both economic and political terms, with political macro-institutions that can be described as confederate and economic institutions akin to a customs union (with significant external barriers before 1858) rather than a common market. In the western parts of the country, in particular, the local domains retained a large autonomy in economic policy and played a significant role in the promotion of new cash crops and the development of cottage industries. Our tentative interpretation is therefore that political fragmentation among polities engaged in a peaceful competition contributed to reduce regional inequality and, if not necessarily personal inequality, the prevalence of poverty.
References


### Table 1. Share of top income in per capita GDP and share in above subsistence GDP

<table>
<thead>
<tr>
<th></th>
<th>1850</th>
<th>1874</th>
<th>1890</th>
<th>1909</th>
<th>1925</th>
<th>1935</th>
<th>1940</th>
<th>1955</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP per capita</td>
<td>790</td>
<td>860</td>
<td>1012</td>
<td>1301</td>
<td>1885</td>
<td>2120</td>
<td>2874</td>
<td>2771</td>
</tr>
<tr>
<td>GDP pc -300 $</td>
<td>425</td>
<td>495</td>
<td>647</td>
<td>936</td>
<td>1520</td>
<td>1755</td>
<td>2509</td>
<td>2406</td>
</tr>
<tr>
<td>Top 0.1% (a)</td>
<td>5%</td>
<td>5%</td>
<td>5.5%</td>
<td>7.5%</td>
<td>8.5%</td>
<td>7.2%</td>
<td>6.8%</td>
<td>3%</td>
</tr>
<tr>
<td>Top 0.5-0.1% (b)</td>
<td>4%</td>
<td>4%</td>
<td>5%</td>
<td>7%</td>
<td>7%</td>
<td>6%</td>
<td>6%</td>
<td>2.5%</td>
</tr>
<tr>
<td>Top 1-0.5% (c)</td>
<td>3%</td>
<td>3%</td>
<td>3.5%</td>
<td>4%</td>
<td>4%</td>
<td>3.5%</td>
<td>3.5%</td>
<td>2%</td>
</tr>
<tr>
<td>Top 1% (a + b + c)</td>
<td>12%</td>
<td>12%</td>
<td>14%</td>
<td>18.5%</td>
<td>19.5%</td>
<td>16.7%</td>
<td>16.3%</td>
<td>7.5%</td>
</tr>
<tr>
<td>Adj. Top 1%</td>
<td>22.3%</td>
<td>20.8%</td>
<td>21.9%</td>
<td>25.7%</td>
<td>24.2%</td>
<td>20.2%</td>
<td>18.7%</td>
<td>8.6%</td>
</tr>
</tbody>
</table>

Sources: Per capita GDP in 1990 international USD for 1890-1955 in Maddison (2001); the estimates for 1950 are from Bassino et al (2014) and for 1874 from Fukao et al. (2015). Shares of the top 0.1%, 0.5-0.1%, and 1-0.5% in total national income between 1890 and 1955 based on information reported by Moriguchi & Saez (2008: 720), Figure 5; no information available for 1850 and 1874 (presumed lower than in 1890). Question marks indicate our informed guesses.

Note: above subsistence GDP (GDP pc -300$) measured as average per capita GDP minus 300 (assuming subsistence level at one dollar a day). Adj. % Top 1% (adjusted share of top 1% in total income) is the share of top 1% calculated as a ratio to above substance GDP instead of total GDP.

### Table 2. Income distribution in 1936, based on taxable income (TI)

<table>
<thead>
<tr>
<th></th>
<th>Number of households</th>
<th>Households %</th>
<th>Total TI (1000 yen)</th>
<th>% of total TI</th>
<th>Average TI (yen)</th>
<th>Multiple of average TI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top</td>
<td>5000</td>
<td>0.04</td>
<td>289915</td>
<td>2.3</td>
<td>57983</td>
<td>62.8</td>
</tr>
<tr>
<td>Medium</td>
<td>750000</td>
<td>5.55</td>
<td>2545500</td>
<td>20.4</td>
<td>3394</td>
<td>3.7</td>
</tr>
<tr>
<td>Low</td>
<td>12760000</td>
<td>94.41</td>
<td>9633800</td>
<td>77.3</td>
<td>755</td>
<td>0.8</td>
</tr>
<tr>
<td>All</td>
<td>13515000</td>
<td>100.00</td>
<td>12469215</td>
<td>100.0</td>
<td>923</td>
<td>1.0</td>
</tr>
</tbody>
</table>


Note: According to estimates by Ohkawa et al. (1974: 178) gross national expenditures and personal consumption expenditures were 19,324 and 13,328 millions current yen in 1936, respectively.

