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Bogang Jun, Tai-Yoo Kim

Abstract This paper suggests that inequality in landownership is a non-financial hurdle for human capital accumulation. It is the first to present evidence that inequality in landownership had an adverse effect on the level of public education in the Korean colonial period. Using a fixed effects model, the present research exploits variations in inequality in land concentration across regions in Korea and accounts for the unobserved heterogeneity across these regions. The analysis establishes a highly significant adverse effect of land inequality on education in the Korean colonial period.

Keywords Land inequality, Education, Development, Korean economic history

JEL Classification I25, N35, Q15

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1 Introduction

Human capital accumulation plays a critical role in Unified Growth Theory, which explains the transition from Malthusian-trapped growth to modern growth by capturing the relationship between two historical events: the Industrial Revolution and the Demographic Transition (Galor and Weil, 2000; Galor, 2011a). The process of industrialization increases the demand for human capital, which in turn incentivizes individuals to acquire more education. This accumulated human capital further accelerates economic growth. Therefore, circumstances that promote or limit the accumulation of human capital are crucial in explaining cross-country differences in the growth path and the timing of the transition to modern growth.

This paper confirms that inequality in landownership has an adverse effect on the establishment of public primary education, which promotes human capital accumulation at a primary stage of economic development, as hypothesized by Galor et al. (2009). Using evidence from Korea, this study argues that in a society with greater inequality in landownership as an initial condition, institutions that promote human capital accumulation are established later, leading, on average, to less education.

Galor et al. (2009) investigated the economic interests of the established landed elite, the emerging industrial elite, and common workers during the industrialization process. Because of the complementarity between physical capital and technology, the accumulation of physical capital from industrialization results in increased demand for human capital (Lucas, 1988; Uzawa, 1965). The emerging industrial elite, therefore, exhibits a friendly attitude toward public education, which can boost human capital accumulation. The landed elite, on the other hand, initially manifests a negative attitude toward public education for two reasons. The first is the lack of complementarity between land and education, which means highly educated labor is not a requirement for agricultural production. Secondly, and even more importantly, education tends to separate labor from land, resulting in a lower return to land.

The accumulation of human capital requires individuals to make investments in education by allocating their time to attend school or by trading off their other resources to learn a higher skill. Because of capital market imperfections, however, these investments are often suboptimal (Galor and Zeira, 1993). Public investment in education, therefore, lessens the financial burden of accumulating human capital on individuals and reinforces economic growth. As described above, the landed elite initially impedes the implementation of public education. Nevertheless, as the economy gradually shifts from agriculture to industry, landowners accumulate more physical capital and thus change their positions on public education. A society with more equally distributed landownership or scarce land, therefore,

can implement an optimal education policy earlier than a society with greater inequality in landownership. Moreover, this earlier implementation of public education promotes investment in human capital and thus accelerates economic growth.

The aim of this paper is to show evidence of the adverse effect of land inequality on human capital accumulation by using Korean data. Our results are consistent with those of Galor et al. (2009) and Cinnirella and Hornung (2011), who used data from the United States and Prussia, respectively. So far, the adverse relationship between land inequality and human capital accumulation has only been tested using data from Western countries and from countries that achieved industrialization not under colonial occupation but by their own economic interest. Early twentieth-century Korean industrial development, however, occurred in a different context. Because it was occupied by Japan from 1905 to 1945, the Japanese government determined the economic policies to be implemented in Korea. The result of this research, which proves the significant effect of land inequality on education in Korea, shows that the adverse effect of non-financial hurdles such as land inequality on human capital accumulation can be applied more broadly to countries outside of the Western world.

Empirical analysis of this study uses a panel data set from the *Annual Statistical Report of the Government-General* (i.e., the Japanese colonial government in Korea) to show the existence of an adverse effect of landownership on education. Because Japanese occupancy on the Korean peninsula lasted from 1905 to 1945, the data set, which covers the period from 1934 to 1942, was gathered by the Japanese colonial government. This panel data set allows us to control for unobserved heterogeneity across regions at the province level. Through a fixed effects model, we find an effect of inequality in landownership on education without unobserved heterogeneity across regions, by controlling for regional differences in the share of agriculture, the share of jobs requiring more human capital to capture the level of modernization, the population growth rate to control for the quantity-quality trade-off effect, and the share of Japanese individuals to test the effect of colonial occupation. Moreover, the finding is robust even when we control for the supply side of education.

The remainder of this chapter proceeds as follows. In section 2, we present the related literature. Section 3 presents a simple theoretical model based on Galor et al. (2009). Section 4 provides a historical background of Korea, focusing on the distinctive Korean colonial experience in terms of land inequality and education. Section 5 presents empirical results using the Korean data. Finally, section 6 gives concluding remarks.

2 Literature Review

Keynes (1920) and Kaldor (1957) established the classical approach by hypothesizing that inequality is beneficial for economic growth. They focused on the fact that wealthier people have a higher marginal propensity to save, which leads to a higher degree of saving, greater physical capital accumulation, and higher economic growth. After their classical approach, however, the representative agent model of the neo-classical approach hindered further research on the channel of inequality and the relationship between inequality and growth without considering the heterogeneity of income among economic agents (Galor, 2009).

Modern perspective of inequality in terms of growth appeared finally when Galor and Zeira (1988, 1993) constructed a macroeconomic model by adding the heterogeneity of income. Galor and Zeira (1993) showed that inequality, in the presence of credit constraints and fixed costs in human capital acquisition, has an adverse effect on human capital formation and economic growth in an industrialized society in the long run. If there was no credit market imperfection and parents could easily access the capital market and borrow money for their children's education, all parents would invest in their children's education at the optimal level. Under credit market constraints, however, each household is unable to invest in their children's human capital optimally, resulting in low-income families increasing their human capital investment through extra income.

