FROM BAD INSTITUTIONS TO WORSE: THE ROLE OF HISTORY IN DEVELOPMENT*

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Abstract

This paper examines how policy implemented at an economy's agrarian development stage to protect the vested interests of landowners affects a country's subsequent development. We find such a policy negatively impacts an economy's development path in two ways. First, it delays the formation of industry. Second, it facilitates the formation of industry insider groups that further slow down the growth process by delaying the adoption of better technology and by limiting the use of better technology. We provide support for the theory by comparing the development experiences of the United States and Latin American.

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I Introduction

This paper considers the role of history in the evolution of a country's institutions and development. More specifically, it examines how policy implemented at an economy's agrarian development stage to protect the vested interests of landowners affects a country's subsequent development. It shows that the existence of a politically influential group of landed elites retards an economy's development in two ways. First, by enacting policy that makes it costly for resources to move out of agricultural activities, landed elites delay the start of industrialization and slow down the rate at which new industries are formed. Second, the policy has the indirect effect of facilitating the formation of industry insider groups at some future date composed of factor suppliers. These groups further slow down the growth process by delaying the adoption of better technologies and by limiting the use of more productive technologies in the economy. In this sense, institutions go from bad to worse.

Insider groups are more likely to form at some future date in an economy initially controlled by a powerful group of landed elites for the following reason. Policy that makes it costly for resources to move out of agricultural activities increases the cost of innovation. Entrepreneurs, contemplating whether to start a new industry or advance the technology in an established industry, therefore, will need to wait longer for the frontier technology in that industry to advance before innovating. Consequently, innovations will be less frequent, but when they occur, will be associated with larger advances in technology. The economy, therefore, will have fewer established industries at any point in time and will have an industrial structure that is more disparate, both in terms of individual industry size and productivity.

The unevenness of industry is the key to understanding why insider groups are more likely to form in the economy initially dominated by landed elites. A group of

factor suppliers can capture the monopoly profits of its industry by organizing and setting the rental price for its factor services. Organizing and maintaining this group is costly, however, and so a group will only form if the monopoly profits of its industry are sufficiently large. Because the size of the monopoly profits of an industry depends on how advanced the industry's technology is relative to the average level used in the economy, these groups are more likely to form in some industries when the structure of industries is more disparate. This more disparate structure of industry arises from the anti-industrialization policies enacted by landed elites.

Powerful landed elites historically have retarded industrialization through a variety of means: by not enforcing property rights, by restricting ownership of land, by restricting access to schools, by opposing the building of railroads, and by accepting and even encouraging violence against agricultural workers as Alston and Ferrie [1993] document in the case of the southern U.S. states after the abolition of slavery. Landowners have enacted such policies because industrialization worsens their economic and political status. For one, industrialization leads to an increase in the real wage of agricultural workers and a decline in the value of land relative to GDP and other assets. For another, as Clark [1998] documents in the case of England and many currently rich countries, industrialization brings an end to the rise in land rental prices. These changes not only threaten the income of landowners, but their advantageous position in borrowing, a point made by Rajan and Zingales [forthcoming JFE], and their ability to maintain political power, a point emphasized by Acemoglu and Robinson [2000].

In light of the main objective of the paper, it is not important that we take a stand on the exact reason why landowners resist industrialization or the exact policies by which they achieve this end. For this reason, we do not explicitly model

landowners groups or anti-industrialization policy. Policy in this paper instead is treated parametrically as a fixed cost to innovation. We do point out that the model's predictions are roughly consistent with the historical record of industrialization and the aforementioned hypotheses for why landowners would want to retard this process.

We also abstract form the political economy side of the problem. Nevertheless we believe that our theory has something important to contribute to this literature. More specifically, although we do not explicitly model the process by which a group of landed elites loses power to groups composed of factor suppliers to industry, we do describe a set of conditions under which insider groups would form. We argue that understanding these incentives is fundamental to understanding the political economy. The exercise we undertake is as follows. First, we consider two economies that start off identically in every way except in the size of the fixed cost to innovation. We then solve out the equilibrium development paths for these two economies. We then assume an unexpected change in the political environment in some common year in both countries that allows factor suppliers in each industry to form insider groups. In doing so, we take the state of each economy in this common year to be that implied by the equilibrium development path computed in the case where factor suppliers to industry do not have the opportunity to form insider groups. We then compute the new development path for each economy and in doing so determine whether insider groups will form, and the consequences of their formation.

The question we study dictates that we employ a model that allows for both new industries and new technologies in each industry over time. Our model thus combines elements from the expanded variety model of Romer [1990] and the quality ladder model of Aghion and Howitt [1993] and Grossman and Helpman [1991]. We are unaware of any other paper that allows for increases along both horizontal and vertical

dimensions. With respect to these literatures, the most closely related paper to ours is Dinopoulos and Syropoulos [2000], who allow incumbents to expend resources to increase the cost to innovators. Although we consider this type of scenario, our results do not depend on insider groups increasing the cost to innovation. We find that insider groups retard economic progress even when their existence does not lead to an increase in the cost to innovation. Of course, their effect on growth is smaller in this case compared to the case where the cost of innovation increases.

The idea that the power of landed elites two to four centuries ago is important in understanding today's institutions and international income differences is not new. Alston and Ferrie [1993], Acemoglu et. al. [2001, 2002], Rajan and Zingales [forthcoming], and Engerman and Sokoloff [2000, 2002] also make this point. Our work differentiates itself from these important works in two ways. First, our work is theoretical and uses a general equilibrium construct. Second, and more importantly, the nature of the path dependence is different in our paper compared to these others. More specifically, these other papers do not emphasize a further deterioration of institution or policy over time as we do. In these other papers, the bad institutions that characterize these countries today are the same ones that characterized these countries two centuries earlier.[1] We do not share this view of economic history. For many countries, particularly those in Latin American, there clearly were important institutional changes in the middle of the twentieth century, most of which arose out of Populist movements there. These movements gave rise to powerful groups of industry insiders, which have and continue to be major detriments to economic progress.

Our paper also relates to Parente and Prescott [1999] that shows how industry insiders with monopoly rights over the supply of factor inputs to current production processes block the adoption of better technology. Our paper complements theirs in

that it provides a theory for why such groups are more prevalent in some societies. Although the rights of factor supplier groups in our paper are identical to those assumed in Parente and Prescott, we find the negative effect of these groups on economic progress to be smaller. The reason for this is that insider groups do not block the adoption of superior technology forever, whereas in Parente and Prescott they do. The main reason for this difference is that we allow for the frontier technology in each industry to advance over time and we allow for new industries to form. An insider group in any industry in our model, thus, will eventually disband, because innovation will occur in industries not controlled by insider groups, and these innovations will eventually drive the competitive rental price of the factor they supply above the level they can earn as a member of the group.

