# Inequality in Land Ownership, the Emergence of Human Capital Promoting Institutions, and the Great Divergence*

Oded Galor, Omer Moav and Dietrich Vollrath†

May 30, 2006

**Abstract**

This research suggests that favorable geographical conditions, that were inherently associated with inequality in the distribution of land ownership, adversely affected the implementation of human capital promoting institutions (e.g., public schooling and child labor regulations), and thus the pace and the nature of the transition from an agricultural to an industrial economy, contributing to the emergence of the Great Divergence in income per capita across countries. The basic premise of this research, regarding the negative effect of land inequality on public expenditure on education is established empirically based on cross-state data from the beginning of the 20th century in the United States.

*Keywords: Land Inequality, Institutions, Geography, Human capital accumulation, Growth*

*JEL classification Numbers:* O10, O40.

*We are grateful to the Editor, the referees and Yona Rubinstien for insightful and detailed comments. We thank Daron Acemoglu, Josh Angrist, Andrew Foster, Eric Gould, Vernon Henderson, Saul Lach, Victor Lavy, Ross Levine, Joel Mokyr, Daniele Paserman, Kenneth Sokolof, David Weil, Ivo Welch, Joseph Zeira, seminar participants at Brown, CEFIR/NES, Cyprus, Royal Holloway, Tel-Aviv, York, Warwick, and conference participants at the *NBER Summer Institute*, 2003, the *Economics of Water and Agriculture*, 2003, Minerva's conference, 2003, ESSIM, Tarragona, 2004, and CEPR Sardinia 2004, *The Evolution of Insitutions*, 2006 for helpful comments. Galor's is supported by *NSF Grant SES-0004304.* and by the *ISF*, and Moav's research is supported by the *ISF*.

†Galor: Brown University and Hebrew University; Moav: Hebrew University, Royal Holloway, and Shalem Center; Vollrath: University of Houston.

# 1 Introduction

The last two centuries have been characterized by a great divergence in income per capita across the globe. The ratio of GDP per capita between the richest and the poorest regions of the world has widened considerably from a modest 3 to 1 ratio in 1820 to an 18 to 1 ratio in 2001 (Maddison, 2001).[1] The role of geographical and institutional factors, human capital formation, ethnic, linguistic, and religious fractionalization, colonialism and globalization has been the center of a debate about the origin of the differential timing of the transition from stagnation to growth and the remarkable change in the world income distribution.

This paper argues that inequality in the distribution of land ownership, adversely affected the emergence of human capital promoting institutions (public schooling and child labor regulations) and thus the pace and the nature of the transition from an agricultural to an industrial economy, contributing to the emergence of the great divergence in income per capita across countries.[2] The theory further suggests that some land abundant countries that were characterized by an unequal distribution of land, were overtaken in the process of industrialization by land scarce countries in which land distribution was rather equal.

The transition from an agricultural economy to an industrial economy has changed the nature of the main economic conflict in society. Unlike the agrarian economy which was characterized by a conflict of interest between the landed aristocracy and the masses, the process of industrialization has shifted the conflict towards a dispute between the entrenched landed aristocratic elite and the emerging capitalists elite.[3] The capitalists who were striving for an educated labor force had interest in policies that promoted the education of the masses, whereas the landowners whose interest lied in the reduction of the potential mobility of the rural labor force, favored policies that deprived the masses from education.[4]

The process of development and industrialization raised the importance of human capital,

[1] Some researchers (e.g., Jones, 1997 and Pritchett, 1997) have demonstrated that this diverging pattern persisted in the last decades as well. Interestingly, however, as established by Sala-i-Martin (2006), the phenomena has not been maintained across people in the world (i.e., when national boundaries are removed).

[2] Most of the existing studies (e.g., Hall and Jones, 1999), attribute the differences in income per-capita across countries largely to differences in TFP, whereas some (e.g., Manuali and Seshadri, 2005) provide evidence in favor of the dominating role of human capital. Nevertheless, it should be noted that even if the direct role of human capital is limited, as established by Glaeser et al. (2004), it has a large indirect effect on growth via its effect on technological progress and the implementation of growth enhancing institution.

[3] One may view the civil war in the US as a struggle between the industrialists in the north who were striving for a large supply of (educated) workers, and the landowners in the south that wanted to sustained the existing system and to assure the existence of a large supply of cheap (uneducated) labor. In particular, Bowles (1978) discusses the incentives of landlords to restrict access to education in order to preserve a relatively cheap labor force.

[4] "In reality that law reveals the disinterest in rural education, a disinterest based on.... essentially an agrarian structure, inherited from the colonial period. The perpetuation of rural illiteracy is one of the elements that permits the conservation of a traditional rural society. It slows horizontal movement (rural to urban) and vertical movement (aspirations for land reform)," (Ivon Lebot (1972) in his reflection about the education law passed in 1903 in Colombia, quoted in Hanson (1986)).

reflecting the complementarity of physical capital and technology to human capital. Investment in human capital, however, has been sub-optimal due to credit markets imperfections, and public investment in education has been therefore growth enhancing.[5] Nevertheless, human capital accumulation has not benefited all sectors of the economy. Due to a lower degree of complementarity between human capital and land,[6] a rise in the level of education would have increased the productivity of labor in industrial production more than in agriculture, decreasing the return to land due to labor migration, and the associated rise in wages. Landowners, therefore, had no economic incentives to support these growth enhancing educational policies as long as their stake in the productivity of the industrial sector was insufficient.[7]

The theory suggests that the adverse effect of the implementation of public education on landowners' income from agricultural production is magnified by the concentration of land ownership.[8] Hence, as long as landowners have affected the political process and thereby the implementation of education reforms, inequality in the distribution of land ownership has been a hurdle for human capital accumulation, slowing the process of industrialization and the transition to modern growth.[9] In economies characterized by concentration of land ownership, an inefficient education policy persisted and the growth path was retarded. In contrast, in societies in which land ownership was distributed rather equally, growth enhancing education policies were implemented at earlier stages, positively affecting the process of development.[10]

The process of industrialization and the accumulation of physical capital by landowners

[5] See Galor and Zeira (1993), Fernandez and Rogerson (1996), and Benabou (2000).

[6] Although, rapid technological change in the agricultural sector may increase the return to human capital (e.g., Foster and Rosenzweig, 1996), the return to education is typically lower in the agricultural sector, as evident by the distribution of employment in the agricultural sector. For instance, as reported by the U.S. department of Agriculture (1998), 56.9% of agricultural employment consists of high school dropouts, in contrast to an average of 13.7% in the economy as a whole. Similarly, 16.6% of agricultural employment consists of workers with 13 or more years of schooling, in contrast to an average of 54.5% in the economy as a whole.

[7] Landowners, as well as other owners of factors of production, influence the level of public schooling but are limited in their power to levy taxes for their own benefit. Otherwise, following the Coasian Theorem, the landed elite would prefer an optimal level of education, taxing the resulting increase in aggregate income. Nevertheless, landowners may benefit from the economic development of other segments of the economy due to capital ownership, household's labor supply to the industrial sector, the provision of public goods, and demand spillover from economic development of the urban sector.

[8] The proposed mechanism focuses on the emergence of public education. Alternatively, one could have focused on child labor regulation, linking it to human capital formation as in Doepke and Zilibotti (2003), or on the endogenous abolishment of slavery (e.g., Lagerlof, 2003) and the incentives it creates for investment in human capital.

[9] Consistently with the proposed theory, Deininger and Squire (1998) document that the level of education and economic growth over the period 1960-1992 are inversely related to land inequality (across landowners) and the relationship is more pronounced in developing countries.

[10] The adverse relationship between natural resources and growth is documented even in smaller time frames. Sachs and Warner (1995) and Gylfason (2001) document a significant inverse relationship between natural resources and growth in the post World-War II era. Gylfason finds that a 10% increase in the amount of natural capital is associated with a fall of about 1% in the growth rate. Furthermore, based on a cross section study, he reports significant negative relationships between the share of natural capital in national wealth, and public spending on education, expected years of schooling, and secondary-school enrollments, concluding that natural resources crowd out human capital formation.

have raised their interest in the productivity of the industrial sector. Ultimately, a qualitative change in landowners' attitudes towards education reforms took place allowing for the implementation of efficient human capital promoting institutions.[11] In particular, economies in which land was rather equally distributed, implemented earlier public education, leading to the emergence of a skill-intensive industrial sector and a rapid process of development. In contrast, among economies marked by an unequal distribution of land ownership, land abundance that was a source of richness in early stages of development, led, in later stages, to under-investment in human capital, an unskilled-intensive industrial sector, and a slower growth process.[12] Thus, variations in the distribution of land ownership across countries generated variations in the industrial composition of the economy, and thereby the observed diverging growth patterns across the globe.[13]

The predictions of the theory regarding the adverse effect of the concentration of land ownership on the implementation of education reforms is examined empirically based on cross-state data from the beginning of the 20th century in the US. Variations in public spending on education across states in the US during the high school movement are utilized in order to examine the thesis that land inequality was a hurdle for public investment in human capital. In addition, historical evidence surveyed in section 3 suggests that indeed the distribution of land ownership affected the nature of the transition from an agrarian to an industrial economy and has been significant in the emergence of sustained differences in human capital and growth patterns across countries.

## 2 Related Literature

The central role of human capital formation in the transition from stagnation to growth is underlined in unified growth theory (Galor, 2005). This research establishes theoretically (Galor and Weil, 2000, Galor and Moav, 2002) and quantitatively (Doepke, 2004, Fernandez-Villaverde,

[11] The proposed theory relies on the diminishing importance of land rents for the income of the economy over time, in accordance with the long run trend in developed countries. For the United Kingdom, Lindert (1986) documents that the share of land rent in national income in 1867 was 5%, falling to less than 0.5% in 1972-73. A similar pattern is found for the United States, where in 1900 the share of national income going to rent was 9.1%, by 1930 was 6.6%, and by 2005 was 0.7%. (The 1900 figure is from the U.S. Historical Statistics, series F186-191. The 1930 and 2005 figures are from the Bureau of Economic Analysis.) Even if all proprietor's income from farms is additionally assumed to be a factor payment to land, the share of national income in 1930 is 11% and in 2005 is only 0.9%. Under either assumption the share of land rents in national income is approaching zero over time.

[12] According to the theory, therefore, land reform would bring about an increase in the investment in human capital. The differential increase in the productivity of workers in the industrial and the agricultural sectors would generate migration from the agricultural to the industrial sector accompanied by an increase in agricultural wages and a decline in agricultural employment. Consistent with the proposed theory, Besley and Burgess (2000) find that over the period 1958-1992 in India, land reforms have raised agricultural wages, despite an adverse effect on agricultural output.

[13] As established by Chanda and Dalgaard (2003), variations in the structural composition of economies and in particular the allocation of scarce inputs between the agriculture and the non-agriculture sectors are important determinants of international differences in TFP, accounting for between 30 and 50 percents of these variations.

2005, and Lagerlof, 2006) that the rise in the demand for human capital in the process of industrialization and its effect on human capital formation, technological progress, and the onset of the demographic transition, have been the prime forces in the transition from stagnation to growth. As the demand for human capital emerged, variations in the extensiveness of human capital formation and therefore in the rapidity of technological progress and the timing of the demographic transition, significantly affected the distribution of income in the world economy.

The proposed theory suggests that the concentration of land ownership has been a major hurdle in the emergence of human capital promoting institutions. Thus the observed variations in human capital formation and in the emergence of divergence and overtaking in economic performance, is attributed to the historical differences in the distribution of land ownership across countries. The predictions of the theory are consistent with earlier findings about the inverse relationship between land inequality and human capital formation across countries (Deininger and Squire, (1998)) and with our findings that land inequality had a significant adverse effect on education expenditure in the US.

The role of institutional factors has been the focus of an alternative hypothesis regarding the origin of the great divergence. North (1981), Landes (1998), Mokyr (1990, 2002), Parente and Prescott (2000), and Acemoglu, Johnson and Robinson (2002) have argued that institutions that facilitated the protection of property rights, enhancing technological research and the diffusion of knowledge, have been the prime factor that enabled the earlier European take-off and the great technological divergence across the globe.[14]

The effect of geographical factors on economic growth and the great divergence have been emphasized by Jones (1981), Diamond (1997) and Sachs and Werner (1995).[15] The geographical hypothesis suggests that favorable geographical conditions made Europe less vulnerable to the risk associated with climate and diseases, leading to the early European take-off, whereas adverse geographical conditions in disadvantageous regions, generated permanent hurdles for the process of development, contributing to the great divergence.[16]

The exogenous nature of the geographical factors and the inherent endogeneity of the institutional factors lead researchers to hypothesize that initial geographical conditions had a persistent effect on the quality of institutions, leading to divergence and overtaking in economic performance.[17] Engerman and Sokolof (2000) - ES - provide descriptive evidence that geographi-

[14] Divergence could also emerge from differences in legal origins (Gleaser and Shleifer, 2002). Barriers to technological adoption that may lead to divergence are explored by Howitt and Mayer-Foulkes (2005) and Acemoglu, Aghion and Zilibotti (2006).

[15] See Hall and Jones (1999), Masters and McMillan (2001) and Hibbs and Olson (2004) as well.

[16] Bloom, Canning and Sevilla (2003) reject, in a cross section analysis, the geographical determinism, but maintain nevertheless that favorable geographical conditions have mattered for economic growth since they increased the likelihood of an economy to escape a poverty trap.

[17] The role of ethnic, linguistic, and religious fractionalization in the emergence of divergence and "growth tragedies" has been linked to their effect on the quality of institutions (Easterly and Levine, 1997).

cal conditions that led to income inequality, brought about oppressive institutions (e.g., restricted access to the democratic process and to education) designed to maintain the political power of the elite and to preserve the existing inequality, whereas geographical characteristics that generated an equal distribution of income led to the emergence of growth promoting institutions. Acemoglu, Johnson and Robinson (2002) - AJR - provide evidence that reversals in economic performance across countries have a colonial origin, reflecting institutional reversals that were introduced by European colonialism across the globe.[18] "Reversals of fortune" reflect the imposition of extractive institutions by the European colonialists in regions where favorable geographical conditions led to prosperity, and the implementation of growth enhancing institutions in poorer regions.[19]

The proposed theory differs in several important dimensions from the earlier analysis of the relationship between geographically factors, inequality, and institutions. First, the theory suggests that a conflict of interest among the economic elites i.e., industrialists and landowners (rather than between the ruling elite and the masses as argued by ES and AJR) brought about the delay in the implementation of growth enhancing educational policies. Hence, in contrast to the viewpoint of ES and AJR about the persistent desirability of extractive institutions for the ruling elite, the proposed theory suggests that the implementation of growth promoting institutions emerges in the process of development as the economic interest of the industrialists dominates. Second, consistent with existing cross sectional evidence, the theory underlines the adverse effect of unequal distribution of land ownership (rather than wealth inequality as suggested by ES) in the timing of educational reforms. Moreover, the paper establishes empirically that land inequality had a major effect on education reforms in the US whereas wealth inequality has only a secondary effect. Third, the theory focuses on the direct economic incentive (i.e., the adverse effect of education reforms on the land rental rate) that induces the landed elite to block education reforms, rather than on the effect of political reforms on the distribution of political power and thus the degree of rent extraction. Hence, unlike ES, and AJR, even if the political structure remains unchanged, economic development ultimately triggers the implementation of growth promoting institutions.[20]

A complementary approach suggests that interest groups (e.g., landed aristocracy and monopolies) block the introduction of new technologies and superior institutions in order to protect their political power and thus maintain their rent extraction. Olson (1982), Mokyr (1990),

[18] Additional aspects of the role of colonialism in comparative developments are analyzed by Bertocchi and Canova (2002).

[19] Brezis, Krugman and Tsiddon (1993), in contrast, attribute technological leapfrogging to the acquired comparative advantage (via learning by doing) of the current technological leaders in the use of the existing technologies.

[20] In contrast to the political economy mechanism proposed by Persson and Tabellini (2000), where land concentration induces landowners to divert resources in their favor via distortionary taxation, in the proposed theory land concentration induces lower taxation so as to assure lower public expenditure on education, resulting in a lower economic growth. The proposed theory is therefore consistent with empirical findings that taxation is positively related to economic growth and negatively to inequality (e.g., Benabou, 1996 and Perotti, 1996).

Parente and Prescott (2000), and Acemoglu and Robinson (2002) argue that this type of conflict, in the context of technology adoption, has played an important role throughout the evolution of industrial societies.[21] Interestingly, the political economy interpretation of our theory suggests, in contrast, that the industrial elite would relinquish power to the masses in order to overcome the desire of the landed elite to block economic development.[22]

Empirical research is inconclusive about the significance of human capital rather than institutional factors in the process of development. Some researchers suggest that initial geographical conditions affected the current economic performance primarily via their effect on institutions. Acemoglu, Johnson and Robinson (2002), Easterly and Levine (2003), and Rodrik, Subramanian and Trebbi (2004) provide evidence that variations in the contemporary growth processes across countries can be attributed to institutional factors whereas geographical factors are secondary, operating primarily via variations in institutions. Moreover, Easterly and Levine (1997) and Alesina et al. (2003) demonstrate that geopolitical factors brought about a high degree of fractionalization in some regions of the world, leading to the implementation of institutions that are not conducive for economic growth and thereby to diverging growth paths across regions.

