How Equality Created Poverty: Japanese Wealth Distribution and Living Standards 1600-1870

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Abstract

Despite its sophistication, Early Modern Japan, 1600-1868, had among the lowest real wage levels ever recorded, 40% of those in pre-industrial England. This paper shows that this puzzle can be partly resolved if we take into account the greater equality of land-holdings in pre-industrial Japan than in Europe. In England by 1700, 70% of the rural population were landless but in Japan only 13%. As I show theoretically, in the Malthusian demographic regime of the pre-industrial world greater equality should paradoxically generate lower living standards. I show empirically that landless families in Japan were unable to reproduce demographically. Had most households been landless, as in Europe, the population would have been unsustainable without higher wages. If, as many historians believe, high wages and living standards in western Europe explain the onset of the Industrial Revolution, then Japan's failure to industrialize could have been shaped by its unusual pre-industrial equality.

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Recent discussions on why the Industrial Revolution occurred in Europe and not in Asia have focused on the much higher living standards of pre-industrial Europe (Allen, 2009; De Vries, 2008). Yet there has been little explanation of why in a Malthusian regime living standards in such Asian societies as pre-industrial Japan were so low. Malthus believed higher living standards in western Europe stemmed from European restrictions on fertility. But we now know that in East Asia there were constraints on fertility as great as those of Europe. This paper explains the poverty of pre-industrial Japan as in part stemming from a social system that resulted in a much more equal distribution of land than in Western Europe.

In this paper I first show theoretically why landholding equality will lead to lower average output per person and lower wages in a Malthusian economy. I next present new evidence that shows Japan had a highly equal distribution of land and one of the lowest wage rates in the world, which could not have sustained a couple with 2 children. This contrasts with England where there was high inequality in land distribution and high wages by 1700, and is consistent with my hypothesis. Finally, I use demographic data from village censuses to show that a Malthusian system had developed. The land-poor, relying on low wages, failed to reproduce demographically. The land-rich, earning land incomes in addition to wages, experienced population growth. Due to the equality in land distribution there were sufficient land-rich households to keep overall population in equilibrium. This mechanism can explain about 36% of the wage gap between Japan and Northwest Europe.

The theoretical mechanism can be demonstrated graphically in figure 1. A Malthusian economy experiences population growth until the representative household's incomes are at subsistence levels, where birth rates equal death rate conditional on income, due to their lack of control over fertility. Demography determines incomes over the long run. The representative household is the typical peasant or laborer household in the economy. In the extreme case of a perfectly unequal distribution of land, where household incomes composed of only wages, the equilibrium population is where wages equate to subsistence income. This is the landless laborer equilibrium. However, an economy like Japan will continue to experience population growth at this wage level, because the representative household also earns land income (land rental income − taxation). This supplementary income pushes total incomes above subsistence levels. At the extreme of perfect equality in land distribution, population reaches equilibrium where total income, wage plus land rental income, is at the subsistence income. Wages are necessarily below subsistence incomes. This is the landholding peasant equilibrium, a labor abundant economy with lower marginal products and hence lower wages. However, wages are a poor measure of living standards in this economy, as they are significantly supplemented by land rental incomes. Japan, with more equality, was closer to

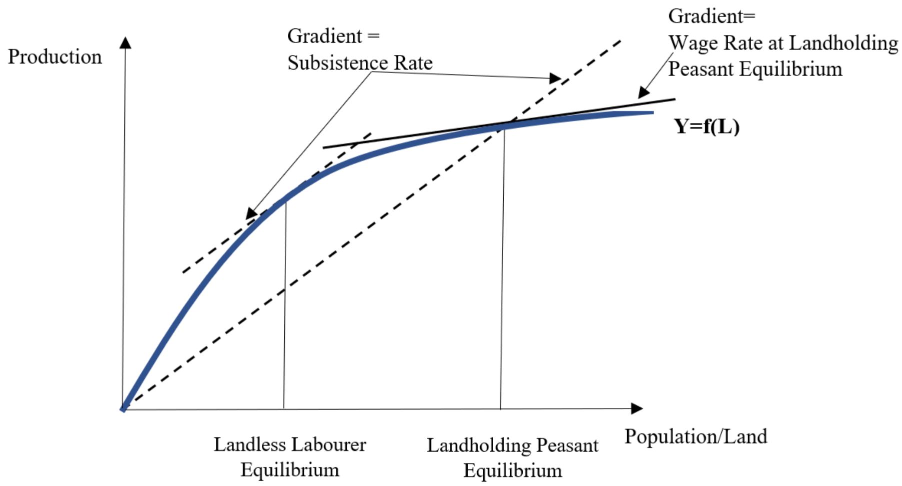

Figure 1: The Agricultural production function

the landholding peasant equilibrium, whereas England, with high inequality, was closer to the landless laborer equilibrium.

What distinguishes these equilibria is the poverty in the landholding peasant equilibrium. Average product per capita are high in unequal economies, so that some wealthy households had high incomes. In perfectly equal economies, average product per capita are at subsistence levels, meaning all are doomed to poverty. Given Japan was not perfectly equal, the landless and land-poor households had to work at wage levels below subsistence, while the land-rich lived above subsistence levels. The extreme levels of poverty experienced by this land-poor class adds another dimension of poverty.

Although Japan was a feudal society at this time, peasants had strong and well established rights over land rental incomes net of taxation by the late 17th century. I call any incomes from this right the "land income". Due to the importance of the term throughout the paper, I define "landholding" as the right to keep any surplus net of taxation. Land rights in feudal Japan were not as strong as ownership of today, but were stronger than the typical feudal society. Landholdings in Japan entailed very strong power to use or lend or sell or inherit land throughout life with security. However, part of the decision making power went to the village council and more rarely to the feudal lords who were important stakeholders over land use. Despite some limitations, landholders could exercise their rights. This can be seen by how land rental markets functioned efficiently (Arimoto and Kurosu, 2015). I note that other authors have used landholdings to describe cultivators, but I am referring to the holder of the right to surplus net of tax. Thus the landholder and cultivator could be, and often were, distinct entities with the cultivator having to negotiate a land rent in return for part of the surplus. I refer to the landless laborers earnings as wages.

A major contribution of this paper is the vast amount of new quantitative evidence, that can help us reassess the "Great Divergence", the divergence in living standards between East Asia and Western Europe. Despite the reinvigorated interest in the Great Divergence since Pomeranz (2009), who argued for comparable living standards in East Asia until 1800, there is sparse sparse evidence in terms of actual wages or incomes. In the case of Japanese living standards, Saito (2015) pointed out the importance of accounting for land incomes but his data did not allow for an estimate of its distribution. The lack of definitive quantitative estimates have led to a wide range of plausible estimates of living standards and a concomitant set of hypothesis to arise. To remedy this, I have focused on Japan (1600-1868), a major East Asian economy. I have digitized and inputted at least 800 servant contracts, and 100,000 observations from village censuses that span 265 villages, that were scattered in thousands of volumes of transcribed sources. I have combined this data with sources collected by others. The data shows that both the low wage estimates, and estimates of higher living standards for the average peasant in the past literature are entirely consistent with my theory. Perhaps more importantly, by empirically grounding my theory, this paper attempts to lead the literature towards a quantitative framework of analysis in East Asia.

A second contribution is to the growing literature on pre-modern inequality. A positive relationship between income inequality and GDP per capita in pre-modern societies has been found by Milanovic (2017). This may be partly explained by an inequality possibility frontier; if income per capita is close to subsistence there is little surplus in the economy so that inequality must be low. However, whether low incomes caused lower inequality or vice versa has been uncertain. This paper shows that in the case of pre-modern Japan, low inequality was causing the economy to be poor.

A third contribution is the novel idea that inequality could have led to divergent levels of wages and, perhaps more importantly, development trajectories over the long run between Japan and England. I am essentially combining two ideas that have existed in the literature; the idea that inequality can affect growth, and the idea that East Asia was labor abundant. The idea that inequality mattered in pre-industrial economies has been made in the context of enclosure in England since Karl Marx popularized the idea (Marx, 1867; Cohen and Weitzman, 1975), but they have been focused on England or more generally across Europe (Brenner, 1976). However, the effect on economic development has been through institutions. There have also been multiple hypothesis for why East Asia had high population density and an abundance of labor (also known as "involution" within this literature). However, these arguments have rested on the property of rice crops allowing for intensification (Geertz, 1968), higher agricultural productivity, or a high equilibrium trap (Elvin, 1973) which may pertain to a re-distributive mechanisms (Chao, 1986). I argue that early modern Japan was stuck in a low-wage equilibrium because of the institutional and demographic features that prevented European levels of landholding inequality.

A Malthusian Model with Inequality

In this section, I develop a Malthusian model of population and living standards that explicitly incorporates inequality. Unlike the standard Malthusian model based on a representative agent, I introduce heterogeneity in incomes. I use a two factor model with land and labor where land can be unequally distributed. To keep the model solvable, I take an exogenous distribution of land and focus on conditions under which there can be equilibrium for the particular distribution of land.[1]

The Malthusian model is composed of three basic assumptions. First, fertility is positively correlated to incomes. Second, death rates are negatively correlated with incomes. Third, the fixed amount of land in agriculture means any increase in population results in less income per capita as peasants must farm smaller plots of land. Overall, incomes reach equilibrium over many generations where birth rates equal death rates given income. At the equilibrium, both income and population stabilize.

The Malthusian mechanism has been shown to be at work in pre-industrial economies (Nicolini, 2007), and has been a standard pre-industrial model representing the status quo ante in models of the onset of modern economic growth. Past explanations include capital accumulation (Galor and Moav, 2004), education (Galor and Weil, 2000), technology (Galor and Weil, 2000; Sharp et al., 2012), agriculture (Vollrath, 2011), demography (Clark, 2008; Voigtländer and Voth, 2013) or combinations of factors (Voigtländer and Voth, 2012). These models have ignored whether peasant incomes are composed of wage or land incomes because all but a few peasants were assumed to have been landless laborers earning similar wages. I show that an equal distribution of land implies an equilibrium with a high population and low wages.

Production, Incomes, and Consumption

Suppose we have a agricultural economy, with the following Cobb-Douglas aggregate production function.

$$Y_t = A_t L_t^{\beta} H_t^{(1-\beta)} \tag{1}$$

[1] This is a common way of incorporating inequality (Matsuyama, 2002) since endogenous inequality is extremely hard to model.

Where Y_t is aggregate production, A_t is TFP, L_t is aggregate labor, H_t is aggregate land, and β is the share of labor in production. Each unit of labor compose a household, or in other words, each household has one unit of labor. I fix the quantity of land at $H_t = 1$. There are well functioning land rental markets, as have been found in Japan (Arimoto and Kurosu, 2015), so that labor is evenly distributed across land, with plots of size $\frac{1}{L_t}$. All households are simultaneously farming and renting out land (if they own land), and whether the household is farming it's own land or not is irrelevant. In a Cobb-Douglas type economy, factor prices of one unit of input are determined as follows:

$$w_t(L_t) = \frac{\beta Y_t}{L_t} = \beta A_t L_t^{\beta-1} \tag{2}$$

$$r_t(L_t) = (1-\beta)Y_t = (1-\beta)A_t L_t^{\beta} \tag{3}$$

In this economy, factor prices are determined by the total population and an increased aggregate labor force decreases wages and increases rents.

Income is composed of wages and land incomes. Wages are the same for all individuals. The land income is distributed according to an exogenous distribution of landholdings. Let $F(H)$ be the cumulative distribution function of land; that is $F(H)$ is the fraction of households whose landholdings are less than or equal to H, where $0 \leq H \leq 1$.

Consumption decisions are effectively ignored in this model, as there is only one good. Each household consumes their whole income, which is composed of wages and land rents minus a taxation (denoted by T) per unit of landholding. The taxed money disappears from the economy, which reflects the low level of welfare provided by governments in pre-industrial times. Thus, income of household i is specified by equation 4.

$$y_{i,t}(L_t, H_{i,t}) = w_t(L_t) + (r_t(L_t) - T_t)H_{i,t} \tag{4}$$

Demography

I take the standard assumption in the Malthusian literature, that birth rates and death rates are determined by the level of consumption for each individual household. I assume a functional form such that

$$b(y_{i,t}) = y_{i,t}^{\varphi_b} \quad where\ \varphi_b \in (0,1) \tag{5}$$

$$d(y_{i,t}) = y_{i,t}^{\varphi_d} \quad where\ \varphi_d \in (-\infty,0) \tag{6}$$

where $b(.)$ denotes birth rate and $d(.)$ denotes death rates. I assume that birth rates are concave and death rates are convex. The Malthusian literature often refers to a subsistence income level, which I define in this context as follows.

Definition 1 *The subsistence income level in this economy is the income (or consumption) level y^* such that $b(y^*) = d(y^*)$. The subsistence income level is normalized to $y^* = 1$.*

The aggregate birth rate and death rate are

$$B(L_t) = L_t \int_0^1 b(y(H, L_t))f(H)dH \tag{7}$$

$$D(L_t) = L_t \int_0^1 d(y(H, L_t))f(H)dH \tag{8}$$

The dynamics of the economy are driven by the following equation.

$$L_{t+1} = L_t + B(L_t) - D(L_t) \tag{9}$$

Given this structure of the economy, we can define equilibrium as follows.

Definition 2 *The economy is at equilibrium when there is a population of size L^* and distribution of land $F(H)$ such that*

$$B(L^*) = D(L^*)$$

I am silent about how a particular land distribution is reached. This is because modelling such dynamics would not only be tricky, but also require strong assumptions on how land is inherited across generations. I now illustrate the model's implications, with some examples.