The paper is organized as follows. Section 2 describes the basic environment. Section 3 analyzes the case where the political environment does not give industry groups the ability to form. Section 4 analyzes the case where there is a change in the political environment that gives industry groups the ability to form. Section 5 provides a narrative history of the comparative development experiences of Latin American and the United States within the context of our theory. Section 6 concludes the paper.

II The Model Economy

There are three sectors: an agricultural sector, an industrial sector, and a household sector. There are two factors of production: land and labor.[2] The agricultural sector is competitive. The production of the agricultural good requires both labor and land inputs. The industrial sector produces a set of differentiated products using labor inputs only. At the beginning of time, only the agricultural good is produced.

Over time, industries start up and the number of goods produced in the economy expands. Established industries upgrade the technologies they use. For each industry, there is a frontier technology that increases exogenously over time. A fixed cost is associated with starting a new industry as well as advancing the technology in an existing industry. The fixed cost reflects natural obstacles as well as man-made obstacles. On account of the man-made obstacles, the fixed cost can vary across countries. The household sector consists of a continuum of infinitely-lived agents with measure one. Households rent land to farms and supply labor either to industrial firms or farms. Households derive utility from consumption of the agricultural and industrial goods. Agricultural and industrial goods enter symmetrically into household utility. The structure of the economy is described in more details as follows.

Agricultural Sector: The agricultural sector is indexed by the subscript 0. The agricultural good is produced according to the following Cobb-Douglas technology:

$$Y_{0,t} = N_{0,t}^{\alpha} L_{0,t}^{1-\alpha}. \tag{1}$$

In equation (1), $Y_{0,t}$ denotes output of the agricultural good, $N_{0,t}$ denotes labor employed and $L_{0,t}$ denotes land employed in agricultural production.

Industrial Sector: Industrial good are differentiated products indexed by the subscript $i = 1, 2, 3 \ldots$. Industry output of the ith differentiated good at date t is denoted by $Y_{i,t}$. Labor is the only input to the production of industrial goods. The labor input required per unit of output of the ith differentiated good at date t depends on the technology used by a firm in the industry. The total output of a firm equals the number of workers it employs times its technology level. We let $A_{i,t}$ denote the most productive technology used in the ith industry in period t. In the case where all firms

use the same technology, industry output is just

$$Y_{i,t} = A_{i,t}N_{i,t}, \tag{2}$$

where $N_{i,t}$ is total industry employment.

At any date the most productive technology used in the ith industry is limited by the frontier technology in that industry. We denote the frontier technology at date t in industry i by $B_{i,t}$. Thus, $A_{i,t} \leq B_{i,t}$. We assume that the frontier technology in each industry increases exogenously at rate γ. This is the case whether the industry has or has not been started-up. Consequently for any industry i,

$$B_{i,t} = (1+\gamma)^t B_{i,0}. \tag{3}$$

We further assume that the frontier technology varies across industries at any date in time. More specifically, at date 0, we assume that

$$B_{i+j,0} = (1+\gamma)^{-j} B_{i,0}. \tag{4}$$

Thus, the frontier technology for an industry is a decreasing function of its index. We make this assumption so as to ensure that along the equilibrium path higher indexed industries will be started-up only later.

Both the start-up of an industry and the advancement of technology in an established industry use up resources. This resource costs is assumed to be the same for both types of activities and to be independent of the industry and the technology adopted. Without loss of generality, we model the fixed cost in terms of the agricultural good. We envision the size of this cost to reflect obstacles put up by nature and obstacles put up by people. We implicitly attribute the prevalence of man-made obstacles to the existence of a powerful landed elite. For the purposes at hand we do not need to identify the different components of the fixed cost. The only two things

that are relevant are that the total fixed cost is non-zero and that it varies across countries. We use the letter F to denote the units of the agricultural good needed to either start up an industry or advance the technology in an existing industry.

The existence of the fixed cost implies monopolistic elements of the economy. To simplify the analysis, we assume that in the period following a technology adoption in an industry (including an industry's start-up), any firm can enter the industry and use that technology to produce output. This assumption has two important implications for the decentralized equilibrium. First, any firm that incurs the fixed cost and introduces new technology to an industry will have monopoly power for only one period. Second, in any industry and in any period, there will be at most two technologies operated by firms. These are the most advanced technology used today in the industry, $A_{i,t}$, and the most advanced technology used in the previous period, $A_{i,t-1}$.

Household Sector: There is a continuum of measure one of infinitely-lived households. Period utility of the household is defined over the agricultural good as well as the industrial goods produced in the period. We denote the set of goods produced at date t by I_t. Goods enter symmetrically into household utility. This facilitates the notation as well as the analysis. We denote the consumption of good i at date t by $y_{i,t}$. Period utility denoted by U_t is

$$U_t = (\sum_{i=0}^{I_t} y_{i,t}^{\rho})^{\frac{1}{\rho}}. \tag{5}$$

In equation (5), ρ is the parameter that determines the elasticity of substitution between goods. We assume that the elasticity is sufficiently high, i.e.,$\rho < 1$. This restriction implies positive and finite profits to innovators.

Each household is endowed with one unit of time each period. Each household is

additionally assumed to be endowed with one unit of land and to have equal claims to any industry profits. This equal claim applies to currently established industries as well as any industry that will be established in the future. The assumption of equal ownership is made to simplify the notation. Any other ownership structure will not change our results, as with homothetic preferences, the income distribution does not affect aggregate demand.

III Initial Institutions

We begin by characterizing the equilibrium path for two economies that differ only in the fixed cost to innovation. At this stage of the analysis, we do not consider the possibility of institutional change along the economy's development path and the formation of industry insider groups. The numeraire for the economy is the agricultural good.

The problems of households, agricultural firms, and industrial firms are static. The dynamic elements in the economy are the number of industries and the technologies used in each industry that are implied by the static decisions of economic agents. We now describe these problems and characterize their solutions.