### Table 3. Estimation result for regional convergence in per capita GDP conditional of initial level of per capita GDP

<table>
<thead>
<tr>
<th></th>
<th>(1) 1874-1890</th>
<th>(2) 1890-1909</th>
<th>(3) 1909-1925</th>
<th>(4) 1925-1940</th>
</tr>
</thead>
<tbody>
<tr>
<td>logGDP_{t-a}</td>
<td>-0.25 (-2.80)***</td>
<td>-0.37 (-6.52)***</td>
<td>-0.19 (-2.86)*</td>
<td>-0.28 (-2.52)***</td>
</tr>
<tr>
<td>Dindus</td>
<td>-0.30 (4.74)***</td>
<td>0.33 (7.66)***</td>
<td>0.01 (0.13)</td>
<td>0.24 (3.06)***</td>
</tr>
<tr>
<td>Intercept</td>
<td>1.76 (2.88)***</td>
<td>2.69 (6.98)***</td>
<td>1.73 (2.37) **</td>
<td>2.43 (2.96)***</td>
</tr>
<tr>
<td>Adj. R2</td>
<td>0.37</td>
<td>0.58</td>
<td>0.12</td>
<td>0.14</td>
</tr>
<tr>
<td>Observation</td>
<td>46</td>
<td>47</td>
<td>47</td>
<td>47</td>
</tr>
</tbody>
</table>

Sources: Fukao et al. (2015).

Note: pooled specification with year dummies omitted (the explanatory power is mostly driven by dummies).
Table 4. Estimation results for prefecture level average height in mm (log-log and semi-log)

<table>
<thead>
<tr>
<th>Variable</th>
<th>(1) log-log</th>
<th>(2) log-log</th>
<th>(3) semi-log</th>
<th>(4) semi-log</th>
</tr>
</thead>
<tbody>
<tr>
<td>logGDP per capita</td>
<td>0.007 (3.92)***</td>
<td>0.008 (3.12)***</td>
<td>11.31 (3.93)***</td>
<td>11.86 (3.12)***</td>
</tr>
<tr>
<td>D1874</td>
<td>-0.020 (-16.14)***</td>
<td>-0.020 (-21.92)***</td>
<td>-31.14 (-16.17)***</td>
<td>-31.62 (-21.03)***</td>
</tr>
<tr>
<td>D1890</td>
<td>-0.009 (-8.36)***</td>
<td>-0.010 (-12.66)***</td>
<td>-15.46 (-8.43)***</td>
<td>-15.36 (-12.01)***</td>
</tr>
<tr>
<td>Intercept</td>
<td>7.33 (567.78)***</td>
<td>7.30 (452.65)***</td>
<td>1517 (74.62)***</td>
<td>1484 (58.49)***</td>
</tr>
<tr>
<td>Adj. R2</td>
<td>0.74</td>
<td>0.93</td>
<td>0.74</td>
<td>0.93</td>
</tr>
<tr>
<td>Observations</td>
<td>140</td>
<td>140</td>
<td>140</td>
<td>140</td>
</tr>
</tbody>
</table>

Sources: Bassino (2006) for average height (in mm) measured in 1894, 1910, and 1929 (conscripts born in 1874, 1890, and 1909, respectively); Fukao et al. (2015) for per capita GDP (in 1990 USD) in 1874, 1890, and 1909. Note: 47 prefectures; height data missing in 1874 (year of measurement) for Okinawa.

Table 5. Inequality possibility frontier (IPF) and extraction ratio (ER) at the national level

<table>
<thead>
<tr>
<th></th>
<th>1850</th>
<th>1874</th>
<th>1890</th>
<th>1909</th>
<th>1925</th>
<th>1935</th>
<th>1940</th>
<th>1955</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP p.c.</td>
<td>790</td>
<td>860</td>
<td>1012</td>
<td>1301</td>
<td>1885</td>
<td>2120</td>
<td>2874</td>
<td>2771</td>
</tr>
<tr>
<td>α</td>
<td>2.6</td>
<td>2.9</td>
<td>3.4</td>
<td>4.3</td>
<td>6.3</td>
<td>7.1</td>
<td>9.6</td>
<td>9.2</td>
</tr>
<tr>
<td>Gini conject.</td>
<td>35?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gini height</td>
<td>44</td>
<td>42</td>
<td>(41)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gini income</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IPF</td>
<td>62.0</td>
<td>65.1</td>
<td>70.4</td>
<td>71.9</td>
<td>80.6</td>
<td>82.8</td>
<td>87.3</td>
<td>86.8</td>
</tr>
<tr>
<td>ER</td>
<td>56.4</td>
<td>67.6</td>
<td>59.7</td>
<td>55.9</td>
<td>59.5</td>
<td>60.6</td>
<td>61.4</td>
<td>44.9</td>
</tr>
</tbody>
</table>

Sources: GDP per capita in 1990 USD for 1850 from Bassino et al. (2011), and for 1874 from Fukao et al. (2015), and from Maddison (2010) for other years (according to Maddison’s series, per capita GDP was 679 USD in 1850 and 756 USD in 1874); Gini of income interpolated from Minami (1995a, 1995b) for 1909, 1925, 1935, and 1940; based on height Gini of personal inequality (Figure 5) for 1874 and 1890; for 1850 informed guess (same figure as the conjecture for 1860 by Saito (2008, 158) based on income distribution). Notes: α is the ratio of per capita GDP to subsistence level (300 USD per capita per year), IPF is calculated as maximum Gini (Gm=(α-1)/α).