Case 1: Perfect Equality

We suppose that the distribution of land is such that

$$f(H) = \begin{cases} 1 & if\ H = \frac{1}{L_t} \\ 0 & if\ H \neq \frac{1}{L_t} \end{cases}$$

In this case, we find that $c_{i,t} = \frac{Y_t}{L_t} - \frac{T_t}{L_t} = 1$ for all i determines the equilibrium, such that $w_t = \beta(1 + \frac{T_t}{L_t})$. This is shown in Figure 2, and it is clear that wages will be substantially below the average living standard of people within the economy. The wage level is determined

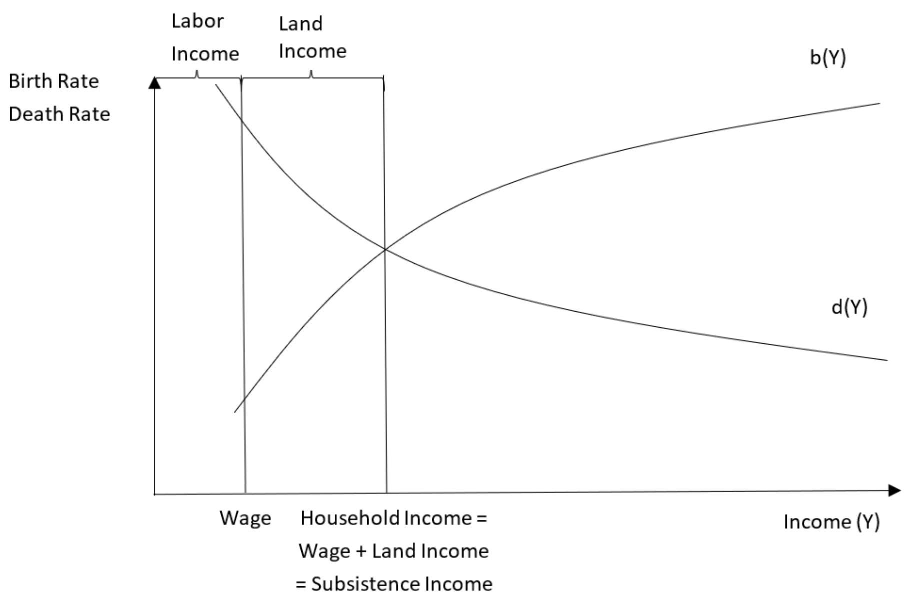

Figure 2: The Case of Perfect Equality with no Taxation

by labor's share of production and the level of taxation.

$$\frac{dw_t}{d\beta} = 1 > 0, \quad \frac{dw_t}{dT_t} = \frac{\beta}{L_t} > 0 \tag{10}$$

Both higher taxation and a higher labor's share increase wages. This case provides a lower bound for wages within a economy.

Case 2: Extreme Inequality

I consider the case where $T_t = r_t$ with no land income. In this case, the only income received by households are wages, and land distribution no longer matters. We could alternatively think of this as extreme inequality in landholdings such that a small landholding class holds all of the land. If the land holding class is small enough, the equilibrium wage will not be affected by population dynamics of the land holding class, and we get the same equilibrium. In this case, $y_{i,t} = w_t = 1$ determines the equilibrium as shown in Figure 3. Wages will be higher in an economy with high taxation or extreme inequality.

Case 3: The General Case

In general, there is a distribution of incomes with the minimum income being the wage rate. The wage rate will be less than or equal to one in all cases. Equilibrium is reached where the declining population of smaller landholders balance out the increasing population of

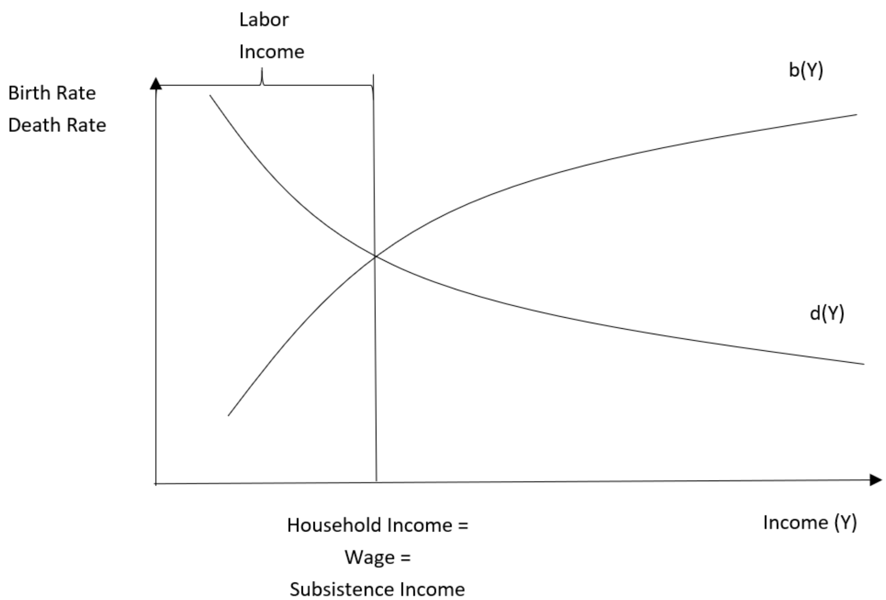

Figure 3: The Case of Extreme Inequality

larger landholders. The lower end of the income distribution must have negative population growth in equilibrium.

In order to understand how various levels of inequality affect wages, I define an increase in inequality as a transfer of land (and therefore income) from any individual to a richer individual. In this case, I would say there is an increase in inequality compared to the initial distribution of income. More formally:

Definition 3 *Suppose the initial distribution of land is $F_0(H)$, and there are two levels of land holdings, H_1 and H_2 such that $H_1 < H_2$. Suppose there is a transfer of land of size $\epsilon > 0$ across individuals such that the individual who had H_1 ends up with $H_1 - \epsilon$ units of land, and the individual who had H_2 ends up with $H_2 + \epsilon$ units of land. I call any distribution resulting from any number of transfers described above as $F_1(H)$. I say $F_1(H)$ has an increased level of inequality compared to $F_0(H)$. If instead the economy moves from $F_1(H)$ to $F_0(H)$, I say there is a decreased level of inequality.*

Given this narrow definition of inequality, an economy with higher inequality will result in a increased wage level, as I prove in Proposition 1.

Proposition 1 *Suppose an economy is at equilibrium with land distribution $F_0(H)$. If there is an increase in inequality, the economy will have a decrease in population, and an increase in wages.*

Proof. See Appendix A □

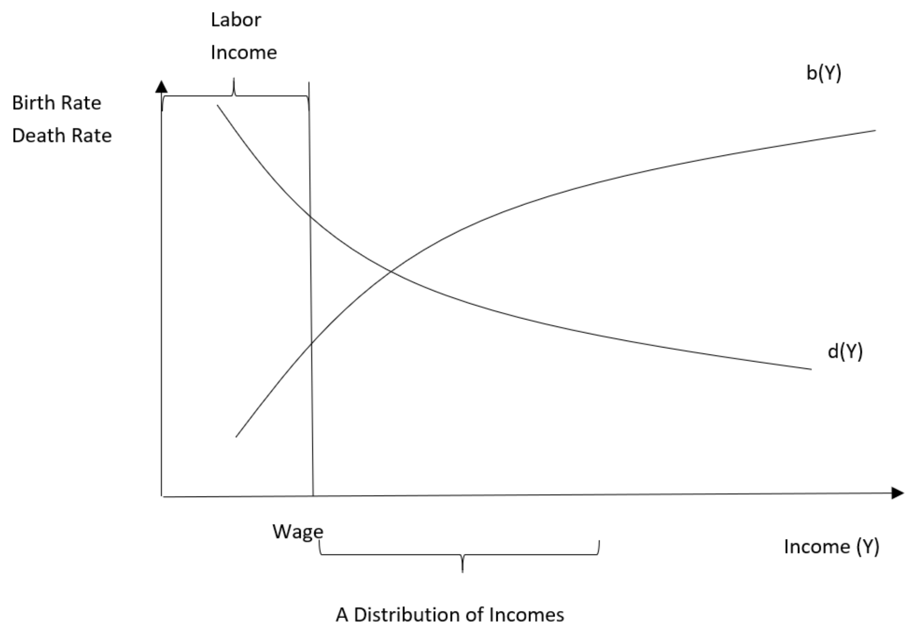

Figure 4: The General case

Two implications are worth noting. First, I cannot compare any two distributions of income given the definition of relative levels of inequality. Suppose the poorest peasant transfers landholdings to the richest peasant. Simultaneously, a peasant in the 80th percentile of wealth transfers landholdings to the median peasant. There will certainly be an increase in the proportion of wealth held by the top 10%, but there could also be a decline in the Gini coefficient. I cannot give strict predictions in these cases. However, this is a weakness shared by any attempt to compare distributions of income in terms of inequality. For practical purposes, any large change in a measure of inequality should follow the model's intuition.

Second, the distribution of income among the rich is less important than its distribution among the poor, due to the decreasing marginal effect of income on population ($\frac{d^2(b(y)-d(y))}{dy^2} < 0$) and hence its effect on wages. Thus, a society facing changes in inequality due to transfers among the nobility, all else being equal, will see almost no change in wages.

Model Summary

The key assumptions were as follows. **A1.** Birth rates increase with income. **A2.** Death rates decrease with income. **A3.** Wages decrease as population increases. Given this, there were 2 key predictions. **P1.** Increased inequality will lead to higher wages over the long run. **P2.** In equilibrium, the landless have decreasing population, as wage earnings alone are insufficient to keep birth rates at replacement levels. In contrast, the land-rich have increasing population.

Ideally, I would have data on inequality and wages to test the most important prediction: wages are positively correlated with inequality. Unfortunately, there is not enough cross-country data to test this prediction. Instead, I present the available but limited intra-country evidence for assumption 3 and prediction 1, to show that it is consistent with what we know. I then use a dataset from village censuses to test assumptions 1 and 2, and prediction 2.

Macro-level Evidence

This section shows that, consistent with my model, Japan had relatively low wages and low inequality in the pre-industrial world. Due to the lack of suitable evidence in the literature, I use original data to make new estimates of inequality and wages in early modern Japan.

The Most Labor Abundant Economy in History?

I use wages received by 1,661 servants who worked between 1600-1863 to measure wage levels, as is detailed in Kumon (2018a). Servants lived with and worked for their employers over long periods, typically over a year, and mostly did agricultural and household work. Servitude was the prevalent form of wage labor in the countryside. They received food, clothing, and lodging during their tenure, in addition to a wage for their services. Compared to the unskilled day wages estimated by Bassino and Ma (2006) that has been commonly used in the literature, this series is more representative of the wage of the rural masses, cover more time, and exist for both sexes.[2] I proxy for the real wage by calculating the "rice wage", the amount of rice that a laborer can buy with their wage.[3]

Figure 5 plots the rice wage for both men and women, using the number of people that can be fed at 1940 kcals per day[4] as the unit. The wage levels are clearly below subsistence for a family, which is consistent with the prediction that an egalitarian economy will have wages that are insufficient to sustain families. This is driven by the population growth in the 17th century, which would have resulted in smaller plots per laborer. By 1700, a man could only feed 2 people with his income, while a woman could feed 1.5 people, the lowest wage

[2]There are also other issues of potential measurement error for day wages. The issue of payments in kind have been raised by Deng and O'Brien (2016). Bassino et al. (2005) suggests we should add other work done on the side. Finally, the seasonality of day wages is a concern, in contrast to annual wages which averages this out.

[3]This was necessary due to the lack of price data in 17th century, but it remains a good proxy of real wages as food consumption was the biggest component of consumption at this time. In fact, the cost of the subsistence basket by Bassino and Ma (2006) is almost identical to the cost of 1940 kcals of rice per day. I account for the payment in kind by adding 1940 kcals of rice per day.

[4]I follow the literature on subsistence baskets, that specify this number

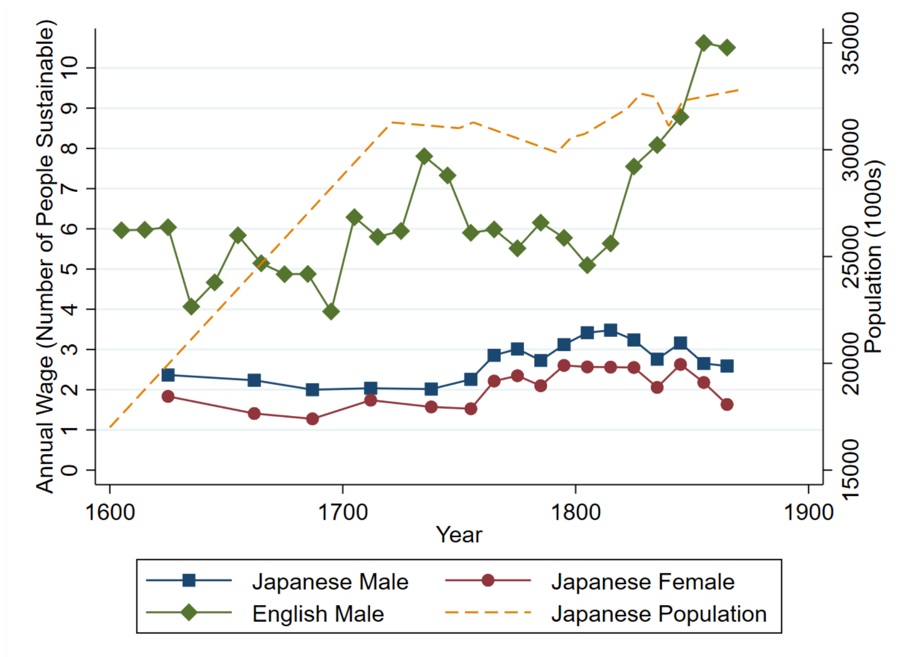

Figure 5: Rice Wages and Population in Early Modern Japan 1600-1863
Source: Clark (2007) Kumon (2018a). *Population is from Bassino et al. (2017)*

rate to be observed in the pre-industrial world. Japan was clearly caught in a Malthusian trap.