The Household's Problem

At any point in time households will be identical with respect to income. The labor market is competitive and so wages in equilibrium will be the same across sectors and industries. Moreover, each household has the same equity in all firms and the same amount of land services to rent. Let w_t denote the date t rental price of labor, r_t the rental price of land, and π_t the profits of all industries at date t. Then

household income at time t, E_t, is

$$E_t = w_t + r_t + \pi_t.$$

In each period, the household solves the following static maximization problem:

$$\max_{y_{i,t}} (\sum_{i=0}^{I_t} y_{i,t}^{\rho})^{\frac{1}{\rho}}$$

subject to

$$\sum_{i=0}^{I_t} p_{i,t}\ y_{i,t} = E_t,$$

where $p_{i,t}$ is the price of the ith consumption good at time t. The price of the agriculture good, $p_{0,t}$, is normalized to 1. The utility maximizing consumption bundle satisfies the following condition:

$$(\frac{y_{i,t}}{y_{0,t}})^{\rho-1} = p_{i,t}. \tag{6}$$

Define the price level, P_t, for this economy to be the price of the household's market basket relative to the price of the agricultural component of this basket. It follows that

$$P_t = \sum_{i=0}^{I_t} p_{i,t}^{\frac{\rho}{\rho-1}}. \tag{7}$$

Substituting equation (6) into the household budget constraint and using the definition of the price level yields the following demand equations:

$$y_{0,t} = \frac{E_t}{P_t}, \tag{8}$$

$$y_{i,t} = p_{i,t}^{\frac{1}{\rho-1}} \frac{E_t}{P_t}, \quad i \neq 0. \tag{9}$$

As can be seen, household demand for the ith product increases proportionally in response to an increase in real income (E_t/P_t), and decreases in response to an increase in its relative price.

Agricultural Sector

The agriculture sector solves the following maximization problem:

$$\max_{N_{0,t},L_{0,t}} N_{0,t}^{\alpha} L_{0,t}^{1-\alpha} - w_t N_{0,t} - r_t L_{0,t}.$$

The first order necessary conditions for profit maximization are

$$w_t = \alpha N_{0,t}^{\alpha-1} L_{0,t}^{1-\alpha}, \tag{10}$$

$$r_t = (1-\alpha) N_{0,t}^{\alpha} L_{0,t}^{-\alpha}. \tag{11}$$

With the supply of land fixed at 1 , the agriculture demand for labor is

$$N_{0,t} = (\frac{\alpha}{w_t})^{1/(1-\alpha)}, \tag{12}$$

and the rental rate of land is

$$r_t = \frac{(1-\alpha)N_{0,t}}{\alpha} w_t. \tag{13}$$

Industrial Sector

For the industrial sector, the static profit maximization problem of a firm depends on whether its industry is new or old, and for old industries, whether innovation has occurred in the period. There are three possible cases. The first case corresponds to an established industry in which there is no technological change in the period. This industry is competitive. We denote the set of competitive industries in the period by I_t^C . The second case corresponds to a new industry. In this case, there is a single monopolist. We denote the set of industries at date t that fall into this category by I_t^N . The last case corresponds to an established industry that has undergone innovation. This industry is a monopoly which has competitors with access to an

inferior technology. The set of industries at date t that fall into this category is denoted by I_t^M. In any period, $I_t = \{0\} \cup I_t^C \cup I_t^N \cup I_t^M$.

Established Industry

The Competitive Case

For an established industry that undergoes no change in technology in the current period, the industry is competitive. All firms use the same technology $A_{i,t}$ and are able to hire any amount of labor at the competitive wage rate w_t. The unit cost of production is just $w_t/A_{i,t}$. Competition implies that

$$p_{i,t} = \frac{w_t}{A_{i,t}}. \tag{14}$$

For such an industry, output is determined entirely by household demand. Thus, industry output in equilibrium is

$$Y_{i,t} = y_{i,t} = p_{i,t}^{\frac{1}{\rho-1}} \frac{E_t}{P_t}, \tag{15}$$

and industry labor demand is

$$N_{i,t} = (\frac{A_{i,t}^{\rho}}{w_t})^{\frac{1}{1-\rho}} \frac{E_t}{P_t}. \tag{16}$$

It follows that a competitive industry with a higher level of technology will charge a lower price, produce more output and employ more workers in equilibrium.

Monopoly Case

An established monopolistic industry is one in which innovation has occurred in the period. By assumption the innovating firm has monopoly control over the use of that technology. Because the industry is established, any firm in the economy can produce this industry's good with the technology that was in use from the previous period, $A_{i,t-1}$. Such firms have a constant marginal cost equal to $w_t/A_{i,t-1}$ and infinite capacity. Thus, an innovating firm faces the problem of maximizing its profits subject

to a constraint that it charge a price sufficiently low to deter production in the period by firms using $A_{i,t-1}$. The relevant maximization problem of an innovating firm is, thus,

$$\max_{p_{i,t}}[p_{i,t} - \frac{w_t}{A_{i,t}}]p_{i,t}^{\frac{1}{\rho-1}}$$

subject to

$$p_{i,t} \leq \frac{w_t}{A_{i,t-1}}.$$

It follows that the profit-maximizing price is

$$p_{i,t} = \min\{\frac{w_t}{A_{i,t-1}}, \frac{w_t}{\rho A_{i,t}}\}. \tag{17}$$

At such a price, the innovating firm serves the entire market. In equilibrium, industry output is given by equation (15). Labor demand for the industry, which is just the firm's labor demand, is

$$N_{i,t} = (p_{i,t})^{\frac{1}{\rho-1}} \frac{E_t}{P_t} / A_{i,t}, \tag{18}$$

and industry profits are

$$\pi_{i,t} = (p_{i,t} - \frac{w_t}{A_{i,t}})(p_{i,t})^{\frac{\rho}{\rho-1}} \frac{E_t}{P_t} - F. \tag{19}$$

Equation (19) implies that profits of an established industry that is monopolistic depend not only on the new technology but also on the technology last used in the industry.

New Industry

For a newly established industry, the innovator faces no potential competition. Thus, the maximization problem of the monopolist is not subject to a pricing constraint as in the previous case. Given household demand for its product, and a constant marginal cost of $w_t/A_{i,t}$, the profit-maximizing price is

$$p_{i,t} = \frac{w_t}{A_{i,t}\rho}, \tag{20}$$

Industry output is also given by equation (15) in equilibrium with industry labor demand

$$N_{i,t} = (\frac{A_{i,t}^{\rho}\rho}{w_t})^{\frac{1}{1-\rho}}\frac{E_t}{P_t}, \tag{21}$$

and industry profits

$$\pi_{i,t} = (1-\rho)[\frac{A_{i,t}\rho}{w_t}]^{\frac{\rho}{1-\rho}}\frac{E_t}{P_t} - F. \tag{22}$$

The profits of a newly established industry are increasing in technology, $A_{i,t}$, decreasing in the competitive wage rate, w_t, and decreasing in the elasticity parameter, ρ.

Equilibrium

We now define an equilibrium for this economy. In doing so we exploit several features of the environment. For one, our assumption regarding the frontier technology across industries implies that industries will be started sequentially. This is to say that if industry j exists at date t, then all industries indexed by $i < j$ will likewise exist. For another, our assumption that the size of the fixed cost is independent of the technology implies that the frontier technology will always be adopted when an adoption occurs or an industry is starting.

