Land Inequality and the Origin of Divergence and Overtaking in the Growth Process: Theory and Evidence*

Oded Galor, Omer Moav and Dietrich Vollrath†

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Abstract

This research develops a unified growth theory that captures the transition from the domination of geographical factors in the determination of productivity in early stages of development to the domination of institutional factors in mature stages of development. It identifies a novel channel through which favorable geographical conditions that were inherently associated with inequality adversely affected the emergence of institutions that promote human capital accumulation. The research suggests that the distribution of land ownership within and across countries affected the nature of the transition from an agrarian to an industrial economy generating diverging growth patterns across countries. Furthermore, the qualitative change in the role of land in the process of industrialization brought about changes in the ranking of countries in the world income distribution. 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 High School Movement in the first half of the 20th century in the US.

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

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†Galor: Hebrew University and Brown University; Moav: Hebrew University; Vollrath: Brown University.

1 Introduction

The last two centuries have been characterized by a great divergence of income per capita across the globe. The ratio of GDP per capita between the richest and the poorest regions has widened considerably from a modest 3 to 1 ratio in 1820 to an 18 to 1 ratio in 2001 (Maddison (2001)).[1] The origin of the Great Divergence has been a source of controversy. The relative role of geographical and institutions factors, ethnic, linguistic, and religious fractionalization, colonialism and globalization has been in the center of a debate about the origins of this remarkable change in the world income distribution in the past two centuries.

The role of institutional and cultural factors has been the focus of influential hypotheses regarding the origin of the great divergence. North (1981), Landes (1998), Mokyr (1990, 2002), and Parente and Prescott (2000) have argued that institutions that facilitated the protection of property rights and enhanced technological research and the diffusion of knowledge, have been the prime factors that enabled the earlier European take-off and the great technological divergence across the globe.

The effect of geographical factors on economic growth and the great divergence have been emphasized by Jones (1981), Diamond (1997) and Sacks and Werner (1995).[2] The geographical hypothesis suggests that more 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.[3]

Recent research by Engerman and Sokolof (2000) and Acemoglu, Johnson and Robinson (2002) propose that initial geographical conditions had a persistent effect on the quality of institutions, leading to divergence and overtaking in economic performance. Engerman and Sokolof (2000) provide descriptive evidence that geographical conditions that led to income inequality, brought about oppressive institutions designed 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) provide evidence that reversals in economic performance across countries have a colonial origin, reflecting institu-

[1] Some researchers (e.g., Jones (1997) and Pritchett (1997)) have demonstrated this diverging pattern persisted in the last decades as well. Interestingly, however, as established by Sala-i-Martin (2002), the phenomena has not been maintained across people in the world (i.e., when national boundaries are removed).

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

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

tional reversals that were introduced by European colonialism across the globe.[4] "Reversals of fortune" reflect the imposition of extractive institutions by the European colonialists in regions in which favorable geographical conditions led to prosperity, and the implementation of growth enhancing institutions in poorer regions.

Furthermore, 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) and Alesina et al. (2003) demonstrate that geo-political 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.

Empirical research suggests that indeed 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.

This paper develops a dynamic general equilibrium theory that unifies the geographical and the institutional paradigms, capturing the transition from the domination of the geographical factors in the determination of productivity in early stages of development to the domination of the institutional factors in mature stages of development. It identifies and establishes the empirical validity of a novel channel through which favorable geographical conditions that were inherently associated with inequality affected the emergence of human capital promoting institutions (e.g., public schooling, child labor regulations, abolishment of slavery, etc.),[5] and thus the pace of the transition from an agricultural to an industrial society.[6]

The research suggests that the distribution of land ownership within and across countries and its effect on human capital formation, brought about diverging growth patterns across countries. Land abundance,[7] which was beneficial in early stages of development, generated a

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

[5]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.

[6]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.

[7]Land abundance is defined in this paper as a high level of effective land per capita, determined by the size of

hurdle for human capital accumulation and economic growth among countries that were marked by an unequal distribution of land ownership. The qualitative change in the role of land in the process of industrialization created changes in the ranking of countries in the world income distribution. 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 and were dominated by other land abundant economies in which land distribution was rather equal.[8]

The accumulation of physical capital has raised the importance of human capital in the process of industrialization, reflecting the complementarity between capital and skills. Investment in human capital, however, has been sub-optimal due to markets imperfections, and public investment in education has been growth enhancing.[9] Nevertheless, human capital accumulation has not benefited all sectors of the economy. Due to a low degree of complementarity between human capital and land,[10] universal public education has increased the cost of labor beyond the increase in the average labor productivity in the agricultural sector, reducing the return to land. 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.[11]

The theory suggests that the adverse effect of the implementation of universal public education on landowners' income from agricultural production is magnified by the degree of concentration of land ownership. 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.[12] In these economies an inefficient education

the land, its quality and climatic conditions.

[8]Thus reversal of fortune may occur due to internal economic forces, as well as the external forces proposed by Acemoglu et al. (2002).

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

[10]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. Furthermore, 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.

[11]Landowners, as well as other owners of factors of production, are assumed to influence the level of public schooling but are limited in their power to levy taxes for their own benefit. Otherwise, following the Coasian Theorem, 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.

[12]Consistently with the proposed theory, Deininger and Squire (1998) document that the level of education and

policy persisted and the growth path was retarded.[13] In contrast, in societies in which agricultural land was scarce or land ownership was distributed rather equally, growth enhancing education policies were implemented.[14] The process of industrialization fueled by the accumulation of physical capital, has raised the interest of landowners in the productivity of the industrial sector and might have brought about a qualitative change in landowners' attitudes towards education reforms. In particular, among land abundant economies, those in which land is equally distributed adopted growth-enhancing public education earlier, generating diverging growth patterns across countries.[15]

The proposed theory suggests that among economies marked by an unequal distribution of land ownership, land abundance that was a source of richness in early stages of development, is in fact the factor that led in later stages to under-investment in human capital and slower economic growth.[16] 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), 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.[17] Interestingly, the political economy interpretation of our theory suggests, in contrast, that the industrial elite would relinquish power to the masses in

economic growth over the period 1960-1992 are inversely related to land inequality (across landowners) and the relationship is more pronounced in developing countries.

[13]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 (e.g., Benabou (1996) and Perotti (1996)).

[14]The potentially adverse relationship between natural resources and growth is evident 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, Gylfason (2001) argues that natural resources crowd out human capital. In 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.

[15]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.

[16]Lane and Tornel (1996) suggest that the reversal of fortune of some natural resource abundant countries may be attributed to the rigidity of rent seeking activities in periods of decline in their terms of trade.

[17]Barriers to technological adoption that may lead to divergence are explored by Caselli and Coleman (2002), Howitt and Mayer-Foulkes (2002) and Acemoglu, Aghion and Zilibotti (2003) as well.

order to overcome the desire of the landed elite to block economic development.[18]

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 High School Movement in the first half 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. Historical evidence from the US on education expenditures and land ownership in the period 1880-1920 suggests that land inequality had a significant adverse effect on the timing of educational reforms during the high school movement in the United States.

In addition, anecdotal evidence suggests that indeed the distribution of land within and across countries 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, income levels, and growth patterns across countries.[19] The link between land reforms and the increase in governmental investment in education that is apparent in the process of development of several countries lends credence to the proposed theory.

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 1949, the Republic of Korea instituted the Agricultural Land Reform Amendment Act that drastically affected landholdings. Owner cultivated farm households increased from 349,000 in 1949 to 1,812,000 in 1950, and tenant farm households declined from 1,133,000 in 1949 to nearly zero in 1950 [Yoong, 2000]. Consistent with the proposed theory, following the decline in the inequality in the distribution of land, expenditure on education soared. 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. Land reforms and the subsequent increase in governmental investment in education were followed by a stunning growth performance that permitted Korea to nearly triple its income relative to the United States in about twenty years, from 9% in 1965 to 25% in 1985. Hence, consistently with the proposed theory, prior to its land reforms Korea's income level

[18] See Lizzeri (2004) as well.

[19] See Gerber (1991), Colleman and Caselli (2001) and Bertocchi (2002) as well.

was well below that of land-abundant countries in North and South America. However, in the aftermath of the Korean's land reform and its apparent effect on human capital accumulation, Korea overtook some land abundant countries in South America that were characterized by an unequal distribution of land.