Population growth subsided at around 1720, partly due to increased infanticide, resulting in higher wages by 1800.[5] Yet throughout this era, Japanese wages consistently stayed below English levels that could be even triple of the Japanese wage before the Industrial Revolution. Even compared to other contemporary economies, Japanese wages remained at the lower end of the distribution (see Figure 1). Compared to present day poverty, Japan consistently remained well below the $1 a day threshold of extreme poverty, which can feed at least 5.5 people.[6] By any measure, Japan was extremely poor in this era.

Could this all be an illusion caused by measurement error? The evidence suggests other-

[5]The magnitude of infanticide has been estimated by Drixler (2013) who states that as much as 40%-50% of all births resulted in infanticide in the Northeast Japan. Was this Japan escaping the Malthusian mechanism? Although some may be tempted to interpret infanticide as birth control, breaking the positive link between fertility and births, the realities were far more complex. Social pressures had large sway over choice of infanticide, as individuals were at times equated to dogs who could not control fertility or vice versa. Given such limitation, infanticide is best interpreted as an increase in the death rate function that led to an increase in wages. However, for the optimists that see this as a break from the past, one can still see that equality reduced wages until at least the 1720s.

[6]The $1 a day thershold uses 1990 prices and is equivalent to $2.07 per day in 2017, using US prices. I use a wheat diet, since it is the primary grain in the US. It is possible to buy 10 lbs of "great value all purpose flour" at Walmart for $2.84, which amounts to 11006 kcals. This was checked on September 9th 2018.

Table 1: Comparison of Primary Grain Wage based on Kcals purchasable

Location	Period	Primary Grain Wage (Wheat Kgs Equivalent)	Primary Grain Wage (Family Size Sustainable)
Amsterdam	1780-1800	9.5	12.2
Rural England	1780-1800	5.0	6.4
Paris	1780-1800	4.5	5.8
$1 a Day	1990	4.5	5.5
China (Yangzi Delta)*	1750-1849	3.0	3.8
Korea*	1791-1800	2.7	3.5
South India*	1750-90	2.3	3.0
Rural Japan*	1780-1799	2.2	2.9

Source: Clark (2008), Kumon (2018a). For rice countries, I convert grain wages into kgs of wheat equivalent. I assume 1 kg of wheat yields 0.75 kgs of wheat flour, and 3320 kcals per kg of wheat flour and 3510 kcals per kg of rice. Family size sustainable is number of people that can be fed on a 1940 kcal diet using the primary grain.
* denotes countries for which I use a rice wage.

wise, as it is consistent with urban unskilled day wages[7] from the 1750s. Japanese peasants could survive despite low wages, because they had a second source of income: land incomes.

A Persistently Equal Distribution of Land

Early modern Japan began with a revolutionary change in landholdings, due to two institutional changes. The first was the forced movement of the samurai class to the cities (*heino bunri*), which loosened their traditional grip over landholdings. The second was a series of cadastral surveys (*kenchi*) of the late 16th and early 17th century. The primary aim of the surveys was to find the yield and therefore the taxation potential of all villages. In doing so, all plots of land were surveyed, and a peasant's name was assigned to each plot of land.[8] A long debate has raged over the meaning of this name, as to whether it signaled the holder (in terms of who held rights over the land rent after taxation) or cultivator, but there is agreement that the name was associated with the holder by the late 17th century.[9] The lords also protected the rights of holding based on this survey as long as peasants paid taxation, giving institutional grounds upon which they could own land (Nakabayashi, 2013). Unlike the preceding era, in which there was a complicated chain of claims over land rents, there were firm grounds on which peasants could own land.

[7]Bassino and Ma (2006)

[8]The title of all peasants entered in the survey was *naukenin*.

[9]See Hayami (2009) for an approachable summary of the debate of the meaning of the name on cadastral surveys

Table 2: Landholding Inequality in Japan (1670-1870)

Region	Gini	Prop. Landless	Prop. Wealth top 20%	Prop. Wealth Bottom 40%	Villages
Chugoku	0.48	0.07	0.53	0.10	6
Kinki	0.69	0.30	0.73	0.03	10
Tokai	0.55	0.11	0.49	0.13	30
Hokuriku-Koshin	0.62	0.23	0.66	0.04	84
Kanto	0.48	0.07	0.55	0.11	139
Tohoku	0.43	0.11	0.49	0.13	29
All Regions	0.53	0.13	0.58	0.09	298

I weight each village equally. I take a weighted average by regional population to estimate inequality in all regions. All households, including landless, are included in all measures.

Further evidence for peasant landholdings can be seen in land sales contracts or the use of land as collateral, which have been widely documented across Japan. Such contracts are impossible without widespread agreement that their landholding rights were strong in addition to positive returns to landholdings making such claims sell-able. The largest landholders rented out their land to the land-poor as they lacked the labor within their household to farm the land. In return, they collected large amounts of land incomes from tenants. Landholdings had large benefits as the owner could claim about a third of the yield from a plot, a large boost in income.[10]

I use population censuses and landholding surveys from Japanese villages which listed the landholdings for all households within the village.[11] Unfortunately, most of them list only landholdings within the village though this should result in only a small downward bias in landholdings (as discussed in the data section below) because the majority of land was held within villages. Critically, landholdings were listed in terms of expected yield, a measure of value, which means inequality estimates would be reflective of income. I calculate inequality in landholdings at the village level for the 298 villages with data.

Table 2 shows that inequality was low with only 13% of peasants being landless and a Gini coefficient that averaged 0.53. There was some regional variation, but Gini coefficients remained between 0.4-0.7 (see Figure 6 for regional map).[12] Although this may seem like high inequality, wealth inequality is always much higher than income inequality because

[10]See Appendix E for how I calculated this value

[11]These commonly have the title of *shumon-ninbetsu-aratame-cho*, or *mochidaka-aratamecho*. Some of these list only landholdings, unlike the censuses.

[12]I leave out the Shikoku and Kyushu region, for which there are too few observations. These regions appear to be equal, but the figures could be misleading.

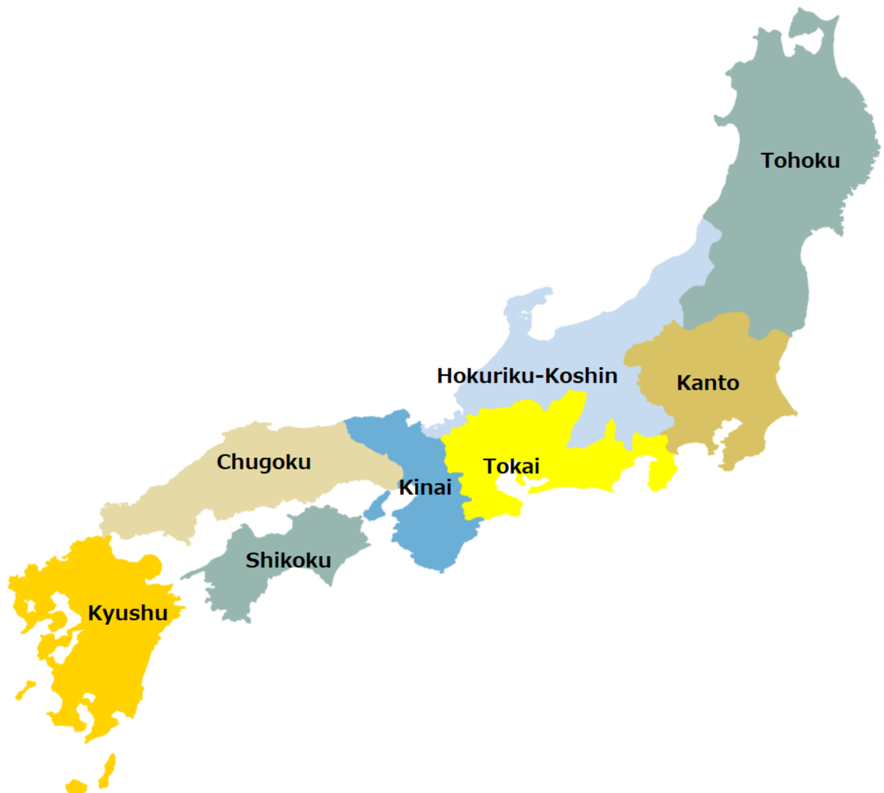

Figure 6: A Map of Japanese Regions

wages are far more equally distributed, especially in a pre-industrial economy with unskilled laborers. Thus, these numbers translate into Gini coefficients of income as low as 0.26, a remarkably egalitarian economy.[13]

Despite Japan being comparatively equal, Japan was far from perfect equality. There were distinct social classes of people. The bottom 40% of landless or marginal landholders held only 10% of land. These people were in deep poverty, as they relied on extremely low wages for survival. The next 40% held 33% of the land, and formed a middle class, while the top 20% held 58% of land, and were the land-rich class within the village.

A further unique feature of Japan was the persistence of equality, unlike in Europe where there was a constant upward trend in inequality (Alfani, 2015; Alfani and Ammannati, 2017; Bengtsson et al., 2018). Using data from 30 villages with long data series, I can find no trend in inequality. This contrasts with similar village-level data from pre-industrial Italy, where Gini coefficients are estimated to have increased by 0.06 per century.[14] Something about

[13]Given wages could sustain 3 people for a man at around 1800, I take the landholding equivalent of the wage to have been 4.4 *koku* of land, where 1 koku is about 3 quarters of the rice needed to survive a year. After distributing this equally among all households, I calculate the Gini coefficient. This is not entirely accurate for all villages, but suffices as an approximation.

[14]By long series, I mean more than 25 years in span. For the details of the regression, see Appendix D.

Table 3: Wealth Inequality in Pre-industrial Countries

Country	Year	Type	Unit	Gini	Prop. Landless %
England	1688	Wealth	All Households		84.8
England	1803	Wealth	All Households		86.5
Sweden	1750	Wealth	Rural Households	0.72	20
Denmark	1789	Wealth	Rural Households	0.87	59
Finland*	1800	Wealth	Rural Taxed Males	0.87	71
Northern Spain+	1749-59	Land	All Households	0.78	
NW. Italy*+	1700-99	Wealth	Rural Taxed Households	0.77	
Central Italy*+	1700-99	Wealth	Rural Taxed Households	0.75	
China+	Qing	Land	Rural Households	0.6-0.71	13-26
China	1929-33	Land	Farm Families		17
Japan	1700-1868	Land	Rural Households	0.53	13

** indicates cases where inequality is underestimated. + indicates small samples of villages. Taxed households refer to estimates based on wealth taxation, for which those without wealth are not included. For Sweden, the estimates only include rural residents. If urban owners are included, the Gini Coefficient becomes 0.77. Northern Spain estimates are from Palencia, Northwest Italy estimates are from Piedmont, and Central Italy estimates are from Tuscany. Sources: Lindert (1987), Bengtsson et al. (2018), Soltow (1979), Soltow (1981), Nicolini and Ramos Palencia (2016), Alfani (2015), Alfani and Ammannati (2017), Buck (1937), Chao (1986)*

Japan was keeping inequality at bay.

When compared to other pre-industrial economies, the extent of equality in Japan becomes clear. Table 3 shows various measures of wealth or land inequality in the pre-industrial world. It is not entirely comparable, for two reasons. First, the defined type, unit, and region of measurement vary. Many estimates based on tax records did not include those without wealth. Also, some are based on households while others on male adults. Some of these include all households, both urban and rural, while others are only rural.

Second, there is potential measurement error because there were some rights over land rents that were not considered ownership but were a form of wealth which have not been accounted for (and probably never will due to the lack of data). For instance, England had copyholding rights that were distinct from land ownership but nonetheless gave the holders access to land rents through subleases.[15] Although the distribution of copyholding is

[15] Gayton (2013) shows that copyholders could sublet at 75.8 pence per acre per annum net of rents to the owner. This amounts to about 3.5 people worth of wheat flour if the copyholder had 30 acres. Yet, there have been no systematic exploration of the extent of copyholding in England to show how copyholdings were distributed.

unknown, Lindert (1987) uses occupational structure to estimate the number of households owning any real estate for the whole of England. Assuming 50% of population worked in agriculture at least 70% of the population must have been landless in agriculture.[16] Another error may come from commons, but the common "waste" lands accessible to all in England amounted to only 3.8% of land by 1600 (Clark and Clark, 2001).[17] Although no evidence exists to fully address this issue, it is difficult to imagine the broader finding will be overturned.

Gini coefficients for wealth or land in rural parts of Europe ranged between 0.7-0.9.[18]. The landless were dominant in Europe (with perhaps the exception of Sweden). The degree of difference between Europe and Japan was large, bringing doubt that measurement error may have decisively affected these findings. Overall, a rich and unequal Europe relative to a poor and equal Japan lines up with the model. Moreover, wages that are clearly below subsistence levels for a family are also consistent with prediction 1. It is interesting that England, which had the industrial revolution, was one of the most unequal economies in the world with masses of landless laborers by the 17th century. Within the model, this will translate into the economy with the most labor scarcity, a trait that may have been advantageous for the English Industrial Revolution.