Definition: An equilibrium is an index of industries, $\{I_t, I_t^C, I_t^M, I_t^N\}_{t=0}^{\infty}$, a sequence of prices $\{P_t, r_t, w_t, \{p_{i,t}\}_{i=0}^{I_t}\}_{t=0}^{\infty}$, a sequence of aggregate profits $\{\pi_t\}_{t=0}^{\infty}$, a sequence of household variables $\{E_t, \{y_{i,t}\}_{i=0}^{I_t}\}_{t=0}^{\infty}$, a sequence of agricultural sector variables $\{Y_{0,t}, N_{0,t}\}_{t=0}^{\infty}$, a sequence of industrial sector variables $\{(A_{i,t}, N_{i,t}, Y_{i,t}, \pi_{i,t})_{i=1}^{I_t}\}_{t=0}^{\infty}$ which satisfy: equations (8) and (9), (household utility maximization): equations (10) and (11) (agricultural firms' profit maximization): equations (14)-(16) (profit maximization for established competitive industry, $i \in I_t^C$): equations (17)-(19) (profit maximization for established monopoly industry, $i \in I_t^M$): equations (20)-(22) (profit

maximization for new industry, $i \in I_t^N$), and the following additional conditions

i. $\pi_t = \sum_{i \in I_t^M \cup I_t^N} \pi_{i,t}$ (Definition of Aggregate Profits)

ii. $\sum_{i=0}^{I_t} N_{i,t} = 1$ (Labor Market Clearing)

iii. $L_{0,t} = 1$ (Land Market Clearing)

iv. $Y_{i,t} = y_{i,t}$ for all $i > 0$ (Industrial Goods Market Clearing)

v. $Y_{0,t} = y_{0,t} + \sum_{i \in I_t^M \cup I_t^N} F$ (Agricultural Goods Market Clearing)

vi. for all $i \in I_t^N \cup I_t^M$, $\pi_{i,t} > 0$.

vii. for any $i \notin I_t$, monopoly profits associated with entry with the frontier technology $B_{i,t}$ given by (22) are negative,

viii. for all $i \in I_t^C$, monopoly profits associated with adopting the frontier technology at date t, $B_{i,t}$ given by (19) are negative.

Only the last three conditions warrant additional comments. Condition (vi) states that all start-ups and innovators find it is indeed profitable to establish a new industry or to adopt a better technology. Condition (vii) simply states that at the equilibrium prices and allocations, no firm would find it profitable to start-up a new industry that does not yet exist. Condition (viii) simply states that at the equilibrium prices and allocations, no firm in an existing competitive industry would find it profitable to adopt a better technology.

Computation

With the exception of condition (vi), (vii) and (viii) the definition of an equilibrium is standard. Given the set of index variables (I_t^C, I_t^M, I_t^N), equilibrium values for all other variables are determined from equations (7)–(22). These can be uniquely

determined by using a one dimensional search over the equilibrium wage rate. [3] For sure, the most difficult part of the computation is to find the equilibrium set of indexes (I_t^C, I_t^M, I_t^N) in each period. It is inefficient and unnecessary to go through all possibilities. Our strategy is first to guess the candidates of established industry that are likely to innovate and to guess the candidates that are most likely to be started. These candidates are then ordered by the potential profits from innovation or starting. Then, candidates are added to or removed from sequentially to sets I_t^N and I_t^M until conditions (vi), (vii) and (viii) are all satisfied.

Multiple equilibria are possible in this environment. The reason for this is that when an established industry innovates, labor demand in the economy decreases in a period. This will depress the competitive wage rate, which encourages more innovations. The possibility of multiple equilibrium, however, is mitigated by potential start-ups, which have the opposite effect on labor demand and the competitive wage rate. We can not rule out the the possibility of multiple equilibria. In what follows we compute the equilibrium with the smallest fraction of established industries innovating. We think this is the most reasonable one to compute as any other, if it exists, would require coordination across industries.

We now report the equilibrium path for a parameterized version of the model. We compare the paths of two economies, which differ in the fixed cost to innovation. For Economy A, $F = 0.02$, which implies that the cost of starting a new industry is 2 percent of agriculture output in the pre-industrialization era. For Economy B $F = 0.1$. Economy A is interpreted as a country that does not have a powerful group of landed elites whereas Economy B does. We compute the equilibrium paths for these two economies for 200 periods, that is meant to correspond to the 1750-1950 era. We assume that before 1750, the technologies for producing industrial goods

did not exist in either economy. The value of the other parameters are as follows. The parameter ρ is set to 0.5, which implies an elasticity of substitution of 2. The parameter α is set to 0.6, which roughly corresponds to the labor's historical share in agriculture. The annual growth rate of productivity γ is set to 1 percent. This implies a 7.3 factor increase in the frontier technology over 200 years. The frontier technology level of the first industry at time 0, $B_{1,0}$ is set to 1. The initial frontier technology levels of all the other industries are given by equation (4).

Figures I–V plot the development paths for the two economies over the 1750-1950 period. Figure I shows per capita real output in both economies relative to their 1750 values using a chain-weighted[4] index. Figure II depicts the importance of agriculture as measured by its employment share in the two economies. Figures III and IV plot the rental prices of labor and land in both economies. Finally, Figure V shows the development of the industrial sector in both economies over this period as measured by the number of established industries at each date.

As can be seen, the model generates a pattern of industrialization that is roughly consistent with the historical record. Output grows and new goods are introduced in both economies. For Economy A, per capita output is 7.36 times higher in 1950 compared to 1750. Along the economy's development path agriculture's share of economic activity declines. The decline is too rapid relative to actual real world experience. However, this is an artifact of the symmetric treatment of the agricultural good and the industrial goods in the household's utility function. Real wages increase and the rental price of land declines over time.[5] The change in these series is not smooth. The spikes correspond to innovations in the economy, particularly in established industries, as innovations create monopolies, which decrease labor demand.

The biggest difference highlighted by the figures is the number of established

industries at each date in the two economies. In 1950, for example, there are 38 industries in Economy A compared to only 6 in Economy B. These differences translate into large differences in welfare between the two economies, as individual households value variety. In 1950, one would have to scale up the quantity of each good consumed by a household in Economy B by a factor of 5.5 so that its utility would equal that achieved by a household living in Economy A. The difference in utility is much larger than the output difference in 1950. Using an arithmetic average of prices of each good in 1950, per capita GDP in Economy A is only 18 percent higher than per capita GDP in Economy B.