North and South America provide anecdotal evidence for differences in the process of development, and possibly overtaking, due to the effects of the distribution of land ownership on education reforms within land-abundant economies. As argued by Engerman and Sokoloff (2000) the original colonies in North and South America had vast amounts of land per person and income levels comparable to the European ones. North and Latin America differed in the distribution of land and resources. The United States and Canada were deviant cases in their relatively egalitarian distribution of land. For the rest of the new world, land and resources were concentrated in the hand of a very few, and this concentration persisted over a very long period.[20] Consistent with the proposed theory, these differences in land distribution between North and Latin America, were associated with significant differences in investment in human capital. As argued by Coatsworth (1993 pp 26-7) in the US there was a widespread property ownership, early public commitment to educational spending, and a lesser degree of concentration of wealth and income whereas in Latin America public investment in human capital remained well below the levels achieved at comparable levels of national income in more developed countries.[21] Furthermore, Engerman and Sokoloff (2000) maintain that although all of the economies in the western hemisphere were rich enough in the early 19th century to have established primary schools, only the United States and Canada made the investments necessary to educate the general population.

The proposed theory further suggests that the divergence in the growth performance of North and Latin America in the second half of the twentieth century, (e.g., Argentina, Brazil, Chile and Mexico vs. the US and Canada), may be attributed in part to the more equal distribution of land in the North, whereas the overtaking (e.g., Mexico and Columbia overtaken by Korea and Taiwan) may be attributed to the positive effect of land abundance in early stages of development and the adverse effect of its unequal distribution in later stages of development. Moreover, 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

[20] For instance, in Mexico in 1910, 0.2% of the active rural population owned 87% of the land [Estevo, 1983].

[21] As argued by Engerman and Sokolof (2000), even among Latin American countries variations in the degree of inequality in the distribution of land ownership were reflected in variation in investment in human capital. In particular, Argentina, Chile and Uruguay in which land inequality was less pronounces invested significantly more in education.

and human capital are significantly higher than that of Guatemala and El Salvador where coffee plantations are rather large.[22]

2 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 and output grows due to the accumulation of physical and human capital.

2.1 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;

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

2.1.1 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

[22] 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. Moreover, unlike our theory, their mechanism does not generate the economic forces that permit the economy to escape this institutional trap.

the neoclassical boundary conditions that assure the existence of an interior solution to the producers' profit-maximization problem.[23]

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, ρ_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,

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

2.1.2 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. The output produced at time t, y_t^M, is

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

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. Both factors depreciate fully after one period. In contrast to the agricultural sector, human capital has a positive effect on workers' productivity in the manufacturing sector, increasing workers' efficiency units of labor.

Producers in the manufacturing sector operate in a perfectly competitive environment. Given the wage rate per efficiency unit of human capital, 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 human capital, 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

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

2.2 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. Individ-

[23] The abstraction from technological change is merely a simplifying assumption. The introduction of endogenous technological change would allow output in the agricultural sector to increase over time despite the decline in the number of workers in this sector.

uals, 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,[24] c_{t+1}^i, and a transfer to the offspring, b_{t+1}^i.[25] They are represented by a log-linear utility function

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

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

In the first period of their lives individuals devote their entire time for the acquisition of 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.

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 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.[26]

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

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 posses one efficiency unit of human capital - basic skills.

In the second period 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

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

[25]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).

[26]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 2.4, 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.

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,[27]

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

The indirect utility function of a member i of generation t, v_t^i is therefore

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

where $\xi \equiv (1-\beta)\log(1-\beta) + \beta\log\beta$. The indirect utility function is monotonically increasing in I_{t+1}^i.

2.3 Physical Capital, Human Capital, and Output

Let B_t denote the aggregate level of intergenerational transfers in period t. It follows from (8) and (10) that,

$$B_t = \beta y_t. \tag{12}$$

A fraction τ_t 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 consumption. The capital stock in period $t+1$, K_{t+1}, is therefore

$$K_{t+1} = (1-\tau_t)\beta y_t, \tag{13}$$

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

Since population is normalized to 1, the education expenditure per young individual in period t, e_t, is,

$$e_t = \tau_t\beta y_t, \tag{14}$$

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

$$H_{t+1} = \theta_{t+1}h\left(\tau_t\beta y_t\right), \tag{15}$$

[27] 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 $b_{t+1}^i = \beta I_{t+1}^i$.

where, θ_{t+1} is the fraction (and the number) of workers employed in the manufacturing sector. Hence, output in the manufacturing sector in period $t+1$ is,

$$y^M_{t+1} = [(1-\tau_t)\beta y_t]^\alpha [\theta_{t+1} h(\tau_t \beta y_t)]^{1-\alpha} \equiv y^M(y_t, \tau_t, \theta_{t+1}) \tag{16}$$

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

$$k_{t+1} = \frac{(1-\tau_t)\beta y_t}{\theta_{t+1} h(\tau_t \beta y_t)} \equiv k(y_t, \tau_t, \theta_{t+1}), \tag{17}$$

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

$$(1-\tau_t)\beta y_t R_{t+1} = \alpha y^M_{t+1}, \tag{18}$$

and the labor share in the manufacturing sector is given by

$$\theta_{t+1} h(\tau_t \beta y_t) w^M_{t+1} = (1-\alpha) y^M_{t+1}. \tag{19}$$

The supply of labor to agriculture, L_{t+1}, is equal to $1-\theta_{t+1}$. Output in the agriculture sector in period $t+1$ is therefore

$$y^A_{t+1} = F(X, 1-\theta_{t+1}) \equiv y^A(\theta_{t+1}; X) \tag{20}$$

As follows from the properties of the production functions as long as, $X > 0$, and $\tau_t < 1$, noting that $y_t > 0$ for all t, both sectors are active in $t+1$. Hence, since individuals can either supply one unit of labor to the agriculture sector and receive the wage w^A_{t+1} or supply h_{t+1} units of human capital to the manufacturing sector and receive the wage income $h_{t+1} w^M_{t+1}$ it follows that

$$w^A_{t+1} = h_{t+1} w^M_{t+1} \equiv w_{t+1}, \tag{21}$$

and the division of labor between the two sectors, θ_{t+1}, noting (3), (5) and (17) is determined accordingly.

Since the number of individuals in each generation is normalized to 1, aggregate wage income in the economy, which equals to the sum of labor shares in the two sectors, equals w_{t+1}. Namely, as follows from (3), (19) and (20),

$$w_{t+1} = (1-\theta_{t+1}) F_L(X, 1-\theta_{t+1}) + (1-\alpha) y^M_{t+1}. \tag{22}$$

Lemma 1 *The fraction of workers employed by the manufacturing sector in period* $t+1$, θ_{t+1} :
(a) 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* $lim_{y\to\infty}\ \theta(y_t, \tau_t; X) = 1$.
(b) maximizes the aggregate wage income, w_{t+1}, *and output* y_{t+1} *in period* $t+1$:

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

Proof.
(a) Substitution (3), (5), and (17) into (21) it follows that

$$F_L(X, 1-\theta_{t+1}) = h(\tau_t \beta y_t)(1-\alpha)\left(\frac{(1-\tau_t)\beta y_t}{\theta_{t+1} h(\tau_t \beta y_t)}\right)^{\alpha}, \tag{23}$$

and therefore the Lemma follows from the properties of the agriculture production technology, $F(X, L_t)$, and the concavity of $h(e_t)$.
(b) Since θ_{t+1} equalizes the marginal return to labor in the two sectors, and since the marginal product of factors is decreasing in both sectors, part (b) follows. □

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

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

Proof. Follows from (3), (5), (17), (20) and Lemma 1. □

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

(c) $\tau_t^* = \arg\max w_{t+1}$ *and* $dw_{t+1}/d\tau_t > 0$ *for* $\tau_t \in (0, \tau_t^*)$*.*

(d) $\tau_t^* = \arg\min \rho_{t+1}$ *and* $d\rho_{t+1}/d\tau_t < 0$ *for* $\tau_t \in (0, \tau_t^*)$*.*

(e) $\tau_t^* = \arg\max \theta(y_t, \tau_t; X)$ *and* $d\theta(y_t, \tau_t; X)/d\tau_t > 0$ *for* $\tau_t \in (0, \tau_t^*)$*.*

(f) $\tau_t^* = \arg\max y_{t+1}^M$ *and* $dy_{t+1}^M/d\tau_t > 0$ *for* $\tau_t \in (0, \tau_t^*)$*.*

(g) $\tau_t^* = \arg\max(1-\tau_t)R_{t+1}$ *and* $d(1-\tau_t)R_{t+1}/d\tau_t > 0$ *for* $\tau_t \in (0, \tau_t^*)$*.*

Proof.