What is the Direction of Causation?

I end this section with a brief discussion of the direction of causation. Milanovic (2017) shows that income inequality and incomes also had a negative correlation. However, the direction of causation was uncertain because low incomes mean inequality cannot be unequal without a collapse in society. Could this all be reverse causality?

There is no causal evidence for such a long-term phenomenon. However, there are two lines of arguments that can be made. The first is that European economies saw decreasing wages after the Black death but there was no decreasing inequality. In fact the finding is the opposite with increasing inequality during this era (Alfani, 2015; Alfani and Ammannati,

[16] I get the 50% share of agriculture from an estimate for c.1710 by Shaw-Taylor and Wrigley (2014). I assumes all of the real estate holders, 15.2% of the population, were in rural areas. Then $1 - \frac{15.2}{50} = 0.7$ so 70% were landless. This is obviously an underestimate. Shaw-Taylor (2012) uses occupations listed in the parish registers to show that up to three quarters of people in south-east England involved in agriculture can be identified as wage laborers by 1700, seemingly consistent with the table above (see Appendix C for further discussion).

[17] Common waste were seen as unprofitable lands and the returns were equal to the opportunity cost of time. Hence, such land may not have had land incomes.

[18] Although wealth is more inclusive than land, land was the dominant form of wealth in the countryside. Moreover, many tax registers, on which this is based, would have had difficulties observing wealth other than land. I also note that in Eastern Europe, demesnes (farms that were managed by lords) that were owned by lords remained a large proportion of the economy, limiting peasant holdings (Cerman, 2012).

2017; Alfani and Ryckbosch, 2016).[19] In the case of Japan, there is a rise in wages from the 1750s as a result of infanticide but inequality was unaffected.

The second argument is theoretical. Theoretical studies looking at inequality and poverty suggest inequality will get higher as societies get closer to the subsistence line (Carter and Lybbert, 2012; Zimmerman and Carter, 2003). There are no theoretical grounds for a functioning market to decrease inequality as society gets poorer. There could be social or political institutions that take on this function but there is no evidence of such institutions emerging in 17th century Japan as wages declined. Both arguments suggest wages were not affecting inequality in the required direction. It is much more consistent to argue that inequality was driving down wages.

Micro-level Evidence

Data

I use population census (most commonly called the *Shumon Ninbetsu Aratame Cho*) from 1660-1868 as my primary source of data. The data was collected by the lord of each domain in an attempt to weed out Christians who were banned by the Tokugawa shogunate. To achieve their ends, the lords forced every person in each village to annually declare their religion in the survey. Despite Christianity being an extreme minority in Japan by the 18th century, the surveys continued as it took on new administrative functions. Some copies of the registers held by the village heads survived in village storehouses, and these were later collected by historians.[20]

The registers include data for all individuals within the village (name, age, and relation to household head), as well as the whereabouts of all individuals who disappeared from or entered the village, to make sure all individuals were accounted for. Moreover, some of the villages recorded the value of landholdings for each household. The reason for this is somewhat puzzling as another document (the *kenchi cho*) existed for this purpose. What is known is that certain lords or administrators chose this particular format, although it was not always consistent within domains.[21]

I use data from villages that included landholdings data, which amount to 298 villages. Due to the inclusion of sources that only include information on household landholdings

[19]The same can be said of pre-black death England

[20]Most of the copies held by lords appear to have been burned, due to the lack of storage space and old registers having little administrative value.

[21]Matsuura (2009) finds shogunate lands more often had landholdings data. Also, documents titled *shumon-ninbetsu aratame cho* were more likely to include this information.

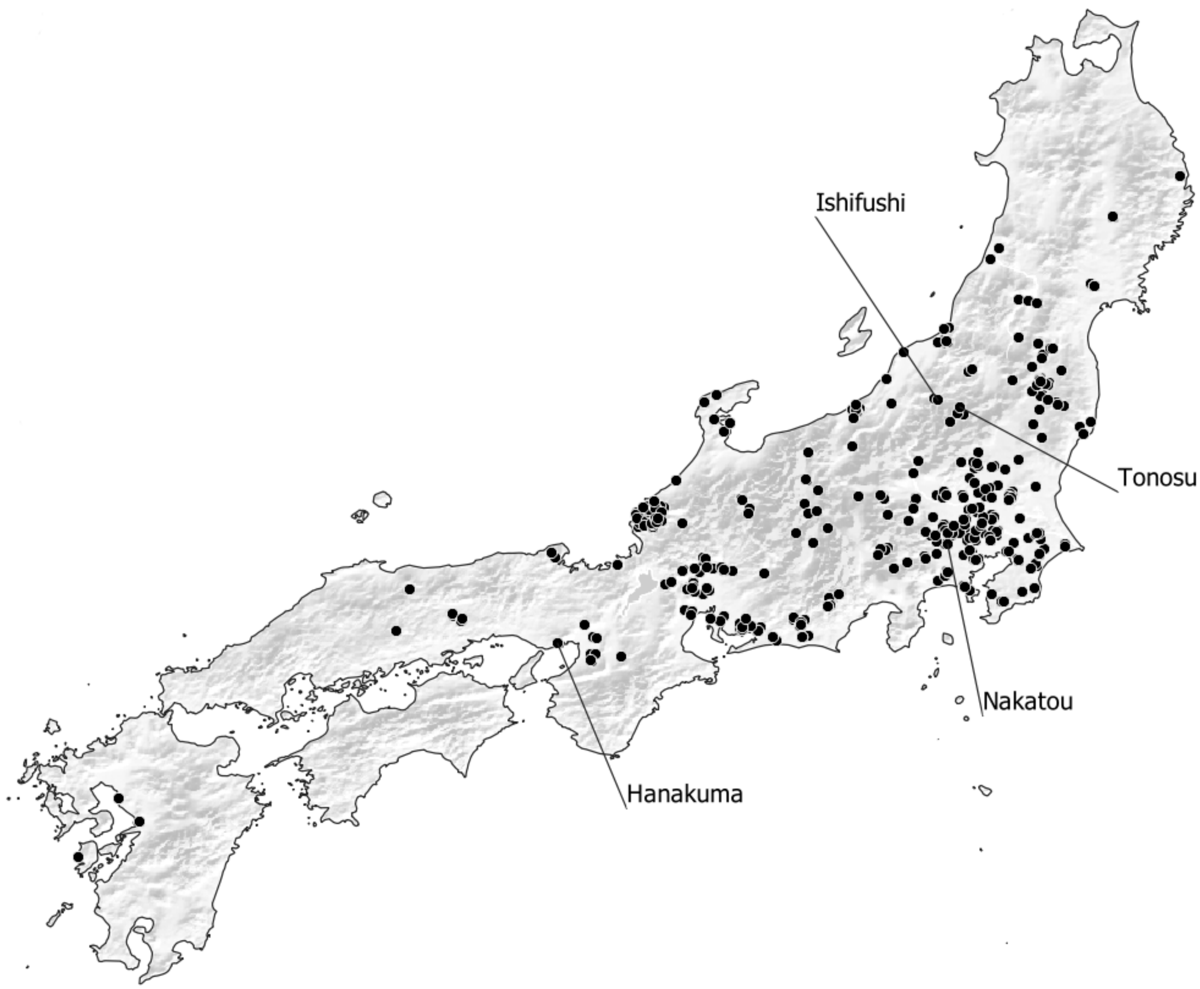

Figure 7: Map of Japan with Village Locations

The 4 villages with panel data are labelled. Shaded regions indicate higher elevations. The map is made using data from Natural Earth.

within the village and lack of access to individual level data in other villages, there are 265 villages for which I have data on both landholdings and individuals.

The data is from 3 sources. The first source is the DANJURO database, which is the most detailed with a linked panel dataset of individuals and households from 4 villages (see table 4).[22] I rely heavily on this rich source for a robust IV specification. A second source is the Population and Family History Project at Reitaku University. I have access to linked household landholding data from their database of village censuses which I have used to look at long-run dynamics in wealth inequality. I do not have the data for individuals from this database. The third source consist of local histories of Japan, which often include a source

[22]Created by Hiroshi Kawaguchi of Tezukayama University. His database is available online at http://kawaguchi.tezukayama-u.ac.jp

Table 4: The Villages with Linked Panel-Data

Prefecture-Village	Year	Individual Observations	Household Observations
Fukushima-Ishifushi	1752-1812	11,593	2,321
Fukushima-Tonosu	1790-1859	18,155	4,349
Tokyo-Nakatou	1843-1864	12,096	1,997
Hyogo-Hanakuma	1789-1869	20,822	5,313

I use the modern day prefecture as the region in which each village was located.

book with village censuses. By combing through thousands of these books and digitizing then inputting over 100,000 observations, I have created a new dataset of demography and inequality. Most of the data is from censuses, but a few are landholding surveys that only include landholdings by households. The data are usually only single year observations of villages, but I gain geographical breadth in the analysis.

The geographical coverage of data can be seen in Figure 7. The data covers Central and Eastern Japan better than the west. Although many areas have no observations, much of the central areas were uninhabitable mountains, while the few plains had a disproportionately high population density in which my observations are concentrated.

There are a number of data issues. The biggest problem is the measurement error in the value of landholdings, my primary variable of interest. This stems from two sources.

First, landholdings were only recorded for land within the village, as already mentioned. I can check the degree of the problem by looking at the proportion of land held by outsiders in 47 villages for which outsider landholdings were also listed. The average was 15%, a small proportion of land. The richest peasants were usually those who held land outside the village, so I underestimate wealth at the top of the distribution. This causes a modest downward bias in my Gini coefficient estimates, and it will work against my hypothesis in the empirics below.

Second, there is measurement error in the land values (in terms of yield) as land values are based on cadastral surveys from the 17th century. These surveys never got updated to account for increased plot sizes or increased productivity. Peasants undoubtedly knew the market value of their lands, but obviously did not declare it in official documents as they feared more taxation, causing mis-measurement.[23] I can find the extent of this problem by looking at private records of large landholders, who recorded both the land income and the official land values that were recorded in the census. By estimating a regression, I find that the variance of the measurement error was 0.7. If the variance of the measurement error

[23] This is because peasants often bought and sold land within the village

was similar in my sample, this suggests attenuation of a factor of 0.94, a tiny number (see Appendix F). Unfortunately, I am using multiple landholding variables so I cannot directly control for bias, but nonetheless the bias should be very small.

Third, births were recorded only if the infant was alive during the survey. Hence, still births or deaths of infants soon after birth are unrecorded.[24] Therefore, I interpret the number of births within the data as infants who survived to the first survey. This also means that deaths do not include many infant deaths, which was a big source of mortality at this time.

Fourth, some village heads did not record the migrations and deaths accurately, and the reasons for the exit of many individuals are unknown. Although I know when individuals exit a village, it is impossible to know if this was due to migration or death. The correlation of exits and deaths will cause selection bias, when estimating the effects of landholdings on death. The next section shows how I estimate effects that are robust to these issues.

Specification and Results

This section tests some key assumptions and predictions of the model. First, landholdings must have a causal effect on demographic outcomes of peasant households. Second, the landless peasant households must have living standards below subsistence, such that their death rates are higher than birth rates. The evidence will be presented in two ways. I first use linked panel data from 4 villages for the ideal robust specification. However, this leaves a concern that my results might be relevant only for these 4 particular villages out of over 60,000 villages in early modern Japan. Therefore, I use a second specification that has geographical breadth but may have endogeneity issues. However, the first exercise using the panel data will show that endogeneity should not be a big concern.

I test whether incomes from landholdings mattered and whether it had a non-linear effect by estimating the number of births or deaths as a function of land holdings(see Equation 11).[25]

$$Y_{v,h,t} = \beta_0 + \beta_1 f(Land\ holdings_{h,t}) + \beta_2 X_{h,t} + \theta_{v,t} + \epsilon_{v,h,t} \tag{11}$$

Here, Y denotes the demographic variable of interest (per 1000 observations), v denotes village, h denotes household, t denotes time, and X is a set of control variables. For demo-

[24] The extent of missed births are estimated to have been 18-23% of females and 15-20% of males, due to death in infancy (Bideau and Brignoli, 1997).

[25] One problem with this data was that some households declared their holdings was joint with another household. This is likely to be due to the splitting of family holdings between heirs. In this case, I assume that the main household effectively held two thirds of the land, while the other held one third.

graphic variables, I look at deaths, migration, births, the number of births within marriage, and the number of reproductive couples.[26] I expect β_1 to be positive for births and negative for deaths.

I avoid including control variables that may be caused by landholdings, such as household size or the existence of married couples. For instance, the existence of married partners within a household itself is partially caused by the household wealth, and including this variable will bias the effect of land holdings downwards. I look at household level data when looking at births to see how birth rates at the household level were affected by its wealth. For deaths, I look at individual level data in order to additionally control for age and sex which were key predictors of death.

One important feature of this test is the lack of an individual fixed effect. This makes it a repeated cross-sectio. This is intentional, because much of the variance in landholdings is between rather than within households/individuals, as is confirmed by variance decomposition.[27] A simple OLS regression of landholdings and its lag gives a coefficient of 0.996 with standard errors of 0.001, also implying there is very slow change in land holdings across time. In such a case, a big concern is that households with time variation in landholdings may be a group that is behaving differently, and could lack generality. Instead, I include village-time fixed effects, to compare differences in demographic outcome within each village-year.