Banerjee and Newman (1993) also examined the relationship between inequality and economic development under credit market imperfection. They focused on the effects of wealth heterogeneity on the occupational decisions of agents. Poor agents chose to become laborers, whereas wealthy agents chose to become entrepreneurs by investing in their own education. Banerjee and Newman argued that if credit market imperfection holds, lower inequality may lead to under-investment in entrepreneurial activities, which results in a harmful effect on economic development.

Fershtman et al. (1996), Owen and Weil (1998), Maoz and Moav (1999), Checchi et al. (1999), and Hassler et al. (2000) represent the stream of the modern approaches, which emphasize credit market imperfection and heterogeneity among individuals (Galor, 2009). They examine the effects of inequality on intergenerational mobility by analyzing the efficient distribution of human capital among occupations. Empirical research in proving the relationship between inequality/ intergenerational mobility and growth under credit market imperfection, however, has been difficult because the identification of credit constraints is yet a problem to be overcome by future relevant work (Black and Devereux, 2011).

In addition to credit market imperfections, non-financial hurdles can also impede the accumulation of human capital. Galor et al. (2009) proposed a theory in which inequality in landownership has a significant effect on economic growth. They showed that the differences

in expenditure for education across the states in the United States stem from the variation in the distribution of landownership. Similar to Galor and Zeira (1993), this theory explores favorable conditions for human capital accumulation, but differs in that the hurdle for human capital accumulation is not a financial barrier but rather inequality in landownership.

Cinnirella and Hornung (2011) found supporting evidence for the adverse effect of inequality in landownership on the timing of human capital formation by using data from nineteenth century Prussia. Becker and Woessmann (2010, 2009) had already shown that Protestantism in Prussia promoted human capital accumulation because of its instruction in reading the Bible before Prussia's industrialization, which resulted in Prussia's relatively stronger literacy rate compared to other European countries. Cinnirella and Hornung (2011), however, focused on variations in inequality in land and the level of education across Prussia. They argued that landowners delayed the establishment of mass education by maintaining the institution of serfdom, which restricted the mobility of labor and therefore the benefit from human capital accumulation. Despite the presence of schools and teachers, regions with higher land concentration had lower education attainment. It was only after serfdom was abolished and the peasantry emancipated in Prussia, that its level of education finally rose and permitted its transition into a higher growth path.

3 The Model

In their seminal work, Galor et al. (2009) and Galor (2011a, 2011b) stressed the importance of human capital in the growth process and underlined the non-monotonic relationship between inequality and growth. Using their framework, we can derive a simple model in the spirit of Galor et al. (2009).

Consider an overlapping generations model in which each individual lives two periods and has one parent and one child. In this model, there are two production sectors, agriculture and manufacture, which produce the same homogenous good that is used in consumption and investment.

The aggregated output in this society is as follows:

$$y_t = y_t^A + y_t^M \tag{1}$$

where y_t^A is the aggregate output in the agricultural sector and y_t^M is the aggregate output in the manufacturing sector.

Both sectors have a neo-classical, constant-returns-to-scale, strictly increasing, and concave production function. Specifically, the production function of the manufacturing sector is a Cobb–Douglas production function. Thus,

$$y_t^A = F(X_t, L_t) \tag{2}$$

$$y_t^M = K_t^{\alpha} H_t^{1-\alpha} = H_t k_t^{\alpha}, \quad k_t = K_t / H_t, \quad \alpha \in (0,1) \tag{3}$$

where X_t is land, L_t is the number of workers employed by the agricultural sector in period *t*, K_t is the quantity of physical capital, and H_t is the quantity of human capital (measured in efficiency units) employed in production in period *t*. Physical capital fully depreciates after one period.[1]

The inputs are different in each production function. In the agricultural sector, the inputs are land, which is fixed over time, and labor. In the manufacturing sector, the inputs are capital, which is accumulated over time, and labor. Human capital is independent of labor productivity in the agricultural sector, whereas in the industrial sector, human capital has a positive effect on labor productivity. Because markets in both sectors are perfectly competitive, the results of profit maximization are as follows:

$$w_t^A = F_L(X_t, L_t), \ \rho_t = F_X(X_t, L_t) \tag{4}$$

$$R_t = \alpha k_t^{\alpha-1} \equiv R(k_t), \ w_t^M = (1-\alpha) k_t^{\alpha} \equiv w^M(k_t) \tag{5}$$

where w_t^A is the wage rate per worker in the agricultural sector, ρ_t is the rate of return to land, R_t is the rate of return to capital, and w_t^M is the wage rate per efficiency unit of labor.

As above conditioned, individuals in this model live two periods and have one parent and child. Because each individual has the same "warm glow preferences," they only differ in their initial wealth. The utility function of individual *i* in period *t* is a log-linear utility function as follows:

$$u_t^i = (1-\beta) \ln c_{t+1}^i + \beta \ln b_{t+1}^i \tag{6}$$

where c_{t+1}^i is second-period consumption, b_{t+1}^i is a transfer to an individual's offspring, and $\beta \in (0,1)$, which is constant over time. In the first period of an individual's life, the person spends one's time accumulating human capital. A fraction, $\tau_t \geq 0$, of one's capital transfers from one's parent, b_t^i, is collected by the government for the public education system as a tax, and a fraction, $1-\tau_t$, of these capital transfers is saved for future income. In the second period, he/she earns income, which includes wages, w_{t+1}, return to capital, $b_t^i(1-\tau_t)R_{t+1}$, and return to land, $x^i \rho_{t+1}$, and he/she allocates this income to consumption and bequests to his

1 This assumption makes the model simpler, which leads us to focusing on the main framework. Nevertheless, it is a conservative assumption because our results become apparent with slower capital depreciation. In addition, it is often treated as a customary assumption in the field of economic growth theory to overcome the weakness of the representative agents model (see Acemoglu, 2009).

child. The entire stock of land that he/she receives from one's parent is transferred to one's child. Therefore, the second period income, I_{t+1}^i, of individual *i* is as follows:

$$I_{t+1}^i = w_{t+1} + b_t^i(1-\tau_t)R_{t+1} + x^i\rho_{t+1} \quad (7)$$

The optimal transfer of individual *i* born in period *t* is $b_{t+1}^i = \beta I_{t+1}^i$, and the optimal consumption of individual *i* born in period *t* is $c_{t+1}^i = (1-\beta)I_{t+1}^i$.