Glaeser et al. (2004) revisit the debate whether political institutions cause economic growth, or whether, alternatively, growth and human capital accumulation lead to institutional improvement. In contrast to earlier studies, they find that human capital is a more fundamental source of growth than political institutions (i.e., risk of expropriation by the government, government effectiveness, and constraints on the executives). Moreover, they argue that poor countries emerge from poverty through good policies (e.g., human capital promoting policies) and only subsequently improve their political institutions.

Finally, the paper contributes to the political economy approach to the relationship between inequality, redistribution and economic growth. This literature argued initially that inequality generates political pressure to adopt redistributive policies, and that the distortionary taxation that is associated with these policies adversely affects investment and economic growth (Alesina and Rodrik, 1994 and Persson and Tabellini, 1994). Existing evidence, however, do not support either of the two underlying mechanisms (Perotti, 1996). In contrast, the proposed theory suggests that inequality (in the distribution of land ownership) is in fact a barrier for redistribution and growth promoting educational policy, provided that land owners have sufficient political power. This mechanism resembles the one advanced by Benabou (2000) in his exploration of the relationship between redistribution and growth.[23] He demonstrates that a country would implement an efficient tax policy and converge to a higher income steady-state provided that the

[21] Barriers to technological adoption that may lead to divergence are explored by Caselli and Coleman (2002), Howitt and Mayer-Foulkes (2005) and Acemoglu, Aghion and Zilibotti (2006) as well.

[22] See Lizzeri and Persico (2004) and Ghosal and Proto (2005) as well.

[23] See also Benabou (2002) for the trade-offs between redistribution and economic growth.

initial level of inequality is low and that the better endowed agents have therefore limited interest to lobby against it.[24] Otherwise the efficient redistribution will be blocked, perpetuating initial inequality and confining the economy to a low-income steady-state.[25]

# 3 Historical Evidence

Historical evidence suggests that indeed the distribution of land ownership has been a significant force in the emergence of sustained differences in human capital formation and growth patterns across countries.

## 3.1 Land Ownership and the Level of Education

Anecdotal Evidence suggests that the degree of concentration of land ownership across countries and regions are inversely related to education expenditure and attainment. North and South America provide the most distinctive set of suggestive evidence about the relationship between the distribution of land ownership, education reforms, and the process of development. The original colonies in North and South America had a vast amount of land per person and levels of income per capita that were comparable to the Western European ones. North and Latin America, however, differed in the distribution of land and resources. While the United States and Canada have been characterized by a relatively egalitarian distribution of land ownership, in the rest of the new world land and resources have been persistently concentrated in the hand of the elite (Deininger and Squire, 1998).

Consistent with the proposed theory, the persistent differences in the distribution of land ownership between North and Latin America were associated with significant divergence in education and income levels across these regions (Maddison, 2001). Although all of the economies in the western hemisphere were developed enough in the early 19th century to justify investment in primary schools, only the United States and Canada were engaged in the education of the general population (Coatsworth, 1993, and Engerman and Sokoloff, 2000).

Variations in the degree of inequality in the distribution of land ownership among Latin American countries were reflected in variation in investment in human capital as well. In particular, Argentina, Chile and Uruguay in which land inequality was less pronounced invested significantly more in education (Engerman and Sokolof, 2000). Similarly, Nugent and Robinson (2002) show that in Costa Rica and Colombia where coffee is typically grown in small farms (reflecting lower inequality in the distribution of land) income and human capital are significantly

[24] This mechanism is echoed in Gardstein (2006) that argues that the support for the protection of property rights is greater the more equal income distribution and the smaller is the political bias.

[25] Similarly, Bourguignon and Verdier (2000) suggest that if political participation is determined by the education (socioeconomic status) of citizens, the elite may not find it beneficial to subsidize universal public education despite the existence of positive externalities from human capital.

higher than that of Guatemala and El Salvador, where coffee plantations are rather large.[26] Moreover, one of the principles championed by the progressives during the Mexican Revolution of 1910 was compulsory, free public education. However, the achievement of this goal varied greatly by state. In the north, with a relatively more equitable land distribution, enrollment in public schools increased rapidly as industrialization advanced following the revolution. This is in contrast to the southern states, which were dominated by the *haciendas* who employed essentially slave labor. In these states there was virtually no increase in school enrollment following the revolution (Vaughan, 1982). Similarly, rural education in Brazil lagged due to the immense political power of the local landlords. Hence, in 1950, thirty years after the Brazilian government had instituted an education reform, nearly 75% of the nation was still illiterate (Bonilla, 1965).

## 3.2 Land Reforms and Subsequent Education Reforms

Evidence from Japan, Korea, Russia, and Taiwan indicates that land reforms were followed by significant education reforms. There are two interpretations for those historical episodes in which land reforms is followed by education reforms. First, land reforms may diminish the economic incentives of landowners to block education reforms. Second, the feasibility of land reforms is indicative of the political weakness of the landed aristocracy that prevents them from blocking growth enhancing education reforms. Both interpretations are consistent with the theory regarding the adverse effect of the concentration of land ownership on education reforms. The former, directly via the proposed economic mechanism, and the later indirectly via a political mechanism in which, given the conflict of economic interest between the landowners and capitalists, the degree of implementation of education reforms is an outcome of the balance of power in society.

### 3.2.1 Japan and the Meiji Restoration

Towards the end of Tokugawa regime (1600- 1867), although the level of education in Japan was impressive for its time, the provision of education was sporadic and had no central control or funding, reflecting partly the resistance of the landholding military class for education reforms (Gubbins, 1973). The opportunity to modernize the education system arrived with the overthrow of the traditional feudal structure shortly after the Meiji Restoration of 1868. In 1871, an Imperial Decree initiated the abolishment of the feudal system. In a sequence of legislation in the period 1871-1883, decisions on land utilization and choice of crops were transferred to farmers from their landlords, prohibitions on the sale and mortgage of farmland were removed, a title of ownership was granted to the legal owners of the land, and communal pasture and forest land was

[26] In contrast to the proposed theory, Nugent and Robinson (2002) suggest that a holdup problem generated by the monopsony power in large plantations prevents commitment to reward investment in human capital, whereas small holders can capture the reward to human capital and have therefore the incentive to invest. This mechanism does not generate the economic forces that permit the economy to escape this institutional trap.

transferred from the ownership of wealthy landlords to the ownership of the central government. This legislations resulted in the distribution of land holdings among small family farms, which persisted until the rise of a new landlord system during the 1930's (Hayami, 1975, chapter 3).

Consistent with the proposed theory, the process of education reform followed rapidly the process of land reform. In 1872 the Educational Code established compulsory and locally funded education for all children between ages 6 and 14 (Gubbins, 1973, chapter 30). In addition, a secondary school and university system was funded by the central government. The Education Code of 1872, was refined in 1879 and 1886, setting the foundations for the structure of Japanese education until World War II. The progress in education attainment following the land reforms of the Meiji government was substantial. While in 1873 only 28% of school-age children attended schools, this ratio increased to 51% by 1883 and to 94% by 1903 (Passin, 1965).

### 3.2.2 Russia before the Revolution

Education in Tsarist Russia lagged well behind comparable European countries at the close of the 19th century. Provincial councils dominated by wealthier landowners, were responsible for their local school systems and were reluctant to favor education for the peasants (Johnson, 1969). Literacy rates in the rural areas were a mere 21% in 1896, and the urban literacy rate was only 56%. As the Tsar's grip on power weakened during the early 1900's the political power of the wealthy landowners gradually declined leading to a sequence of agrarian reforms that were initiated by the premier Stolypin in 1906. Restrictions on mobility of peasants were abolished, fragmented landholdings were consolidated, and the formation of individually owned farms was encouraged and supported through the provision of government credit. Stolypin's reforms accelerated the redistribution of land to individual farmers and landholdings of the landed aristocracy declined from about 35-45% in 1860 to 17% in 1917. (Florinsky, 1961).

Consistent with the proposed theory, following the agrarian reforms and the declining influence of the landed aristocracy, the provision of compulsory elementary education had been proposed. The initial effort of 1906 languished, but the newly created representative Duma continued to pressure the government to provide free compulsory education. In the period 1908-1912, the Duma approved a sequence of a significant increase in expenditures for education (Johnson, 1969). The share of the Provincial council's budget that was allocated to education increased from 20.4% in 1905 to 31.1% in 1914 (Johnson, 1969), the share of the central government's budget that was devoted to the Ministry of Public Education increased three-fold from 1.4% in 1906 to 4.9% in 1915, and the share of the entire population that was actively attending schools increased 3-fold from 1.7% in 1897 to 5.7% in 1915 (Dennis, 1961).

### 3.2.3 South Korea and Taiwan

The process of development in Korea was marked by a major land reform followed by a massive increase in governmental expenditure on education. During the Japanese occupation in the period 1905-1945, land distribution in Korea became increasingly skewed and in 1945 nearly 70% of Korean farming households were simply tenants (Eckert, 1990). In 1948-1950, the Republic of Korea instituted the Agricultural Land Reform Amendment Act that drastically affected landholdings.[27] The principle of land reform was enshrined in the constitution of 1948 and the actual implementation of the Agricultural Land Reform Amendment Act began on March 10th, 1950.[28] This act prohibited tenancy and land renting, put a maximum on the amount of land any individual could own, and dictated that an individual could only own land if they actually cultivated it. Owner cultivated farm households increased 6-fold from 349,000 in 1949 to 1,812,000 in 1950, and tenant farm households declined from 1,133,000 in 1949 to essentially zero in 1950. (Yoong-Deok and Kim, 2000).

Following the land reforms, expenditure on education soared. In 1949, a new Education Law was passed within South Korea that focused specifically on transforming the population into a technically competent workforce capable of industrial work. This led to dramatic increases in the number of schools and students at all levels of education. Between 1945 and 1960 the number of elementary schools increased by 60% and the number of elementary students went up by a staggering 165%. In secondary education the growth is even more dramatic, with both the number of schools and the number of students growing by a factor of ten in the same time period. The number of higher education institutions quadrupled and the number of higher education students increased from only 7,000 in 1945 to over 100,000 in 1960. In 1948, Korea allocated 8% of government expenditures to education. Following a slight decline due to the Korean war, educational expenditure has increased to 9.2% in 1957 and 14.9% in 1960, remaining at about 15% thereafter.(Sah-Myung, 1983).

Taiwan experienced a similar path over the same period once the Japanese colonization ended. The government of Taiwan implemented a land reform in the time period 1949-1953. It enforced rent reductions, it sold public land to individual farmers who had previously been tenants, and permitted the purchase of rented land. In 1948, prior to the land reform, 57% of farm families were full or part owners, 43% were tenants or hired hands. By 1959 the share of full or part owners had increased to 81%, and the share of tenants or hired-hands dropped to 19% (Cheng, 1961).

[27] A major force behind this land reform was the aim of the U.S. provisional government after WWII to remove the influence of the large landowners (who were either Japanese or collaborators with the Japanese).

[28] Formally the education reform took place prior to the land reforms, but the provision for land reform was enshrined in the constitution prior to the educational reform. The imminent land reform could have reduced the incentives for the landed aristocracy to oppose this education reform.

A massive educational reform followed the land reform. The number of schools in Taiwan grew by 5% per year between 1950 and 1970, while the number of students grew by 6% a year. The pattern of growth mirrors that of South Korea, with especially impressive growth of 11% per year in the number of secondary students, and a 16% per year in higher education students. Funding for education grew from 1.78% of GNP in 1951 to 4.12% in 1970 (Lin, 1983).

In 1950 South Korea and Taiwan were primarily agricultural economies with a GDP per capita $770 and $936, respectively.[29] South Korea and Taiwan lagged in GDP per capita well behind many countries within Latin America, such as Colombia ($2153) and Mexico ($2365), sharing with these countries a legacy of vast inequality in the distribution of agricultural land. In contrast, to the Latin American countries, the implementation of land reforms in South Korea and Taiwan and its apparent effect of education reforms affected their growth trajectory significantly, leading them to one of the most successful economic growth stories of the post-war period. From a level of income per capita in 1950 that placed them not only far behind the nations of Latin America but behind also Congo, Liberia, and Mozambique, these two countries have each grown at an average rate of nearly 6% per year between 1950 and 1998, leaving behind the countries of sub-Saharan Africa and overtaking the Latin American countries in this period. In 1998 South Korea and Taiwan had GDP per capita levels 150% higher than Colombia and 100% higher than Mexico (Maddison, 2001).

## 4 The Basic Structure of the Model

Consider an overlapping-generations economy in a process of development. In every period the economy produces a single homogeneous good that can be used for consumption and investment. The good is produced in an agricultural sector and in a manufacturing sector using land, physical and human capital as well as raw labor. The stock of physical capital in every period is the output produced in the preceding period net of consumption and human capital investment, whereas the stock of human capital in every period is determined by the aggregate public investment in education in the preceding period. The supply of land is fixed over time. Physical capital accumulation raises the demand for human capital and output grows due to the accumulation of physical and human capital.[30]

[29] Measured in 1990 international dollars (Maddison, 2001).

[30] Alternatively, the rise in the demand for human capital could have been based on technological progress, and output growth could have been due to technological progress and factor accumulation. This specification would not alter the main qualitative results.

### 4.1 Production of Final Output

The output in the economy in period $t$, $y_t$, is given by the aggregate output in the agricultural sector, $y_t^A$, and in the manufacturing sector, $y_t^M$,

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

#### 4.1.1 The Agricultural Sector

Production in the agricultural sector occurs within a period according to a neoclassical, constant-returns-to-scale production technology, using labor and land as inputs. The output produced at time $t$, $y_t^A$, is

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

where $X_t$ and $L_t$ are land and the number of workers, respectively, employed by the agricultural sector in period $t$. Hence, workers' productivity in the agricultural sector is independent of their level of human capital. The production function is strictly increasing and concave, the two factors are complements in the production process, $F_{XL} > 0$, and the function satisfies the neoclassical boundary conditions that assure the existence of an interior solution to the producers' profit-maximization problem.

Producers in the agricultural sector operate in a perfectly competitive environment. Given the wage rate per worker, $w_t^A$, and the rate of return to land, $\rho_t$, producers in period $t$ choose the level of employment of labor, $L_t$, and land, $X_t$, so as to maximize profits. That is, $\{X_t, L_t\} = \arg\max\ [F(X_t, L_t) - w_t L_t - \rho_t X_t]$. The producers' inverse demand for factors of production is therefore,

$$\begin{aligned} w_t^A &= F_L(X_t, L_t); \\ \rho_t &= F_X(X_t, L_t). \end{aligned} \tag{3}$$

#### 4.1.2 Manufacturing Sector

Production in the manufacturing sector occurs within a period according to a neoclassical, constant-returns-to-scale, Cobb-Douglas production technology using physical and human capital as inputs.[31] The output produced at time $t$, $y_t^M$, is

$$y_t^M = K_t^\alpha H_t^{1-\alpha} = H_t k_t^\alpha; \quad k_t \equiv K_t/H_t; \quad \alpha \in (0,1), \tag{4}$$

where $K_t$ and $H_t$ are the quantities of physical capital and human capital (measured in efficiency units) employed in production at time $t$. Physical capital depreciates fully after one period. In

[31] As will become apparent, the choice of a Cobb-Douglas production function assures that there is no conflict of interest between Capitalists and Workers regarding the optimal education policy, permitting the analysis to focus on the conflict between the Landowners and the Capitalists.

contrast to the agricultural sector, human capital has a positive effect on workers' productivity in the manufacturing sector.

Producers in the manufacturing sector operate in a perfectly competitive environment. Given the wage rate per efficiency unit of labor, $w_t^M$, and the rate of return to capital, $R_t$, producers in period $t$ choose the level of employment of capital, $K_t$, and the number of efficiency units of labor, $H_t$, so as to maximize profits. That is, $\{K_t, H_t\} = \arg\max\, [K_t^{\alpha} H_t^{1-\alpha} - w_t^M H_t - R_t K_t]$. The producers' inverse demand for factors of production is therefore

$$\begin{aligned} R_t &= \alpha k_t^{\alpha-1} \equiv R(k_t); \\ w_t^M &= (1-\alpha) k_t^{\alpha} \equiv w^M(k_t). \end{aligned} \tag{5}$$

## 4.2 Individuals

In every period a generation which consists of a continuum of individuals of measure 1 is born. Individuals live for two periods. Each individual has a single parent and a single child. Individuals, within as well as across generations, are identical in their preferences and innate abilities but they may differ in their wealth.