One concern is reverse causality where households that are about to have children may accumulate land in preparation.[28] Several papers have found positive effects of income on fertility in the pre-industrial economy, but the causation has always been uncertain.[29] I use household landholdings lagged by 15 years as an IV to get a causal estimate of landholdings on demography. Due to landholdings being a slow moving variable, it is highly correlated with current landholdings, but should not be correlated with preferences of the current household head or variations in household size that was not predicted by past landholdings. To avoid being dependent on a 15-year lag, I conduct robustness tests with other lags.

The summary statistics in table 5 are already consistent with my hypothesis. They show that household birth rates (total births per 1000 households per year) are positively

[26] I define this as all married couples with the wife under age 45.

[27] I find that when I am looking at individuals, the standard error between is 3.7 while within is 1.5. For households, the standard error between is 3.1 while within is 1.5.

[28] Alternatively, households that have had children may sell land.

[29] One important paper is Clark and Hamilton (2006) which looks at England (1585-1638) and finds that wealth had a positive impact on the number of surviving heirs, so that there was "survival of the richest" within the economy. Razi (1980) looked at medieval England, and used court rolls from Halesowen to find that the land-poor seemed to disappear from the manor, whereas the land-rich had reproductive success. In the case of pre-industrial Japan, the classic study by Smith (1977) found that the Japanese village had similar dynamics.

Table 5: Summary Statistics for the Sample of Four Villages with Linked Panel Data

Variable	Fukushima Ishifushi	Fukushima Tonosu	Tokyo Nakatou	Hyogo Hanakuma
Houshold Level Data				
Land Holdings (*koku*)	3.6	3.6	2.6	3.9
	(2.8)	(3.3)	(3.4)	(3.6)
Household Size	4.8	4.2	5.9	4.0
No. Births per 1000 for landholdings bin				
$0-2.5$	64	68	49	77
$2.5-5$	83	86	62	102
$5-7.5$	116	128	63	100
7.5+	116	142	131	110
All Households	82	88	56	92
No. Reproductive Couples per 1,000 for landholdings bin				
$0-2.5$	620	479	619	334
$2.5-5$	795	573	673	461
$5-7.5$	935	929	634	506
7.5+	1,010	972	597	567
All Households	761	608	630	430
Individual Level Data				
Female Dummy	0.45	0.44	0.49	0.50
Out-Migration per 1,000	14	6	27	15
In-Migration per 1,000	11	6	31	16
Deaths per 1,000 for landholdings bin				
$0-2.5$	17	17	9	27
$2.5-5$	16	19	12	25
$5-7.5$	10	17	14	25
7.5+	14	18	7	27
All Households	15	18	10	26

Standard Errors are in Parenthesis

Table 6: **Regression results for Mortality**

	Death		Out-Migration		All-Exits	
	(1)	(2)	(3)	(4)	(5)	(6)
Value Land Held	-0.103	-0.115	-2.350***	-2.128***	-2.447***	-2.207**
	(0.263)	(0.592)	(0.336)	(0.710)	(0.431)	(0.961)
Value Land Held^2	0.002	0.016	0.116***	0.121***	0.118***	0.136***
	(0.009)	(0.031)	(0.011)	(0.039)	(0.013)	(0.048)
F-Statistic	0.08	0.71	85.26	9.62	51.68	8.85
F-test Significance (99%)	No	No	Yes	Yes	Yes	No
IV	No	Yes	No	Yes	No	Yes
Kleibergen-Paap F Stat		3.40		3.40		3.40
N	58,613	38,386	58,613	38,386	58,613	38,386
adj. R^2	0.038	0.041	0.015	0.018	0.023	0.027

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: All dependent variables are per 1000 individuals. I additionally control for age, age squared, age cubed, and sex. The F-test tests the joint significance of all value of land held variables. Standard errors are clustered by individuals.

correlated with land holdings.[30] This appears to be driven by a better chances of marriage by the rich because the number of reproductive couples in a household is positively correlated with land holdings.

The statistics on deaths and out-migration are more problematic. As described earlier, some exits from the village remained unaccounted in the census.[31] Death rates as low as 10 per 1000 seen within some categories imply a life expectancy of 100 years, which seems too low. If I compare this to life expectancy calculated in 3 surveys between 1891-1913, the life expectancy at age one were consistently estimated as an additional 49-52 years, or 19-20 per thousand.[32] Given medical advances between pre-industrial times and 1891, the actual number must have been much higher. Therefore, any death-rate results must be treated with caution.

A household's having greater landholdings failed to decrease deaths in both my OLS and IV specification (see Table 6). The results could be due to no effect of incomes on mortality. Alternatively, it could be that poor people out-migrated some family members in times of

[30]Here, births capture all entries into the village described as birth and all unaccounted entries into the village below the age of 4.

[31]I coded all instances in which a death was recorded as a death. All other instances of disappearance are considered as out-migrations.

[32]I use the life tables compiled by the government in the population statistics

Table 7: Regression results for Fertility

	No. Births		No. Reproductive Couples		Births within Marriage	
	(1)	(2)	(3)	(4)	(5)	(6)
Value Land Held	5.767***	9.880***	48.81***	53.94***	0.046	7.291
	(1.912)	(2.998)	(7.785)	(14.35)	(2.238)	(4.556)
Value Land Held^2	0.011	-0.317	-1.135***	-1.251	0.158	-0.340
	(0.121)	(0.207)	(0.340)	(0.957)	(0.114)	(0.337)
F-Statistic	18.67	19.62	24.84	28.43	2.38	3.74
F-test Significance (99%)	Yes	Yes	Yes	Yes	No	No
IV	No	Yes	No	Yes	No	Yes
Kleibergen-Paap F stat		8.04		8.04		8.04
N	13,267	8,779	13,267	8,779	7,066	4,630
adj. R^2	0.014	0.011	0.105	0.107	0.027	0.016

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: All dependent variables are per 1000 households. Reproductive couples indicate the number of married couples, with the female below age 45. The F-test tests the joint significance of all value of landholding variables. Standard errors are clustered by households.

trouble. If I instead look at the probability of out-migration, it decreases as landholdings increase. This fits the literature where family members would temporarily work as servants if they were hit by shocks.

Another possibility is mis-measurement of deaths and out-migration resulting in the lack of a reason for people disappearing in the registers. Many cases of disappearances are classified as unknown. If I do not have confidence in these measures, the best I can do is to pool all cases of out-migration and deaths as exits.[33] Specification (5) and (6) shows that the negative correlation remains in this case, although I lack significance in the case of IV. These results are consistent with landholdings having a zero or negative impact on death rates.

Unlike mortality, fertility was positively correlated landholdings with decreasing returns to landholdings as expected (see Table 7). When using my IV, I find that the expected birth rate for a peasant with 10 *koku* of land, a household in the top 5%, had 2 times more births than a landless peasant. This could have been caused by more couples being married at reproductive ages (the extensive margin), or more births within marriage (the intensive

[33]This is pooling all cases in my sample where an individual is not observed in the next register.

margin). Column (4) finds a statistically significant positive relationship for the existence of married women under age 45. In contrast, once a couple was married, there was very little difference in birth rates for those at reproductive age (see column (5) and (6)). Thus, richer households' having more births was largely due to the extensive margin (i.e. their earlier age of marriage). This in turn can be explained by lower ages of marriage, lower mortality during marriage, or higher turnover of generations.[34]

The findings are highly robust to other specifications (See Appendix G). I changed the length of lag in my IV up to 30 with the idea that a longer lag will better satisfy the exclusion restrictions. The results do not change, and are not necessarily more desirable due to potential selection bias.[35] I also estimate the equation for individual villages and find the results generally hold (with perhaps the exception of one village). I look at whether accounting for selection bias with a Heckman model affects the results, but this also does not change the main result.

The finding of a positive correlation between incomes and births is not entirely surprising in itself as Clark and Hamilton (2006) have found a similar pattern in pre-industrial England. However, the big difference is in the distribution of households at the various levels of income. The population of England was not affected by this mechanism because most peasants were landless. In contrast, many Japanese peasant were not landless, allowing land-rich peasants to compensate for the lower birth rate of the land-poor peasant. I now test whether this had a significant effect in Japan.

Outcomes by Landholding Class

I expect to find land-rich peasants having a high birth rate, while the land-poor should have a low birth rate. I estimate a similar regression but I use categories of landholdings and estimate the birth rate of each group. The categories are 0-1 *koku*, 1-3 *koku*, 3-5 *koku*, 5-7 *koku*, and 7+ *koku*.[36] Households with less than 3 *koku* were likely to have been land renting households, while households in the 3-5 *koku* range would have mostly been cultivating their own plots. Households with more than 5 *koku* would have been land-rich households. Although these categories are arbitrary, changing them does not alter the results. I estimate

[34] This would mean richer households marry early, and therefore give birth to their heir earlier, so that the heir may be married while their parents are reproductive.

[35] The coefficients do appear to increase as the lags increase. This is probably due to increased attrition of the land-poor households and shows the potential bias of my instrument.

[36] 0-1 *koku* (19% of households), 1-3 *koku* (29% of households), 3-5 *koku* (24% of households). 5-7 *koku* (14% of households), and 7+ *koku*(14% of households)

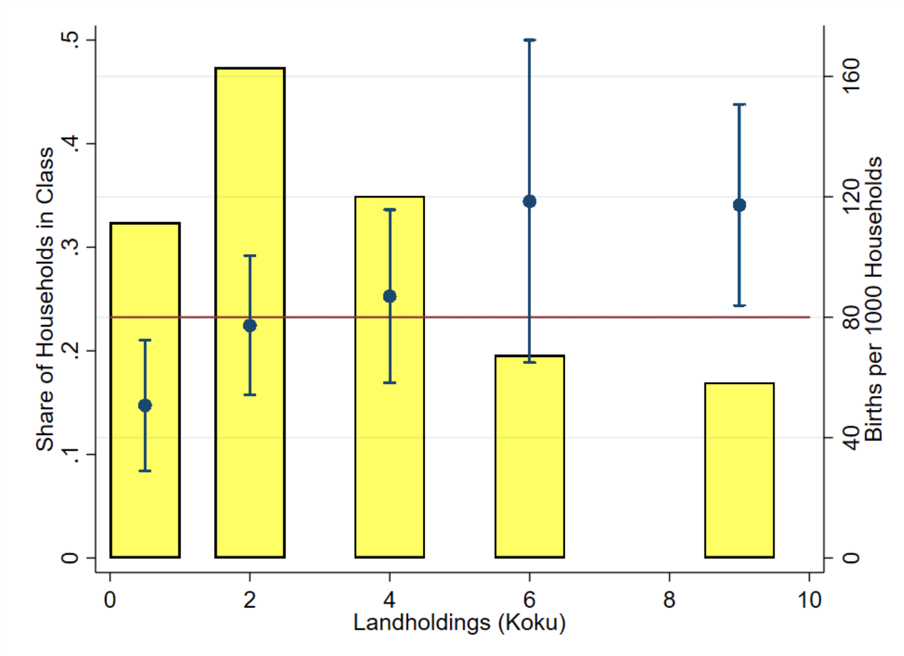

Figure 8: Birth Outcomes and Shares by Landholdings Class: 4 Villages

The bars plot the share of households in each bin. The 95% Confidence Interval is plotted for births per 1000 households. I weigh each village equally.

equation 12 using the same bins of landholdings for 15 year lags.

$$Y_{v,h,t} = \beta_0 + \beta_1 f(Land\ holdings_{h,t}) + \theta_v + \epsilon_{v,h,t} \tag{12}$$

I use village fixed effects, instead of village-time fixed effects, which allow me to easily visualize the results.

Ideally, I would compare the birth rate to the death rate within each village, but the data for deaths is not very reliable. Also death rates were not affected by land holdings. To overcome these issues I assume that life expectancy at age one was at most an additional 50 years, which was typical for Japan in 1891-1913 (as mentioned earlier). This results in death rates of 20 per 1000 per year. A household would need to be able to sustain at least 4 people to be able to replace their families over generations. This suggests the landless must have birth rates above 80 per 1000 to avoid causing depopulation. These are conservative estimates, and families likely needed higher birth rates to achieve replacement levels.[37]

I graphically present the results in Figure (8), where I plot the predicted birth rates of all households and the average death rate of 80. The households who were close to landless

[37] The average birth rate was 84 per 1000 in villages where population was fairly stable. This suggests death rates were around 80-84 per 1000.

clearly suffered from a statistically significant negative population growth. In contrast, the land-rich had positive population growth which was not quite significant, but has the correct sign. Households needed 1-7 *koku* of land to sustain themselves, or enough to sustain 0.25-1.75 people on a rice diet.[38] If we assume the landless relied on wages, they were clearly below the subsistence income in early modern Japan, as predicted by the model.

The proportion of each landholding class show population was maintained due to a high level of equality. Just over 30% of the population were land-poor, but the 30% of land-rich households counteracted any population decrease being experienced at the bottom. Had most of the population been landless, much like in England, what would have occurred? It is impossible to preclude major social changes within the village had people become landless. However, if the relationships found above persisted, there would have been major depopulation. As long as there are decreasing returns to labor on land, this would increase the marginal productivity of land and hence wages. A new equilibrium would be reached with a lower population and higher wages for the landless. Low wages were only sustained due to Japan having an equal economy.

Sample Bias? Evidence from 265 villages

A major concern with the analysis above is the limited geographical scope of the data, meaning it could merely be capturing special cases within Japan as a whole. To allay fears of regional biases, I can look at a less robust specification that estimates the same relationship using mostly cross sectional data from across Japan. I use data from 265 villages that also include individuals. Although potential endogeneity is a worry, the similarity between OLS and IV estimates above and the high correlation of landholdings over time suggest otherwise.