We assume there are only three homogenous groups of individuals in period 0: landowners, capitalists, and laborers, who have the same preferences but different initial levels of wealth and landownership. Landowners own the entire stock of land X in the economy, and the fraction of all individuals who are landowners is given by $\lambda \in (0,1)$. Because all land holdings are transferred from parents to children, the distribution of landownership is constant over time, and each landlord possesses X/λ units of land. Capitalists possess the entire initial stock of physical capital, and their fraction in the population is given by $\mu \in (0,1)$. The rest of the individuals, whose fraction is given by $1-\lambda-\mu \in (0,1)$, are laborers who own neither land nor physical capital. Because every individual has one parent and one child, the fraction of each type of laborer does not change over time. As this economy develops, however, every individual can accumulate physical capital.

We further assume that landowners are the pivotal force in determining the implementation of public education policy. This assumption is not strong, considering the case that established interest groups influence governments' choice of policies (Acemoglu and Robinson, 2000; Grossman and Helpman, 1994; Krusell and Ríos-Rull, 1996; Kuznets, 1968; Mokyr, 1992; Prescott and Parente, 1999). We focus on the landowner's income evolution. The second period income of a landowner is

$$I_{t+1}^L = w(y_t,\tau_t;X) + (1-\tau_t)R(y_t,\tau_t;X)b_t^L + \rho(y_t,\tau_t;X)X/\lambda \quad (8)$$

and his/her transfer to his/her child is

$$b_{t+1}^L = \beta[w(y_t,\tau_t;X) + (1-\tau_t)R(y_t,\tau_t;X)b_t^L + \rho(y_t,\tau_t;X)X/\lambda] \equiv b^L(y_t,b_t^L,\tau_t;X,\lambda) \quad (9)$$

As Galor et al. (2009) showed, theoretically, there exists a critical level of total capital transfers to all landowners, $\hat{B}_t^L = \lambda b_t^L$, such that the implementation of public education becomes more profitable for landowners despite the cost of tax, τ_t. In other words, as the economy develops, the share of land in aggregate output decreases, and the stakes of landowners in other sectors increase. Because of these changes in the landowners' economic interests, their opposition to public education diminishes until eventually they support public education instead. Therefore, an economy that has a politically powerful landed elite, which is

akin to having a higher inequality in landownership, tends to accumulate human capital slowly. Thus, inequality in landownership can have an adverse effect on human capital accumulation.

4 Historical Backgrounds

Korea was under Japanese occupancy from 1905 to 1945 and its economy was periphery to the Japanese economy. Under Japanese rule, land distribution became increasingly skewed, the ratio of tenants to all farming households growing from 42 percent in 1913 to 70 percent in 1945 (Eckert et al. 1991). Propelling this change was the Japanese migration policy of Japan and the Government-General, the Japanese colonial government, in Korea. From the beginning of the colonial period, the Japanese government encouraged its people to migrate into Korea under the suggestion that the ideal pattern of Japanese settlement in Korea was to become a landlord. (Kikkawa, 1904). In 1907, the Oriental Development Company, a semi-governmental Japanese company, began to purchase large tracts of land in Korea to entice Japanese settlers. This company eventually became the largest landlord in Korea (Moskowitz, 1974; Eckert et al., 1991). In 1912, the enforcement of Japanese Land Survey on Korean Land also augmented the tenancy rate by strengthening the legal rights of landowners and encouraging Japanese investment in Korean land. (Kim et al., 1989; Shin, 1982; Eckert et al., 1991; Kim, 2007)

In the 1910s Japan implemented the plan for improvement in rice production, which also contributed to the increase in tenancy rate. At the time Japan was experiencing a soaring demand for cheaper rice as it progressed in industrialization. This increased demand from the Japan mainland was combined with the demand for Korean rice from the Japanese military troops stationed in Manchuria after the Russo-Japanese War in 1904. To meet this greater demand for food, the colonial government was instructed to increase the production of rice at the sacrifice of other crops. Because rice grew best in wet paddy land, it was necessary to construct a more extensive irrigation system, the cost of which was very high. Rather than providing governmental support, the expenses for the irrigation project were placed on the shoulders of the producers themselves - the tenants and the farmers with their own land. Because the policy inevitably connected the Korean rice market with the Japanese and Chinese markets, price fluctuation also increased. Meanwhile, because Japanese landowners preferred detailed written contracts, Korean tenants who did not have experience in written contracts and were in tight economic situations were forced into increasingly unfair tenancy contracts. As a result, the economic condition of tenants continued to deteriorate, increasing the rate of tenancy even more. While in 1914 there had been 41 Japanese landlords who owned more than 100 *jung-bo*, approximately 1,000,000 square meters of land, by 1919 there

were 88 such landlords. Korean large landowners also enlarged their estates during the 1910s. (Chung, 1988)

With the onset of the 1920s, the colonial government implemented an even more active agricultural policy that contributed even further to the expansion of tenancy. Under the name of " The plan for the increased yield of rice," the colonial government promoted major irrigation projects to convert more land into wet paddy soil for rice. Because the brunt of the expensive construction costs fell on Korean farmers, small landowner and tenant classes collapsed. The plan lasted until 1934, when the disastrous effects of the 1929 Great Depression culminated in a widespread agricultural panic and a severe crisis for the Korean rural economy. Throughout the duration of this plan, then, tenancy rate had continued to increase. (Park, 1971; Kazuo, 1976; Chang, 1994; Park, 2001; Lee, 2003)