(a) As follows from (16) and (20) aggregate output in period $t+1$, y_{t+1} is

$$y_{t+1} = y^M(y_t, \tau_t, \theta_{t+1}) + y^A(\theta_{t+1}; X). \tag{24}$$

Hence, since $\tau_t^* = \arg\max y_{t+1}$ and since, as established in Lemma 1, $\theta_{t+1} = \arg\max y_{t+1,}$ it follows form the envelop theorem that the value of τ_t^* satisfies the condition in part (a).

(b) It follows from part (a), (5) and (17) that

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

Hence, $\tau_t^* = \tau^*(y_t) < 1$ and $\tau_t^* > 0$ for all $y_t > 0$ (since $\lim_{e_t \to 0^+} h'(e_t) = \infty$) and $\tau^*(y_t)y_t$ is strictly increasing in y_t.

(c) Follows from the differentiation of w_{t+1} in (22) with respect to τ_t using the envelop theorem since, as established in Lemma 1, $\theta_{t+1} = \arg\max w_{t+1}$.

(d) Follows from part (c) noting that along the factor price frontier ρ_t decreases in w_t^A and therefore in w_t.

(e) Follows from part (c) noting that, as follows from the properties of the production function (2), L_{t+1} and w_{t+1}^A are inversely related and hence $\theta_{t+1} = 1 - L_{t+1}$ is positively related to w_{t+1}^A and therefore to w_{t+1}.

(f) Follows from differentiating y_{t+1}^M in (16) with respect to τ_t noting that y_{t+1}^M is strictly increasing in θ_{t+1} and as follows from part (e) $d\theta(X, y_t, \tau_t)/d\tau_t > 0$ for $\tau_t \in (0, \tau^*)$.

(g) Follows from part (f) noting that, as follows from (18), $(1-\tau_t)R_{t+1} = \alpha y_{t+1}^M/(\beta y_t)$. □

The size of the land, X, has two opposing effects on τ_t^*. 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. Due to the Cobb-Douglass production function in the manufacturing sector the two effects cancel one another and as established in Lemma 2 the value of τ_t^* is independent of the size of land.

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, $(1-\tau_t^*)R_{t+1}$. If the elasticity of substitution would be 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.

Corollary 2 *The optimal level of taxation from the viewpoint of individual* i, *is* τ_t^* *for a sufficiently low* x^i.

Proof. Since the indirect utility function, (11), is a strictly increasing function of the individual's second period wealth, and since as established in Lemma 2, w_{t+1}, and $(1-\tau_t)R_{t+1}$ are maximized by τ_t^*, it follows from (8) that, for a sufficiently low x^i, $\tau_t^* = \arg\max v(I_{t+1}^i)$. □

Hence, the optimal level of taxation for individuals whose land ownership is sufficiently low equals the level of taxation (and hence the level of expenditure on public schooling) that maximizes aggregate output.

2.5 Political Mechanism

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 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 segment of society would support an alternative policy.

2.6 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, $1/\lambda$, of the entire stock of land, X, and is endowed with b_0^L units of output. Since landlord 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 and the division of capital within the class of landlord is constant over time, where each landlord owns X/λ units of land and 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

$$I_{t+1}^L = w(y_t, \tau_t) + (1-\tau_t)R(y_t, \tau_t)b_t^L + \rho(y_t, \tau_t)X/\lambda, \tag{25}$$

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

$$b_{t+1}^L = \beta[w(y_t, \tau_t) + (1-\tau_t)R(y_t, \tau_t)b_t^L + \rho(y_t, \tau_t)X/\lambda] \equiv b^L(y_t, b_t^L, \tau_t; X/\lambda) \tag{26}$$

Proposition 1 *For any given level of capital and land ownership of each landlord $(b_t^L, \lambda; X)$ there exists a sufficiently high level of output $\widehat{y}_t = \widehat{y}(b_t^L, \lambda; X)$ above which the optimal taxation from a Landlord's viewpoint, τ_t^L, maximizes aggregate output, i.e.,*

$$\tau_t^L \equiv \arg\max I_{t+1}^L = \tau_t^* \quad \textit{for} \;\; y_t \geq \widehat{y}_t$$

where $\widehat{y}(b_t^L, 1; X) = 0$; $\lim_{\lambda \to 0} \widehat{y}(b_t^L, \lambda; X) = \infty$;
$\widehat{y}_\lambda(b_t^L, \lambda; X) < 0$; $\widehat{y}_X(b_t^L, \lambda; X) > 0$.

Proof. Follows from the properties of the agriculture production function (2), Lemma 1 and 2, noting that, since $1-\theta_{t+1} = \arg\max \rho_{t+1}$, for $b_t^L = 0$, $dI_{t+1}^L/dw_{t+1} > 0$ if $\lambda > 1-\theta_{t+1}$. □

Corollary 3 *For any given level of capital and land ownership of each landlord $(b_t^L, \lambda; X)$ there exists a sufficiently high level of output $\widehat{y}_t = \widehat{y}(b_t^L, \lambda; X)$ above which the level of taxation, τ_t^*, that maximizes aggregate output, is optimal from the viewpoint of every member of society.*

Lemma 3 *(a) The equilibrium tax rate in period t, τ_t, is equal to either 0 or τ_t^*, i.e.,*

$$\tau_t \in \{0, \tau_t^*\};$$

(b) If $\hat{t}$ is the first period in which $\tau_t = \tau_t^*$ then

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

Proof. follows from the political structure, Corollary 2 and the assumption that $\tau_0 = 0$. □

Lemma 4 *Landlords desirable tax rate in period t, τ_t^L,*

$$\tau_t^L = \begin{cases} \tau_t^* & if \quad b_t^L \geq \hat{b}_t; \\ \\ 0 & if \quad b_t^L < \hat{b}_t, \end{cases}$$

where

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

and there exists a sufficiently large λ such that, $\hat{b}(y_t, X/\lambda) = 0$ for any y_t.

Proof. Follows from (25) and Lemma 3. □

Corollary 4 *The switch to the efficient tax rate τ_t^* occurs when $b_t^L \geq \hat{b}_t$, i.e.,*

$$b_t^L \geq \hat{b}_t \quad \textit{if and only if} \;\; t \geq \hat{t}.$$

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

Proposition 2 *The conditional evolution of output per capita, as depicted in Figure 1, is given by*

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

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. The proof follows from (1), (13), (15), (16) and (20), applying the envelop theorem noting that, as follows from Lemma 1 and Lemma 2, $\theta_{t+1} = \arg\max y_{t+1}$ and $\tau_t^* = \arg\max y_{t+1}$.□

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

Corollary 5 *Given the size of land, X, there exists a unique $\bar{y}^0$ and a unique $\bar{y}^*$ such that*

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

and

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

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

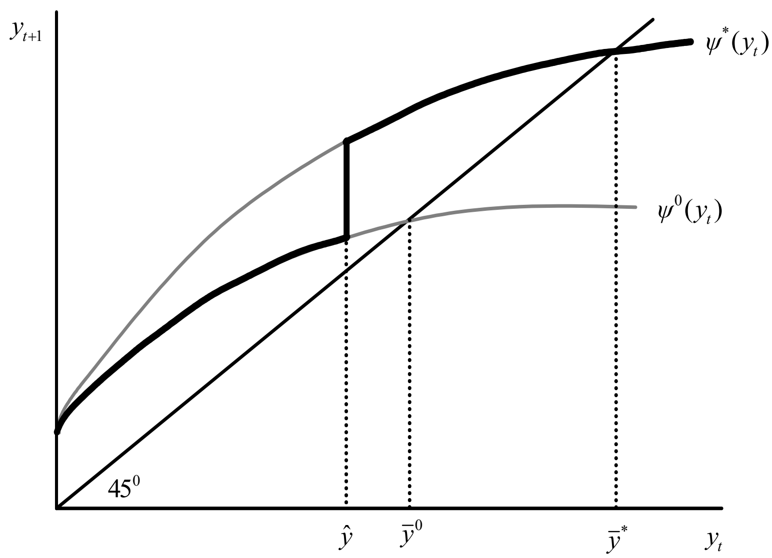

Figure 1: Education Reform and The Evolution of Output

3.1 The Dynamical System

The evolution of output, as follows from Lemma 3 and Proposition 2, is

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

The timing of the switch from a zero tax rate to the efficient tax rate τ_t^* occurs, as established in Corollary 4 once $b_t^L \geq \hat{b}_t$. Since $\tau_t = 0$ for all $t < \hat{t}$, and since $\hat{b}_t = \hat{b}(y_t; X/\lambda)$, the timing of the switch, $\hat{t}$, is determined by the co evolution of $\{y_t, b_t^L\}$ for $\tau_t = 0$

$$y_{t+1} = \psi^0(y_t)$$

$$b_{t+1}^L = b^0(y_t, b_t^L)$$

Let the bb locus (depicted in Figure 3) be the set of all pairs (b_t^L, y_t) such that, for $\tau_t = 0$, b_t^L is in a steady state. i.e., $b_{t+1}^L = b_t^L$.