Preferences of individual $i$ who is born in period $t$ (a member $i$ of generation $t$) are defined over second period consumption,[32] $c_{t+1}^i$, and a transfer to the offspring, $b_{t+1}^i$.[33] They are represented by a log-linear utility function

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

where $\beta \in (0,1)$.

In the first period of their lives individuals acquire human capital. In the second period of their lives individuals join the labor force, allocating the resulting wage income, along with their return to capital and land, between consumption and income transfer to their children. In addition, individuals transfer their entire stock of land to their offspring.[34]

An individual $i$ born in period $t$ receives a transfer, $b_t^i$, in the first period of life. A fraction $\tau_t \geq 0$ of this capital transfer is collected by the government in order to finance public education, whereas a fraction $1-\tau_t$ is saved for future income. Individuals devote their first period for the acquisition of human capital. Education is provided publicly free of charge. The acquired level

[32] For simplicity we abstract from first period consumption. It may be viewed as part of the consumption of the parent.

[33] This form of altruistic bequest motive (i.e., the "joy of giving") is the common form in the recent literature on income distribution and growth. It is supported empirically by Altonji, Hayashi and Kotlikoff (1997). As discussed in section 4, if individuals generate utility from the utility of their offspring the qualitative results remain intact.

[34] This assumption capture the well established fact that at least in early stages of development, land is not fully tradable due to (e.g., agency and moral hazard problems). (See Bertocchi, 2006). It is designed to assure that landowners could be meaningfully defined as a distinct viable class. If land would be fully traded, land holdings would be equivalent to any other asset holdings and in contrast to historical evidence, landowners would not be a significant force in the political structure of the economy.

of human capital increases with the real resources invested in public education. The number of efficiency units of human capital of each member of generation $t$ in period $t+1$, $h_{t+1}$, is a strictly increasing, strictly concave function of the government real expenditure on education per member of generation $t$, $e_t$.[35]

$$h_{t+1} = h(e_t), \tag{7}$$

where $h(0) = 1$, $\lim_{e_t \to 0^+} h'(e_t) = \infty$, and $\lim_{e_t \to \infty} h'(e_t) = 0$. Hence, even in the absence of real expenditure on public education individuals still posses one efficiency unit of human capital - basic skills - assuring the operation of the industrial sector in every time period.

In the second period of life, members of generation $t$ join the labor force earning the competitive market wage $w_{t+1}$. In addition, individual $i$ derives income from capital ownership, $b_t^i(1-\tau_t)R_{t+1}$, and from the return on land ownership, $x^i \rho_{t+1}$, where $x^i$ is the quantity of land owned by individual $i$. The individual's second period income, $I_{t+1}^i$, is therefore

$$I_{t+1}^i = w_{t+1} + b_t^i(1-\tau_t)R_{t+1} + x^i \rho_{t+1}. \tag{8}$$

A member $i$ of generation $t$ allocates second period income between consumption, $c_{t+1}^i$, and transfers to the offspring, $b_{t+1}^i$, so as to maximize utility subject to the second period budget constraint:

$$c_{t+1}^i + b_{t+1}^i \leq I_{t+1}^i. \tag{9}$$

Hence the optimal transfer of a member $i$ of generation $t$ is,[36]

$$b_{t+1}^i = \beta I_{t+1}^i, \tag{10}$$

consumption $c_{t+1}^i = (1-\beta)I_{t+1}^i$, and the indirect utility function of a member $i$ of generation $t$, $v_t^i$, is therefore monotonically increasing in $I_{t+1}^i$:

$$v_t^i = \ln I_{t+1}^i + \xi \equiv v(I_{t+1}^i), \tag{11}$$

where $\xi \equiv (1-\beta)\ln(1-\beta) + \beta \ln \beta$.

### 4.3 Physical Capital, Human Capital, and Output

The aggregate level of intergenerational transfers in period $t$, as follows from (10), is a fraction $\beta$ from the aggregate level of income $y_t$. A fraction $\tau_t$ of this capital transfer is collected by the

[35] A more realistic formulation would link the cost of education to (teacher's) wages, which may vary in the process of development. As can be derived from section 3.4, under both formulations the optimal expenditure on education, $e_t$, is an increasing function of the capital-labor ratio in the economy, and the qualitative results remain therefore intact.

[36] Note that individual's preferences defined over the transfer to the offspring, $b_t^i$, or over net transfer, $(1-\tau_t)b_t^i$, are represented in an indistinguishable manner by the log linear utility function. Under both definitions of preferences the bequest function is given by $b_{t+1}^i = \beta I_{t+1}^i$.

government in order to finance public education, whereas a fraction $1-\tau_t$ is saved for future consumption. The capital stock in period $t+1$, $K_{t+1}$, is therefore

$$K_{t+1} = (1-\tau_t)\beta y_t, \tag{12}$$

whereas the government tax revenues are $\tau_t \beta y_t$.

Let $\theta_{t+1}$ be the fraction (and the number - since population is normalized to 1) of workers employed in the manufacturing sector. The education expenditure per young individual in period $t$, $e_t$, is,

$$e_t = \tau_t \beta y_t, \tag{13}$$

and the stock of human capital, employed in the manufacturing sector in period $t+1$, $H_{t+1}$, is therefore,

$$H_{t+1} = \theta_{t+1} h\left(\tau_t \beta y_t\right), \tag{14}$$

Hence, output in the manufacturing sector in period $t+1$ is,

$$y_{t+1}^M = [(1-\tau_t)\beta y_t]^\alpha [\theta_{t+1} h\left(\tau_t \beta y_t\right)]^{1-\alpha} \equiv y^M(y_t, \tau_t, \theta_{t+1}), \tag{15}$$

and the physical-human capital ratio $k_{t+1} \equiv K_{t+1}/H_{t+1}$ is,

$$k_{t+1} = \frac{(1-\tau_t)\beta y_t}{\theta_{t+1} h(\tau_t \beta y_t)} \equiv k(y_t, \tau_t, \theta_{t+1}), \tag{16}$$

where $k_{t+1}$ is strictly decreasing in $\tau_t$ and in $\theta_{t+1}$, and strictly increasing in $y_t$. As follows from (5), the capital share in the manufacturing sector is

$$(1-\tau_t)\beta y_t R_{t+1} = \alpha y_{t+1}^M, \tag{17}$$

and the labor share in the manufacturing sector is given by

$$\theta_{t+1} h(\tau_t \beta y_t) w_{t+1}^M = (1-\alpha) y_{t+1}^M. \tag{18}$$

The supply of labor to agriculture, $L_{t+1}$, is equal to $1-\theta_{t+1}$ and the supply of land is fixed over time at a level $X > 0$. Output in the agriculture sector in period $t+1$ is, therefore,

$$y_{t+1}^A = F(X, 1-\theta_{t+1}) \equiv y^A(\theta_{t+1}; X). \tag{19}$$

As follows from the properties of the production functions both sectors are active in $t+1$ as long as $\tau_t < 1$. Hence, since individuals are perfectly mobile between the two sectors they can either supply one unit of labor to the agriculture sector and receive the wage $w_{t+1}^A$ or supply $h_{t+1}$ efficiency units of labor to the manufacturing sector and receive the wage income $h_{t+1} w_{t+1}^M$.[37] Hence,

$$w_{t+1}^A = h_{t+1} w_{t+1}^M \equiv w_{t+1}, \tag{20}$$

[37] Even if mobility between the sectors is not fully unrestricted, the qualitative results would not be altered.

and the fraction of employment in the manufacturing sector, $\theta_{t+1}$, equalizes the marginal product of workers in the two sectors, and thus maximizes output per capita in the economy.

**Lemma 1** *The fraction of workers employed by the manufacturing sector in period* $t+1$, $\theta_{t+1}$ *is uniquely determined:*

$$\theta_{t+1} = \theta(y_t, \tau_t; X),$$

*where* $\theta_X(y_t, \tau_t; X) < 0$, $\theta_y(y_t, \tau_t; X) > 0$, *and* $lim_{y \to \infty}\ \theta(y_t, \tau_t; X) = 1$.
*Moreover,* $\theta_{t+1}$ *maximizes output in period* $t+1$, $y_{t+1}$ :

$$\theta_{t+1} = \arg\max y_{t+1}.$$

**Proof.** Substitution (3), (5), and (16) into (20) it follows that

$$\Phi(\theta_{t+1}, y_t, \tau_t; X) \equiv F_L(X, 1-\theta_{t+1}) - h(\tau_t \beta y_t)(1-\alpha)\left(\frac{(1-\tau_t)\beta y_t}{\theta_{t+1} h(\tau_t \beta y_t)}\right)^{\alpha} = 0. \qquad (21)$$

Hence, since $\partial\Phi(\theta_{t+1}, y_t, \tau_t; X)/\partial\theta_{t+1} > 0$, it follows from the *Implicit Function Theorem* that there exist a single valued function $\theta_{t+1} = \theta(y_t, \tau_t; X)$, where the properties of the function are obtained noting the properties of the function $h(\tau_t \beta y_t)$ and $F_L(X, 1-\theta_{t+1})$. Moreover, since $\theta_{t+1}$ equalizes the marginal return to labor in the two sectors, and since the marginal products of all factors of production are decreasing in both sectors, $\theta_{t+1} = \arg\max y_{t+1}$. □

**Corollary 1** *Given land size,* $X$, *prices in period* $t+1$ *are uniquely determined by* $y_t$ *and* $\tau_t$. *That is*

$$w_{t+1} = w(y_t, \tau_t; X);$$
$$R_{t+1} = R(y_t, \tau_t; X);$$
$$\rho_{t+1} = \rho(y_t, \tau_t; X).$$

**Proof.** As established in Lemma 1, $\theta_{t+1} = \theta(y_t, \tau_t; X)$, and the corollary follows noting (3), (5), (16) and (19). □

### 4.4 Efficient Expenditure on Public Education

This section demonstrates that the level of expenditure on public schooling (and hence the level of taxation) that maximizes aggregate output is optimal from the viewpoint of all individuals except for landowners who own a large fraction of the land in the economy.

**Lemma 2** *Let* $\tau_t^*$ *be the tax rate in period* $t$, *that maximizes aggregate output in period* $t+1$,

$$\tau_t^* \equiv \arg\max y_{t+1}.$$

*(a)* $\tau_t^*$ *equates the marginal return to physical capital and human capital:*

$$\theta_{t+1} w^M(k_{t+1}) h'(\tau_t^* \beta y_t) = R(k_{t+1}).$$

*(b)* $\tau_t^* = \tau^*(y_t) \in (0,1)$ *is unique, and* $\tau^*(y_t)y_t$*, is strictly increasing in* $y_t$*.*

*(c)* $\tau_t^* = \arg\max y_{t+1}^M$*.*

*(d)* $\tau_t^* = \arg\max(1-\tau_t)R_{t+1}$*.*

*(e)* $\tau_t^* = \arg\max \theta(y_t, \tau_t; X)$*.*

*(f)* $\tau_t^* = \arg\max w_{t+1}$*.*

*(g)* $\tau_t^* = \arg\min \rho_{t+1}$*.*

**Proof.**

(a) As follows from (15), (19), and Lemma 1, aggregate output in period $t+1$, $y_{t+1}$ is

$$y_{t+1} = y(y_t, \tau_t; X) = y^M(y_t, \tau_t, \theta(y_t, \tau_t; X)) + y^A(\theta(y_t, \tau_t; X); X). \tag{22}$$

Hence, since, as established in Lemma 1, $\theta_{t+1} = \theta(y_t, \tau_t; X) = \arg\max y_{t+1,}$ it follows from the envelop theorem that

$$\frac{\partial y_{t+1}}{\partial \tau_t} = \frac{\partial y^M(y_t, \tau_t, \theta_{t+1})}{\partial \tau_t}. \tag{23}$$

Furthermore, since $\tau_t^* = \arg\max y_{t+1}$ then $\partial y^M(y_t, \tau_t^*, \theta_{t+1})/\partial \tau_t = 0,$ and thus as follows from (15),

$$\theta_{t+1}(1-\alpha)h'(\tau_t^*\beta y_t) = \alpha\frac{\theta_{t+1}h(\tau_t^*\beta y_t)}{(1-\tau_t^*)\beta y_t}. \tag{24}$$

Noting 16, $\tau_t^*$ satisfies

$$\theta_{t+1}(1-\alpha)k_{t+1}^{\alpha}h'(\tau_t^*\beta y_t) = \alpha k_{t+1}^{\alpha-1}, \tag{25}$$

and the proof follows, noting that $\alpha k_{t+1}^{\alpha-1} \equiv R(k_{t+1})$ and $(1-\alpha)k_{t+1}^{\alpha} \equiv w^M(k_{t+1})$.

(b) As follows from (24)

$$\frac{(1-\tau_t^*)\beta y_t}{h(\tau_t^*\beta y_t)} = \frac{\alpha}{(1-\alpha)h'(\tau_t^*\beta y_t)}. \tag{26}$$

Hence, since $h(\tau_t^*\beta y_t) \geq 1$ for all $\tau_t^*\beta y_t \geq 0$ and $\lim_{e_t \to 0^+} h'(e_t) = \infty$, it follows that $\tau_t^* = \tau^*(y_t) \in (0,1)$ for all $y_t > 0$. The uniqueness $\tau_t^*$ follows from the properties of the function $h(\tau_t^*\beta y_t)$. Furthermore, $\tau^*(y_t)y_t$ is increasing in $y_t$. Suppose not. Suppose that $\tau^*(y_t)y_t$ is decreasing in $y_t$. It follows that $\tau^*$ is strictly decreasing in $y_t$ and therefore the left hand side of (26) is strictly increasing in $y_t$ whereas the right hand side is decreasing. A contradiction.

(c) As derived in part (a), since $\tau_t^* = \arg\max y_{t+1}$, it follows from the envelope theorem that

$$\tau_t^* = \arg\max y^M(y_t, \tau_t, \theta(y_t, \tau_t; X)) = \arg\max[(1-\tau_t)\beta y_t]^{\alpha}[h(\tau_t\beta y_t)]^{1-\alpha}\theta_{t+1}^{1-\alpha}. \tag{27}$$

(d) Follows from part (c) noting that, as follows from (17), $(1-\tau_t)R_{t+1} = \alpha y_{t+1}^M/(\beta y_t)$.

(e) As follows from part (c)

$$\tau_t^* = \arg\max[(1-\tau_t)\beta y_t]^{\alpha}[h(\tau_t\beta y_t)]^{1-\alpha}\theta_{t+1}^{1-\alpha}, \tag{28}$$

and therefore for any $\theta_{t+1}$,

$$\tau_t^* = \arg\max[(1-\tau_t)\beta y_t]^\alpha [h(\tau_t \beta y_t)]^{1-\alpha}. \tag{29}$$

Moreover, since

$$\begin{aligned}\theta_{t+1} &= \theta(y_t, \tau_t; X) \\ &= \arg\max y_{t+1} = \arg\max[(1-\tau_t)\beta y_t]^\alpha [h(\tau_t \beta y_t)]^{1-\alpha} \theta_{t+1}^{1-\alpha} + F(X, 1-\theta_{t+1}),\end{aligned} \tag{30}$$

it is strictly increasing in $[(1-\tau_t)\beta y_t]^\alpha [h(\tau_t \beta y_t)]^{1-\alpha}$, and therefore $\tau_t^* = \arg\max \theta(y_t, \tau_t; X)$.
(f) As follows from (3) and (20),

$$w_{t+1} = F_L(X, 1-\theta_{t+1}), \tag{31}$$

and therefore since $w_{t+1}$ is monotonically increasing in $\theta_{t+1}$ it follows from part (e) that $\tau_t^* = \arg\max w_{t+1}$.
(g) Follows from part (f) noting that along the factor price frontier $\rho_t$ decreases in $w_t^A$ and therefore in $w_t$. □

As established in Lemma 2 the value of $\tau_t^*$ is independent of the size of land, $X$. The size of land has two opposing effects on $\tau_t^*$ that cancel one another due to the Cobb-Douglass production function in the manufacturing sector. Since a larger land size implies that employment in the manufacturing sector is lower, the fraction of the labor force whose productivity is improved due to taxation that is designed to finance universal public education is lower. In contrast, the return to each unit of human capital employed in the manufacturing sector is higher while the return to physical capital is lower, since human capital in the manufacturing sector is scarce.

Furthermore, since the tax rate is linear and the elasticity of substitution between human and physical capital in the manufacturing sector is unitary, as established in Lemma 2, the tax rate that maximizes aggregate output in period $t+1$ also maximizes the wage per worker, $w_{t+1}$, and the net return to capital, $(1-\tau_t^*)R_{t+1}$. Hence, there is no conflict of interest between Capitalists and Workers regarding the optimal education policy.[38] Moreover, given the factor price frontier, since $\tau_t^*$ maximizes the wage per worker, $w_{t+1}$, it minimizes the rent on land, $\rho_{t+1}$.