I use the following specification.

$$Number\ of\ Children_{v,h,t} = \beta_{v,t} + \beta_1 f(landholding_{v,h,t}) + \epsilon_{v,h,t} \tag{13}$$

The number of children refers to the total number of family members below age 15.[39] I take this number, because most children stayed within the household until they reached this age.[40] I split the landholdings into bins. I compare the number of children by landholding class to the average number of children from post-1720. This is because population was static

[38]This estimate is likely to be biased down, as the poorest households would have left out of attrition from this sample.

[39]I avoid the issue of some censuses listing based on legal residence rather than current location if I use children under age 15 because they would rarely be away from home at such a young age. One data issue is that regions varied in when infants began registration. Some could begin at age one while others could begin at much later ages. I control for this using village-time fixed effects.

[40]Some children can be observed becoming servants as young as age 10, but these are exceptions.

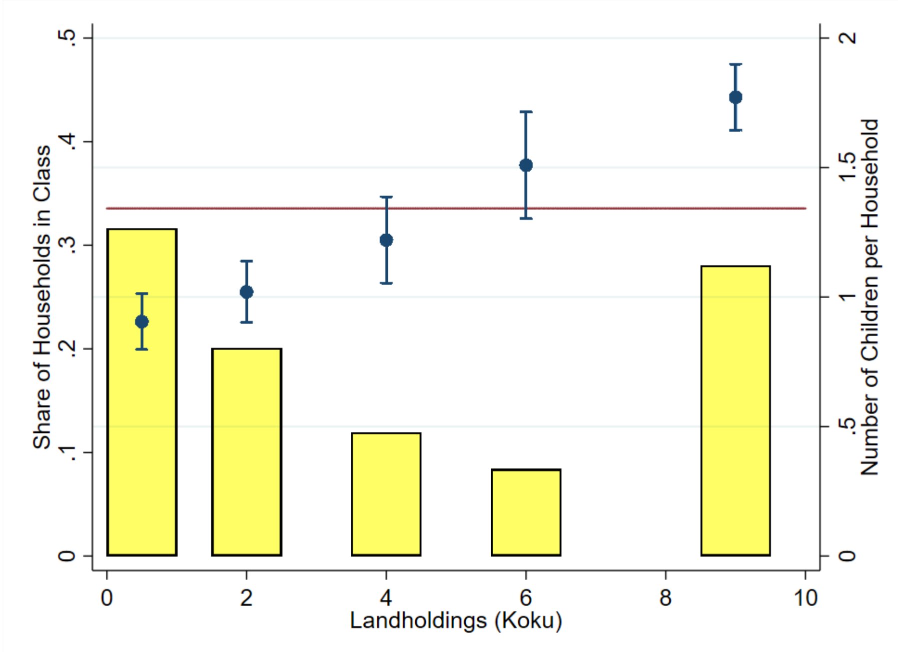

Figure 9: Outcomes and Shares by Landholdings Class: 265 Villages

The bars plot the share of households in each bin. The 95% Confidence Interval is plotted for births per 1000 households. I weigh each village equally.

so this average should be comparable to the number of children required to keep population stable.[41]

I find that the positive correlation between landholdings and fertility was a well grounded fact for Japan as a whole (see Figure 9). All landholding classes have more children than the landless class, who had less than one child. The richest have about 1 more child than the landless surviving to be observed in these censuses. This is a substantial difference, considering children under 15 would have only constituted about half of all children within a generation. I can split the sample by time or region, but the findings remain similar. I can also control for age which is desirable if households are managing assets with old people with no children selling off their lands but the findings remain robust.[42] Landholdings were a key determining factor for having children everywhere. The four villages analyzed above are indeed representative of Japan as a whole.

[41] The average births is close to the number I expect based on calculations from life tables in the 1890s. I also get comparable results when I change figure 8 into a specification based on number of children.

[42] This comes at the cost of over-controlling because landholdings partially work through age. There is quicker generational churn among richer households. Therefore, we are more likely to observe a rich household at a time when the number of observed children is high which can be confirmed in the data. I control for age by taking the person closest to age 40 and controlling for their age up to the 5th polynomial. This should be a member of the reproducing generation in the household making it the right age to control.

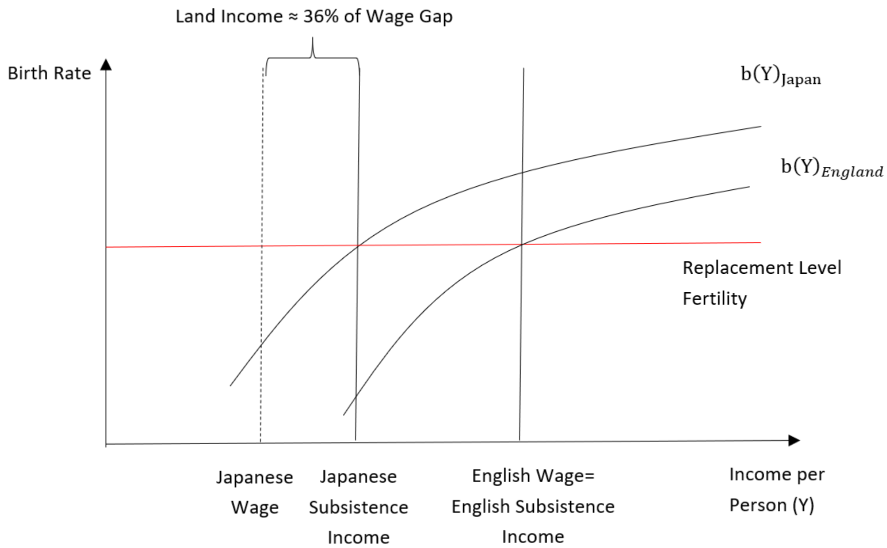

Figure 10: Measuring the Gap in Subsistence Incomes: England and Japan

These findings contrasts with England c. 1600 where even the laboring class had fertility above replacement levels (Clark and Hamilton, 2006). The laboring class had 2.2 surviving children compared to the replacement level of 2.07.[43] This is consistent with the model, where a highly unequal society must have the landless laborers reproducing at or very close to replacement levels. The laboring class being slightly above subsistence reflects the fact that population was still growing and the economy had not settled in a Malthusian equilibrium. In comparison, the landless households of Japan had less than 2 surviving children per generation which was clearly below replacement levels. There was survival of the richest in Japan too, but with a far starker outlook for the poor.

How do these findings compare to the low wages found in Japan, which could subsist approximately 3 people in 1800? To reach the subsistence level in early modern Japan, households required landholdings of between 3-7 *koku*. This was approximately enough land income to feed 0.75-1.75 people on rice. This would have bought total income levels to where it could feed 3.75-4.75 people on rice, or a 43% increase from the wage in 1800. The absolute value of these incomes are much more compatible with a households' capability to raise children. Thus, land incomes proved decisive for whether a household could reproduce or await their eventual extinction.

Finally, how much does this mechanisms explain of the gap in wages between England and Japan? I can do this by comparing subsistence incomes and assuming incomes can be compared across Japan and England. A rough estimate suggests approximately 21%−50% of the gap can be explained, with 36% being the middle value (see Figure 10). Other

[43]The replacement level is from (Clark, 2008) 115

mechanisms were also clearly at play, but a large portion of the gap can be explained by the differing degrees of inequality across these two societies.

Conclusion

This paper has shown that early modern Japan had a peculiar Malthusian equilibrium where wages were below subsistence level. The population of the poor were decreasing. Population was propped up by a sufficient number of land-rich households whose population growth kept total population in equilibrium. Such an equilibrium was only possible due to the highly equal distribution of land in Japan unlike economies in Europe and other continents. Over the long-run, this equality led Japan to develop on the path of a labor abundant economy with low wages, low GDP per capita, and high population as its key features. However, the low wages did not preclude Japan from developing economically. Hayami (2003) shows that less cows and horses were used in agriculture, as they were substituted with manpower. Technologies were developing on a labor intensive path.

A consequence of this equilibrium was poverty. GDP per capita was low and there was little surplus in the economy. Moreover, the landless laborers of Japan, with nothing but their wages to rely on, became perhaps the poorest people in history. However, the landless households were only 13% of the population. Wages were a poor measure of living standards for the other 87% of the population. The average peasant earned perhaps 43% more than the wage income. This brought households to income levels at which demographic reproduction was possible. This cautions against relying on wages as the only measure of incomes. An implication for other low wage economies is that some form of wealth may be supplementing incomes of the masses, allowing low wages to persist.

Although I have shown that relative equality was causing low wages, what were the fundamental causes that led early modern Japan to become such an equal society? Wealth became highly concentrated with modernization (Moriguchi and Saez, 2008), meaning something specific about early modern Japan was keeping society equal. I end this paper with three likely explanations deserving further tests.

A first likely factor is inheritance and adoption. In the pre-industrial world, the number of heirs were randomly determined due to a combination of fertility and mortality. However, Japanese households practiced adoption which assured that richer households had at least one heir, effectively hedging against this risk (Kurosu and Ochiai, 1995), unlike in England. The lower inheritance risk in Japan, combined with partible inheritance, can have an effect of reducing inequality. Intuitively, if a rich English person died without an heir, which happened at least 20% of the time among the richest (Clark and Hamilton, 2006), the wealth would have gone to a relative who was likely to also be rich. Therefore, inheritance could lead to further accumulations of wealth. In Japan, there would be at least one or more heirs so that wealth could only be parcelized, thereby causing inequality to be lower after inheritance. A simple simulation augmenting my model with social mobility and partible inheritance, confirms this intuition.

A second likely factor is the re-distributive power of the village council. In early modern Japan, the village as a whole was responsible for paying taxation. The village council was always concerned with how this would be accomplished. One concern was to keep the village land-labor ratio at a optimal level. In the case of the Northeast Japan, famines caused a shortage in labor and villages redistributed some of the abandoned lands to mostly landless immigrants in an attempt to balance land-labor ratios (Drixler, 2016). Land redistribution was an effective way of enticing entire household to immigrate, rather than offering higher wages that could prove temporary.[44] Similarly, rulings favoring redistribution of land to the landless within the village also occurred.[45] In this case, it was to prevent landless households with nothing to lose from emigrating. It also had the added benefit of keeping a trustworthy household in the village rather than replacing them with immigrants who were strangers. As seen in these cases village councils worked in favor of equality.

A third likely factor was that property rights were only secure if land was held by a resident of the village. Any landholdings that went beyond village borders were not under the protection of the law, and risked being lost (Nakabayashi, 2013).[46] Furthermore, permission from the village council was required for some management decisions on land. For those with cross-village holdings, the holder did not belong in the village council weakening management power and thereby making such holding less attractive. Such costs may have been a disincentive to the accumulate land across villages, preventing the emergence of large landholders.

These explanations are certainly not exhaustive, but already illustrate that many basic factors worked favorably towards equality in Japan. Interestingly, there appears to have been a lack of clear intention by any actor to make Japan into an equal economy. Instead, a combination of factors appear to have coincidentally functioned to make Japan highly equal. The cost of this equality was extreme poverty for the land-poor, low average living standards, and perhaps the delaying of industrialization until the 1890s.

[44] Carter and Kalfayan (1989) points out a similar incentive to redistribute land in Latin America.

[45] One example is the *shichichi-ukemodoshi* institution, that allowed land sellers the option to repurchase land in the future at the same price.

[46] The lords could intervene if an appeal was made to them by the owner as cited in the cadastral survey.

Appendices

A Proof for Proposition 1

Proof. If I denote the initial equilibrium situation with subscript zero, it is clear that

$$B(L_0) = D(L_0)$$

Suppose a transfer of income ϵ occurred between the poorer individual denoted by subscript p and richer individual denoted by subscript r. Due to the concavity of the function $b(c_{i,t})$, it is clear that the increase in population resulting from increased births by the rich will be smaller than the decrease in population resulting from the decreased birth rate by the poor. The first term below is the change in birth rate for the richer household, and the second term is the change in birth rate for the poor household, the whole term is negative.

$$[b(w_0+(r_0-T_0)(H_r+\epsilon))-b(w_0+(r_0-T_0)H_r)]+[b(w_0+(r_0-T_0)(H_p-\epsilon))-b(w_0+(r_0-T_0)H_p)] < 0$$

Due to the convexity of the death rate function, the overall death rate will also be higher.

$$[d(w_0+(r_0-T_0)(H_r+\epsilon))-d(w_0+(r_0-T_0)H_r)]+[d(w_0+(r_0-T_0)(H_p-\epsilon))-d(w_0+(r_0-T_0)H_p)] > 0$$

As I can say the same for all households that faced transfers, the overall effect is a decrease in population. Due to the decreasing return to land, the lower population causes an increase in wages in the next period. □

B Income Inequality as Alternative Measure

Due to pre-industrial economies having relatively equal distributions of wages, with the mass of unskilled laborers earning very similar wages, most inequality was the result of inequality in wealth. Therefore, any measure of income inequality should be highly correlated with wealth inequality.

There are two potential issues. The first is that the share of incomes going to labor and other factors could affect the degree to which wealth inequality affects income inequality. There is little data to directly deal with this issue, but there is little evidence that the share differed greatly. The second is that income inequality itself has been imperfectly measured due to the far more limited information available.