In order to simplify the exposition of the dynamical system it is assumed that the value of β is sufficiently small,

$$\beta < 1/R(y_t, 0) \qquad \forall y_t \tag{A1}$$

where as follows from (3), (5) and Lemma 1, $R(y_t, 0) < \infty$ for all y_t and therefore there exists a sufficiently small β such that A1 holds.

Lemma 5 *Under A1, there exists a continuous single-valued function $\varphi(y_t; X/\lambda)$,such that along the bb locus*

$$b_t^L = \varphi(y_t; X/\lambda) \equiv \frac{\beta[w(y_t, 0) + \rho(y_t, 0)X/\lambda]}{1 - \beta R(y_t, 0)} > 0,$$

where for sufficiently small λ,

$$\varphi(0, X/\lambda) < \hat{b}(0, X/\lambda).$$

and for $\lambda = 1$

$$\hat{b}(y_t; X/\lambda) < \varphi(y_t; X/\lambda) \quad \text{for all } y_t.$$

Furthermore, as depicted in Figure 3, for $\tau = 0$,

$$b_{t+1}^L - b_t^L \gtreqless 0 \qquad \text{if and only if } b_t^L \lesseqgtr \varphi(y_t; X/\lambda).$$

Proof. Follows from (26), A1, and Lemma 4, noting that for $\lambda = 1$, $I_t^L = y_t$ and hence $\tau_t^* = \arg\max I_{t+1}^L$. □

Let yy^0 be the locus (depicted in Figure 3) of all pairs (b_t^L, y_t) such that, for $\tau_t = 0$, y_t is in a steady state equilibrium,. i.e., $y_{t+1} = y_t$.

Lemma 6

$$yy^0 = \{(y_t, b_t^L) : y_t = \bar{y}^0, b_t^L \in R_+\}$$

Furthermore, as depicted in Figure 3, for $\tau = 0$,

$$y_{t+1} - y_t \gtreqless 0 \qquad \text{if and only if } y_t \lesseqgtr \bar{y}^0.$$

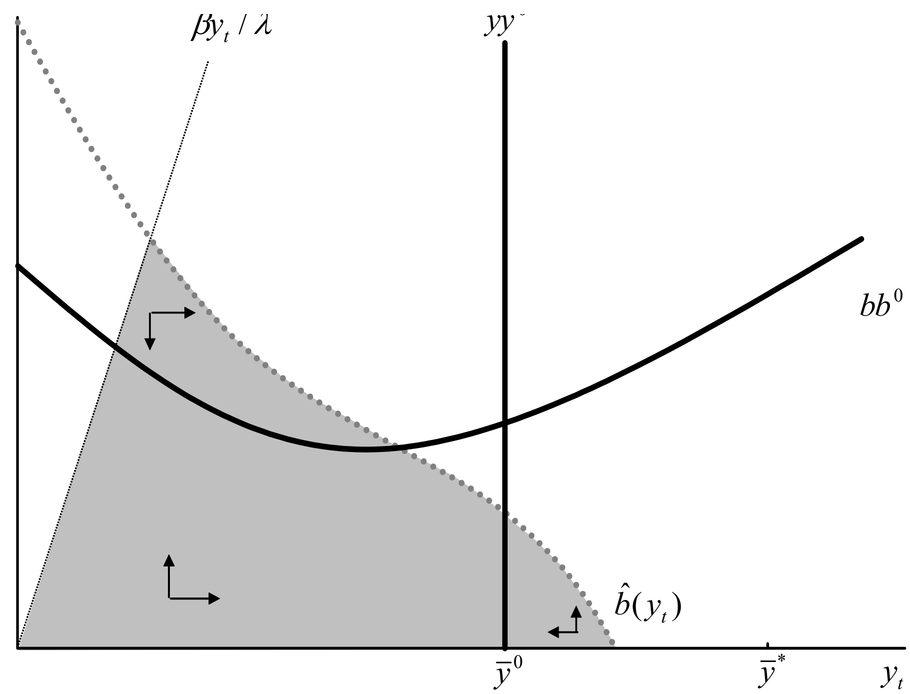

Figure 2: The Evolution of Output and Landowner's Bequest

Proof. Follows from Proposition 2 and Corollary 5. □

Corollary 6 *For a sufficiently low* λ *there exists* $y > 0$ *such that*

$$\hat{b}(y; X/\lambda) = \varphi(y; X/\lambda).$$

Proof. follows from Lemma 5 and Proposition 16. □

Lemma 7 *Let* $\tilde{y}(X/\lambda)$ *be the smallest value of* y_t *such that* $\hat{b}(y_t; X/\lambda) = \varphi(y_t; X/\lambda)$*. Under A1*

$$d\tilde{y}(X/\lambda)/d\lambda \leq 0,$$

where $\lim_{\lambda \to 0} \tilde{y}(X/\lambda) = \infty$*.*

Proof. It follows from the properties of $\hat{b}(y_t; X/\lambda)$ and $\varphi(y_t; X/\lambda)$, noting that $w(y_t, \tau_t)$, $\rho(y_t, \tau_t)$ and $R(y_t, \tau_t)$, are independent of λ, and $\rho(y_t, 0) > \rho(y_t, \tau_t^*)$ for all $y_t > 0$. □

In order to simplify the exposition of the dynamical system it is assumed that $\tilde{y}(X/\lambda)$ is unique.

Proposition 3 *The economy is characterized by:*

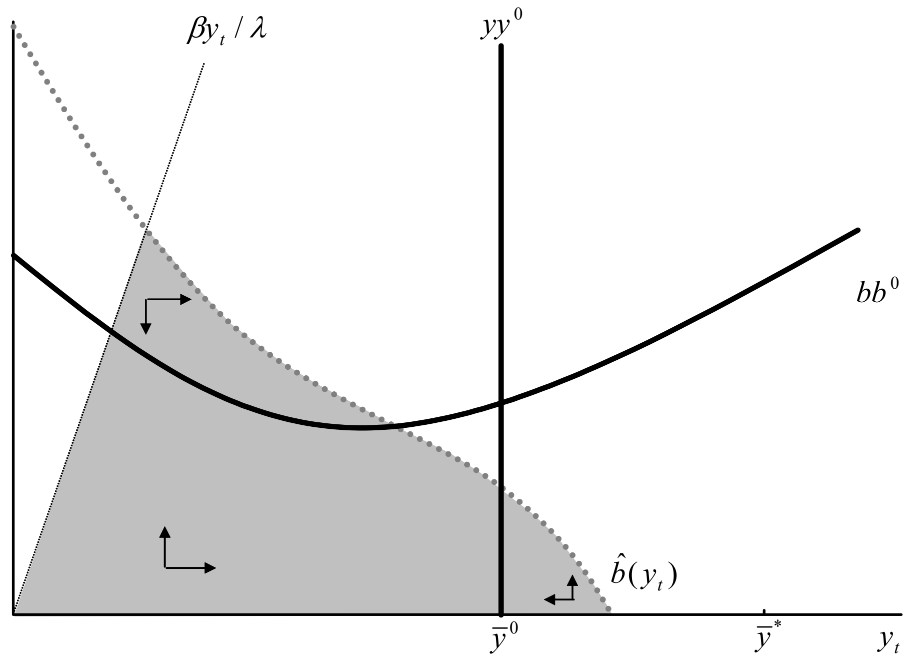

Figure 3: The Evolution of Output and Landowner's Bequest

(a) A unique globally stable steady state equilibrium, $\bar{y}^*$, if $\tilde{y}(X/\lambda) < \bar{y}^0$, that is if λ is sufficiently large.
(b) Two locally stable steady states, $\bar{y}^*$ and $\bar{y}^0$, if $\tilde{y}(X/\lambda) > \bar{y}^0$, that is if λ is sufficiently small.

Proof. Follows from the political mechanism, the definition of $\tilde{y}$ and Lemma 5 and 7. □

Theorem 1 *Consider countries that are identical in all respects except for their initial land distribution.*
(a) Countries that have a less equal land distribution, i.e., countries with a low level of λ, will experience a delay in the implementation of efficient education policy and will therefore experience a lower growth path.
(b) Countries characterize by a sufficiently unequal distribution of land and sufficiently low capital ownership by the landlord will permanently conduct an inefficient education policy and will therefore experience a lower growth path as well as a lower level of output in the long-run.