As follows from Lemma 2, the desirable tax policy from the viewpoint of individual $i$ depends on the income that the individual derives for land holding, $x^i \rho_{t+1}$, relative to the income that the individual generates from capital holding and wages, $w_{t+1} + b_t^i(1-\tau_t)R_{t+1}$. In particular,

[38] The absence of disagreement between the Capitalists and Workers about the optimal tax policy would hold as long as the production function is Cobb-Douglas. However, even if the elasticity of substitution would be different than one, in contrast to land owners, both groups would support public education although they would differ in their desirable tax rates. If the elasticity is larger than unity but finite, then the tax rate that maximizes the wage per worker would have been larger than the optimal tax rate and the tax rate that maximizes the return to capital would have been lower, yet strictly positive. If the elasticity of substitution is smaller than unity, the opposite holds.

as established in the following proposition, individuals whose land income is sufficiently small relative to their capital and wage income would support the efficient tax policy.

**Proposition 1** *Given* $(b_t^i, y_t, X)$*, there exists a sufficiently low level of land holding by individual* $i$*,* $\hat{x}^i$*, such that the desirable level of taxation from the viewpoint of individual* $i$ *is the level of taxation that maximizes output per capita,* $\tau_t^*$*.* $\hat{x}^i$ *is inversely related to the level of* $b_t^i$*.*

**Proof.** Since the indirect utility function of individual $i$, is a strictly increasing function of the individual's second period wealth, $I_{t+1}^i$, the desirable level of taxation from the viewpoint of individual $i$, maximizes $I_{t+1}^i = I^i(y_t, \tau_t, b_t^i, x^i; X) = w(y_t, \tau_t; X) + b_t^i(1 - \tau_t)R(y_t, \tau_t; X) + x^i\rho(y_t, \tau_t; X)$. As established in Lemma 2, $w_{t+1}$, and $(1-\tau_t)R_{t+1}$ are maximized by $\tau_t^*$, and $\rho_{t+1}$ is minimized by $\tau_t^*$. Hence, $\partial I^i(y_t, \tau_t^*, b_t^i, x^i, X)/\partial\tau_t = 0$ and for $x^i = 0$, $\tau_t^*$ is a global maximum and for $x^i \to \infty$, $\tau_t^*$ is a global minimum. Since $\partial\rho(y_t, \tau_t, b_t^i, x^i, X)/\partial\tau_t < \infty$, it follows from the continuity of $I^i(y_t, \tau_t^*, b_t^i, x^i, X)$ in $x^i$ that there exists a sufficiently low level of $x^i$, $\hat{x}^i$, such that $\tau_t^* = \arg\max I_{t+1}^i$ for all $x^i \leq \hat{x}^i$ (i.e., there exists a sufficiently low $x^i$ such that $\tau_t^*$ maximizes $I_{t+1}^i$ globally), where $\hat{x}^i$ is inversely related to the levels of $b_t^i$. □

### 4.5 Political Mechanism

In light of our interest in the effect of economic rather than political transitions on education reforms and economic growth, the political structure of the economy was designed as a stationary structure that is unaffected by economic development. In particular, we deliberately impose a crude political mechanism under which education reforms require the consent of the class of Landowners. Although economic development does not affect this political structure, it changes the economic incentives confronted by landowners and thereby affect their attitude towards educations reforms.

Clearly, even in democracies, the median voting model is not perfectly applicable. Strong interest groups, such as landowners, exert a larger influence on public policy relative to their representation in the population. For the sake of simplicity we adopt an extreme modeling approach that provides landowners as a group with a veto power against education reforms. The adoption of some alternative approaches, such as a lobbing model, or probabilistic voting model (Lindbeck and Weibull, 1987), would not change the qualitative results. Moreover, in order to focus on the conflict between Landowners and the remaining segments of the economy, we abstract from a potential conflict of interest among landowners, assuming land is equally distributed across landowners, and coordination among landowners is therefore not essential.[39]

[39]The introduction of inequality in landholdings across landowners would not affect the qualitative results. It would have an ambiguous effect on the timing of education reforms. Large landowners that would be expected to suffer a larger loss in rental rents due to education reforms, would be engaged in more intense lobbying activity to block these reforms, but their force will be diminished due to their smaller representation within the group of landowners.

Suppose that changes in the existing educational policy require the consent of all segments of society. In the absence of consensus the existing educational policy remains intact. Suppose further that consistently with the historical experience, societies initially do not finance education (i.e., $\tau_0 = 0$). It follows that unless all segments of society would find it beneficial to alter the existing educational policy the tax rate will remain zero. Once all segments of society find it beneficial to implement educational policy that maximizes aggregate output, this policy would remain in effect unless all segments of society would support an alternative policy.

### 4.6 Landlords' Desirable Schooling Policy

Suppose that in period 0 a fraction $\lambda \in (0, 1)$ of all young individuals in society are Landlords while a fraction $1 - \lambda$ are landless. Each landlord owns an equal fraction of the entire stock of land, $X$, and is endowed with $b_0^L$ units of output. Since landlords are homogeneous in period 0 and since land is bequeathed from parent to child and each individual has a single child and a single parent, it follows that the distribution of land ownership in society is constant over time, where each landlord owns $X/\lambda$ units of land. Similarly, capital is equally divided within the class of landlords, each endowed with $b_t^L$ units of output in period $t$.

The income of each landlord in the second period of life, $I_{t+1}^L$, as follows from (8) and Corollary 1, is therefore

$$I_{t+1}^L = w(y_t, \tau_t; X) + (1 - \tau_t)R(y_t, \tau_t; X)b_t^L + \rho(y_t, \tau_t; X)X/\lambda, \tag{32}$$

and $b_{t+1}^L$, as follows from (10) is therefore

$$b_{t+1}^L = \beta[w(y_t, \tau_t; X) + (1 - \tau_t)R(y_t, \tau_t; X)b_t^L + \rho(y_t, \tau_t; X)X/\lambda] \equiv b^L(y_t, b_t^L, \tau_t; X, \lambda). \tag{33}$$

As summarized in the following Lemma, the economy advances and the share of land in aggregate output gradually declines, the stake of landowners in other sectors gradually increases, due to their labor and capital holdings, and their objection to education reforms therefore declines over time.[40]

**Proposition 2** *In the absence of taxation in the initial period, i.e.,* $\tau_0 = 0$, *given the political mechanism,*

*(a) There exists a critical level of the aggregate capital inheritance of all landowner,* $\hat{B}_t^L$, *where* $B_t^L = \lambda b_t^L$, *above which their income under the efficient tax policy* $\tau_t^*$ *is higher than under* $\tau_t = 0$,

[40]If land is also used in the manufacturing sector, the results will not be affected qualitatively, as long as the share of land that is employed in the industrial sector is initially small. The rise in the rental rate on industrial land in the process of urbanization and its impact on the rise on the rental rate of land in the economy as a whole, would just accelerate the transition, since it will increase landowners benefits from the process of industrialization.

*and the economy switches to* $\tau_t^*$ *- the tax rate that maximizes income per capita.*

$$\hat{B}_t^L = \frac{\lambda\left[w(y_t, 0; X) - w(y_t, \tau_t^*; X)\right] + X[\rho(y_t, 0; X) - \rho(y_t, \tau_t^*; X)]}{(1-\tau_t^*)R(y_t, \tau_t^*; X) - R(y_t, 0; X)} \equiv \hat{B}^L(y_t; X, \lambda).$$

*(b) The critical level of capital holdings,* $\hat{B}_t^L$*, above which the efficient tax policy is chosen,*

*(i) increases with the degree of land inequality in the economy, i.e.,*

$$\partial\hat{B}^L(y_t; X, \lambda)/\partial\lambda < 0;$$

*(ii) is zero for a sufficiently low level of land inequality (i.e. for a sufficiently large* $\lambda$*). In particular,*

$$lim_{\lambda\to 1}\hat{B}^L(y_t; X, \lambda) \le 0.$$

*(iii) is zero for a sufficiently large level of income per capita. In particular,*

$$lim_{y_t\to\infty}\hat{B}^L(y_t; X, \lambda) \le 0.$$

*(c) Let* $\hat{t}$ *be the first period in which the efficient tax policy,* $\tau_t = \tau_t^*$*, is implemented. The efficient tax policy will remain in place thereafter, i.e.,*

$$\tau_t = \tau_t^* \qquad \forall t \ge \hat{t}.$$

**Proof.**

(a) Noting that landlords are identical and their number is unchanged in the process of development, the tax policy that maximizes income of all landowners also maximizes the income of each landowner. As follows from (32), $\hat{B}_{t+1}^L = \hat{B}^L(y_t; X, \lambda)$ is the level of $B_t^L = \lambda b_t^L$ that equates the income of landowners in the case were $\tau_t = 0$ and $\tau_t = \tau_t^*$. $\hat{B}_{t+1}^L$ exists since as established in Lemma 2 $\tau_t^* = \arg\max(1-\tau_t)R_{t+1}$ and thus $(1-\tau_t^*)R(y_t, \tau_t^*; X) - R(y_t, 0; X) > 0$.

(b) (i) Follows directly from the derivation of $\hat{b}(y_t; X, \lambda)$, with respect to $\lambda$, noting that for a given $y_t$, $\lambda$ has no effect on prices and that for $y_t > 0$, $\tau_t^* = \arg\max w_{t+1} > 0$, and therefore $[w(y_t, 0; X) - w(y_t, \tau_t^*; X)] < 0$.

(b) (ii) Since the agriculture production function (2) is CRS, it follows that the aggregate return to land is

$$X\rho_{t+1} = F(X, 1-\theta_{t+1}) - w_{t+1}(1-\theta_{t+1}). \tag{34}$$

Hence, landlord's income, $\lambda I_{t+1}^i = \lambda w_{t+1} + (1-\tau_t)R_{t+1}B_t^L + X\rho_{t+1}$, is

$$\lambda I_{t+1}^L = w(y_t, \tau_t; X)\left[\lambda + \theta_{t+1} - 1\right] + (1-\tau_t)R(y_t, \tau_t; X)B_t^L + F(X, 1-\theta_{t+1}). \tag{35}$$

Since $\theta_{t+1} = \arg\max \rho_t = \arg\max F(X, 1-\theta_{t+1}) - w_{t+1}(1-\theta_{t+1})$, it follows from the envelope theorem that

$$\frac{\partial\lambda I_{t+1}^L}{\partial\tau_t} = \frac{\partial w(y_t, \tau_t; X)}{\partial\tau_t}\left[\lambda + \theta_{t+1} - 1\right] + \frac{\partial(1-\tau_t)R(y_t, \tau_t; X)}{\partial\tau_t}B_t^L. \tag{36}$$

Thus if $\lambda > 1 - \theta_{t+1} > 0$, it follows from Lemma 2 that for any $B_t^L \geq 0$,

$$sign\left[\frac{\partial \lambda I_{t+1}^L}{\partial \tau_t}\right] = \begin{cases} > 0 \text{ for } \tau < \tau_t^* \\ = 0 \text{ for } \tau = \tau_t^* \\ < 0 \text{ for } \tau > \tau_t^*, \end{cases} \tag{37}$$

and therefore for a sufficiently large $\lambda$ the threshold is zero, i.e., $lim_{\lambda \to 1} \hat{B}^L(y_t; X, \lambda) \leq 0$.

(b) (iii) As follows from Lemma 1, as $y_t \to \infty$, $\theta_{t+1} \to 1$ and therefore it follows from (36) that for any $B_t^L \geq 0$, (37) holds and hence $lim_{y_t \to \infty} \hat{B}^L(y_t; X, \lambda) \leq 0$.

(c) As established in Proposition 1, the desirable tax policy from the viewpoint of workers and capitalists is $\tau_t^*$. Hence, given that the political mechanism requires a consensus for changes in the tax policy, once the chosen tax rate is $\tau_t^*$ it will remain so thereafter.[41] □

**Remark**. There exists a range of agricultural production functions (e.g., in which the elasticity of substitution between labor and land is $0, 1$ and $\infty$), such that the desirable level of taxation from the viewpoint of landowners (in the range $\tau_t^L \in [0, \tau_t^*]$ are $\tau = 0$ or $\tau = \tau^*$.[42] However, even if the desirable level of taxation from the viewpoint of a landowner would have been $\tau_t^L \in (0, \tau_t^*)$, given the political mechanism, and the absence of taxation in period 0, the tax rate that prevails in the economy in every period $t$ is either 0 or $\tau_t^*$. Under a different political structures the transition from a zero tax rate to $\tau_t^*$ could be a gradual process. The process of development will induce landowners to compromise (or support) increasingly higher levels of taxation and the qualitative results regarding the adverse effect of land inequality on the implementation of education reforms would remain intact.

# 5 The Process of Development

This section analyzes the evolution of an economy from an agricultural to an industrial-based economy. It demonstrates that the gradual decline in the importance of the agricultural sector along with an increase in the capital holdings in landlords' portfolio may alter the attitude of landlords towards educational reforms. In societies in which land is scarce or its ownership is distributed rather equally, the process of development allows the implementation of an optimal education policy, and the economy experiences a significant investment in human capital and a rapid process of development. In contrast, in societies where land is abundant and its distribution

[41] It should be noted that, in fact, landowners optimal tax rate will remain $\tau^*$ thereafter, since education reforms would further increase the stake of landowners in the non-agricultural part of the economy.

[42] (i) If land and labor are perfect substitutes the marginal productivity of land is independent of the amount of labor employed. Landowners would therefore prefer $\tau_t = \tau_t^*$ so as to maximize the return to their labor and capital holdings. (ii) If land and labor are perfect complements, as established in Proposition 5, as long as the wage rate is below the threshold level above which the demand for workers in agriculture is zero, landowners prefer the lowest level of industrial output, $y_t^M$, and hence $\tau_t = 0$. Clearly, above the threshold they prefer $\tau_t^*$ since the return to land is zero anyway. (iii) If the production function is Cobb-Douglas $F(X, L_t) = AX^\gamma L_t^{1-\gamma}$, as established in Appendix 1, landowners would prefer either $\tau_t = 0$ or $\tau_t = \tau_t^*$ over any $\tau_t \in (0, \tau_t^*)$.

is unequal, an inefficient education policy will persist and the economy will experience a lower growth path as well as a lower level of output in the long-run.

**Proposition 3** *The conditional evolution of output per capita, as depicted in Figure 1, is given by*

$$y_{t+1} = \begin{cases} \psi^0(y_t) \equiv (\beta y_t)^\alpha \theta(y_t, 0; X)^{1-\alpha} + F(X, 1-\theta(y_t, 0; X)) & for \quad \tau_t = 0; \\ \psi^*(y_t) \equiv [(1-\tau_t^*)\beta y_t)^\alpha [\theta(y_t, \tau_t^*; X) h(\tau_t^* \beta y_t))^{1-\alpha} + F(X, 1-\theta(y_t, \tau_t^*; X)) & for \quad \tau_t = \tau_t^*, \end{cases}$$

*where,*
$\psi^*(y_t) > \psi^0(y_t)$ *for* $y_t > 0$.
$d\psi^j(y_t)/dy_t > 0$, $d^2\psi^j(y_t)/dy_t^2 < 0$, $\psi^j(0) = F(X,1) > 0$, $d\psi^j(y_t)/dX > 0$, *and*
$lim_{y_t \to \infty} d\psi^j(y_t)/dy_t = 0$; $j = 0, *$.

**Proof.** As follows from (1), (15) and (19), $y_{t+1} = y_{t+1}^A + y_{t+1}^M = [(1-\tau_t)\beta y_t)^\alpha [\theta_{t+1} h(\tau_t \beta y_t))^{1-\alpha} + F(X, 1-\theta_{t+1})$. Thus, noting that, $h(0) = 1$ the evolution of $y_{t+1}$ as stated in the proposition is obtained. Since $\tau_t^* = \arg\max y_{t+1}$ and $\tau_t^* > 0$, it follows that $\psi^*(y_t) > \psi^0(y_t)$ for $y_t > 0$. As follows from Lemma 1 and Proposition 2, the properties of the functions $\psi^*(y_t)$ and $\psi^0(y_t)$ follows, noting that $\theta_{t+1} = \arg\max y_{t+1}$, $\tau_t^* = \arg\max y_{t+1}$ and applying the envelop theorem.□

Note that the evolution of output per capita, for a given schooling policy, is independent of the distribution of land and income.

**Corollary 2** *Given the size of land, X, there exists a unique* $\bar{y}^0$ *and a unique* $\bar{y}^*$ *such that*

$$\bar{y}^0 = \psi^0(\bar{y}^0);$$

$$\bar{y}^* = \psi^*(\bar{y}^*),$$

*where* $\bar{y}^* > \bar{y}^0$.