Given these caveats, the conclusions remain unchanged when I consider Gini coefficients

Table 8: **Income Inequality and Wages in Pre-industrial Countries**

Country	Year	Gini	Wage (Kcals)
England	1290	0.36	13231
England	1688	0.45	15497
Holland	1732	0.61	
Netherlands	1808	0.57	
Old Castile	1752	0.52	
France	1788	0.55	
India-Mogul	1750	0.44	
China	1880	0.24	5096
Japan	1840s	0.2	6189
Java	1880	0.39	
Brazil	1872	0.41	
Chile	1861	0.64	

for income (See Table 8). The larger scope of this data shows that inequality was unsurprisingly high in Latin America, while Mogul India and Java had middling levels of inequality. One thing of note is that China appears to have had Gini coefficients as low as Japan, which strongly suggests that land distribution was relatively equal in this country. This is because wages were relatively equally distributed, so it must have been low inequality in land distributions driving this result. Although the evidence is indecisive, China may have faced similar consequences to Japan.

C Other forms of Wealth? A Japanese-English Comparison

A problem with my measures of wealth inequality is the omission of various forms of wealth. Any form of wealth can be the channel for my proposed mechanism. One glaring omission is capital incomes, but there are such limited sources of capital in rural communities in the case of Japan which makes comparison difficult.[47] However, capital incomes were clearly a smaller share of the rural economy than land incomes, and also must have been highly correlated with land incomes. Therefore, I limit the discussion of wealth in the form of real estate in Japan and England.

[47] Capital incomes are easier to hide from surveys, both today and in the past. Therefore, there is less data on it.

The clear pattern in many pre-industrial countries was that land rents were split among many actors other than the landholder or landowner, due to incentive problems or institutions. By land rents, I mean the land's share of income in a production function, which could be both explicitly or implicitly received. Therefore, there could be substantial numbers of people who claimed rent depending on the social structure. The claimants often included middlemen between the lord and the cultivator. It is difficult to identify all of the claimants, despite them earning land incomes.

In the case of England, the most notable omissions are copyhold lands which essentially gave rights to surplus after paying a small fee to the land owner. This gave copyholders a large share of land rental income. Gayton (2013) shows in the case of Hampshire Downlands that copyholders could sublet at 75.8 pence per acre per annum net of rents to the owner. This amounts to about 2.3 people worth of wheat flour if the copyholder had 20 acres.[48] Whether the land income or the amount of holdings is representative is unknown, but shows such incomes could be significant.

Despite the importance of copyholds, little is known in a systematic way. As stated by Whittle and Yates (2000), "Customary land tenure in medieval and early modern England is infuriatingly complex. The countryside was a mosaic of manorial units, and each manor had its own customs determining types of tenure and access to land". Thus, measuring the number and distribution of copyholds has not been done and needs to await future research.

One way around this issue has been to look at occupations. Laborers could be considered landless, whereas husbandmen or yeomen or farmers could be considered some kind of landholders. Lindert (1980) uses local censuses and burial records and estimates that three times more laborers existed than landholding occupation in 1688. Similarly Shaw-Taylor (2012) uses parish registers to show that three quarters of rural south-east England were landless laborers by 1700. Thus, even accounting for potential copyholdings, landless laborers were the majority in rural England.[49]

I have already shown the comparable findings for Japan, but one additional thing is worth noting. Many cultivators in Japan also had ties to land, especially when the landholder changed due to default on a loan in which land was used as collateral (Shirakawabe, 2012).[50] The ex-holder could sometimes claim cultivation rights, adding a friction to the labor market. This would also mean cultivators could claim some of the land rent through a bargaining process, perhaps making them marginally better off than wage laborers. In this sense, they

[48] 20 acres could most likely have been cultivated by one household. There is no consensus as to what was standard landholding size, making it difficult to suggest a representative size.

[49] Another study by Whittle and Yates (2000) also confirms the high inequality in land distribution, using a military survey of 1522 that showed value of moveable wealth among all able bodied men aged 16 or over.

[50] This institution was known as the "Shichi Ukemodoshi sei".

were akin to a copyholder rather than a laborer, although they are likely to have claimed a smaller share of the land rent. In the context of my model, it would increase the extent of equality, further reducing wages.

One final issue is that I cannot include commons in the analysis, due to the ambiguity of the collector of land rents. However, in the case of England, Clark and Clark (2001) uses a sample of lands acquired by charities to estimate that 3.8% of lands were common waste, that could be exploited by all. Such commons were over-exploited and had little returns in terms of land incomes, so that land incomes were also minimal.

The larger common fields that had limited membership for use may have been 34.8% of land in 1475-1524, but by 1700 it was only 21.5% and in decline. The limits of membership in such commons have been disputed, but Shaw-Taylor (2001) finds strong evidence that many landless peasants did not enjoy commons rights prior to enclosure, and hence they could not have been extracting implicit land rents from such lands. Thus, landless laborers in England can be safely considered to have received no land-based incomes.

In contrast, Japanese peasants who resided in the village had access to commons (known as *iriaichi*) due to the vast availability of mountainous lands, covering approximately two thirds of land area. These lands were used to collect fuel, fertilizer, and seasonal foods such as horse chestnuts or oak acorns to supplement their incomes.[51] Therefore, at least in the case of Japan, the landholdings were an underestimate of land incomes collected by peasants, which may have led to further declines in wages in pre-industrial Japan.

D Trends in Inequality

Using data from 30 villages with long series of inequality[52], I estimate specification 14 that tests whether there was a time trend after controlling for fixed effects (for details, see Kumon (2018b)). I use similar data from pre-industrial Italian cities from 1300 to 1800 as comparison (Alfani, 2015; Alfani and Ammannati, 2017).

$$Gini_{v,t} = \beta_v + \beta_1 \frac{Year_{i,t}}{100} + \epsilon_{v,t} \tag{14}$$

Table 9 shows there is no clear linear trend in Japan, whereas Italian villages were seeing increases in inequality of 0.07 per century. Using a cubic function results in significance but the prediction merely shows inequality meandering about a constant level. This comes as a surprise, because the modern literature for the world, including Japan, shows a seemingly

[51] Von Verschuer and Cobcroft (2016)
[52] By this, I mean more than 25 years in span.

Table 9: **The Time trend of Inequality in Japan and Italy**

	(1) Japan	(2) Japan	(3) Italy	(4) Italy
$Year_{i,t}/100$	0.00	212.9***	0.07***	-3.10
	(0.03)	(62.58)	(0.01)	(2.08)
$(Year_{i,t}/100)^2$		-11.92***		0.19
		(3.50)		(0.13)
$(Year_{i,t}/100)^3$		0.22***		-0.00
		(0.07)		(0.00)
F-statistic		6.37		2.12
P-value		0.00		0.15
N	1015	1015	121	121
adj. R^2	0.962	0.968	0.756	0.781

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

The dependent variable is the Gini Coefficient

unstopable upward trend in inequality[53]. Although the evidence does not allow a decisive argument to be made, Kumon (2018b) suggests it could be due to high wealth mobility in much of Japan combined with inheritance institutions that generally worked against accumulation. In contrast, European evidence suggests inequality was increasing everywhere, continuously pushing up equilibrium wage levels. Overall, the persistently equal economy allowed the equilibrium of low wages to persist within Japan.

E Landholdings in Japan: An Institutional Background

The Assignment of Landholdings

Tokugawa Japan (1600-1868) was an agricultural economy, with 60-70% of GDP being agricultural.[54] Of the total GDP, 30-35% was composed of land rents. The distribution of land incomes was the primary source of inequality, and competing interests fought over land rights. In this feudal economy, the main claim over land came from the 300 lords who were given ownership over vast amounts of land by the Tokugawa shogunate, in return for various

[53]Piketty (2014) presents a general argument for this, and Moriguchi and Saez (2008) shows this was true for Japan.

[54]Saito and Takashima (2016)

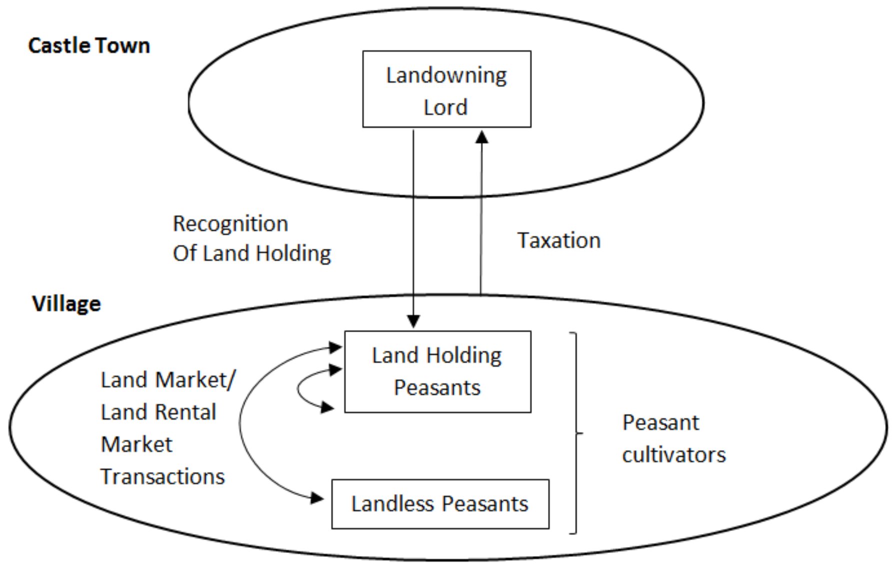

Figure 11: The Japanese Feudal Economy in the Tokugawa Period

services. Thus, the lords were the *de jure* owners of land, and had the right to extract land rents in kind and in money. I call this income of the lord "taxation". The lords and the samurai class were separated from the rural economy because they lived in castle town due to an institution known as *Heino-Bunri*. Therefore, the day-to-day maintenance of agricultural land and the collection of these taxes was left to the mostly autonomous peasants.

In order to collect taxation, the lord had to clarify the liability for taxation and have a broad understanding of the yield within the rural economy. To collect information, the lords conducted large scale cadastral surveys of their lands in the early 17th century and recorded the size and yield of all plots. Taxation was based on the estimated yield. Ultimately, the village had to organize and collect the tax that was demanded by the lord and paid it to the lord (*Murauke-sei*). To facilitate the distribution of tax within the village, a name was attached to each plot in the cadastral survey (the *Naukenin*), and they were deemed responsible for paying the taxation on the plot. However, if individual peasants could not pay their share, others in the village had to compensate for the missing tax.

Within the village, the peasant whose name was attached to the plot was recognized as the *de facto* "owner", and the lord would support the claim if any disputes arose. In general, the lord did not interfere in the land distribution within villages, as long as taxes were paid. The peasant landholder was left with many rights over there landholdings, including the sale or rent of the land, and the claim to all land rents that remained after taxation.

Land distribution were always unequal to some extent, resulting in some peasants holding more land than they could cultivate. To resolve this issue, households either employed servants or rented out their excess lands. Land rental markets were established in the early Tokugawa period and were the favored solution to excess land by the end of the Tokugawa period.[55] By the 18th-19th century, these land rental markets were working efficiently, and Arimoto and Kurosu (2015) show that most if not all of the surplus in landholdings relative to the family labor force were resolved by land rentals in Northeast Japan. Land sales were also common, and many plots frequently changed hands in the cadastral surveys.[56] The existence of these markets imply two facts. First, land rights were secure enough to allow for the sale of such rights. Second, the positive price attached to land show that the asset gave the owners a positive stream of income implying that the lords had indeed failed to extract all of the land rent as argued above.

The land holding peasant could collect large amounts of land income, but many of these households were still too poor to subsist purely on land incomes. All but the richest cultivated land. Thus, the most common survival strategy by peasants was to cultivate the land they owned (if any) and rent plots from others with a surplus to make ends meet. Although peasants working their own land may not have thought of their extra incomes from landholdings as land incomes, they certainly earned implicit land incomes. Therefore, I do not differentiate between land incomes earned from renting plots to others and implicit land incomes attained from farming owned plots.

I summarize the feudal economy using my terminology in Figure 11. Although various feudal economies had differing features, many shared the fact that land rents was distributed between peasants and lords. Furthermore, peasants often had the ability to informally sell or rent land that they owned. This can be seen in some estates of imperial Russia on the eve of emancipation, or in medieval England where estate records show land transactions among peasants from at least the 13th century.[57] Feudal lords were never powerful enough to extract all of the land rent. Hence, it is no surprise that Japanese peasants were earning land incomes under a Feudal regime. Another lingering idea is that peasants were heavily taxed under Feudalism, leaving them little land income. I now turn to this issue.

The magnitude of Land Incomes

How significant were land incomes in a feudal economy such as Tokugawa Japan, where peasants lacked the rights over land? The average tax rate by the government was 40%

[55] Takeyasu (1966) shows how various village records attach different names to the same plot within the same year. He argues that this was due to the cultivator being different to the owner, suggesting the existence of a land rental market.

[56] Takeyasu (1969) shows that land was frequently changing hands as early as the 17t century.