Proof. The theorem is a corollary of Proposition 3 and Lemma 3 and 7. □

This theorem suggests that 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 4, 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.

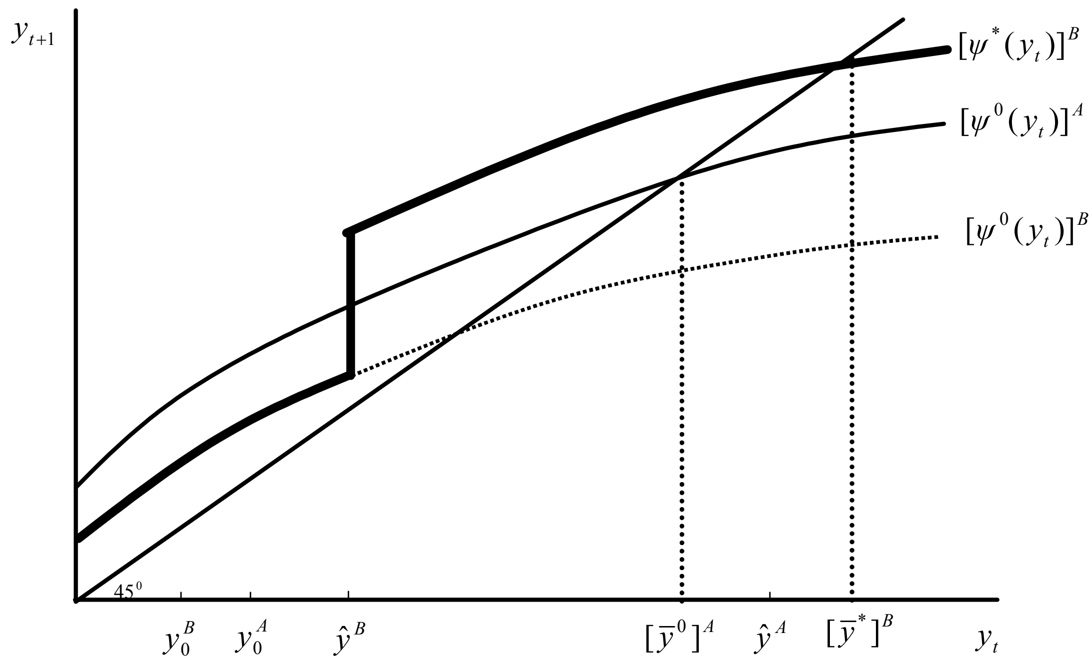

Figure 4: Overtaking – country A is relatively richer in land, however, due to land inequality it fails to implement efficient schooling and is overtaken by country B. Alternatively, for a lower degree of inequality, country A will eventually implement education reforms and ultimately takeover country B (not captured in the figure).

4 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 in the US during the high school movement. Historical evidence from the US on education expenditures and land ownership in the period 1880-1920 suggests that land inequality had a significant adverse effect on the timing of educational reforms during this period.

4.1 The US High School Movement 1910-1940

The qualitative changes in the education structure of the United States during the early 20th century and the variations in the timing of these education reforms across states provide a potentially fertile setting for the test of the theory.

During the time period 1910-1940 the education system in the US underwent a major transformation from insignificant secondary education to nearly universal secondary education.[28] 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.

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 thought towards building a skilled work-force for the services and manufacturing sectors. As argued by Goldin (1999), "American high schools adapted to the needs of the modern workplace of the early twentieth century. Firms in the early 1900's began to demand workers who knew, in addition to the requisite English, skills that made them more effective managers, sales personnel, and clerical workers. Accounting, typing, shorthand, algebra, and specialized commercial courses were highly valued in the white-collar sector. Starting in the late 1910's, some of the high-technology industries of the day, such as chemicals, wanted blue-collar craft workers who had taken plane geometry, algebra, chemistry, mechanical drawing, and electrical shop."

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.

4.2 Testable Predictions

According to the proposed theory, the nature of the relationship between land inequality and public expenditure on education has changed in the process of development. In early stages of development (i.e. prior to the onset of the high school movement in about 1910), the level of

[28]See Goldin (1998, 1999) and Goldin and Katz (1997).

development of each state did not necessitate investment in high school education. Hence, land inequality would be expected to have limited effect on educational expenditures, and variations in educational expenditures would reflect mostly differences in income across states. In later stages, however, high school education was needed in order to produce skilled workers for the industrial and the service sectors. At this stage, due to the lower complementarity of high school education with the agricultural sector, concentration of land would be expected to adversely affect educational expenditure, and variation across states would be expected to reflect variations in land inequality as well as in income. Ultimately, as the necessary skills were formed by 1940, variations in educational expenditures across states would be expected to reflect mostly variations in income again.

In addition, the theory predicts that capital accumulation has a mediating influence on the impact of land inequality. As capital stocks rise relative to the value of land, the stake of landowners in the viability of the economy as a whole increases and the incentives for landowners to oppose education decrease. Capital accumulation would be expected therefore to reduce the negative impact of land inequality on education expenditures.

Hence, in the context of the available data, the theory predicts that:

1. There exists an insignificant relationship between land conditions and education expenditures in 1900, controlling for income.

2. There exists a significant negative relationship between land inequality and education expenditures in 1920, controlling for income.

3. The negative relationship between land inequality and education expenditures is reduced in magnitude the larger the ratio of capital to land.

4.3 Data Sources and Basic Regularities

In light of the proposed theory, we exploit variations in public expenditure on education across states in the US to examine the effect of land inequality and capital accumulation on the high school movement. The historical data that is utilized in this study is gathered from several sources (their sources and method of construction are reported in the Appendix).

- Income across states is measured using estimates provided by Easterlin (1957) for 1900 and 1920.

- The characterization of the timing of the high school movement is based on the classification of Goldin (1998). As reflected in that study, in 1900 the high school movement had only just begun and by 1920 it was well underway in nearly every state. By 1950 most of the changes in secondary education had been completed. Limitations of data will only permit us to examine the years 1900 and 1920.

- Land inequality is measured by the Gini coefficients on land distribution within each state that we constructed using US Census data. The Gini coefficients are created for 1880, 1900 and 1920. The 1880 coefficients are used in some cases as direct controls for land inequality, and in others as instruments for the 1900 and 1920 measures.[29]

- The relative importance of capital is measured by the ratio of total capital stock (Easterlin (1957)) to the total value of agricultural land obtained from the US Census. The ratio is measured for the years 1880, 1900 and 1920.

During this period the states varied widely in both land inequality and in the importance of capital in their economies. 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 indices were around 0.29, and highest in the South, with Gini indices around 0.50. The importance of capital varied more dramatically across the regions. In the Northeast in 1880, there was nearly one dollar of physical capital for every dollar of farmland, and in a state like Rhode Island the ratio was already \$2.87 of capital per dollar of land. By contrast, in the Midwest and South, there was only about thirteen cents of capital for every dollar of farmland. The average for the U.S. as a whole was thirty-three cents.

By 1920 there was a general shift upward in both the Gini index of land inequality and the value of capital relative to land. The average Gini was 0.53, and the West tended to have the highest land inequality, with a Gini of 0.68. The Midwest again had the most equally distributed farmland, but its average Gini was 0.38. The level of capital had also increased dramatically by 1920. The average U.S. state had \$3.23 of capital for every dollar of farmland. Again, Northeastern states had values even higher than this, averaging about \$13.34. The Midwest had the lowest average value, but still had approximately one dollar of capital to every dollar of farmland.

[29]These Gini coefficients 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 coefficient underestimates the degree of land inequality within each state. As this exclusion is likely to make it more difficult to establish a relationship between the variation in land inequality and variation in education, the reported results are likely to underestimate the actual effects.

These values indicate the changing nature of the U.S. economy over this period. As agriculture became less significant there seems to have been a general upward shift in land inequality, perhaps not unexpected, as some landowners consolidated holdings as others moved on to invest in the new manufacturing sectors. The assets of the nation became increasingly skewed towards physical capital, concurrent with the onset of the high school movement.

Examining the data graphically we are able to preview some of the results. Figures 5 and 6 show basic plots of log income per capita to log education expenditures per child in 1900 and 1920. In 1900 there is a very tight relationship between income and education across the whole range of states. Southern states cluster towards low education and income and it is the Western states that have both high income and education expenditures.