**Proof.** Follows from the properties of $\psi^*(y_t)$ and $\psi^0(y_t)$, as established in Proposition 3. □

The evolution of income per capita. as depicted in Figure 1, and as follows from Proposition 2 and Proposition 3, is

$$y_{t+1} = \begin{cases} \psi^0(y_t) & for \quad t < \hat{t} \\ \psi^*(y_t) & for \quad t \geq \hat{t}. \end{cases}$$

Hence, the economy evolves on the lower trajectory dictated by $\psi^0(y_t)$ till time $\hat{t}$ (e.g., where the level of income is $\hat{y} \equiv y_{\hat{t}}$) and then moves to a higher trajectory that is governed by $\psi^*(y_t)$.

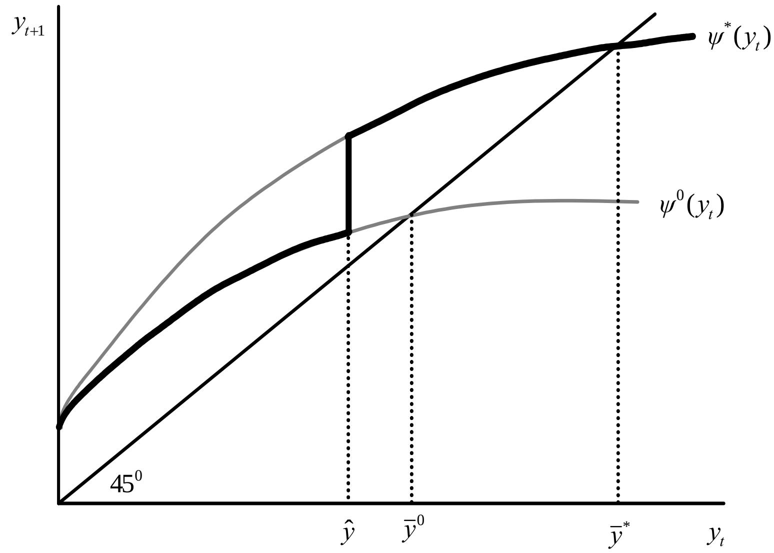


Figure 1: Education Reform and the Evolution of Output Per Capita

**Proposition 4** *For a given set of initial conditions, (i.e., $y_0$, $k_0$, $X$, $h_0 = 1$, $B_0^L = \lambda\beta I_0^L < \hat{B}^L(y_0; X, \lambda)$ and therefore $\tau_0 = 0$), a less equal land distribution, (i.e., a low level of $\lambda$), will generate a delay in the implementation of an efficient education policy and will therefore result in an inferior growth path. That is, a less equal land distribution implies that the timing of the implementation of the efficient tax policy, $\hat{t}$, is delayed.*

**Proof.** As follows from (33), noting that $B_{t+1}^L = \lambda b_{t+1}^L = \lambda\beta I_{t+1}^L$, the evolution of aggregate capital holdings of landowners, for $\tau_t = 0$, and for $t > 0$ is

$$B_t^L = \beta\left[\lambda w_{t-1} + R_{t-1}B_{t-1}^L + X\rho_{t-1}\right]. \tag{38}$$

As established in Proposition 3, as long as $\tau_t = 0$, the evolution of income per capita, $y_t$, is independent of $\lambda$. Hence it follows from Corollary 1 that factor prices are independent of $\lambda$ and therefore, as follows from (38), $B_t^L$ is increasing in $\lambda$. Hence, noting that as established in Proposition 2 $\hat{B}^L(y_t; X, \lambda)$ is decreasing with $\lambda$, the lower is $\lambda$ the larger is $\hat{t}$ (i.e., the later is the time period in which $B_t^L > \hat{B}_t^L$). □

**Proposition 5** *(Persistence of Inefficient Education Policy) If the productivity in the manufacturing sector is limited, and the degree of complementarity between land and labor is sufficiently high, then there exists a sufficiently high level of land inequality (i.e., a sufficiently low $\lambda$), such that inefficient education policy will persist indefinitely (i.e., $\hat{t} \to \infty$).*

**Proof.** Suppose that the production function in the agriculture sector is $y_t^A = F(X, L_t) = \min\{X, L_t\}$, where, $X < 1$ (i.e., $X$ is smaller than the size of the working population) to assure that some workers are employed in the industrial sector. Hence, for $w_t < 1$, $X = L_t = 1 - \theta_t$. As follows from (18) and (20), $w_t = (1-\alpha)\, y_t^M / \theta_t$. Therefore, for $w_t < 1$,

$$\rho_t = 1 - w_t = 1 - \frac{1-\alpha}{\theta_t} y_t^M = 1 - \frac{1-\alpha}{1-X} y_t^M.$$

Suppose, for the sake of simplicity, that $X = \alpha$. Then, for $y_t^M < 1$

$$\begin{aligned} w_t &= y_t^M; \\ \rho_t &= 1 - y_t^M. \end{aligned}$$

Hence, if for $y_t^M < 1$, the income of all landowners, noting (17), is

$$\lambda I_t^L = \lambda w_t + \rho_t X + s_t^L \alpha y_t^M = \alpha + [\lambda + \alpha(s_t^L - 1)] y_t^M,$$

where $s_t^L$ is the share of landowners in the total capital stock. Since $s_t^L < 1$, it follows that for a sufficiently low $\lambda$ landowners' income is decreasing with $y_t^M$, as long as $y_t^M < 1$.Hence, since $\bar{y}^0 < \psi^*(\bar{y}^0)$, then if $\psi^*(\bar{y}^0) < 1$ landowners prefer $\tau_t = 0$, rather than $\tau_t = \tau_t^*$ when $y_t = \bar{y}^0$. □

Hence, under the conditions specified in Proposition 5 there exists a steady state equilibrium in which an inefficient education policy exists. In particular, as depicted in Figure 2, country $A$ reaches a steady-state equilibrium at a level of income per-capita $\left[\bar{y}^0\right]^A$, prior to the implementation of education reforms that would have occurred if the level of income per capita in the economy would have reached $\hat{y}^A$.

Thus, among countries where land inequality is higher, (i.e., $\lambda$ is smaller) a poverty trap, in which inefficient education policy persists may emerge. In particular, a country could reach the low income steady state $\bar{y}^0$ before reaching the point in which $B_t^L$ is sufficiently large to bring about a policy shift. In contrast, for sufficiently equal economies, $\hat{t}$ is necessarily finite. In particular if land ownership is equally distributed across members of society (i.e., if $\lambda = 1$), then as established in Proposition 2, the efficient tax policy is implemented in period 0.

Hence, the distribution of land within and across countries affected the nature of the transition from an agrarian to an industrial economy, generating diverging growth patterns across countries. Furthermore, land abundance that was beneficial in early stages of development, brought about a hurdle for human capital accumulation and economic growth among countries that were marked by an unequal distribution of land ownership. As depicted in Figure 2, some land abundant countries which were associated with the club of the rich economies in the pre-industrial revolution era and were characterized by an unequal distribution of land, were overtaken in the process of industrialization by land scarce countries. The qualitative change in the role of land in the process of industrialization has brought about changes in the ranking of countries in the world income distribution.

**Remark**. If the utility of individuals is defined over the discounted stream of utilities of their offspring, the qualitative results will not be affected. An earlier implementation of education reforms would raise the income of future members of a landowner's dynasty on the account of the contemporary income of the landowner. The optimal timing of the implementation of education reforms from the viewpoint of each landowner would depend, therefore, on the discount factor applied for future members of the dynasty. It would occur earlier than in the case in which individuals do not generate utility from the utility of their offspring, but would be still affected adversely by the degree of land inequality, since it determines the relative stake of landowners in other segments of the economy.[43]

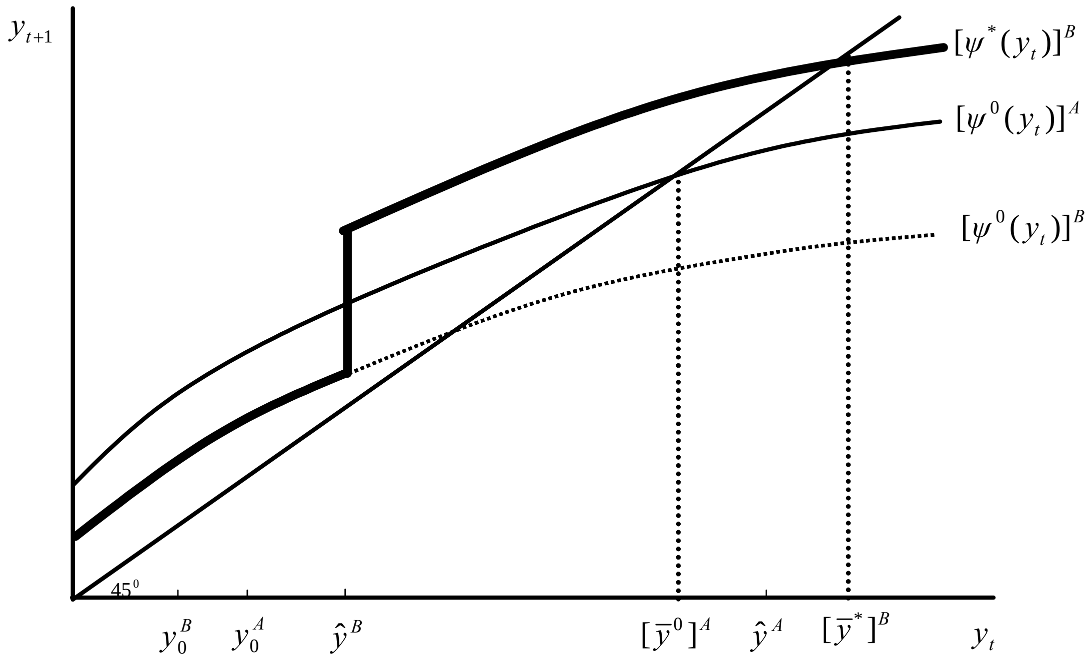


Figure 2: Overtaking – country A is relatively richer in land, however, due to land inequality it fails to implement efficient schooling and is overtaken by country B. Alternatively, for a lower degree of inequality, country A will eventually implement education reforms and ultimately takeover country B (not captured in the figure).

[43] In particular, if $\bar{y}^* < 1$, in the context of Proposition 5, there exists a sufficiently high level of land inequality such that inefficient education policy will persist indefinitely (i.e., landowners would not find it beneficial to implement education reforms in any time period). In this case, regardless of the discount factor applied to offspring the timing of education reforms will not be affected at all (i.e., $\hat{t} \to \infty$).

# 6 Evidence from the US High School Movement

The central hypothesis of this research, that land inequality adversely affected the timing of education reform, is examined empirically using variations in public spending on education across states and over time in the US during the high school movement. Historical evidence from the US on education expenditures and land ownership in the period 1880-1950 suggests that land inequality had a significant adverse effect on educational expenditures during this period.[44]

## 6.1 The US High School Movement

During the time period 1900-1950 the education system in the US underwent a major transformation from insignificant secondary education to nearly universal secondary education. As established by Goldin (1998), in 1910 high school graduation rates were between 9-15% in the Northeast and the Pacific regions and only about 4% in the South. By 1950 graduation rates were nearly 60% in the Northeast and the Pacific regions and about 40% in the South. Furthermore, Goldin and Katz (1997) document significant variation in the timing of these changes and their extensiveness across regions.[45]

The high school movement and its qualitative effect on the structure of education in the US reflected an educational shift towards non-agricultural learning that is at the heart of the proposed hypothesis. The high school movement was undertaken with the intention of building a skilled work-force that could better serve the manufacturing sector. Over this period, firms increasingly demanded skilled workers that could be effective managers, sales personnel, and clerical workers, and courses in accounting, typing, shorthand, and algebra were highly valued in the white-collar occupations. In addition, in the 1910s, some of the high-technology industries of the period started to demand blue-collar craft workers who were trained in mathematics, chemistry, and electricity (Goldin, 1999).

The proposed theory suggests that land inequality was significant in determining the pace of education reforms across the U.S. We exploit differences in education expenditures across states over 1900-1950 to identify the role of the inequality in the distribution of landownership on the pace of education reforms, controlling for the level of income per capita, the percentage of the black population, and the urbanization rate within each state.

[44] For other studies of the relationship between land and economic performance in the US over this time period see Gerber (1991) and Coleman and Caselli (2001).

[45] Consistently with the proposed theory and the empirical findings, Wright (1986) suggests that Southern governments, influenced heavily by landholders, refused to expand enrollments and spending in education because the North which provided a significant outside option for educated workers would reap the benefits from it.

## 6.2 Data

The historical data that is utilized in this study is gathered from several sources. Education expenditure levels are obtained from the Historical Statistics of the United States for 1920 and 1950, and from the U.S. Bureau of Education, Report of the Commissioner of Education for 1880 and 1900. These expenditures are converted to 1929 dollars to match the income per capita estimates used.

The level of expenditure per child within each state is computed, utilizing data on the number of children in the state in each of the relevant years from the relevant U.S. Census.[46] The total population of school-age children in each state, rather than the actual number of students, is used because states could controlled their total expenditures by limiting the number of actual pupil (e.g., the exclusion of blacks from public education in the South during much of the period under study).

Education expenditure varied greatly over this period. For example, in 1900 the state of Alabama was spending \$2.58 (in 1929 dollars) per child on education. In contrast, Massachusetts had expenditures of \$36.45 per child, a fourteen-fold difference. By 1920, Alabama had expenditures of \$11.58 per child, while spending in Massachusetts had increased to \$44.67, only four times greater than Alabama's spending. In 1950, the gap had narrowed to less than a factor of two, \$63.50 for Alabama and \$107.55 for Massachusetts.

The level of land inequality is captured by constructing a Gini coefficient for land distribution within each state using U.S. Census data.[47] Data on the number and area of farms for each state/year observation was used to estimate a Lorenz curve, from which the Gini was derived. (See Appendix 3). In 1880, the average U.S. state had a Gini index of land inequality of approximately 0.41. Inequality was lowest in the Midwest, where the Gini indexes were around 0.29, and highest in the South, with Gini indexes around 0.50. Over time, Gini coefficients rose across the whole U.S., and by 1920 the average Gini was 0.53. The upward shift hid wide variation in changes in land inequality across states. The Gini in California rose from 0.58 to 0.81 over this period, and many other states in the West saw large increases in land inequality. On the other hand, the South, starting from a high initial level of inequality, witnessed flat or declining Gini's over this period, with a drop from 0.62 to 0.54 in South Carolina and drop from 0.57 to 0.51 in Georgia.

[46] The precise age ranges used in each census vary, but as these changes are common to all states, this does not introduce any bias into the results. The available age ranges are 5-17 years old in 1880, 5-20 years in 1900, 7-20 years in 1920, and 5-19 years in 1950

[47] An important point to note about these Gini coefficients is that they only reflect inequality in land-holdings *within* the group of landowners. Differences between states in the level of landlessness are not captured, and therefore the Gini underestimates the variation in land inequality across U.S. states. As this exclusion will make it more difficult to establish a relationship between the variation in land inequality and variation in education, we feel it is an acceptable omission and in fact tends to strengthen the results that follow.

Several other controls are included in the specifications. Income per capita, is based estimates in Easterlin (1957) for 1880, 1900, 1920 and 1950 (measured in 1929 dollars). The percentage of population that is black is taken from the U.S. Census for the relevant years. As mentioned above, black students often suffered not only from insufficient funding but were also excluded from the education system entirely in many places. Margo (1990) identifies several avenues along which black students suffered in relation to their white peers during the periods of the study. Blacks also lived predominantly in the South, where land inequality was relatively high as a result of the plantation system. Therefore we include the measure of black population to ensure that the relationship between education and land inequality is not simply reflecting the effects of the racial political situation in the South during this period.[48] The final control, the percentage of urban population, also taken from the U.S. Census. It is added for several reasons. Given economies of scale, it may be that more urbanized states in fact have lower expenditures per child due to their higher density. Furthermore, urbanization and industrialization are highly correlated, and urbanization may partly control for capital intensity across states as well.[49]

### 6.3 Empirical Specification and Results

The empirical analysis examines the effect of inequality on the distribution of land ownership in state $i$ in period $t-1$, on log expenditure per child in state $i$ in period $t$, over four periods of observation: 1880, 1900, 1920 and 1950. In particular, for $t = 1900, 1920, 1950$, and $t-1 = 1880, 1900, 1920$, respectively,

$$\ln e_{it} = \beta_0 + \beta_1 G_{i,t-1} + \beta_2 \ln y_{i,t-1} + \beta_3 U_{i,t-1} + \beta_4 B_{i,t-1} + v_{it}, \tag{39}$$

where $G_{i,t-1}$ is the Gini coefficient of inequality in land ownership in state $i$ in period $t-1$, $\ln y_{i,t-1}$ is log income per capita in state $i$ in period $t-1$, $U_{i,t-1}$ is the percentage of the urban population in state $i$ in period $t-1$, $B_{i,t-1}$ is the percentage of the black population in state $i$ in period $t-1$, and $v_{it}$ is the error term of state $i$.[50]

[48] An additional avenue of influence for the black population (and labor in general) involves mobility. Wright (1986) argued that some Southern states limited education spending because of the fear that the educated workers would migrate out of their home states. However, while the amount of internal migration was large in absolute terms, relative to the size of the population it was much less important. Eldridge and Thomas (1957) calculate an index of interstate redistribution, which measures the percent of the population that would have to be moved in any decade in order to match the previous decades distribution by state. In 1900-1910, this index is 4.25%, and then is lower in every decade through 1940-1950. As this index also reflects changes in population distribution due to fertility differences between states, it overestimates the effect of internal migration. It thus seems likely that there was appreciable friction to labor mobility, and that local education expenditures could, to some extent, benefit local populations. Including net migration rates from Eldridge and Thomas (1957) as part of the empirical specifications that follow do not alter the results.