During Japanese occupation, the colonial government had the power to reorganize Korean society in accordance to the wishes of the metropole. It was a "strong state" without the interference of Korean sociopolitical interest groups. (Woo, 1991) If Japan needed an agricultural colony, then the colonial government would focus all its energy on developing the agricultural sector. If it needed an industrialized colony instead, then the Government-General would force Korea into the process of industrialization. (Ju, 2003) During the 1910s and the 1920s, the Government-General in Korea sought to promote an agricultural economy in Korea by proscribing the development of Korean industries and companies and selling Japanese industrial goods in the Korean market. In a committee meeting held in September, 1920, it was resolved that the Government-General of Joseon should avoid causing any economic conflicts between its industrial policies and the interest of the Japanese industry. In accordance with the resolution, the colonial government promoted no equivalent industrial policy that might create competition for the Japanese industrial sector during the time it enforced the 'The plan for the increased yield of rice' from 1926 to 1934. (Ju, 2003; Seo, 2007)

Japanese control over the Korean colonial government became more liberalistic in the 1930s, loosely restricted to "controlling the Korean economic environment to make the entrance of Japanese industry into the Korean market easier." (Ju, 2003) Japan had become substantially industrialized by the end of the First World War, and its industrial sector had matured by the 1930s. Like the free trade imperialism of Great Britain in the mid-nineteenth century, Japan was now ready to expand its power under a more liberalistic policy. (Eckert et al., 1991; Seo, 2007; Howe, 1997; Darwin, 2009; Gallagher and Robinson, 1953). Although Cumings (1984) and Woo (1991) argued that the colonial government converted to an active industrialization policy in the 1930s, Japan nevertheless maintained the basic colonial agenda that promoted the specialization of an industrialized Japan and an agricultural Korea until the Sino-Japanese War of 1937, albeit under a more liberalistic government. (Ju, 2003; Heo, 1983)

It was only after the outbreak of the second Sino-Japanese War in 1937 that Japan initiated a serious industrialization of Korea. Because the Korean Peninsula is geographically located between Japan and China, Japan sought to industrialize the northern regions of the peninsula to create a supply base for its invasion upon China. In the 5-year development plan submitted in May, 1937, just before the outbreak of the war, the colonial government proposed a boost in the production of coal liquefaction, iron, coal, light metals such as aluminum, and cotton, all of them industries that would form a foundation to support Japanese military power. (Ju, 2003) When the 'committee of inquiry into the current situation' convened in September, 1938, it resolved to make the flow of military supplies between Japan, Korea and China smoother by setting up colonial Korea as a forwarding supply base and propelling a rapid development of military industry there. (Seo, 2007) Although it is true that Korean industrialists did begin to appear by 1919, who were well learned in the language and the skills of entrepreneurship, it was nevertheless the Japanese colonial policy that played the most important role in Korean industrialization during the colonial period. (Eckert et al., 1991, Seo, 2007).

Implementation of a public education system in colonial Korea was also different from that of the nineteenth-century United States or Prussia. The goal of public education under Japanese rule was to create imperial subjects that were easier to control. This Japan sought to achieve by instilling Japanese culture and language in young Koreans. While private Korean schools did persist, they were usually oppressed. The colonial public education system was fundamentally unequal, with Japanese students receiving quality advanced education while Korean students were only given a minimal level of schooling. Understanding this historical context is thus crucial to comprehending the Korean public education system. (Eckert et al., 1991; Kim, 1999).

Despite a central education policy set forth by the colonial government, different localities reacted differently due to varying regional characteristics, such as the degree of industrialization, urbanization, inequality in landownership, as well as differences in regional culture and geography. Also, landowners in Korea exercised great influence over the lives of their tenants, to a degree comparable to that of serfdom in early nineteenth century Prussia (Soh, 2005). This meant that they could also wield their power over tenants' access to education. The level of elementary education, therefore, could also influenced by the degree of inequality in land distribution. Accordingly, this paper focuses on the variations in the reactions to the educational policy across different regions.

An examination of the Korean historical context of the early twentieth century is truly meaningful in the sense that we can test the proposed model to show whether there exists an adverse relation between land inequality and the level of education even in such a

unique historical context, i.e. the colonial experience. If the relation holds, like the results of previous studies with Prussian and American cases, the proposed model can be generalized.

5 Empirical Analysis

5.1 Data description

The data in this paper are sourced from the *Annual Statistical Report of the Government-General* and the unit of analysis is the Korean province. The Government-General, which instituted the Japanese colonial government in Korea from 1910 to 1945, published the Reports annually during their rule in Korea up to 1943. As its title suggests, the Report was a compilation of major statistical information. These data were first collected in 1907 by the Residency-General. The investigated items changed over the Japanese ruling period, but they remained consistent for the time period we consider in this paper (i.e., 1934 to 1942). Our data includes items such as land and weather, population and households, agriculture, manufacturing, fishery, forestry, money and banking, education, religion, and finance. (Park and Seo, 2003).

5.2 Empirical specification and results

The empirical analysis in this paper examines the effect of inequality in distribution of landownership on the level of education through comparisons of the variations across provinces. Inequality in the distribution of landownership, $LandInequality_{i,t-1}$, is measured as the ratio of the number of households of tenants in province i in period $t-1$. As shown in Table 1, Cinnirella and Hornung (2011) and Galor et al. (2009) also measured the inequality in landownership as land concentration to reflect the landowner's power. While it is true that the variable does not capture the variation among tenants, this does not affect the results because the critical factor is whether or not a person is under the influence of the landowner. The level of education, $Education_{i,t}$, is measured as the number of public elementary school students per person in province i in period t, which is the same in Cinnirella and Hornung (2011). The data covers eight periods of observation from 1934 to 1942 and thirteen provinces. A single period of observation is one year, so that when t is 1935, $t-1$ is 1934, and so on through to 1942.