There are other important differences between the economies not brought out by the figures, but are critical to the results established in the next section. For one, industries in the low-fixed cost country are much more uniform in both productivity and size compared to the high-fixed cost country. In 1950 for example, the standard deviation of technology levels used in industry in Economy A is .90 whereas it is 1.02 in Economy B. The largest industry in Economy A employs 3 percent of labor force. In comparison, the largest industry in Economy B employs 19 percent of labor force.

Figures VI and VII attempt to sharpen the nature of these industrial differences. Figure VI shows the productivity or technology of each new industry at the date it starts up, whereas Figure VII shows in each period the size of the smallest technological advance achieved by any established industry in the economy. As can be seen, Economy A is characterized by more frequent start-ups of new industry as well as more frequent adoptions by established industries, but smaller advances in productivity. These differences reflect the differences in the fixed cost to innovations.

Another feature of Figures VI and VII is that the size of the technological advance needed to warrant new industry start-ups or adoption becomes larger with each new

round of innovations. In this sense, the effect of the fixed cost accumulates and multiplies over time. Each round of innovation makes it more difficult for the next round to occur. The reason for this is that with innovation, the average technology level of the industrial sector increases. As a result, the real wage exhibits a secular rise. An increase of the real wage has the consequence of lowering the profitability associated with either starting up an industry or adopting a new technology in an established industry. Consequently, a larger advance in the frontier technology is required for an innovation to occur.

In summary, an economy with a high fixed cost to innovation is characterized by more frequent industry start-ups and more frequent technology innovation by established industries. A new industry starts up much later in an economy with a high fixed cost, and innovations in that economy are larger in magnitude. As a result, the economy with a high fixed cost has production concentrated in a few industries whereas the economy with a low fixed cost will have its product spread out among a large number of industries. Furthermore, the technologies operated in industry at any point in time vary by much more in the high cost economy compared to the low cost one. These differences in industrial structures will play an important role in determining the future development path of the two economies when the political environment is assumed to change.

IV Institutional Change

We now consider how past institutions affect the formation of subsequent ones. We do this by assuming that in 1950 there is an unexpected, but permanent change in the political environment that gives factor suppliers in established industry the

option of organizing and acquiring monopoly rights of the type described in Parente and Prescott [1999].

Monopoly Rights

Following Parente and Prescott, we assume that a group of individuals that organizes and acquires monopoly rights over the supply of labor services to an established industry is able to set its member size, the price to be paid for its member's services, and the productivity of its members.[6] For the present purpose, we deviate slightly from Parente and Prescott and assume this right pertains to the use of any technology that is or has been used in the industry, and that no innovation in an established industry can occur as long as an insider group exists. We call this the " Strong Insider" case.[7]

We do not permit workers in an industry to acquire monopoly rights in the period an innovation occurs. The group of individuals who worked in the industry the previous period are those who are entitled to acquire monopoly rights in the current period. No individual from this group can be excluded. This implies that the size of an insider group today is constrained below by the size of last period's work force in the industry. The group can admit new members. For simplicity, we assume that new members are entitled to the same earnings as old members.

There is a cost to maintaining the group in each period the group exists, measured in units of the agricultural good. The maintenance cost makes it less likely that insider groups will form. We denote the maintenance cost by $\Phi(\lambda)$ and assume it is a decreasing function of the group's size, λ. The motivation for the assumption is that a larger group may have greater political leverage, and thus may not need spend as much to gain government support.[8]

With the change in political environment, an established industry either has an insider group or it does not. Industries without insider groups are either competitive or monopolistic. A new industry is monopolistic and can not have an insider group. Let I_t^G be the set of industries that have insider groups at date t. Then the set of industries that exist at date t is decomposed as follows: $I_t = \{0\} \cup I_t^C \cup I_t^M \cup I_t^G \cup I_t^N$.

To simplify the analysis, we assume that the individuals who end up working in a new industry or an established one that innovates are randomly chosen from the competitive labor market. In effect, an individual in the economy who is not part of an insider group in the current period goes to a competitive labor market not knowing which industry he will end up working in the period. The implication of this latter assumption is that we can continue to treat the households' problem as static in nature. With this random allocation device, a household can not choose to work for a particular industry at a wage rate below the competitive one with the expectation of higher future wages. If he should be so lucky to end up in an industry for which the conditions for insider groups to form exist, he will end up with a wage higher than the competitive one in future periods. In short, we make this assumption to rule out the dynamic decision of agents with respect to supplying labor.

We let $\tilde{w}_{i,t}$ denote the wage of an insider and $\lambda_{i,t}$ denote the size of the insider groups in industry i at time t. The income of a regular worker is $w_t + r_t + \pi_t$ and the income of an insider in industry i is $\tilde{w}_{i,t} + r_t + \pi_t$. Since preferences are homothetic, aggregate demand for any good is still a function of aggregate income.[9] Namely, aggregate demand for good i is just

$$y_{i,t} = (p_{i,t})^{\frac{1}{\rho-1}} \frac{E_t}{P_t},$$

with aggregate income

$$E_t = \sum_{i \notin I_t^G} w_t N_{i,t} + \sum_{i \in I_t^G} \tilde{w}_{i,t} \lambda_{i,t} + r_t + \pi_t. \tag{23}$$

The objective of the insider group is to choose its size and its industry's output so as to maximize per member income subject to its production capacity, the demand for its good, and last period's industrial employment, i.e.,

$$\max_{\lambda_{i,t}, Y_{i,t}} \frac{p_{i,t} Y_{i,t} - \Phi(\lambda_{i,t})}{\lambda_{i,t}}$$

subject to

$$\begin{aligned} Y_{i,t} &\leq A_{i,t} \lambda_{i,t} \\ p_{i,t} &= Y_{i,t}^{\rho-1} (\frac{E_t}{P_t})^{1-\rho} \\ \lambda_{i,t} &\geq N_{i,t-1}. \end{aligned} \tag{24}$$

Given the group's size, industry revenue, $p_{i,t} Y_{i,t} = Y_{i,t}^{\rho} (\frac{E_t}{P_t})^{1-\rho}$, is strictly increasing in output. Consequently, the industry with an insider group operates the technology efficiently, that is,

$$Y_{i,t} = A_{i,t} \lambda_{i,t} \tag{25}$$

This is in contrast to Parente and Prescott (1999), where the technology is operated inefficiently.