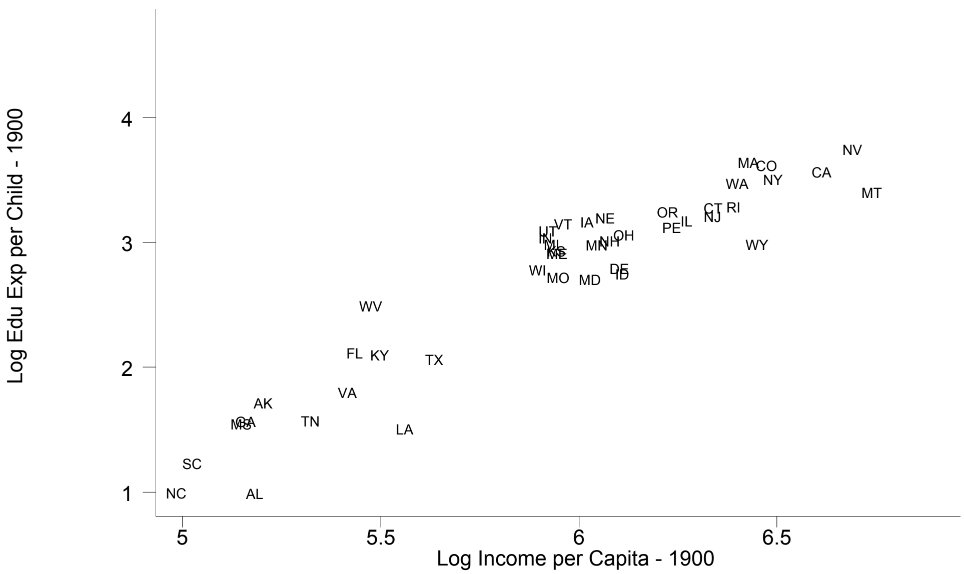

Figure 5: Education and Income in 1900

As is apparent from the figures, income as well as education expenditure had risen from 1900 to 1920. In 1920 the South still is the lagging region while the West tends to be the leader. One significant difference between the two figures, though, is the large amount of variation in education expenditure observed amongst the states in 1920 compared to 1900. This variation is generally confined to the upper-income states in 1920; in particular, the variation is found among the non-Southern states.

To see the significance of this variation in 1920, consider the following. In 1900, the correlation of income and education expenditures across all states is 0.94 and this is significant at well under 1%. If we exclude the southern states in 1900, the correlation is still 0.80 and

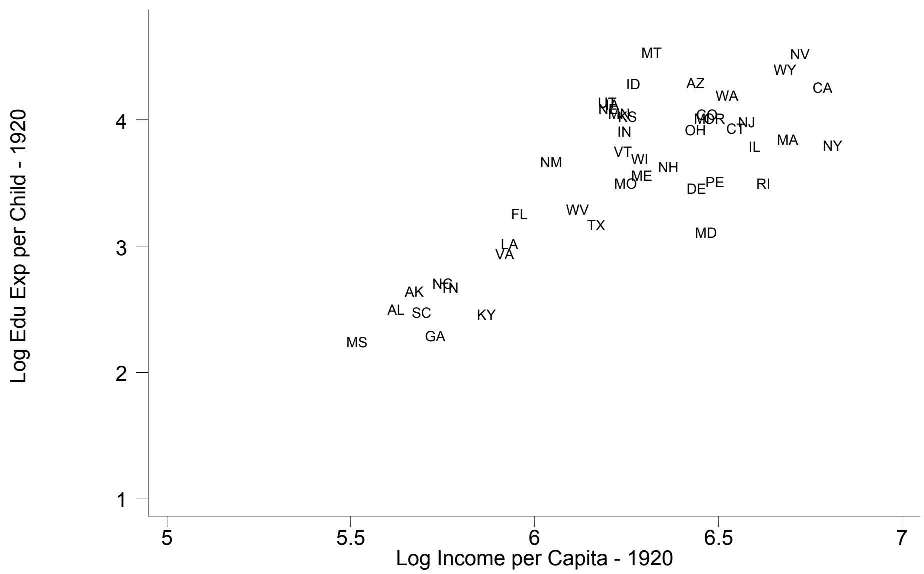

Figure 6: Education and Income in 1920

is still significant at well under 1%. When we turn to 1920, the story changes. Overall, the correlation of income and education expenditure is 0.80 and this is significant again at less than 1%. However, excluding the South in 1920 the correlation of income and education expenditure is only 0.16 and is insignificant.

By 1920 something has broken the tight relationship between income and education, at least in those non-Southern states above a certain income threshold. As noted above, this is precisely the time the high school movement is moving across America, reacting to the need for an educated, industrial work force. The testable prediction of this paper is that this variation in education expenditures in 1920 is significantly impacted by differences in land inequality and the relative importance of capital across states.

We plot the simple relationship between land inequality and education expenditures in Figure 7. There does not appear to be a clear negative relationship across all the states. Consider, however, the set of Western states[30] that are located in the upper right portion of the figure, marked with underlined state codes. These states appear with both high education expenditures and high measured land inequality. Their position, though, can be explained partly by their relatively high income to the rest of the nation (about $140 higher per person). In addition, the Gini index (as mentioned above) does not capture differences between states

[30]Specifically: Arizona (AZ), California (CA), Colorado (CO), Idaho (ID), Montana (MT), Nevada (NV), New Mexico (NM), Oregon (OR), Utah (UT), Washington (WA) and Wyoming (WY).

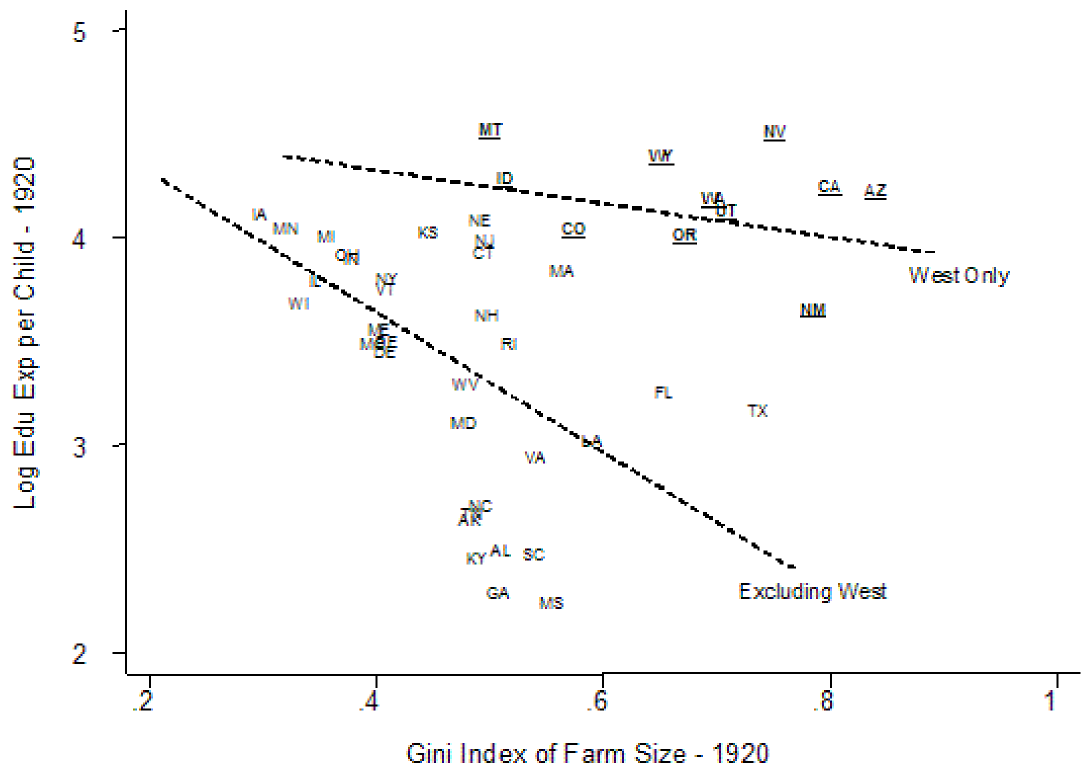

Figure 7: Education Expenditure and Land Inequality in 1920

in the availability of farms, only their distribution. The western states tended to have higher levels of farm ownership and more farms per person than the rest of the nation, meaning that their level of land inequality is likely overstated.

Simple regressions of education expenditure versus land inequality are indicated in Figure 7 excluding the West, and for the West alone. Excluding western states, there is a significant negative relationship between land inequality and education expenditures. In the West alone, the relationship is negative, though of smaller absolute value, and is not significant.