We use the following empirical specification:

$$Education_{i,t} = \beta_0 + \beta_1 LandInequality_{i,t-1} + BX_{i,t-1} + \upsilon_{i,t} \quad (10)$$

where X is the vector of control variables including the share of agriculture, which is the number of farmers relative to the total population of province *i* in period *t* – 1; the share of manufacture, which is the number of workers in the manufacturing sector relative to the total population of province *i* in period *t* – 1; the share of commerce/transportation, which is the number of workers in commerce/transportation relative to the total population in province *i* in period *t* – 1; the rate of population growth in province *i* in period *t* – 1; the share of Japanese, which is the number of Japanese people relative to the total population of province *i* in period *t* – 1; and the number of public elementary schools per 1,000 people in province *i* in period *t* – 1. This formulation captures the lag in making changes to education with respect to current economic and political conditions.

(Insert Table 1 here)

Table 1 shows the control variables that are used in this research as well as Cinnirella and Hornung (2011) and Galor et al. (2009). This paper chooses the same variables as Cinnirella and Hornung (2011) to control for the economic environment, although we use the share of the commerce and transportation sector rather than the manufacturing sector to reflect the level of modernization/industrialization. The reason why this paper chooses the share of commerce and transportation rather than that of manufacturing will be explained momentarily. To control for the supply side of education, this paper controls for the school density, which is measured as the number of public elementary schools per 1,000 people, as Cinnirella and Hornung (2011). To control for the historical context, this paper considers the share of Japanese, while Galor et al. (2009) controlled for the share of black people and Cinnirella and Hornung (2011) for the share of people not using German, the share of the Protestant population and differences in inheritance law. Table 2 provides summary statistics for the variables.

(Insert Table 2 here)

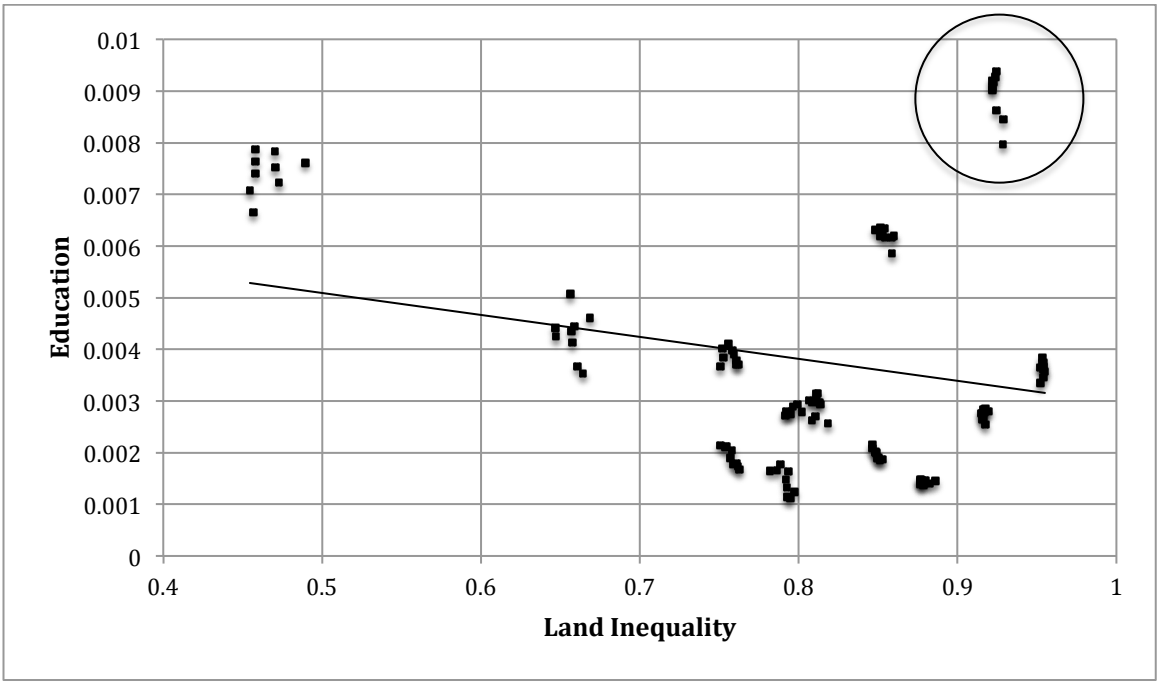
This paper uses panel data. A primary benefit of panel data is that they can solve the problem of unobserved heterogeneity, whereas this is difficult to control when using cross-

sectional or time series data. The error term $\upsilon_{i,t}$ can be divided into time invariant unobserved heterogeneity across provinces in the level of education, η_i , and time variant unobserved heterogeneity at the national level, δ_t . That is,

$$\upsilon_{i,t} = \eta_i + \delta_t + \varepsilon_{i,t} \tag{11}$$

Because data in this paper are not a sample of the population but rather reflect the entire population, it is reasonable to think of $\upsilon_{i,t}$ as a parameter to be estimated instead of a random variable. Our model, then, is a two-way fixed effects model.