Table 6. Estimation result for change in per capita GDP conditional of initial levels of per capita GDP and height Gini or poverty headcount (PHC)

<table>
<thead>
<tr>
<th></th>
<th>(1) 1890-1909</th>
<th>(2) 1909-1925</th>
<th>(3) 1890-1909</th>
<th>(4) 1909-1925</th>
</tr>
</thead>
<tbody>
<tr>
<td>logGDP t-a</td>
<td>-0.061 (-0.86)</td>
<td>-0.241 (-4.36)***</td>
<td>-0.051 (-0.69)</td>
<td>-0.285 (-5.19)***</td>
</tr>
<tr>
<td>logGini</td>
<td>1.890 (2.96)***</td>
<td>-4.331 (-4.43)***</td>
<td>0.192 (2.62) **</td>
<td>-0.256 (-5.12)***</td>
</tr>
<tr>
<td>logPHC</td>
<td></td>
<td></td>
<td>0.109 (0.18)</td>
<td>9.717 (6.63) ***</td>
</tr>
<tr>
<td>Intercept</td>
<td>-6.442 (-2.49)***</td>
<td>18.073 (4.86)***</td>
<td>0.12</td>
<td>0.46</td>
</tr>
<tr>
<td>Adj. R2</td>
<td>0.19</td>
<td>0.39</td>
<td>0.12</td>
<td>0.46</td>
</tr>
<tr>
<td>Observations</td>
<td>47</td>
<td>47</td>
<td>47</td>
<td>47</td>
</tr>
</tbody>
</table>

Sources: see text.

Notes: coefficients for Gini and PHC not significant for the period 1874-1890, and with pooled data.
Table 7. Estimation results for Gini and poverty headcount (PHC) variation

<table>
<thead>
<tr>
<th></th>
<th>(1) ΔlogGini 1874-1890</th>
<th>(2) ΔlogGini 1890-1909</th>
<th>(3) ΔlogPHC 1874-1890</th>
<th>(4) ΔlogPHC 1890-1909</th>
</tr>
</thead>
<tbody>
<tr>
<td>ΔlogGDP_t-a</td>
<td>-0.029 (-2.11)*</td>
<td>-0.003 (-0.27)</td>
<td>-0.364 (-3.15)***</td>
<td>-0.130 (-0.81)</td>
</tr>
<tr>
<td>Gini_t-a</td>
<td>-0.012 (-8.29)***</td>
<td>-0.014 (-10.51)***</td>
<td>-0.055 (-7.70)***</td>
<td>0.000 (0.02)</td>
</tr>
<tr>
<td>PHC_t-a</td>
<td></td>
<td></td>
<td>-0.224 (-5.60)***</td>
<td>-0.060 (-1.59)</td>
</tr>
<tr>
<td>DWest</td>
<td>-0.018 (-3.19)***</td>
<td>0.003 (0.89)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>0.503 (7.98)***</td>
<td>0.554 (10.08)***</td>
<td>0.752 (11.41)***</td>
<td>0.283 (4.02)***</td>
</tr>
<tr>
<td>Adj. R2</td>
<td>0.80</td>
<td>0.75</td>
<td>0.76</td>
<td>0.00</td>
</tr>
<tr>
<td>Observations</td>
<td>46</td>
<td>47</td>
<td>46</td>
<td>47</td>
</tr>
</tbody>
</table>

Sources: see text.
FIGURES

Figure 1. Evolution of prefectural per capita GDP in 1990 USD
Source: Fukao et al. (2015).

Figure 2. Evolution of the CV of regional per capita GDP between 1850 and 1955 (in %)
Source: Fukao et al. (2015) for 1874-1955; guesswork based on agricultural output per head for 1850 (provisional): see appendix 1 for a list of prefectures by region.
Figure 3. Evolution of prefecture level Gini of personal inequality derived from height data, 1874-1921 (years of birth)
Source: height database from Bassino (2006); height CV converted into height Gini using coefficient estimated by van Zanden et al. (2014), appendix 2 (Table 3, p. 33, model (5) FE 1820-1929).

Figure 4. Prefecture level estimates of height Gini of personal inequality in 1874, 1890, and 1909 (years of birth)
Sources: height Gini calculated as described in notes of Figure 3.
Figure 5. Prefecture level poverty headcount in 1874, 1890, and 1909 (% of population below poverty threshold).
Sources: see text.