To make a clearer assessment of the relationships we turn to a more complete regression analysis. The results confirm that when other factors - like income - are controlled for, there is indeed a negative relationship between education and land inequality.

4.4 Empirical Specification and Results

The empirical analysis is based on simple cross-sectional regressions of states in both 1900 and 1920.[31] Expenditure on education per child is the dependent variable in each case. Income per capita in the years 1900 and 1920, respectively, a Gini coefficient for farm size distribution, and the capital/land ratio are included as explanatory variables. In addition, the interaction of the Gini and the capital/land ratio is included to capture test for the effects noted in prediction 3 above. We use two-stage least square methods, with the 1880 values for the Gini and capital/land ratio as instruments for the contemporaneous values, to avoid the endogeneity of land distribution and capital/land ratios with education.

We check robustness by including the following controls: the percentage of population that is black, the percentage of population that is urban, and the year the state was admitted to the union. The percentage of population that is black is designed to capture the differential effects of racial policies on educational expenditures. The percentage of population that resides in urban areas is included to control for several possible influences: (a) economies of scale in education that are more pronounced in urban areas, (b) variations in teacher salaries and thus educational expenditures vary between rural-intensive and urban-intensive states, and (c) the increased demand for education in urban-intensive states. The year of statehood is included to control for several influences. As mentioned above, newer states tended to be more homogenous in terms of population and to have farms more widely available. This measure also controls for geographic variations between states in their distance to major markets, which may have an additional influence on the need to develop industry and secondary education.

For the regressions, we include results from excluding the southern states. As seen above, the South lagged far behind in income per capita and this lag may cause relationships to appear which simply reflect some fundamental difference between the South and the rest of the nation. At this point the South is only beginning to come out of the Reconstruction period following the Civil War and there seems to be no question this was an important feature of its development. In addition, we saw previously that the South's income was distinctly lower than the rest of the country, and this may have prevented them from reaching the stage at which high school mattered to the economy. In this case, the predicted relationships of land

inequality and capital/land ratios may be irrelevant for the South.

[31] It should be noted that another avenue of empirical investigation would be to examine the differences in land conditions within states over time and their impacts on education expenditures. This research avenue, however, would generate severe problems of endogeneity. Furthermore, variations in land inequality over time within states are smaller than that across states at any given time and are too subtle to offer much explanatory power.

4.4.1 2SLS Specifications

Tables 1 and 2 report the outcome of cross-sectional 2SLS regressions for the years 1900 and 1920, respectively. Column (1) in both tables shows the simple regression of expenditure per child on income per capita.[32] In 1900, the R-squared of the regression is roughly 89%. In contrast, in 1920 the R-squared of the same regression is 64%. In 1920 - in the midst of the high school movement - there are larger differences in education between states unexplained by income than in 1900 - just prior to the beginning of the movement. As will become apparent, land conditions are one of the significant determinants of the variation in education expenditure in 1920.

The effect of land, in both distribution and importance to the economy is shown in columns (2) thru (5) of both tables. We see that in 1900, there is a significant negative effect of the Gini coefficient for land distribution but that this significance nearly disappears once we add controls for race, urbanization and statehood. When the South is excluded, the relationship of land inequality to education disappears completely in 1900. There is no evidence at any point that the relative importance of capital to land has any impact on education expenditures in 1900. While this does not prove that land inequality was unimportant in generating differences in education in 1900 it does, along with results that follow, offer evidence that the power of land inequality was increasing over time as the high school movement progressed.

Table 2 shows the full impact of the land conditions in 1920. Consistent with the testable predictions column (3) shows that with the addition of the interaction of the Gini index with the capital/land ratio, the significance of the Gini index increases as well as the magnitude of the estimated coefficient. This result, it should be noted, holds despite the presence of the outlying western states seen in figure 7.

Column (4) includes the additional controls for urbanization, percentage black, and the year of statehood. The effect of the percentage of black in the population on expenditures per child is negative but not significant, perhaps indicating that some of the negative association of race and education worked through poor land distributions for the black population (See Margo [1990] for further discussion of the relationship between race and education in the South). The percentage urban has no significant impact. The year of statehood shows up significantly and with a positive coefficient. We cannot identify precisely what this represents, but we speculate it is capturing the factors mentioned above in regard to the western states: homogeneity of

[32] For reasons explained in the Appendix, the 1900 regression includes only 41 states while the 1920 regression included 45 states. Restricting the 1920 regression to the same 41 states as in 1900 has no effect on the results.

Table 1: 2SLS Regressions for Education Expenditure in 1900

	Education Expenditures per Child in 1900:						
Exp Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Log Inc per cap	1.527*	1.503*	1.619*	1.112*	1.024*	0.911*	0.696*
	(16.06)	(18.13)	(14.71)	(3.93)	(3.58)	(2.40)	(0.45)
Gini of Farm Size		-1.938*	-2.864*	-1.144	-0.284	-0.732	0.027
		(3.02)	(3.35)	(1.11)	(0.29)	(0.61)	(0.02)
Gini x Cap/Land			2.285*	1.055	0.676	-0.162	-1.706
			(2.00)	(0.90)	(0.63)	(0.09)	(0.15)
Cap/Land Ratio			-1.243*	-0.585	-0.389	-0.079	0.975
			(2.01)	(0.88)	(0.64)	(0.08)	(0.15)
Percent Black				-1.325*	-5.116*	-1.095†	-1.898
				(2.18)	(1.77)	(1.85)	(0.13)
Percent Urban				0.279	0.216	0.328	0.215
				(0.42)	(0.56)	(0.58)	(0.27)
Year of Statehood				0.000	0.001	0.001	0.004
				(0.03)	(0.27)	(0.34)	(0.17)
Auto Reg per Cap						1.799	3.754
						(0.99)	(0.25)
Constant	-6.397*	-5.282*	-5.399*	-3.347	-1.375	-4.618	-8.753
	(11.28)	(9.49)	(8.52)	(0.72)	(0.28)	(0.97)	(0.25)
Observations	41	41	41	41	26	41	26
Excluding	none	none	none	none	South	none	South
Method	OLS	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS

Absolute values of robust t-statistics are given in parentheses

Gini, Cap/Land Ratio and their interaction are instrumented for with value from 1880

† indicates significance at 10%

* indicates significance at 5%

Table 2: 2SLS Regressions for Education Expenditure in 1920

	Education Expenditures per Child in 1920:						
Exp Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Log Inc per cap	1.519*	1.562*	1.895*	1.478*	1.162*	1.113*	1.187*
	(10.42)	(8.24)	(10.30)	(4.80)	(4.37)	(4.19)	(3.57)
Gini of Farm Size		-1.603†	-1.721*	-1.293*	-0.932*	-0.807†	-0.968*
		(1.86)	(2.14)	(3.05)	(2.20)	(1.86)	(2.11)
Gini x Cap/Land			0.403	0.349†	0.549*	0.167	0.593
			(1.22)	(1.95)	(2.31)	(0.98)	(1.12)
Cap/Land Ratio			-0.242	-0.189†	-0.301*	-0.086	-0.324
			(1.39)	(1.93)	(2.32)	(0.90)	(1.11)
Percent Black				-0.582	-0.945	-0.456	-0.919
				(0.85)	(0.20)	(0.77)	(0.19)
Percent Urban				-0.275	-0.408	-0.222	-0.414
				(0.65)	(1.14)	(0.61)	(1.19)
Year of Statehood				0.007*	0.004	0.006*	0.004
				(3.18)	(1.64)	(2.87)	(1.40)
Auto Reg per Cap						2.677*	-0.269
						(2.29)	(0.12)
Constant	-5.961*	-5.389*	-7.270*	-17.014*	-9.321*	-13.819*	-9.270†
	(6.62)	(4.55)	(7.43)	(3.56)	(1.99)	(3.25)	(1.87)
Observations	45	45	45	45	30	45	30
Excluding	none	none	none	none	South	none	South
Method	OLS	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS

Absolute values of robust t-statistics are given in parentheses
Gini, Cap/Land Ratio and their interaction are instrumented for with value from 1880
† indicates significance at 10%
* indicates significance at 5%

population and availability of farms to the population. The exclusion of the South, in column (5), does not change the results significantly.

Given these results in columns (4) and (5), the net marginal effect of land inequality on education expenditures becomes less negative as capital/land ratios increase, as predicted by the theory. For the large majority of states the capital/land ratios are sufficiently low (the median value is 0.17) that increasing land inequality would have a large negative impact on education expenditures. On the upper end of the spectrum, states such as Massachusetts and Rhode Island - both early industrializers in the U.S. - have high enough capital/land ratios that increasing land inequality no longer has a net negative impact.