It follows that the labor income of a member of such a group is

$$\tilde{w}_{i,t} = \frac{p_{i,t} Y_{i,t} - \Phi(\lambda_{i,t})}{\lambda_{i,t}} = A_{i,t}^{\rho} (\frac{E_t}{P_t})^{1-\rho} \lambda_{i,t}^{\rho-1} - \Phi(\lambda_{i,t}) / \lambda_{i,t}. \tag{26}$$

Equation (26) implies that the wage increases with the productivity of the current technology and decreases with the size of the group over the set of feasible choices of group size. It follows that the group will never admit any new members. Thus,

$$\lambda_{i,t} = N_{i,t-1}. \tag{27}$$

Equilibrium

An equilibrium after the change in the political environment is the set of industrial indices $\{I_t^C, I_t^M, I_t^G, I_t^N\}_{t=0}^{\infty}$, all other variables defined in Section 3 with the exception of E_t which is now given by equation (23), and a set of variables for industries with insider groups $\{(\lambda_{i,t}, Y_{i,t}, \tilde{w}_{i,t}, p_{i,t})_{i \in I_t^G}\}_{t=0}^{\infty}$ satisfying equation (24)–(27). These variables satisfy all the conditions i–viii plus the following additional conditions:

ix(a) $I_t^G = \emptyset$ for $t \leq 1950$,

ix(b) for any $i \in I_t^G$, $\tilde{w}_{i,t} > w_t$,

ix(c) for any $i \in I_t^C$, the wage they could earn if they unionize is lower than the competitive wage rate w_t.

Computation

We now compute the post-1950 equilibrium paths corresponding to Economy A and Economy B from the proceeding section under the new political environment.[10] For reasons similar to those described in Section 3, there is the possibility that multiple equilibria exist. In the numerical experiments that follow we compute the equilibrium associated with the smallest fraction of industries controlled by insiders. Again, this is the most reasonable one to compute as any other equilibrium, if it exists, would require some coordination. The maintenance cost in the numerical experiments is linear, that is $\Phi(\lambda) = \phi_0 - \phi_1 \lambda$ with $\phi_0 = 0.025$ and $\phi_1 = 0.05$. For both economies we take the initial industrial structure to be the 1950 structures associated with each economy's equilibrium computed in the previous section.

We conduct two sets of experiments. In the first, the existence of insider groups does not affect the size of the fixed cost to innovation. We refer to this as the "No Added Protection" case. In the second, the existence of insider groups does affect the

size of the fixed cost to innovation. We refer to this as the "Added Protection" case.

No Added Protection

Figure VIII plots the percentage of workers that belong to insider groups in each economy when there is no change in the costs to innovation. As can be seen, no factor suppliers in any industry choose to form insider groups in the low fixed cost economy. If the cost of maintenance were lowered, say $\phi_0 = 0.02$, insider groups would form in the low fixed cost economy, but they would represent a very small fraction of the labor force. In contrast, insider groups prevail in the high fixed cost economy. After 2000, these groups represent 40 percent of the labor force. This shows that bad initial institutions facilitate the formation of industry insiders with monopoly rights over the supply of inputs to the current production process.

The reason why insider groups are likely to form in Economy B is related to the non-uniform industrial structure implied by the high fixed cost. An industry which has higher productivity relative to others and employed less labor in the previous period is the most likely candidate for an insider group to form. The best candidates, therefore, are industries that just innovated. Those favorable conditions are more pronounced in the high-fixed cost economy because innovations are infrequent, and when they do occur are large in size. This uneven development of industries makes it very attractive for workers in industries with higher productivity to separate themselves from the general labor pool and form insider groups.

How detrimental is the formation of these groups to an economy's development? It turns out that their effect is not large compared to the effect of the high costs to innovation. Figure IX compares the post-1950 path of per capita output for Economy B when there is a change in political environment that allows insider groups to form and when there is no such change. In most periods, the economy without insider

groups is richer than the one with insider groups, but the difference in income is not particularly large.

The effect of these groups on the economy's output is not particularly large because all insider groups eventually disband. No group will last forever because innovations will be made in industries not controlled by insider groups, and these innovations will drive up the competitive wage rate above the level individuals can earn as members of an insider group.[11] As increases in the competitive wage rate are not smooth in this model, these break-ups tend to be concentrated at certain points in time. The consequence of this is that the economy with insider groups periodically catches up to the economy without insider groups. Indeed, as the figure suggests, the existence of these groups gives rise to a cycle, whereby the economy with insider groups falls behind and then catches up to the output of the economy without insider groups. With each new cycle, the gap in output widens. In this sense, the cycle intensifies.

Added Protection

An alternative scenario suggested by Parente and Prescott [1999] allows for the cost of innovation to increase with the formation of insider groups. As Parente and Prescott argue, these groups will require some form of protection by the government in the form of regulations and trade barriers. To the extent that some of this regulation is not industry specific, the protection of a group in an existing industry will impact the size of the fixed cost in other industries. In light of these possibilities, we now assume that the increase in the fixed cost to innovation at time t is proportional to the average fraction of the labor force in insider groups in the past five years. More specifically, in the computation, the cost to innovation is $F + 0.2 * N_{Gt}$, where N_{Gt} is the five-year moving average of insider group employment.

We now compute the equilibrium for this alternative cost structure. Figure X

compares the chain-weighted GDP index for economy B when there is a change in political environment that allows insider groups to form and when there is no such change. As can be seen, the effect of insider groups on the economy is much larger. The higher fixed cost to innovation has the direct effect of reducing the frequency of innovations, thereby retarding economic growth further. It also has an indirect effect. Namely, the higher fixed cost results in an increase in the length of time an insider group will choose to exist. Insider groups on average last for 51 periods compared to 32 periods in the No Added Protection Case.[12] As no innovations occur in an industry with insider groups, their longer lives further delays the adoption of better technology. Additionally, their longer lives reduce an economy's output by restricting the use of better technology to a smaller segment of the workforce.

Even in this case, the effects of insider groups in our model are much smaller than in Parente and Prescott [1999]. This is primarily due to the fact that insider groups in our model never permanently block the adoption of better technology whereas in Parente and Prescott they do. Additionally, in our model inferior technology is always operated efficiently whereas in Parente and Prescott it is operated inefficiently. There are a number of reasons for these differences. First, in our model the frontier technology increases over time. Second, in our model new industries start up. Finally, demand for each industrial good is price-elastic. This last assumption limits the size of each union.

V A Narrative History of Latin American and North American Development

In this section we interpret the development experiences of the United States and Latin America within the context of our theory. Obviously, a detailed history of the development of each individual Latin American country is beyond the scope of this paper. Consequently, in what follows we focus on the common elements of these countries' experiences that pertain to our theory. The key elements of our theory are that (i) regions that were initially controlled by a group of landed elites were slower to industrialize on account of the institutions and policies landowners set in place and that (ii) these policies and institutions facilitated the subsequent formation of industry insider groups, which further retarded the development of these countries.