[57] (Dennison, 2011) Chapter 5

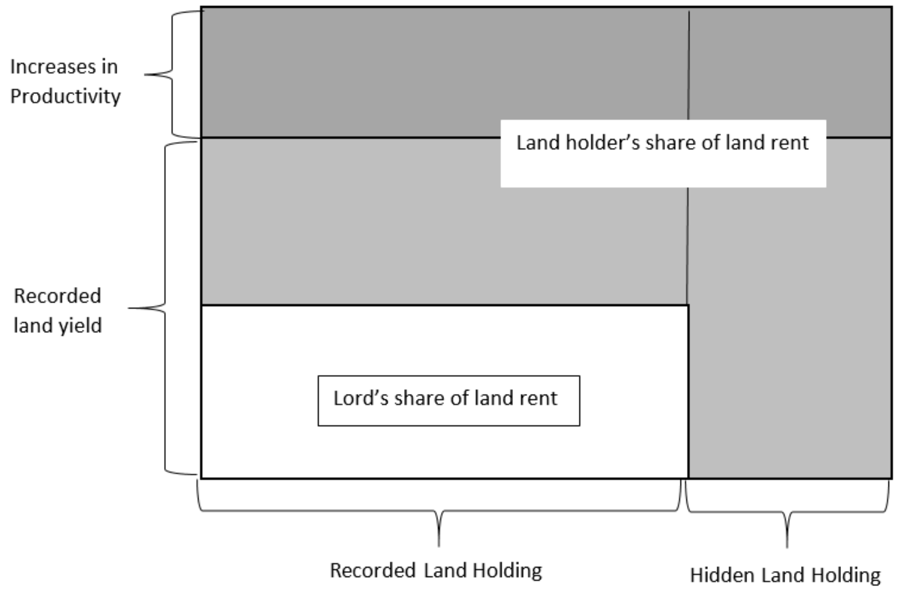

Figure 12: Land Rents Distribution among Landholders and Lords

Note: The horizontal access indicates changes in land area, and the vertical axis changes in productivity, both of which increase the land rent. The shaded area is the share of land rent going to the landholder.

of estimated yields.[58] These high tax rates imply small land rental incomes net of taxation during this period. However, the real tax rates became lower over time because the cadastral surveys of the mid 17th century became outdated[59], and the lord's did not conduct new surveys to update the yield of their lands. Therefore, tax rates were based on outdated yields[60] allowing tax evasion through two channels: the increase in hidden fields, and the increase in productivity.

Hidden fields or the expansion of existing fields (known as "*Nawanobi*") were common in villages, and such fields were simply not taxed. Therefore, the land holder could pocket the whole land rent. It is impossible to know the extent of hidden fields during the Tokugawa period because such information was well guarded by the peasant. However, we can find the

[58]This refers to tax in proportion to the yield estimated by the government in 1868, as calculated by Paik et al. (2016). Due to a political system that granted autonomy to the over 300 lords there was considerable heterogeneity in tax policy across the country. Moreover, there has been no systematic studies of taxation policy of the lords due to decentralized tax collection. We only know that some governments had fixed tax rates (*Jyomen-hou*), while others had proportional tax rates (*Kemi-hou).* The rate of taxation varied widely by region.

[59]This was partly because cadastral surveys could lead to peasant revolts which were costly to deal with. Moreover, they were existential threats to the lords because the shogun could use such instability as an excuse to confiscate their lands. Therefore, the lords were definitely aware of increased yields but strategically turned a blind eye towards it. For more, see Paik et al. (2016)

[60]Even when values were measured by officials in the 17th century, the plot values were based on grades of land quality, causing some further errors (see Brown (1987)).

Table 10: Land income as % of yield for a Peasant holding the land he cultivates

Year	1650	1700	1750	1800	1850	1872
Landholder's net share	0.18	0.24	0.29	0.33	0.37	0.40
Laborer's net share	0.37	0.37	0.37	0.37	0.37	0.37
Land Income as % of Wage	48.6	65.2	77.2	90.0	98.9	107.3
Living standard (lbs of wheat)				8.76		

For more details on the derivation, see [Working paper]

average amount of hidden fields that were detected due to a resurvey of Japan preceding the land reform of 1873.[61] A weighted average by total yield at the time of the survey suggests that approximately 33% of the land was hidden by the end of the Tokugawa period. These lands would have increased land incomes. However, such lands were also likely to have been marginal lands that were only profitable given the context of high taxation.

Another factor increasing land income was the increased productivity of land. All increases in productivity accrued to peasants because lords would not account for increased productivity in their taxation. Productivity from improved technology increased rice yields by approximately 31% between 1650 and the 1850s. Figure 12 shows how the share of land income going towards peasants increased, taking the whole area to be the land rent. How much did land incomes increase over the whole period?

The third row of Table 10 shows the estimated share of yield going to a peasant holding all of the land he cultivates in comparison to a landless wage laborer. By 1800, a land holding peasant would have been 90% richer than a landless peasant, which is a significant boost in incomes. Such large incomes would have allowed relatively small landholders to see economically significant increases in living standard and shows the importance of accounting for land incomes in the context of Tokugawa Japan.

F Measuring Measurement Error

Although I cannot correct for the measurement error, I can estimate the extent of the error using a separate dataset of 156 land sales contracts.[62]. These record the true value of land, either through a sales price or the landholders own records of the true value, in addition to the official value. The idea is that if the official value is highly correlated with the true value,

[61] Iinkai (1957)

[62] This data is taken from Takeyasu (1966) and Shoji (1986) They are from villages in *Sanuki* of Shikoku, and *Kawachi* of Osaka.

the landholdings I use in my analysis should have small measurement error.

Suppose that the measurement error is in proportion to the land value.

$$official\ yield\ estimate_i = \beta true\ land\ value_i + \epsilon_i$$

Unlike the classical measurement error specification, I estimate β because the official values were based on yield, whereas the true land value capture land rent − taxation, so they are measuring different things. By estimating β, I allow for a flexible relationship between these official yields and true land values. It is akin to changing the measure of official yields to be comparable to land income.

I find that β was 1.05. More importantly, I am finding $\sigma_\epsilon^2 = 0.7$ so attenuation bias is

$$\lambda == 1 - \frac{\hat{\sigma_\epsilon^2}}{\hat{\sigma}_{\tilde{x}}^2} \approx 0.94$$

where $\tilde{x}$ is the observation with error that I have in my main sample. This is a very small amount of bias.

G Robustness Tests

G.1 Different Lags as Instruments

I use lags of up to 30 years as an IV. The F-statistic is extremely high in all cases, so weak instruments are not a concern. The main result is unchanged, although the changing coefficients suggest potential sample selection.

Table 11: Regressions of Deaths on Land Holdings, with various lags as IVs

	Death					
	(1)	(2)	(3)	(4)	(5)	(6)
Value Land Held	0.0364	-0.250	0.139	-0.500	0.923	4.145
	(0.363)	(0.486)	(0.847)	(1.525)	(2.360)	(3.885)
Value Land Held^2	-0.00515	0.00809	0.00849	0.0325	-0.0768	-0.308
	(0.0155)	(0.0210)	(0.0437)	(0.101)	(0.163)	(0.279)
Lags	5 years	10 years	15 years	20 years	25 years	30 years
F-Statistic	0.24	0.29	0.65	0.11	0.27	1.22
F-test Significance (99%)	No	No	No	No	No	No
Cragg-Donald F Statistic	34000	15000	2791.793	1499.322	931.344	328.257
N	44270	33230	24386	17464	12692	9242
adj. R^2	0.046	0.050	0.052	0.057	0.054	0.055

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: All dependent variables are per 1000 individuals. I additionally control for age, age squared, age cubed, and sex. The F-test tests the joint significance of all value of land held variables. Standard errors are clustered by individuals

Table 12: Regression of Births on Land Holdings, with Various Lags as IVs

	No. Births					
	(1)	(2)	(3)	(4)	(5)	(6)
Value Land Held	6.747***	6.823***	9.880***	11.92***	12.84***	15.38**
	(2.316)	(2.539)	(2.998)	(3.767)	(4.772)	(6.743)
Value Land Held^2	-0.0802	-0.0956	-0.317	-0.487*	-0.517	-0.635
	(0.156)	(0.168)	(0.207)	(0.252)	(0.350)	(0.500)
Lags	5 years	10 years	15 years	20 years	25 years	30 years
F-statistic	27.53	20.46	19.62	17.23	17.84	18.96
F-test Significance (99%)	Yes	Yes	Yes	Yes	Yes	Yes
Cragg-Donald F Statistic	14000	5712.861	1639.389	1234.725	1302.393	710.410
N	11711	10228	8807	7436	6370	5521
adj. R^2	0.015	0.013	0.011	0.010	0.010	0.010

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Births count all children that first appear in the register below age 4 without explanation to account for misrecording. Reproductive couples indicate the existence of a couple with the female below age 45. Births within marriage compare births for households who have at least one reproductive couple. The F-test tests the joint significance of all value of land held variables. Standard errors are clustered by households

G.2 Regressions by village

Table 13: The Effects of Land holdings on Death for four panel-data villages using IV (15 year lag)

	Death			
	(1)	(2)	(3)	(4)
Value Land Held	-2.507	0.969	2.684	-0.455
	(1.638)	(1.942)	(2.716)	(1.940)
Value Land Held^2	0.135	-0.0207	-0.171	0.0832
	(0.0909)	(0.0419)	(0.165)	(0.148)
F-Statistic	2.37	0.25	1.14	1.04
F-test Significance (99%)	No	No	No	No
Cragg-Donald F Statistic	3655.120	1046.035	1326.659	904.418
N	9143	1942	5407	7894
adj. R^2	0.045	0.080	0.071	0.054

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: Specification 1 is Hanakuma Village, specification 2 is Nakatou village, specification 3 is Ishifushi village, specification 4 is Konosu Village. Standard errors are clustered by individual

Table 14: The Effects of Land holdings on Births for four panel-data villages using IV (15 year lag)

	No. Births			
	(1)	(2)	(3)	(4)
Value Land Held	10.18**	11.36	-2.598	20.90***
	(4.484)	(8.100)	(6.964)	(7.199)
Value Land Held^2	-0.504**	-0.0732	1.040**	-1.192**
	(0.235)	(0.181)	(0.413)	(0.547)
F-Statistic	5.17	74.55	45.98	11.66
F-Test Significance (99%)	No	Yes	Yes	Yes
Cragg-Donald F Statistic	2501.003	326.259	801.084	480.475
N	3782	612	1644	2741
adj. R^2	0.003	0.049	0.030	0.008

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: Specification 1 is Hanakuma Village, specification 2 is Nakatou village, specification 3 is Ishifushi village, specification 4 is Konosu Village. The p-value for Hanakuma village for Hanakuma village is 0.0586.
Standard errors are clustered by household.

G.3 Selection Bias

Another concern is the potential bias from losing households who disappear from the village or enter the village, for whom we cannot observe lagged landholdings. The selection bias can be specified as follows.

$$y = d \times y^*$$

where

$$d = \begin{cases} 1 & \text{if } stay \\ 0 & \text{if } migrate \end{cases}$$

Any correlation between the error terms of d and y^* will cause selection bias. There is clearly a trade-off between this bias and the strength of my instrument. I can see how this affects my results by comparing those households that do not enter the regression with those that do. In the case of using a lag of 15 years, there is a loss of 6% of households. Table 15 shows that these were younger and smaller households, with little land in the village, making them more mobile. They also died and out-migrated more often, causing their disappearance. The selection bias may cause me to not observe those households who were not settling down to start families. Hence, the bias for birth rates is likely to be upward for those with low

Table 15: Test on differences between in sample and out of sample households

Variable	In Sample	Not In Sample	Difference
Death	17.937	38.204	-20.267***
	(0.560)	(3.805)	(2.755)
Out Migration	13.733	46.081	-32.348***
	(0.491)	(4.162)	(2.473)
Female	0.472	0.510	-0.038***
	(0.002)	(0.099)	(0.010)
Age	33.794	34.173	-0.379
	(0.090)	(0.427)	(0.435)
Household Size	4.509	3.428	1.081***
	(0.019)	(0.074)	(0.079)
Land Holdings	3.679	1.305	2.374***
	(0.031)	(0.058)	(0.127)
Births	83.86	74.02	9.841
	(2.495)	(9.611)	(10.517)
No. Reproductive Couples	582.430	294.751	287.679***
	(5.017)	(17.166)	(21.035)

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

income. The bias for death rates is also biased down because those with lower income are more likely to migrate before death, decreasing the chance of observing them. In both cases, the bias will work against my hypothesis.

I use the OLS framework and assume there is selection of individuals out of the village. I do not observe the characteristics of households after they migrate, so I instead look at household outcomes in the next period ($t + 1$). I estimate a Heckit model, using all independent variables to determine selection.

$$Y_{v,h,t+1} = \beta_0 + \beta_1 f(Land\ holdings_{h,t}) + \beta_2 X_{h,t} + \theta_{v,t} + \epsilon_{v,h,t}$$

The results show that the land-rich households were more likely to be "selected" in to the sample in the following period. However, the other results do not change.

Table 16: The Effects of Land Holdings on Demography, using a Heckit Model

	(1) No. Births	(2) Death
Value Land Held	6.440***	0.148
	(1.891)	(2.234)
Value Land Held^2	-0.0350	-0.0119
	(0.125)	(0.00774)
F-Statistic	35.78	3.37
F-test Significance (99%)	Yes	No
select		
Value Land Held	0.0319***	0.0012
	(0.0510)	(0.0018)
Value Land Held^2	-0.00729***	-0.00009
	(0.00102)	(0.0001)
N	13267	58613

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

G.4 IV Regression with Fixed Effects

I estimate specification 11 with an individual or household fixed effect, using an IV.

Table 17: Fixed Effects regression of Land Holdings on Demography

	(1) No. Births	(1) Death
Value Land Held	20.34	-2.251
	(13.17)	(9.526)
Value Land Held^2	-1.087	0.304
	(0.685)	(0.431)
F-statistic	2.64	1.14
F-test Significance (99%)	No	No
Cragg-Donald F Statistic	446.019	179.251
N	8779	24386
adj. R^2	0.017	-0.117

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

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