To get a sense of how important land inequality can be to education in 1920, consider a simple example using the estimates from specification (4). Both Virginia and Indiana have about $0.58 of capital for every dollar of land (a value very close to the median for 1920). At this capital/land ratio, the marginal effect of the Gini index of education is $-1.293 + 0.349 \times 0.58 = -1.091$. The difference in Gini index between Indiana (0.38) and Virginia (0.55) is 0.17, and is roughly equivalent to moving from the 25th to the 75th percentile in the distribution of Gini's across states. The estimates imply that education expenditures were 18% lower in Virginia due solely to this difference in land inequality. A difference this large would certainly have serious consequences for education outcomes. Our estimates show not just a statistically significant impact of land inequality on education, but a significant practical impact as well.

4.4.2 Land versus Income Inequality

The theory proposed in this paper is concerned with the distribution and relative importance of land in the determination of education expenditures. A potential concern with the empirical results to this point may be that the measure of land inequality, the farm size Gini index, is simply a proxy for income inequality. Goldin and Katz (1997), in fact, find that income inequality is associated with poor education outcomes across states during the US high school movement. They reach this conclusion using in their regressions a proxy for the distribution of income in a state: the number of automobile registrations per person.

The measure of income inequality bears no discernible relationship to that of land inequality. Figure 8 plots the two series against each other. The overall level of correlation is only 0.07, and is distinctly insignificant. One feature to note in this figure is the cluster of southern states in the bottom center. These states have unexceptional land inequality but fall well below the rest of the country in their levels of automobile registrations, indicating far larger

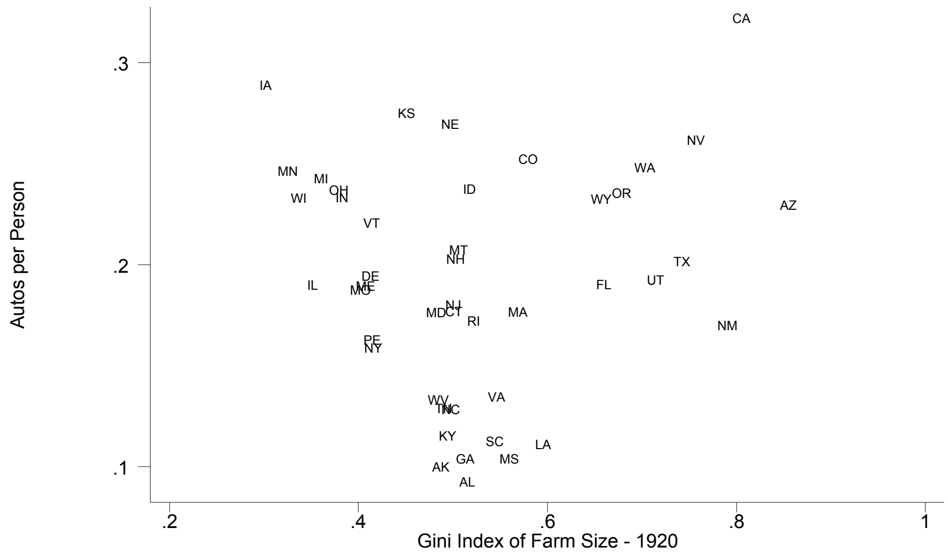

Figure 8: Income versus Land Inequality

income inequality than is present elsewhere.

In columns (6) of Tables 1 and 2 we include the automobile registrations per person as an additional control. In both 1900 and 1920, income inequality is found to have a significant impact on education expenditures. Examining the estimates for land inequality, we see that in 1920 the significance and magnitude of the Gini index decreases, but nonetheless retains an important effect on education expenditures. The terms involving the capital/land ratio are now found to not be significant and are of smaller magnitude as well with the inclusion of the income inequality control.

Column (7) in Table 2 shows some interesting results when the South is excluded from the specification. Here we see the Gini index of land inequality is strongly significant and has increased in magnitude. If we compare this to the estimates in column (5) we see they are nearly identical. The inclusion of a control for income inequality has essentially no effect on the estimate of land inequality when the South is excluded The terms involving the capital/land ratio are not significant, but their estimates are nearly identical to those obtained without controlling for income inequality. The measure of income inequality itself, automobile registrations per person, is completely insignificant when the South is excluded, a fact not previously documented by Goldin and Katz.

As noted above in Figure 8, the southern states all sit in a cluster of very low auto registrations per capita, showing very high income inequality relative to the rest of the nation.

These states are also the ones lagging furthest behind in education expenditures per capita and income during this period. From the results we have it appears that the primary source of variation between the South and non-South in education is income inequality. Within the non-South, though, it is land inequality that is more significantly creating differences in education expenditures.

The South in 1920 lagged well behind the rest of the nation. It may be that income inequality retarded Southern development such that it did not reach a threshold necessary to even consider widespread high school education. Amongst states which had relatively equal income distributions, development had occurred to the level necessary and at that point the variations between them in land inequality became significant in their commitment to education.

Overall the evidence from the high school movement in the United States shows the importance of land inequality in creating differences in educational expenditures across states, whether the South is included in the analysis or not. The significance of land inequality is robust to a variety of controls, and the actual size of the impact of land inequality is found to be substantial.

5 Concluding Remarks

The proposed theory suggests that land inequality affected the nature of the transition from an agrarian to an industrial economy generating diverging growth patterns 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. The qualitative change in the role of land in the process of industrialization affected the transition to modern growth and has brought about changes in the ranking of countries in the world income distribution. Some land abundant countries that were associated with the club of the rich economies in the pre-industrial revolution era and were marked by an unequal distribution of land, were overtaken in the process of industrialization by land scarce countries and were dominated by other land abundant economies in which land distribution was rather equal.[33]

[33] Acemoglu et al. (2002) argue that low population density in 1500 was beneficial for the implementation of growth promoting institutions. Thus, one can mistakenly conclude that their findings may contradict the hypothesis regarding the adverse effect of land abundance (as measured by *effective* land per capita) on the implementation of education reforms. However, in the Malthusian regime that characterized the world prior to 1500, population growth was positively affected by the level of income per capita, and variations in population density across countries and regions reflected differences in technologies and land quality, rather than differences in effective land per capita. In particular, population density reflected land quality (broadly defined) and should not be interpreted as an index for land scarcity. Moreover, the proposed theory suggests that the effect of

The central hypothesis of this research that land inequality adversely affected the timing of education reform is examined empirically, utilizing variations in public spending on education across states in the US during the high school movement. Historical evidence from the US on education expenditures and land ownership in the period 1880-1920 suggests that land inequality had a significant adverse effect on the timing of educational reforms during the high school movement in the United States.

The theory abstracts from the sources of distribution of population density across countries in the pre-industrialization era. The Malthusian mechanism, that positively links population size to effective resources in each region, suggests that the distribution of population density in the world economy should reflect in the long run the distribution of productive land across the globe. Hence, one could have argued that significant economic variations in effective land per capita in the long run are unlikely. Nevertheless, there are several sources of variations in effective resources per-capita in the pre-industrial world. First, due to rapid technological diffusion across countries and continents in the era of "innovations and discoveries" (e.g., via colonialism) population size in the technologically receiving countries has not completed its adjustment prior to industrialization, and the population density in several regions was therefore below its long-run level. Second, inequality in the distribution of land ownership within countries (due to geographical conditions, for instance) prevented population density from fully reflecting the productivity of land. Variations in population density across the globe may therefore reflect variations in climate, settlement date, disease, colonization, and inequality.

The theory suggest that geographical conditions and institutions are intimately linked. Geographical conditions that were associated with increasing returns in agricultural, or in the extraction of natural resources led to the emergence of a class of wealthy landlords that ultimately affected adversely the implementation of human capital promoting institutions. Furthermore, geographical conditions were the prime determinant of the timing of the agricultural revolution [Diamond (1997)] and due to the interaction between technological progress and population growth [Malthus (1789) and Boserup (1965)] the cause of variation in the level of technology and population density, in geographically isolated regions despite similar levels of output per capita. Hence, the link that was created between geographically isolated areas in the era of discoveries, and the associated diffusion of technology, generated geographically-based variations in effective

land abundance on the implementation of growth promoting institutions depends critically on the degree of land inequality which is not controlled by Acemoglu et al. (2002). In particular, it is possible that the same geographical conditions that led to higher population density permitted higher land inequality implying that their findings may in fact be consistent with the theory developed in this paper.

land per capita, that according to the proposed theory led to differences in the implementation of human capital promoting institutions.

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 (2000), 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 - 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.

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