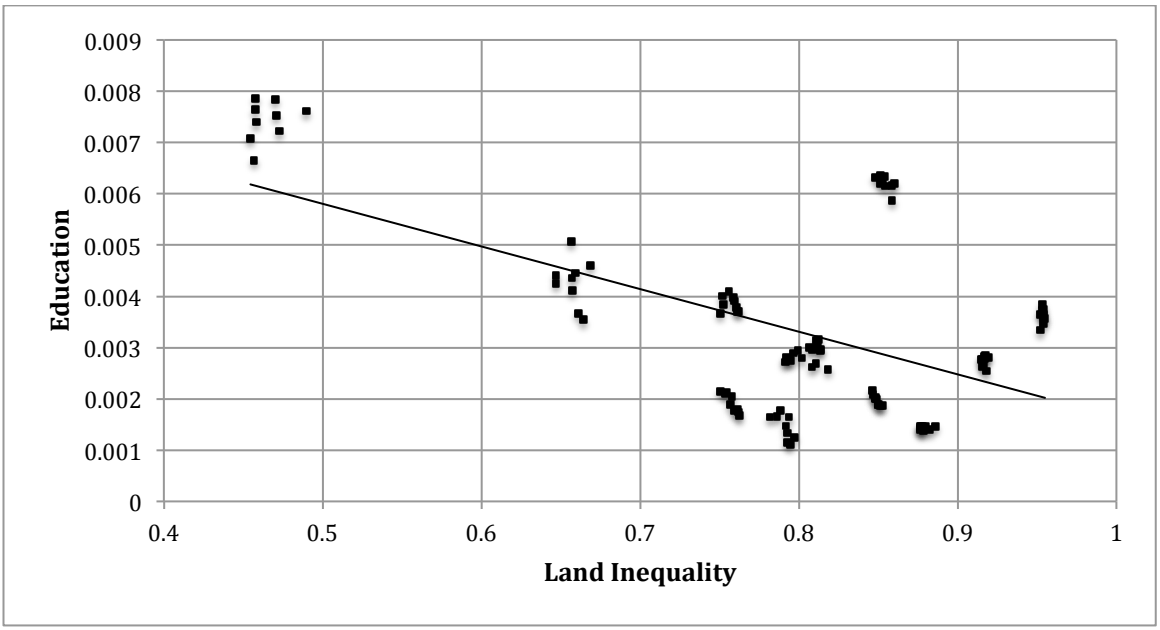
Figure 1 Land inequality and education in all provinces. The points in the circle represent data from the GyeongGi province, which includes Seoul, the capital city of Korea.



Land inequality is measured as the ratio of the number of households of tenants and education is measured as the number of public elementary school students per person
Source: the Annual Statistical Report of the Government-General

The negative correlation between land inequality and education is apparent in Figure 1. The points in the circle represent data from the GyeongGi province, which includes Seoul, the capital city of Korea. It had both the smallest share of farmers and the highest level of commerce and transportation, which are two variables to be controlled for.

Figure 2 Land equality and education excluding the GyeongGi province.



Land inequality is measured as the ratio of the number of households of tenants and education is measured as the number of public elementary school students per person
Source: the Annual Statistical Report of the Government-General

In Figure 2, we remove data pertaining to the GyeongGi province and find stronger evidence of a negative correlation between land inequality and education.

(Insert Table 3 here)

Table 3 shows the correlation between the variables. Because of high correlation between sectors (agriculture, manufacture and commerce/transportation), these variables are used separately. The variable, the share of Japanese correlates with every economic co-variable, namely the share of agriculture, the share of manufacturing, and the share of commerce/transportation. This finding shows that the Japanese factor plays an important role in understanding Korea's economic situation in the period of Japanese occupation. Further, it shows low correlation between the share of Japanese and the level of inequality in landownership, which allows for controlling for both of them at the same time.

(Insert Table 4 here)

Table 4 depicts the results of this estimation in columns (1)–(7). In every column, the adverse effect of land inequality on education is apparent. Lagged land inequality has an adverse and highly significant effect on education with no controls (column (1)) as well as when controlling for the share of agriculture, that of manufacture, that of commerce and transportation, the rate of population growth, the share of the Japanese population, and the

number of public elementary schools per 1,000 people. As one would expect, column (2) shows that the share of agriculture has a negative and highly significant effect on education, and we continue to observe a positive and significant effect of land inequality on education. The share of manufacturing, however, does not have a significant relationship with the education, which is different from the prediction, even though it has a positive sign (column (3)). When the share of commerce and transportation is controlled for, instead of the share of manufacturing, a significant and positive relationship can be observed. The reason why a significant relationship is observed when we control for the share of commerce and transportation rather than that of manufacturing seems to be that the development of commerce and transportation tends to be ahead of that of the manufacturing sector in the history of capitalism. Although the manufacturing sector existed at that time, it had not matured yet and it was difficult to regard the Korean economy as industrialized. Because of collinearity between the share of agricultural jobs and the share of commerce and transportation, we include only the latter in the regressions in columns (4)–(7). In columns (6)–(7), the effect of the population growth rate on education is negative and highly significant, reflecting the quantity-quality trade-off in education in this period. The share of Japanese has a positive and highly significant effect, reflecting the fact that the Japanese population in Korea tended to receive more education. Even controlling for the share of Japanese, the negative and strong effect of land inequality on education holds. It is possible that the significant relationship between land inequality and education may not have held when colonial factors were controlled for, if the colonial government had made a decision on land inequality and on education simultaneously. However, the levels of land inequality and education were not highly correlated and not decided upon by the colonial government at the same time. It is true that tenancy did increase with the colonial government's encouragement towards land inequality during the colonial regime. However, according to Soh (2005), before the 1930s, the tenancy rate had stabilized and land inequality during the period considered in this study was affected by the level of agricultural output of each year. In addition, because landowners were superior to tenants and controlled the tenants' production processes and economic conditions, the decision of the tenants' household pertaining to their children's education could not result only from the education policy of the central government. In column (7), we control for the number of schools per 1,000 people to isolate the effect of the supply of schools on education. The coefficient on the number of schools per 1,000 people is not significant, and including this control does not change our coefficient of interest.