[49] An additional measure of industrialization that can be considered is the ratio of the value of capital (from Easterlin, 1957) to the value of farm land (from the U.S. Census in relevant years). This ratio goes from an average in the U.S. of 0.33 in 1880 to 3.44 in 1920, with considerable variation across states. Inclusion of this measure in place of or in addition to the urban percentage does not alter any of the empirical results that follow.

[50] This specification assures that the explanatory variables are indeed independent of the dependent variable. It can be justified by the existence of a lag between the current economic conditions and their effect on the political

We allow for a time invariant unobserved heterogeneity across states in the level of the log expenditure per child, $\eta_i$, and a linear unobserved heterogeneity across states in the time trend of the log expenditure per child, $\theta_i t$. Namely,

$$v_{it} = \eta_i + \theta_i t + \varepsilon_{it}. \tag{40}$$

First differencing (39), utilizing (40) it follows that[51]

$$\Delta \ln e_{it} = \beta_1 \Delta G_{i,t-1} + \beta_2 \Delta \ln y_{i,t-1} + \beta_3 \Delta U_{i,t-1} + \beta_4 \Delta B_{i,t-1} + \theta_i + \Delta \varepsilon_{it}, \tag{41}$$

where $\Delta \ln e_{it} \equiv \ln e_{it+1} - \ln e_{it}$ (i.e. the difference in the log expenditure per child in state $i$ between 1920 and 1900, and between 1950 and 1920), and $\Delta G_{i,t-1} \equiv G_{i,t} - G_{i,t-1}$ (i.e., the difference in the Gini coefficient of inequality in land ownership in state $i$ between 1900 and 1880, and between 1920 and 1900). The lag operator is similarly defined for the rest of the explanatory variables.

Given the empirical specification (41) and our set of data, we have two possible observations for each state. Due to limitations in the data we have 79 total observations over 41 states, with 3 states having only one period of observation for the dependent variable ($1920 - 1950$).

The negative correlation between the changes in the log of education expenditure in state $i$, $\Delta \ln e_{it}$, and the changes in the lagged Gini coefficient of inequality in land ownership in state $i$, $\Delta G_{i,t-1}$, is apparent in Figure 3, and is demonstrated by the fitted values plotted from an OLS regression.

Table 1 depicts the correlation between all variables utilized in the empirical specifications. In particular, the correlation coefficient between $\Delta \ln e_{it}$ and $\Delta G_{i,t-1}$, is depicted in Figure 3. The table indicates that changes in the Gini coefficient are closely related to changes in the black population in the same periods, as well as to changes in education expenditures per child in the next periods. There appears to be no significant relationship between changes in the Gini and changes in income per capita or urbanization. The changes in the percent of the black population is positively associated with changes in the Gini coefficient and negatively with changes in education expenditures and income per capita. The correlation with a change of a measure of income inequality $\Delta a_{i,t-1}$ will be discussed later.

To undertake more rigorous empirical testing, we begin by assuming that $E(\Delta \varepsilon_{it}) = 0$ and $E(\Delta \varepsilon_{it} \Delta X) = 0$, where $X \equiv (G_{i,t-1}, \ln y_{i,t-1}, U_{i,t-1}, B_{i,t-1})$. In other words, we presume that the *changes* in explanatory variables are not correlated with *changes* in the error term, even though

structure and the implementation of educational policy.

[51] An alternate specification would examine the change in the log of total expenditure ($\Delta \ln E_{it}$) as opposed to the change in the log of expenditure per child ($\Delta \ln e_{it}$). This would eliminate any concern that expenditures per child were changing due to random fluctuations in the size of the population. Regressions using $\Delta \ln E_{it}$ as the dependent variable, (including in some specifications of the change in the size of the log of child population ($\Delta \ln C_{it}$) as an explanatory variable), were performed and the results do not differ qualitatively.

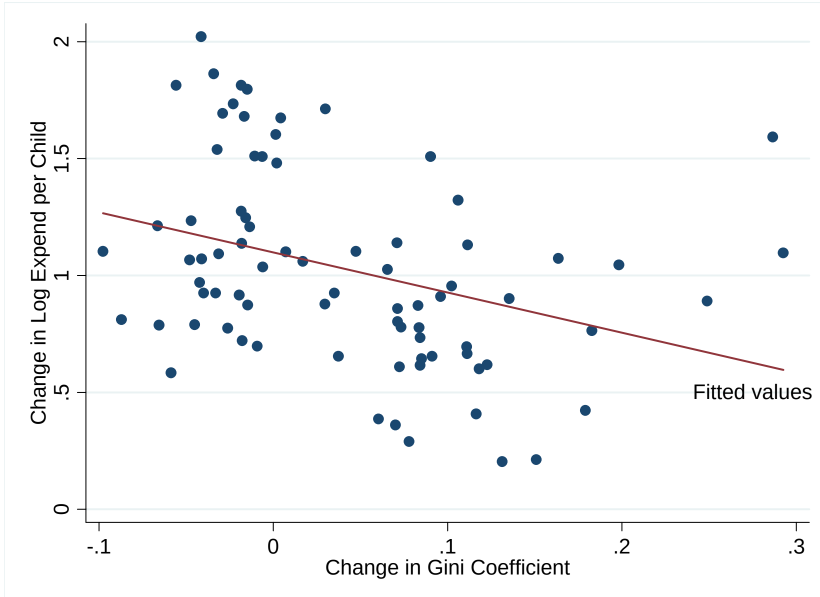


Figure 3: The Correlation of Changes in Education Expenditure and Changes in Land Inequality

Table 1: Correlations of Variables

| | $\Delta \ln e_{it}$ | $\Delta G_{i,t-1}$ | $\Delta \ln y_{i,t-1}$ | $\Delta U_{i,t-1}$ | $\Delta B_{i,t-1}$ | $\Delta a_{i,t-1}$ |
|---|---|---|---|---|---|---|
| $\Delta \ln e_{it}$ | 1.00 | | | | | |
| $\Delta G_{i,t-1}$ | $-0.31^{**}$ | 1.00 | | | | |
| $\Delta \ln y_{i,t-1}$ | $0.42^{**}$ | $-0.16$ | 1.00 | | | |
| $\Delta U_{i,t-1}$ | $-0.03$ | $-0.05$ | 0.13 | 1.00 | | |
| $\Delta B_{i,t-1}$ | $-0.37^{**}$ | $0.23^{**}$ | $-0.26^{**}$ | 0.09 | 1.00 | |
| $\Delta a_{i,t-1}$ | $-0.18^{*}$ | 0.09 | $-0.06$ | 0.11 | $0.25^{**}$ | 1.00 |

** indicates significance at the 5% level, * at the 10% level

the levels of the explanatory variables might be correlated with the error term itself in (39). In addition, we begin by assuming that the time trend parameter, $\theta_i$, is identical across states. Under these assumptions the specification in (41) can be estimated by OLS, with standard errors adjusted for clustering by state. Clustering allows for the differenced error terms for state $i$ ($\Delta\varepsilon_{it}$) to be correlated across different time periods.

Table 2 depicts the results of this estimation in columns (1) – (4), establishing the negative effect of the change in the distribution of land ownership, $\Delta G_{i,t-1}$ on the change in education expenditure $\Delta \ln e_{it}$, alone and while controlling for the change in lagged income per capita, $\Delta \ln y_{i,t-1}$, the change in the percentage of the urban population, $\Delta U_{i,t-1}$, and the change in percentage of the black population, $\Delta B_{i,t-1}$. As indicated by the results in column (1) the effect of $\Delta G_{i,t-1}$ alone on the change in education expenditure, $\Delta \ln e_{it}$, is negative and significant at a 5% level. One would expect that changes in education expenditures would reflect changes in income per capita. Controlling for the change in lagged income per capita, $\Delta \ln y_{i,t-1}$, in column (2) shows that indeed an increase in lagged income per capita has a highly significant positive effect on education expenditure. Nevertheless, the negative effect of $\Delta G_{i,t-1}$ on the change in education expenditure, $\Delta \ln e_{it}$, remains stable and is highly significant. Column (3) adds an additional control for the change in the percentage of the urban population, $\Delta U_{i,t-1}$, capturing a potential adverse effect of urbanization on education expenditure due to economies of scale in education, and its positive effect steaming from the correlation between industrialization and urbanization. The effect of the changes in urbanization on changes in education expenditure is negative but insignificant. The negative effect of $\Delta G_{i,t-1}$ on the change in education expenditure, remains stable and highly significant. Finally, column (4) includes a control for the change in percentage of the black population to ensure that the adverse effect of land inequality on educational expenditure does not reflect the adverse effect of the discrimination in the South (where land inequality is more pronounced), on educational expenditure. As expected the effect of the change in the percentage of the black population on the change in educational expenditure is negative and significant. Nevertheless, the effect of the change in the distribution of land ownership remains significant. The size of the point estimate for $\Delta G_{i,t-1}$ is very stable over the first three specifications, indicating that a one standard deviation decline in $\Delta G_{i,t-1}$ would have increased expenditure per child at the end of the following period by 17-18%. In the fourth specification the effect is 13%.

As an alternate specification, we reestimate equation (41) using fixed effects, allowing for $\theta_i$ to vary by state. The results of this specification is found in column (5) in Table 2, where all control variables are included. In comparison to column (4) the point estimate on the Gini coefficient has slightly fallen, but it remains significant. The size of the coefficient on the percentage black has decreased as well. The results in column (5) may seem to indicate that there is some state-specific time trend and that previously the change in the Gini coefficient was proxying for this state-specific effect.[52]

However, a Hausman test suggests that the OLS specification in column (4) is preferred to the FE specification in column (5). The results of this test are found in column (5). The extremely low value for the Hausman statistic provides strong evidence that the OLS specification does not differ systematically from the FE estimates, and is therefore the preferred specification due to its better efficiency properties.

Consider the difference between a drop in the Gini coefficient of -0.018 (that occurred in

[52] An additional issue is the possibility of serial correlation in the differenced error term, $\Delta v_{it}$, which is assumed to be zero. Following Wooldridge (2002, p. 283), we regress $\Delta \hat{v}_{it}$ on $\Delta \hat{v}_{it-1}$, (i.e., the residuals on their lags, as obtained from the OLS regressions). The estimated relationship is not significantly different from zero in any specification, however the estimate is significantly different from -0.5, which would hold if the $v_{it}$ were perfectly uncorrelated. If we allow for $\Delta v_{it}$ to follow an AR(1) process, the results do not differ appreciably from those presented in table 2.

Table 2: Specifications for Changes in Per Child Education Expenditure

| | Dep. Variable: Change in log expend per child ($\Delta \ln e_{it}$) | | | | |
|---|---|---|---|---|---|
| Exp. Variables | (1) | (2) | (3) | (4) | (5) |
| $\Delta G_{i,t-1}$ [(a)] | -1.72** | -1.75*** | -1.77*** | -1.33*** | -1.19** |
| | (0.72) | (0.58) | (0.62) | (0.54) | (0.62) |
| $\Delta \ln y_{i,t-1}$ | | 1.27*** | 1.31*** | 1.10*** | 1.32*** |
| | | (0.21) | (0.20) | (0.16) | (0.47) |
| $\Delta U_{i,t-1}$ | | | -0.71 | -0.37 | 0.22 |
| | | | (0.67) | (0.51) | (1.00) |
| $\Delta B_{i,t-1}$ | | | | -5.51*** | -4.75** |
| | | | | (1.14) | (2.18) |
| Constant | 0.69 | 1.10 | 0.78 | 0.69 | 0.55 |
| | (0.05) | (0.08) | (0.13) | (0.10) | (0.16) |
| Hausman statistic[(b)] | | | | | 1.29 |
| Hausman p-value | | | | | 0.86 |
| $R^2$ | 0.12 | 0.37 | 0.38 | 0.54 | |
| Observations | 79 | 79 | 79 | 79 | 79 |
| Method | OLS | OLS | OLS | OLS | FE |
| S.E. | Cluster | Cluster | Cluster | Cluster | Standard |

Note: Standard errors in parentheses.
a) A one-sided test that the coefficient on $\Delta G_{i,t-1}$ is less than zero is performed
*** indicates significance at 1% level, ** at the 5% level, * at the 10% level
b) Hausman statistic is distributed $\chi^2(4)$ in column 5

Florida - at the 25th percentile of $\Delta G_{i,t-1}$ across states - between 1900 to 1920), and an increase in the Gini coefficient of 0.102 (that took place in Wyoming - at the 75th percentile of $\Delta G_{i,t-1}$ across states - between 1900 and 1920). Using the estimates in column (4), the total growth in education expenditures in Florida was 17% higher between 1920 and 1950 than in Wyoming.

The period between 1900 and 1950 is an excellent example of the kind of education reform that the theory proposes, as capital accumulation eventually drives up the incentives to provide secondary education for the modern sector. The prediction of the theory that inequality in the distribution of land ownership would slow down this process is found to have strong support in the data from this period. The results in Table 2 show a robust adverse effect of land inequality on education expenditures per child.

### 6.4 Land versus Income Inequality

A potential concern may be that the measure of land inequality, the farm size Gini index, is simply a proxy for income inequality or wealth inequality. Goldin and Katz (1997) suggest that income inequality is associated with poor education outcomes across states during the U.S. high school movement. They reach this conclusion using a rough proxy for the distribution of income in a state: the number of automobile registrations per person.

Goldin and Katz (1997) exploit the significant differences in high school graduation and attendance rates across states in order to examine the factors that were associated with high levels of secondary education. They find that states in the US that were leaders in secondary education had high and equally distributed income and wealth, and that homogeneity of economic and social conditions were conducive to the establishment of secondary education.

The data on motor vehicle registrations by state is available from the U.S. Department of Transportation, that provides this data as far back as 1900. Using this data we are able to create measures of automobile registrations per capita by state for the years 1900, 1920, and 1950. The number of registrations per person in 1880 is obviously equal to zero for all states. On average, there is about one automobile per thousand people in 1900, climbing to 80 per thousand in 1920 and 271 per thousand in 1950. In 1900, the number of automobiles varies from only one per *ten* thousand people in Mississippi to about five per thousand in California. Mississippi again lags the nation in 1950, with only 151 cars per thousand person, while the leader is again California with 374 autos per thousand.

Figure 4 plots the change in the inequality in land ownership as measured by the Gini coefficient against the change in automobiles per capita between the years 1900 and 1920. There is no discernible relationship between the two measures. The correlation between the two measures is 0.18 and insignificant. If we compare the change in Gini and the change in automobiles per capita between the years 1920 and 1950 the correlation is 0.11 and insignificant as well.