We attribute the weaker economic performance of much of Latin America relative to the United States up until the early part of the twentieth century to the existence of powerful landed elites and the institutions and policies they set in place. A number of other authors, most notably Engerman and Sokoloff [2000, 2002], and Acemoglu et al. [2002], have put forth this same hypothesis, and provide some strong empirical support for this view. Engerman and Sokoloff [2002], and Rajan and Zingales [forthcoming], for example, have identified several important differences in institutions and policies that existed historically between economies with and without landed elites.[13] Moreover, Acemoglu et al. [2001] provide evidence that the growth inhibiting institutions and policies set in place by landed elites in Latin American persist even today.

We attribute the poor economic performance of much of Latin America relative to the United States over the twentieth century to the persistence of these growth

inhibiting policies and institutions and to the formation of insider groups toward the middle of the century. This latter part of the hypothesis is surely the novel aspect of our theory, and the one in which the subsequent discussion will focus. These groups, some of which are comprised of workers and some of which are comprised of owners of capital, are prevalent in these societies. As recent events in Latin America, (particularly Argentina and Venezuela) show, these insider groups are still very powerful, and constitute a major barrier to economic reforms.[14] These groups enjoy monopoly rights in the form of above-competitive market earnings and other non-pecuniary benefits. For example, Heckman and Pages [2002] documents that job security, as measured by the expected discounted cost at the time a worker is hired of dismissing a worker, is twice as high in Latin America compared to the United States, and selected OECD countries. The formation of insider groups coexists with high barriers to technological innovation. Djankov et. al. [2000], for example, find that the cost of starting a business is more than 20 percent of GDP on average in the Latin American countries compared to only 1 percent in the United States. The correlation between the job security index and the cost of start-ups is 0.73. The cost of start-up is positively correlated with union membership, an index of anti-competitive practices and an index of corruption.

We associate the formation of insider groups in Latin America with the rise of Populism and the changes brought on by that movement. Populist periods include Peron's first government in Argentina between 1946 and 1949,Vargas's first government in Brazil in 1945, Cardenas in Mexico between 1934 and 1940, Venezuela between 1945-1948, Cuba 1933, and Bolivia in 1936, and Peru under Velasco between 1968 and 1975.

Three exogenous shocks to Latin American economies, namely World War I, the

Great Depression, and World War II, laid the groundwork for Populism and for the formation of insider groups there. These shocks, which resulted in a rise in trade protectionism, shattered the economies of Latin America, which up until then had relied heavily on primary product exports. By the 1930's a large number of people in these countries, many of whom were affiliated with Populist movements had become disenchanted with the export-led model of development and advocated a change to an inward-looking model of industrialization. They advocated an active role for the state in the industrialization process, in part, on account of the high barriers to industrialization inherited from the institutions and policies of the landed elites. To facilitate industrialization particularly in capital equipment producing industries the state subsidized credit, increased trade protection, made large-scale public investments in specific industries, and nationalized industries. As a result of these new policies, large advances in technology were achieved in a number of industries. This gave industry a more disparate structure.

Populism, therefore, in our interpretation was the catalyst for a dramatic change in the industrial structure of Latin American economies, and for the formation of insider groups. The main beneficiaries of Populist policies were industrial elites and their workers, and government bureaucrats. Urban workers in the informal sector and peasant laborers in general were left worse off by the policies of Populist regimes. In our interpretation, Populism was merely a front by which factor suppliers to industry were able to gain monopoly rights. Populism, in effect, constituted an alliance between industrial elites and their workers. This alliance formed out of necessity as the industrial elites needed the political support of the middle class in order to wrestle power away from the landed elites. The middle class, most of whom were industrial workers and government bureaucrats, joined the alliance with the promise of higher

wages and greater job security. The industrial elite could afford to pay higher wages to these groups because they expected the inward-looking model of development to bring about large increases in industry rents.[15]

This interpretation of Populist movements in Latin America is not new. A number of political scientists have offered similar interpretations of events there. Malloy [1977, p.9], for instance, writes that, "Populism became the guise within which change-oriented segments of the middle class sought to construct multiclass coalitions powerful enough to gain control of the state and underwrite programs of structural transformation". These individuals emphasize the key role that the state has assumed in the process, and the corporate structure of government.[16] In this corporative structure, the existence of interest groups, primarily organized labor, are dependent on the state and controlled by the state both through inducements and constraints on groups' behaviors.

These insider groups have proven to be a major barrier to development in Latin America in the last fifty years. Although the 1950's and 1960's proved to be a period of decent economic growth in much of Latin, the post 1970 period has been extremely disappointing. According to Maddison [1995], whereas per capita GDP in Latin America grew at an annual rate of 1.6 percent between 1950 and 1973, it grew at only 0.9 percent between 1973 and 1992. At first, the expansionary policies implemented by Populist governments were sufficient to overcome the growth inhibiting effects of these insider groups. However, these large government deficits proved to be unsustainable, and the detrimental effects of these groups were soon felt.

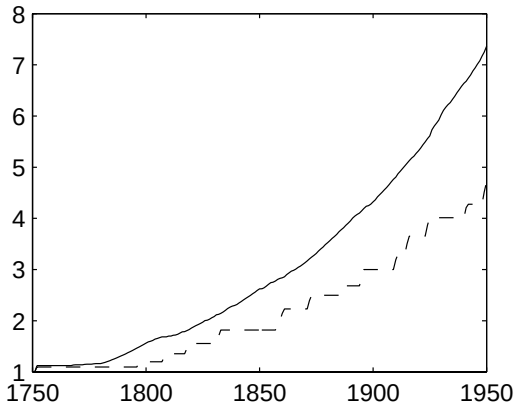
By comparison, such powerful and long-lasting interest groups are absent from U.S. history. For a brief period in the 1930s, industries were able to collude provided they allowed workers to unionize under the National Industrial Recovery Act (NIRA).

Though these policies remained effect to some extent after the Supreme Court ruled the NIRA unconstitutional, they eventually ended because the structure of industry in the United States failed to give firms and workers the necessary incentive to form long-lasting insider groups.[17]

VI Conclusion

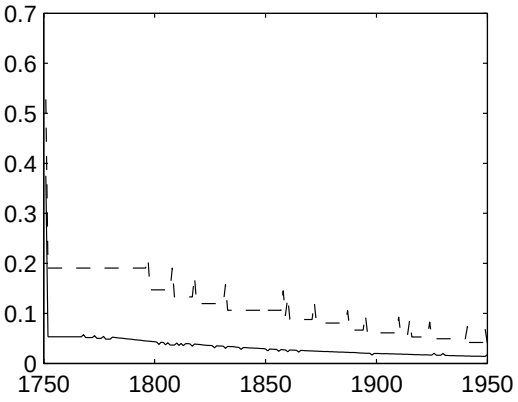
In this paper we have put forth a model that shows how history can shape a country's institutions and development. In particular, we have shown that barriers to industrialization erected by powerful landed elites facilitate the formation of industry insider groups. We have further shown that these insider groups retard an economy's development path by both delaying the adoption of even better technology and by limiting the use of superior technology to a small fraction of the economy. The effects of these insider groups are not as large as those found in the Parente and Prescott [1999] as these groups eventually break-up in our model. The break-up of insider groups would also occur in the Parente and Prescott model if they were to allow the frontier technologies to increase. In this respect, their model most likely overestimates the long-run impact of these groups for development.