(Insert Table 5 here)

(Insert Table 6 here)

Tables 5 and 6 present robustness checks. In both cases, the effect of land inequality on education is negative and highly significant. The main findings in Table 4 are consistent with the findings of Table 5 (lagging land inequality by two years) and Table 6 (no lag at all), and are thus robust.

(Insert Table 7 here)

Table 7 also presents a robustness check. Because the Second Sino–Japanese War occurred in 1937 and the US stopped exporting natural resources such as petroleum and iron, abrogating the Treaty of Friendship, Commerce, and Navigation between the US and Japan, the Japanese colonial government started to control both the price and the distribution system of food in 1940 to overcome the shortage of food and resources. To eliminate this market control effect, we aim to only cover the period from 1934 to 1939. Table 7 shows that the adverse effect of land inequality on the education still holds, even though the number of observations has shrunk.

We tried to perform an instrumental variables (IVs) estimation, as carried out by previous studies (Cinnirella and Hornung, 2011; Galor et al., 2009). These papers used the following IVs: the relative price of agricultural goods, which reflects the differential effect of agricultural prices over time on the concentration of landownership across provinces, and the climatic conditions of all provinces, which are province-specific but time invariant. However, as we mentioned above, because the outbreak of the Second Sino–Japanese War in 1937 and the Pacific War in 1941 led the Japanese colonial government to control both the price and the distribution system of food in 1940, the market price system did not work after 1939. Nor is the price data at the province level available. Furthermore, because the price data from 1934 to 1939 only exists at the nationwide level, we cannot use this data as an IV, which represents the regional-specific characteristics. This paper, therefore, does not have the relevant data to use this identification strategy. Nevertheless, unobserved heterogeneity is sufficiently controlled in the fixed effects model with panel data and with the time lag and concerning the historical context, the adverse effect of land inequality on education becomes apparent.

6 Conclusion

Human capital accumulation plays a critical role in both the transition from Malthusian stagnation to modern growth and the timing of the implementation of modern growth. Institutions promoting human capital accumulation have contributed to the great divergence in per capita income across countries. Credit market imperfections provide one well-studied hurdle for the accumulation of human capital, but non-financial hurdles are also important impediments to human capital accumulation.

Historical and empirical evidence of the effects of non-financial hurdles in the current economic literature, however, has been largely limited to nineteenth-century century Prussia and the early twentieth-century United States, both of which are Western countries. By contrast, Korea under Japanese occupancy developed in an historical context different from these two countries because of its unique geographical location and colonial experience. Our study shows that the adverse effect of inequality in landownership on the accumulation of human capital is still valid in this case, which signifies that the model formalized by Galor et al. (2009) can be applied more broadly to countries outside of the Western world.

We used a panel dataset with observations from 13 provinces in each year from 1934 to 1942. With panel data, we controlled for unobserved variables using a two-way fixed effects model. Although land distribution and the public education system in Korea were driven in part by the colonial powers, reactions to the central education policy varied by provinces because of the differences in the level of inequality in landownership. Our results show that landownership inequality, a non-financial hurdle, has a strongly significant effect on human capital accumulation.

There is no single theory, today, that fully explains the most critical factor that caused the Great Divergence. Every scholar agrees, nevertheless, that one crucial factor behind the differentiation of the level of income between nations is the timing of industrialization. According to our research, land inequality was one of the factors that acted as an obstacle to industrialization. Higher level of land inequality impedes the accumulation of human capital, which in turn delays the timing of industrialization. If there exist two countries that are exactly the same except for the level of land inequality, the country that has the lower level of inequality will take off first. Our study provides empirical evidence for this model. For underdeveloped countries, who still remain trapped in the vicious cycle of the agricultural Malthusian trap, our research will furnish valuable policy implications that will contribute to eliminating the hurdles that hinder their industrialization.

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Table 1 Variables of the estimates of effect of land inequality on education -- Summary of the literature

Variables		Galor et al. (2009)	Cinnirella and Hornung (2011)	This paper
Main variables	Dependent variable	Educational expenditure	School enrollment rate	School enrollment rate
	Explanatory variable	Land concentration	Land concentration	Land concentration
Economic control	Income per capita	✓		
	Urban (share)	✓		
	Industrial (share)		✓	✓
	Agricultural (share)		✓	✓
Demographic Control	Population growth rate			✓
	Population density		✓	
Education	School density		✓	✓
Historical Context	Ethnicity/Language (share)	✓	✓	✓
	Religion (share)		✓	
	Law		✓	

Table 2 Descriptive Statistics of the Annual Statistical Report of the Government-General

Variable	Definition	Mean	Std. Dev.	Min	Max
Education	The number of public elementary school student over the number of population	0.0038	0.0023	0.0011	0.0094
Land inequality	The number of household of tenants over the number of households of all farmers	0.8011	0.1248	0.4545	0.955
Agriculture	The number of farmers over population	0.7283	0.116	0.3612	0.875
Manufacture	The number of workers in manufacturing sectors over population	0.0344	0.024	0.0096	0.1165
Commerce and transportation	The number of workers in commerce and transportation over population	0.0898	0.0403	0.044	0.204
Rate of population growth	The increase in province's population from year t-1 to t	0.0276	0.0273	-0.0194	0.1389
Japanese	The number of Japanese people over population	0.0271	0.0175	0.0087	0.0666
School density	The number of public elementary schools per 1,000 people	0.0117	0.0056	0.0033	0.0262

Note: Variables are from a province-level panel data and the unit of analysis is the Korean province.
Source: the Annual Statistical Report of the Government-General

Table 3 Correlation between variables

	Education	Land inequality	Agriculture	Manufacture	Commerce and Transportation	Population growth	Japanese	School density
Education	1							
Land inequality	-0.2343	1						
Agriculture	-0.7945	0.5230	1					
Manufacture	0.7178	-0.4674	-0.9430	1				
Commerce and Transportation	0.7294	-0.4626	-0.9429	0.9186	1			
Population growth	0.3123	-0.2876	-0.5759	0.5645	0.5708	1		
Japanese	0.9856	-0.3429	-0.8616	0.7864	0.7840	0.3837	1	
School density	0.6007	-0.2786	-0.3974	0.2790	0.3334	-0.0001	0.5811	1