Table 3: Specifications including Changes in Auto Registrations

| | Dep. Variable: Change in log exp per child ($\Delta \ln e_{it}$) | | | | | | |
|---|---|---|---|---|---|---|---|
| Exp. Variables | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| $\Delta G_{i,t-1}$ [(a)] | -1.72** | | -1.67** | -1.71*** | -1.74*** | -1.32*** | -1.18** |
| | (0.72) | | (0.73) | (0.58) | (0.62) | (0.54) | (0.62) |
| $\Delta a_{i,t-1}$ | | -0.08** | -0.07** | -0.06** | -0.05* | -0.01 | -0.02 |
| | | (0.04) | (0.03) | (0.03) | (0.03) | (0.04) | (0.05) |
| $\Delta \ln y_{i,t-1}$ | | | | 1.26*** | 1.30*** | 1.10*** | 1.34*** |
| | | | | (0.22) | (0.21) | (0.16) | (0.48) |
| $\Delta U_{i,t-1}$ | | | | | -0.63 | -0.35 | 0.31 |
| | | | | | (0.63) | (0.50) | (1.04) |
| $\Delta B_{i,t-1}$ | | | | | | -5.45*** | -4.45** |
| | | | | | | (1.17) | (2.32) |
| Constant | 0.69 | 1.03 | 1.10 | 0.70 | 0.77 | 0.69 | 0.54 |
| | (0.05) | (0.05) | (0.05) | (0.08) | (0.13) | (0.10) | (0.17) |
| Hausman statistic[(b)] | | | | | | | 1.62 |
| Hausman p-value | | | | | | | 0.90 |
| $R^2$ | 0.12 | 0.02 | 0.13 | 0.38 | 0.39 | 0.54 | |
| Observations | 79 | 79 | 79 | 79 | 79 | 79 | 79 |
| Method | OLS | OLS | OLS | OLS | OLS | OLS | FE |
| S.E. | Cluster | Cluster | Cluster | Cluster | Cluster | Cluster | Standard |

Note: Standard errors in parentheses.

a) A one-sided test that the coefficient on $\Delta G_{i,t-1}$ is less than zero is performed

*** indicates significance at 1% level, ** at the 5% level, * at the 10% level

b) Hausman statistic is distributed $\chi^2(5)$ in column 7

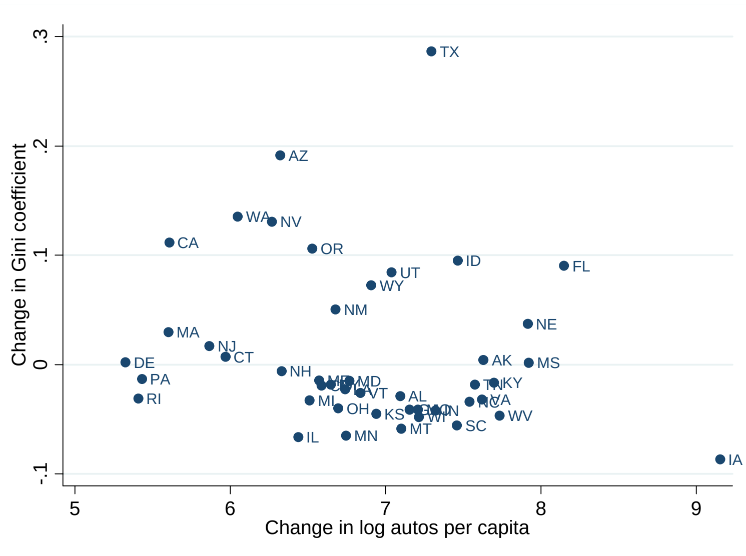


Figure 4: Comparison of Changes in Inequality Measures, 1900-1920

To incorporate this approximation of income inequality into our specifications we include the lagged number of automobiles per capita relative to the national average in the relevant year, denoted $a_{i,t-1}$.[53] After first differencing, $\Delta a_{i,t-1}$ is included in in the right hand size of the specification in (41). The correlation of this measure with the other regressors can be found in table 1.

The results of the regressions can be found in Table 3, which are OLS specifications with clustered standard errors in columns (1) – (6). Column (1) shows the basic regression of the change in education on $\Delta G_{i,t-1}$, for comparison purposes. Column (2) uses only changes in autos per capita as a control variable, and while it is significantly related to the growth in education expenditures in the following period, it is negatively related.[54] This implies that growth in autos per capita relative to the national average – an indicator for decreasing income inequality – was actually associated with falling education expenditures. Notice as well, that changes in land inequality are capable of explaining 12% of the total variation in growth of education

[53] This usage differs slightly from Goldin and Katz, who use the level of autos per capita in a regression on the level of expenditures. We use the relative value of autos per capita since the variations in actual autos per capita over time is so large that it overwhelms the variation in autos per capita across states within any given period. If we do not use relative values, then the first difference in autos per capita looks very similar across states in a given year, giving autos per capita less of an opportunity to explain the variation in education expenditure growth. By using relative values we increase the variation in autos per capita growth across states, and we increase the possibility that this will dominate the effect of the Land Gini coefficient. Using the actual level of autos per capita does not materially impact the results.

[54] The sign on autos per capita is the opposite of what Goldin and Katz (1997) find in their analysis of education expenditures across states. The difference arises from the fact that we are using differences in autos per capita, as opposed to levels, and from the fact that we examine the changes over a longer period of time while GK focused on a single year of cross-sectional data.

expenditures, the relative number of automobiles per capita explains only 2% of total variation.

Combining the two, column (3) includes the change in the Gini and the change in relative autos per capita as controls. In this case, the inverse relationship of education with land inequality remains highly significant, and the size of the coefficient is almost identical to its size if relative autos per capita is excluded. The estimate for relative autos per capita is significant, but again is negative. The R-squared does not increase appreciably, either, when relative autos per capita are added to the specification, indicating its limited ability to explain the variation in the growth of education expenditure.

In column (4) we include the measure of income per capita and find that the size of the coefficient on the change in Gini does not change, while the one-sided t-tests again shows a very significant result. The coefficient on relative autos per capita is again negative, with decreased significance. The regression in column (5) includes urbanization and the results are nearly identical. Column (6) includes the changes in the percentage of the black population, and although the point estimate for the change in the Gini falls (as was the case in the regressions that did not include relative autos per capita) it remains highly significant. The estimated effect of autos per capita is still negative and insignificant.

The final column of table 3 performs a fixed effects regression using all the explanatory variables. As before, the FE specification shows a smaller but significant point estimate for the Gini coefficient, whereas the effect of the relative number of autos per capita remains insignificant. However, a Hausman test provides support for using the OLS estimates due to their better efficiency.

Overall, the results obtained from including the relative number of autos per capita as a control for income inequality are almost identical to those when autos are excluded. A one standard deviation drop in the change of the Gini coefficient is still associated with at least a 13% increase in education expenditures per child in the following period. Given that the inclusion of a proxy for income inequality produced almost no change in the point estimates for the Gini coefficient, it appears that our empirical analysis is not simply confounding the effects of land and income inequality. However, as the number of automobiles per capita is not an ideal measure, it would be desirable to examine the results with better data on income equality if it would become available.

# 7 Concluding Remarks

The proposed theory suggests that the concentration of land ownership has been a major hurdle in the emergence of human capital promoting institutions and economic growth. The rise in the demand for human capital in the in the process of industrialization and its effect on human capital formation and on the onset of the demographic transition have been the prime forces in the transition from stagnation to growth. As the demand for human capital emerged, differences concentration of land ownership across countries generated variations in the extensiveness of human capital formation and therefore in the rapidity of technological progress and the timing of the demographic transition, contributing to the emergence of the great divergence in income per capita across countries. Land abundance, which was beneficial in early stages of development, generated in later stages a hurdle for human capital accumulation and economic growth among countries in which land ownership was unequally distributed, bringing about changes in the ranking of countries in the world income distribution.

The central hypothesis of this research that land inequality adversely affected the timing of education reform is examined and confirmed empirically, utilizing variations in the distribution of land ownership and educational expenditure across states in the US during the high school movement. Furthermore, historical evidence suggests that consistent with the proposed hypothesis, land reforms in Japan, Korea, Russia, and Taiwan were followed by significant education reforms, and that variations in distribution of land ownership across and within North and South America have been a significant force in the emergence of sustained differences in human capital formation and economic growth.

The paper implies that differences in the evolution of social structures across countries may reflect differences in the distribution of land ownership. In particular, the dichotomy between workers and capitalists is more likely to persist in land abundant economies in which land ownership is unequally distributed. As argued by Galor and Moav (2006), due to the complementarity between physical and human capital in production, the Capitalists were among the prime beneficiaries of the accumulation of human capital by the masses. They had therefore the incentive to financially support public education that would sustain their profit rates and would improve their economic well being, although would ultimately undermine their dynasty's position in the social ladder and would bring about the demise of the capitalist-workers class structure. As implied by the current research, the timing and the degree of this social transformation depend on the economic interest of landlords. In contrast to the Marxian hypothesis, this paper suggests that workers and capitalists are the natural economic allies that share an interest in industrial development and therefore in the implementation of growth enhancing human capital promoting institutions, whereas landlords are the prime hurdle for industrial development and social mobility.

# Appendix 1- Landowners Preferred Tax Rate for the case of a Cobb-Douglas Agricultural Technology

**Lemma 3** *The elasticity of $\theta_t$ with respect to $y_t^M$, $e_{\theta_t, y_t^M} \in (0,1)$.*

**Proof.** Suppose not. Suppose that $e_{\theta_t, y_t^M} \leq 0$. Since $w_t = (1-\alpha) y_t^M / \theta_t$ a rise in $y_t^M$ and a decline in $\theta_t$ imply a rise in $w$ and a reduction in the optimal number of workers in agriculture and hence a rise in $\theta_t$. A contradiction. Suppose that $e_{\theta_t, y_t^M} \geq 1$. since $w_t = (1-\alpha) y_t^M / \theta_t$ a rise in $y_t^M$ and a more than proportional rise in $\theta_t$ implies a decline in $w_t$ and a rise in the optimal number of workers in agriculture and hence a decline in $\theta_t$. A contradiction. □

**Proposition 6** *If the agricultural production function is $F(X, L_t) = AX^\gamma L_t^{1-\gamma}$ then landowners' desirable tax rate $\tau_t^L \notin (0, \tau_t^*)$.*

**Proof.** As follows from (3), noting that $L_t = 1 - \theta_t$,

$$\begin{aligned} w &= (1-\gamma) A \left( \tfrac{X}{1-\theta_t} \right)^\gamma ; \\ \rho_t &= \gamma A \left( \tfrac{X}{1-\theta_t} \right)^{\gamma - 1} . \end{aligned} \tag{42}$$

Hence, along the factor price frontier

$$\rho_t = \gamma A^{\frac{1}{\gamma}} \left( \frac{w_t}{1-\gamma} \right). \tag{43}$$

Let $\pi_t \equiv y_t^M / \theta_t$. It follows from (18) and (20) that $w_t = (1-\alpha)\pi_t$ and

$$\rho_t = \gamma A^{1/\gamma} \left( \frac{(1-\alpha)\pi_t}{1-\gamma} \right)^{\frac{\gamma-1}{\gamma}}. \tag{44}$$

Since the wage paid to each worker is equal in the two sectors, it follows from (42) that

$$(1-\gamma) A X^\gamma (1-\theta_t)^{-\gamma} = (1-\alpha)\pi_t, \tag{45}$$

and hence

$$\theta_t = 1 - \left( \frac{(1-\gamma) A X^\gamma}{(1-\alpha)\pi_t} \right)^{1/\gamma}. \tag{46}$$

Note that $\theta_t$ is determined endogenously such that $\theta_t \in (0,1)$.

Since landlord's income in period $t$ is $I_t^L = w_t + (1-\tau_t) R_t b_{t-1}^L + \rho_t X / \lambda$, it follows that the aggregate income of landowners, $\lambda I_t^L$, is

$$\lambda I_t^L = \lambda (1-\alpha)\pi_t + s_t^L \alpha \theta_t \pi_t + X \rho_t, \tag{47}$$

where $w_t = (1-\alpha)\pi_t$, is the wage, $\alpha\theta_t\pi_t = \alpha y_t^M$ is the share of capital in the industrial output, and $s_t^L$ is the share of capital owned by landowners. Substituting (44) and (46) into (47)

$$\begin{aligned} \lambda I_t^L &= \lambda(1-\alpha)\pi_t + s_t^L\alpha\pi_t\left(1-\left(\tfrac{(1-\gamma)AX^\gamma}{(1-\alpha)\pi_t}\right)^{1/\gamma}\right) + X\gamma A^{1/\gamma}\left(\tfrac{(1-\alpha)\pi_t}{1-\gamma}\right)^{\frac{\gamma-1}{\gamma}}; \\ &= \lambda(1-\alpha)\pi_t + s_t^L\alpha\pi_t + \left[\gamma\left(\tfrac{1-\alpha}{1-\gamma}\right)^{\frac{\gamma-1}{\gamma}} - s_t^L\alpha\left(\tfrac{1-\gamma}{1-\alpha}\right)^{1/\gamma}\right]XA^{1/\gamma}\pi_t^{\frac{\gamma-1}{\gamma}}. \end{aligned} \tag{48}$$

Hence,

$$\begin{aligned} \tfrac{\partial\lambda I_t^L}{\partial\pi_t} &= \lambda(1-\alpha) + s_t^L\alpha + \tfrac{\gamma-1}{\gamma}\left[\gamma\left(\tfrac{1-\alpha}{1-\gamma}\right)^{\frac{\gamma-1}{\gamma}} - s_t^L\alpha\left(\tfrac{1-\gamma}{1-\alpha}\right)^{1/\gamma}\right]XA^{1/\gamma}\pi_t^{\frac{-1}{\gamma}}; \\ \tfrac{\partial\left(\lambda I_t^L\right)^2}{\partial^2\pi_t} &= \tfrac{1-\gamma}{\gamma^2}\left[\gamma\left(\tfrac{1-\alpha}{1-\gamma}\right)^{\frac{\gamma-1}{\gamma}} - s_t^L\alpha\left(\tfrac{1-\gamma}{1-\alpha}\right)^{1/\gamma}\right]XA^{1/\gamma}\pi_t^{\frac{-(1+\gamma)}{\gamma}}. \end{aligned} \tag{49}$$

Hence,

$$\frac{\partial\left(\lambda I_t^L\right)^2}{\partial^2\pi_t} \geq 0 \leftrightarrow s_t^L \leq \frac{\gamma\left(1-\alpha\right)}{\alpha\left(1-\gamma\right)}.$$

If however $s_t^L > \frac{\gamma(1-\alpha)}{\alpha(1-\gamma)}$, replacing $\frac{\gamma(1-\alpha)}{\alpha(1-\gamma)}$ for $s_t^L$ in (48),

$$\begin{aligned} \lambda I_t^L &= \lambda(1-\alpha)\pi_t + s_t^L\alpha\pi_t + \left[\gamma\left(\frac{1-\alpha}{1-\gamma}\right)^{\frac{\gamma-1}{\gamma}} - s_t^L\alpha\left(\frac{1-\gamma}{1-\alpha}\right)^{1/\gamma}\right]XA^{1/\gamma}\pi_t^{\frac{\gamma-1}{\gamma}} \\ &= \lambda(1-\alpha)\pi_t + \frac{\gamma\left(1-\alpha\right)}{\left(1-\gamma\right)}\pi_t, \end{aligned}$$

which is strictly increasing in in $\pi_t$.

Hence, if $s_t^L = \frac{\gamma(1-\alpha)}{\alpha(1-\gamma)}$ landlords income is strictly increasing in $\pi_t$ and it follows from Lemma 3 that landowners prefer the highest possible value for $y_t^M$, and therefore $\tau_t^L = \tau_t^*$. Noting that $\frac{\partial\lambda I_t^L}{\partial s_t^L} > 0$ and $\frac{\partial\left(\lambda I_t^L\right)^2}{\partial\pi_t s_t^L} > 0$ it follows that $\tau_t^L = \tau_t^*$ for $s_t^L > \frac{\gamma(1-\alpha)}{\alpha(1-\gamma)}$.

If however, $s_t^L < \frac{\gamma(1-\alpha)}{\alpha(1-\gamma)}$, landowners income is a convex function of $\pi_t$, implying they prefer either the maximal or the minimal value of $\pi_t$. Therefore, it follows from Lemma 3 that landowners prefer the highest or lowest possible value for $y_t^M$, and hence $\tau_t^L \notin (0, \tau_t^*)$. □

# Appendix 2 - Data Sources

*Education Expenditures* - This is obtained from the Historical Statistics of the United States for 1920, and from the U.S. Bureau of Education, Report of the Commissioner of Education for 1900. These expenditures are converted to 1929 dollars to match the income per capita estimates.

*Expenditure per Child* - The number of relevant children in a year is taken from the U.S. Census. The available age ranges are 5-20 years in 1900 and 7-20 years in 1920. Although the age ranges are not consistent we assume that they remain comparable over time. Furthermore, it should be noted that since we are not comparing expenditure per child across periods these differences in reference population are not significant.

*Income per Capita* - These are estimates from Easterlin in Population Redistribution and Economic Growth: United States, 1870-1950, edited by Kuznets and Thomas (1957). See their work for descriptions of how the data is constructed. The income per capita is measured in constant 1929 dollars.

*Percent Black* - This is taken from the U.S. Census for the relevant years

*Percent Urban* - This is taken from the U.S. Census for the relevant years. Urban is defined as any city/town with more than 4,000 people.

*Year of Statehood* - This is widely available information and corresponds the year each state was officially admitted to the United States.

*Gini Index of Farm Distribution* - This measure was constructed for each year from farm distribution data in the U.S. Census. For 1920, the Census reports the distribution of number of farms and total acreage of farms by bin size. This allows for a straightforward estimate of a Gini index. For 1900 and 1880, the Census only reports the distribution of number of farms, but not of total acreage. In order to estimate a Gini assumptions must be made regarding the average size of a farm within each bin. For this we used the 1920 data as a guide. In most cases the average farm size is very close to the average expected if the farms were distributed uniformly over the bin (for example, the average farm size in 1920 in the 20-50 acre bin is close to 35 acres). Therefore, in 1880 and 1900 we use the average size expected in each bin as the actual average size in each bin. The only remaining complication is in the case of the bin for farms greater than 1000 acres. We assume that the average size of farms in this bin is 1800 acres. Using this value makes the total acreage across all bins come out very closely to the actual total acreage of farmland reported in the Census. Due to the small number of farms in this bin, varying this average value has almost meaningless effects on the calculated Gini index.

*Capital Levels* - These are estimates from Easterlin in Population Redistribution and Economic Growth: United States, 1870-1950, edited by Kuznets and Thomas (1957). See their work for descriptions of how the data is constructed. The capital levels are measured in constant 1929 dollars.

*Value of Farm Land* - This is taken from the U.S. Census for the relevant years. The reported value of farmland is converted to 1929 dollars.

*Excluded States* - across the periods studied in this paper not all current U.S. states were actually members of the union. Because of this they are lacking data in one or many of the sources we use. Excluded for these reasons from the 1900 regressions are: Alaska, Arizona, Hawaii, New Mexico, North Dakota, Oklahoma, and South Dakota. Excluded from the 1920 regressions are: Alaska, Hawaii, North Dakota, Oklahoma, and South Dakota.

# Appendix 3 - Construction of the Gini Coefficient

This measure was constructed for each year from farm distribution data in the U.S. Census. For 1920 and 1950, the Census reports the distribution of number of farms and total acreage of farms by bin size. This allows for a straightforward estimate of a Gini index for those years. For 1900 and 1880, the Census only reports the distribution of number of farms, but not of total acreage. In order to estimate a Gini assumptions must be made regarding the average size of a farm within each bin. For this we used the 1920 data as a guide. In most cases the average farm size is very close to the average expected if the farms were distributed uniformly over the bin (for example, the average farm size in 1920 in the 20-50 acre bin is close to 35 acres). Therefore, in 1880 and 1900 we use the average size expected in each bin as the actual average size in each bin. The only remaining complication is in the case of the bin for farms greater than 1000 acres. We assume that the average size of farms in this bin is 1800 acres. Using this value makes the total acreage across all bins come out very closely to the actual total acreage of farmland reported in the Census. Due to the small number of farms in this bin, varying this average value has almost meaningless effects on the calculated Gini index.

## References


[1] ACEMOGLU, D., AGHION, P. and ZILIBOTTI, F. (2006), "Distance to Frontier, Selection, and Economic Growth," *Journal of the European Economic Association,* **4**, 37-74.

[2] ACEMOGLU, D. and ROBINSON, J. A. (2002), "Economic Backwardness in Political Perspective," NBER working paper No. W8831.

[3] ACEMOGLU, D. and JOHNSON, S. and ROBINSON, J.A. (2002), "Reversal of Fortune: Geography and Institutions in the Making of the Modern World Income Distribution", *Quarterly Journal of Economics,* **117***,* 1231-1294.

[4] ALESINA, A., DEVLEESCHAUWER, A., EASTERLY, W. KURLAT, S. and WACZIARG, R.(2003), "Fractionalization", *Journal of Economic Growth*, **8**, 155-194.

[5] BENABOU, R. (1996), "Inequality and Growth", *NBER Macroeconomics Annual*, **11**, 11-74.

[6] BENABOU, R. (2000), "Unequal Societies: Income Distribution and the Social Contract", *American Economic Review*, **90**, 96-129.

[7] BENABOU, R. (2002), "Tax and Education Policy in a Heterogeneous-Agent Economy: What levels of Redistribution Maximize Growth and Efficiency?", *Econometrica,* **70**, 481-517.

[8] BESLEY, T. and BURGESS, R. (2000) "Land reform, poverty reduction, and growth: Evidence from India", *Quarterly Journal of Economics,* **115**, 389-430.

[9] BINSWANGER, H. P. and DEININGER, K. (1997) "Explaining Agricultural and Agrarian Policies in Developing Countries", *Journal of Economic Literature*, **35**, 1958-2002.

[10] BONILLA, F. (1965), "Brazil" in *Education and Political Development*, ed. COLEMAN J. S. (Princeton University Press.)

[11] BOWLES, S. (1978), "Capitalist Development and Educational Structure", *World Development*, **6**, 783-796.

[12] BERTOCCHI, G. (2006), "The Law of Primogeniture and the Transition from Landed Aristocracy to Industrial Democracy", *Journal of Economic Growth,* **11**, 43-70.

[13] BERTOCCHI, G. and CANOVA, F. (2002 ) "Did Colonization Matter for Growth? An Empirical Exploration into the Historical Causes of Africa's Underdevelopment," *European Economic Review* **46**, 1851-1871.

[14] CASELLI, F., and COLEMAN, W.J.(2001), "The US structural transformation and regional convergence: A reinterpretation," *Journal of Political Economy*, **109**, 584-616.

[15] CHANDA, A. and DALGAARD, C.J.(2003), "Dual Economies and International Total Factor Productivity Differences," University of Copenhagen.

[16] Cheng, C. (1961), *Land Reform in Taiwan*. China Publishing Company, Taiwan.

[17] COATSWORTH, J. H. "Notes on the Comparative Economic History of Latin America and the United States." In *Development and Underdevelopment in America: Contrasts of Economic Growth in North and Latin America in Historical Perspective,* Eds. BERNECKER, W.L.and TOBLER, H.W. (Berlin: de Gruyter, 1993), 10-30.

[18] DENINGER, K, and SQUIRE, L. (1998), "New Ways of Looking at Old Issues: Inequality and Growth", *Journal of Development Economics,* **57**, 259-287.

[19] DENNIS, G. (1961), “Education” in *Encyclopedia of Russia and the Soviet Union*, Ed. FLORINSKY, M. T. McGraw-Hill, New York.

[20] DOEPKE, M. (2004), “Accounting for Fertility Decline During the Transition to Growth”, *Journal of Economic Growth* **9**, 347-383.

[21] DOEPKE, M. and ZILIBOTTI, F. (2005), “The Macroeconomics of Child Labor Regulation”, *American Economic Review*, **95**, 1492-1524.

[22] EASTERLIN, R. A. (1957), “Regional Growth of Income: Long Term Tendencies”, in *Population Redistribution and Economic Growth: United States, 1870-1950, Vol. 2: Analysis of Economic Change*. Ed. KUZNETS, S., Miller, A. R. and EASTERLIN, R. A. American Philosophical Society: Philadelphia.

[23] EASTERLY, W. and LEVINE, R. (1997), “Africa’s Growth Tragedy: Policies and Ethnic Divisions,” *Quarterly Journal of Economics* **111**, 1203-1250.

[24] EASTERLY, W. and LEVINE, R. (2003), “Tropics, Germs, and Crops: the Role of Endowments in Economic Development”, *Journal of Monetary Economics*, **50**, 3-39.

[25] ECKERT, C.J. (1990), *Korea Old and New: A History.* Seoul. 1990.

[26] ENGERMAN, S. and SOKOLOFF, K. L. (2000), “Factor Endowment, Inequality, and Paths of Development among New World Economies,” UCLA.

[27] ESTEVO, G. (1983), *The Struggle for Rural Mexico.* Bergin and Garvey, South Hadley, MA.

[28] FERNANDEZ, R. and ROGERSON, R. (1996), “Income Distribution, Communities, and the Quality of Public Education”, *Quarterly Journal of Economics*, **111**, 135-164.

[29] FLORINSKY, M. T. (1961), *Encyclopedia of Russia and the Soviet Union.* McGraw-Hill, New York.

[30] FOX, A.W. (1903), “Agricultural Wages in England and Wales During the Last Half. Century”, *Journal of the Royal Statistical Society*, **66**, 273-348.

[31] GALOR, O. “Unified Growth Theory: From Stagnation to Growth,” in AGHION, P. and DURLAUF, S.eds. *Handbook of Economic Growth*, Elsevier: Amsterdam.

[32] GALOR, O. and MOAV, O. (2002), “Natural Selection and the Origin of Economic Growth,” *Quarterly Journal of Economics*, **117**, 1133-1192.

[33] GALOR, O. and MOAV, O. (2006), “Das Human-Kapital: A Theory of the Demise of Class Structure”, *Review of Economic Studies,* **73**, 85-117.

[34] GALOR, O. and MOAV, O. (2004) “From Physical to Human Capital: Inequality in the Process of Development”, *Review of Economic Studies,* **71**, 1001-1026.

[35] GALOR, O. and MOUNTFORD, A. (2006), “Trade and the Great Divergence: The Family Connection”, *American Economic Review,* **96**, 299-303.

[36] GALOR, O. and .WEIL, D. N. (2000) “Population, Technology and Growth: From the Malthusian Regime to the Demographic Transition,” *American Economic Review,* **90**, 806-828.

[37] GALOR, O. and ZEIRA, J. (1993), “Income Distribution and Macroeconomics”, *Review of Economic Studies,* **60**, 35-52.

[38] GRADSTEIN, M. (2006), “Inequality, Democracy, and the Protection of Property Rights,” *Economic Journal*, forthcoming.

[39] GERBER, J., (1991), “Public-School Expenditures in the Plantation States, 1910,” *Explorations in Economic History,* **28**, 309-322.

[40] GLAESER, E.L., LA PORTA, R. LOPEZ-DE-SILANES, F. and SHLEIFER, A. (2004), “Do Institutions Cause Growth?”, *Journal of Economic Growth* **9**, 271-303.

[41] GLAESER, E.L. and SHLEIFER, A. (2004), “Legal Origins,” *Quarterly Journal of Economics*, **117**, 1192-1230.

[42] GOLDIN, C. (1998), “America’s Graduation from High School: The Evolution and Spread of Secondary Schooling in the Twentieth Century,” *Journal of Economic History,* **58**, 345-74.

[43] GOLDIN, C. and KATZ, L.F. (1998), “The Origins of Technology-Skill Complementary”, *Quarterly Journal of Economics*, **113**, 693-732.

[44] GOLDIN, C. and KATZ, L.F. (1997), ”Why the United States Led in Education: Lessons from Secondary School Expansion, 1910 to 1940.” NBER Working Paper no. 6144.

[45] GHOSAL, S. and PROTO E. (2005), “Why did (not) the East Extend the Franchise? Democracy, Intra-Elite Conflict and Risk Sharing,” Warwick.

[46] GYLFASON, T. (2001).“Natural Resources, Education, and Economic Development,” *European Economic Review,* **45**, 847-859.

[47] GUBBINS, J. H. (1973), *The Making of Modern Japan.* Scholarly Resources, Wilmington, DE.

[48] Inter-University Consortium for Political and Social Research. *Historical, Demographic, Economic and Social Data: The United States, 1790-1970,.* Ann Arbor, MI.

[49] HALL R. E. and C. I. JONES, (1999),. ”Why Do Some Countries Produce So Much More Output Per Worker Than Others?,” *The Quarterly Journal of Economics*, Vol. 114: 83-116.

[50] HANSON, E. M. (1986), *Educational Reform and Administrative Development: The Cases of Colombia and Venezuela.* Hoover Institution Press, Stanford, CA.

[51] HAYAMI, Y. (1975). *A Century of Agricultural Growth in Japan.* University of Minnesota Press, Minneapolis.

[52] HOWITT, P. AND MAYER-FOULKES, D. (2005), “R&D, Implementation and Stagnation: A Schumpeterian Theory of Convergence Clubs”, *Journal of Money Credit and Banking* **37**, 147-177.

[53] JANSEN, M.B. (2000), *The Making of Modern Japan.* Harvard University Press, Cambridge, MA.

[54] JONES, C.I. (1997), “Convergence Revisited,” *Journal of Economic Growth*, **2**, 131-154.

[55] JONES, E.L. (1981), *The European Miracle: Environments, Economies and Geopolitics in the History of Europe and Asia* (Cambridge University Press, Cambridge).

[56] JOHNSON, W.H.E. (1969), *Russia’s Educational Heritage.* Octagon Books, New York.

[57] KUZNETS, S. (1955), “Economic Growth and Income Equality”, *American Economic Review,* **45**, 1-28.

[58] KUZNETS, S. (1968), *Towards a Theory of Economic Growth*, New Haven: Yale University Press,

[59] LAGERLOF, N.P. (2003), "Slavery," York University.

[60] LAGERLOF, N.P. (2006), "The Galor-Weil Model Revisited: A Quantitative Exercise", *Review of Economic Dynamics* **9**, 116-142.

[61] LANDES, D. S. (1998), *The Wealth and Poverty of Nations* (Norton, New York).

[62] LE BOT, I. (1972), Elementos Papa La Historia de la Educacion en Colombia en el Siglo XX. Bogota: Talleres de DANE.

[63] LIN, C.J. (1983). "The Republic of China (Taiwan)" *Schooling in East Asia*, Eds. THOMAS, R.M. and POSTLETHWAITE, T. N. Pergamon Press, Oxford.

[64] LINDBECK, A., and WEIBULL, J. (1987). "Balanced-Budget Redistribution as the Outcome of Political Competition", *Public Choice* **52**, 273-97

[65] LIZZERI, A and PERSICO, N. (2004), "Why Did the Elites Extend the Suffrage? Democracy and the Scope of Government, With an Application to Britain's Age of Reform", *Quarterly Journal of Economics*, **119**, 707 - 765.

[66] LOVEMAN, B. (1974), *Allende's Chile: Political Economy of the Peaceful Road to Disaster.* Latin American Studies Association.

[67] LUCAS, R.E.Jr. (2000). "Some Macroeconomics for the 21st Century," *Journal of Economic Perspectives*, **14**, 159-168.

[68] MADDISON, A. (2001), *The World Economy: A Millennia Perspective* (OECD, Paris).

[69] MANUELLI, R. E. and SESHADRI, A. (2005), "Human Capital and the Wealth of Nations," Wisconsin.

[70] MARGO, R. A. (1990), *Race and Schooling in the South, 1880-1950: An Economic History.* University of Chicago Press: Chicago.

[71] MASTERS, W.E. and MCMILLAN, M.S. (2001), "Climate and Scale in Economic Growth," *Journal of Economic Growth* **6**, 167-187.

[72] MOKYR, J. (1990) *The Lever of Riches: Technological Creativity and Economic Progress* (New York: Oxford University Press).

[73] MOKYR, J. (1992), "Is Economic Change Optimal?" *Australian Economic History Review*, **32**, 3-23.

[74] MOKYR, J. (2002), *The Gifts of Athena: Historical Origins of the Knowledge Economy* (Princeton: Princeton University Press).

[75] NORTH, D.C. (1981) *Structure and Change in Economic History*, W.W. Norton & Co., New York.

[76] NUGENT J. B. and ROBINSON, J. A. (2002) "Are endowments Fate?" CEPR Discussion Paper No. 3206.

[77] PARENTE, S., and PRESCOTT, E.C. (2000), *Barriers to Riches* (MIT Press, Cambridge).

[78] PASSIN, H. (1965), "Japan" in *Education and Political Development*, Ed. COLEMAN, J.S. Princeton University Press.

[79] PEROTTI, R. (1996), 'Growth, Income Distribution, and Democracy: What the Data Say', *Journal of Economic Growth,* **1**, 149-187.

[80] PERSSON, T.and TABELLINI, G. (2000), *Political Economics: Explaining Economic Policy,* MIT Press .

[81] RODRIK, D.,SUBRAMANIAN, A. and TREBBI, F. (2004), "Institutions Rule: The Primacy of Institutions Over Geography and Integration in Economic Development," *Journal of Economic Growth*, **9**, 131-165.

[82] PRITCHETT, L. (1997), "Divergence, Big Time," *Journal of Economic Perspectives*, **11**, 3-18.

[83] QUAH, D. (1997). "Empirics for Growth and Distribution: Stratification, Polarization and Convergence Clubs," *Journal of Economic Growth*, **2**, 27-60.

[84] RINGER, F. (1979), *Education and Society in Modern Europe* (Bloomington: Indiana University Press).

[85] SACHS, J. and WARNER, A.M. (1995). "Natural Resource Abundance and Economic Growth." NBER Working Paper 5398.

[86] SAH-MYUNG, HONG. (1983), "The Republic of Korea (South Korea)" *Schooling in East Asia*, Eds. THOMAS, R.M. and POSTLETHWAITE, T. N. Pergamon Press, Oxford.

[87] SALA-I-MARTIN, X. (2002), "The World distribution of Income: Falling Poverty and Convergence, Period", *Quarterly Journal of Economics*, **121**, 351-398.

[88] U.S. Bureau of Education. 1870-1950. *Report of the Commissioner of Education.* Government Printing Office: Washington D.C..

[89] U.S. Bureau of the Census. 1989. *Historical Statistics of the United States: Colonial Times to 1970.* Kraus International Publications: White Plains, NY.

[90] U.S. Department of Agriculture, Profile of Hired Farm Workers, (1998), Annual Averages.

[91] VAUGHAM, M. K. (1982), *The State, Education, and Social Class in Mexico, 1880-1928.* Northern Illinois University Press, DeKalb, IL.

[92] WRIGHT, D.G. (1970), *Democracy and Reform 1815-1885*, Longman, London.

[93] YOONG-DEOK, J. and KIM, Y.Y. (2000), "Land Reform, Income Redistribution, and Agricultural Production in Korea" *Economic Development and Cultural Change*, **48**, 253-268.