Table 4 The relationship between education and land inequality (Fixed effects model with 1-year lag)

Explanatory variables	Dependent variable: Education						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Land inequality	**-0.0189*** **	**-0.0231*** **	**-0.0195*** **	**-0.0228*** **	**-0.0228*** **	**-0.0248*** **	**-0.0247*** **
	0.0051	0.0048	0.0056	0.0048	0.0048	0.0044	0.0046
Agriculture		**-0.0031*** **					
		0.0007					
Manufacture			**0.0009**				
			0.0031				
Commerce and transportation				**0.0061**** **	**0.0078*** **	**0.0029**	**0.0029**
				0.0016	0.0029	0.0021	0.0022
Rate of population growth					**-0.0022**	**-0.0039*** **	**-0.0038*** **
					0.0014	0.0014	0.0014
Japanese						**0.0571*** **	**0.0566*** **
						0.0139	0.0147
School density							**0.0031**
							0.0253
National time fixed effect	yes	yes	yes	yes	yes	yes	yes
Regional fixed effect	yes	yes	yes	yes	yes	yes	yes
R^2 (within)	0.3285	0.4484	0.3291	0.4314	0.4472	0.5430	0.5431
Number of observations	104	104	104	104	104	104	104

Two-way fixed effect model using province level panel data

Note: ***denotes significance at the 1% level, ** at 5%, and * at 10%.

Table 5 The relationship between education and land inequality (Fixed effects model with 2-year lag)

Explanatory variables	Dependent variable: Education						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Land inequality	**-0.0148****	**-0.0195*****	**-0.0099**	**-0.0199*****	**-0.0198*****	**-0.0203*****	**-0.0208*****
	0.0059	0.0058	0.0064	0.0061	0.0061	0.0060	0.0063
Agriculture		**-0.0029*****					
		0.0010					
Manufacture			**-0.0070***				
			0.0038				
Commerce and transportation				**0.0052****	**0.0046***	**0.0014**	**0.0012**
				0.0021	0.0027	0.0031	0.0032
Rate of population growth					0.0006	-0.0006	-0.0007
					0.0016	0.0017	0.0018
Japanese						**0.0340***	**0.0364**
						0.0184	0.0203
School density							**-0.0100**
							0.0337
National time fixed effect	yes	yes	yes	yes	yes	yes	yes
Regional fixed effect	yes	yes	yes	yes	yes	yes	yes
R^2 (within)	0.2707	0.3446	0.3050	0.3271	0.3286	0.3607	0.3615
Number of observations	91	91	91	91	91	91	91

Two-way fixed effect model using province level panel data

Note: ***denotes significance at the 1% level, ** at 5%, and * at 10%.

Table 6 The relationship between education and land inequality (Fixed effects model with no lag)

Explanatory variables	Dependent variable: Education						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Land inequality	**-0.0060**	**-0.0118*** **	**-0.0070**	**-0.0100** **	**-0.0105** **	**-0.0143*** **	**-0.0108*** **
	0.0048	0.0045	0.0053		0.0046	0.0038	0.0041
Agriculture		**-0.0037*** **					
		0.0007					
Manufacture			**0.0013**				
			0.0029				
Commerce and transportation				**0.0067*** **	**0.0079*** **	**0.0003**	**0.0019**
				0.0017	0.0018	0.0019	0.0020
Rate of population growth					**-0.0022**	**-0.0041*** **	**-0.0043*** **
					0.0015	0.0012	0.0012
Japanese						**0.0871*** **	**0.0782*** **
						0.0132	0.0134
School density							**0.0426** **
							0.0210
National time fixed effect	yes	yes	yes	yes	yes	yes	yes
Regional fixed effect	yes	yes	yes	yes	yes	yes	yes
R^2 (within)	0.2199	0.3844	0.2217	0.3367	0.3520	0.5600	0.5865
Number of observations	117	117	117	117	117	117	117

Two-way fixed effect model using province level panel data

Note: ***denotes significance at the 1% level, ** at 5%, and * at 10%.

Table 7 Robustness Test: the relationship between education and land inequality before the Pacific War

Explanatory variables	Dependent variable: Education					
	no lag (1)	no lag (2)	1-year lag (1)	1-year lag (2)	2-year lag (1)	2-year lag (2)
Land inequality	**-0.0086****	**-0.0091****	**-0.0092***	**-0.0048**	**-0.0088****	**-0.0023**
	0.0048	0.0035	0.0054	0.0036	0.0045	0.0039
Commerce and transportation	**0.0115*****	**0.0037****	**0.0082*****	**-0.0008**	**0.0055**	**-0.0102****
	0.0018	0.0017	0.0020	0.0018	0.0043	0.0050
Rate of population growth		**-0.0046*****		**0.0017**		**0.0006**
		0.0014		0.0014		0.0014
Japanese		**0.0694*****		**0.0702*****		**0.0623*****
		0.0106		0.0112		0.0159
School density		**0.0345***		**0.0212**		**0.0045**
		0.0178		0.0162		0.0176
National time fixed effect	yes	yes	yes	yes	yes	yes
Regional fixed effect	yes	yes	yes	yes	yes	yes
R2 (within)	0.6631	0.8455	0.6693	0.8697	0.6821	0.8200
Observation	78	78	65	65	52	52

Two-way fixed effect model using province level panel data

Note: ***denotes significance at the 1% level, ** at 5%, and * at 10%.

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Nr.	Autor	Titel	CC
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Nr.	Autor	Titel	CC
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