There are a number of future directions to take in this research. Clearly, this research would benefit from some type of formal tests of the theory. One possible test would be an examination of sectoral or industrial productivity disparities in the United States and Latin America. Additionally, this research would benefit from a more detailed account of the economic histories of individual Latin American countries. On the theoretical side, this research would obviously benefit from an explicit treatment of the political economy.



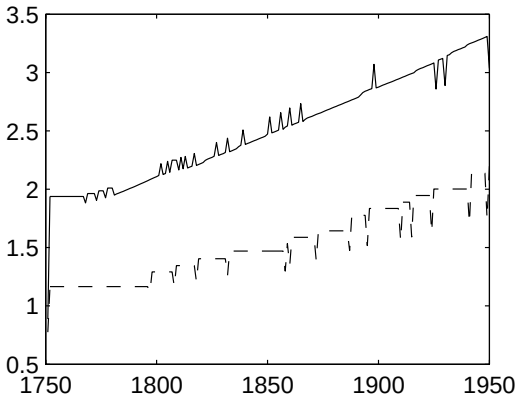
— Low fixed cost - - High fixed cost

Figure I: Chain-weighted GDP: 1750–1950



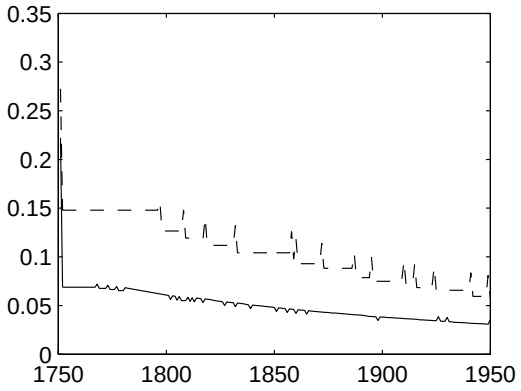
— Low fixed cost - - High fixed cost

Figure II: Employment in Agriculture Sector: 1750–1950



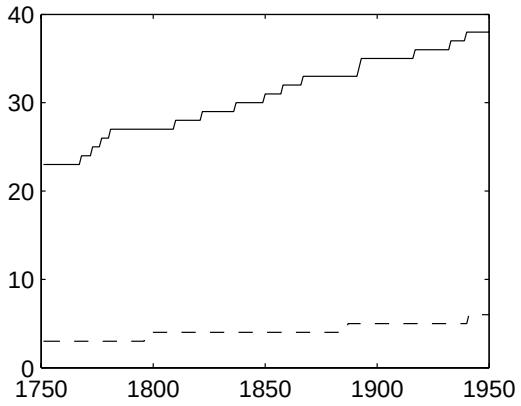
— Low fixed cost - - High fixed cost

Figure III: Real Wage:1750–1950



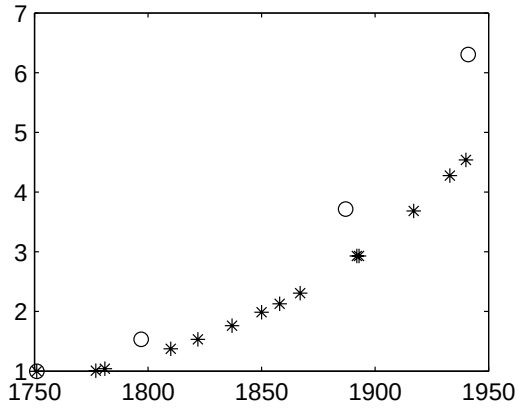
— Low fixed cost - - High fixed cost

Figure IV: Rental Price of Land: 1750–1950



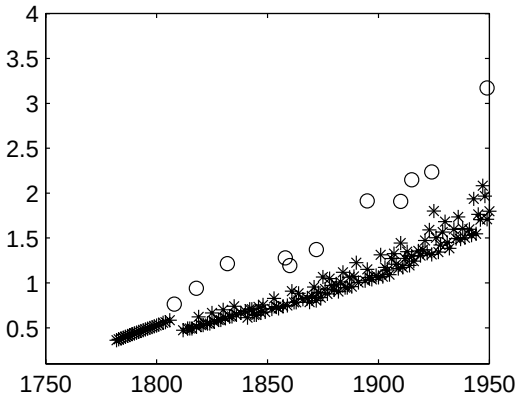
— Low fixed cost - - High fixed cost

Figure V: Number of Established Industries: 1750–1950



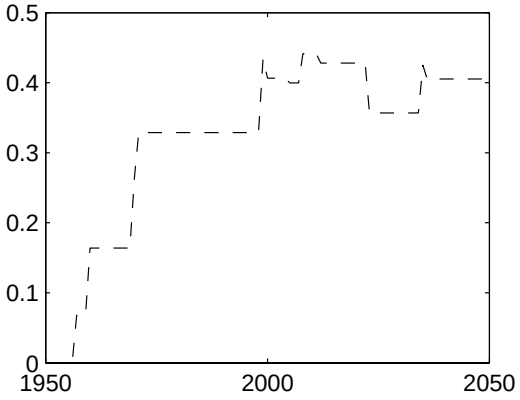
* Low fixed cost o High fixed cost

Figure VI: The Productivity of the Start-ups



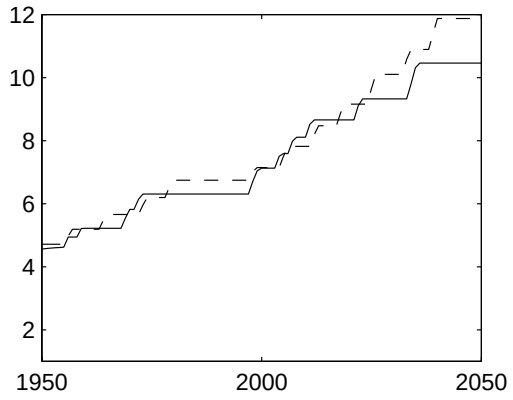
* Low fixed cost o High fixed cost

Figure VII: Technology Improvement of each Innovation



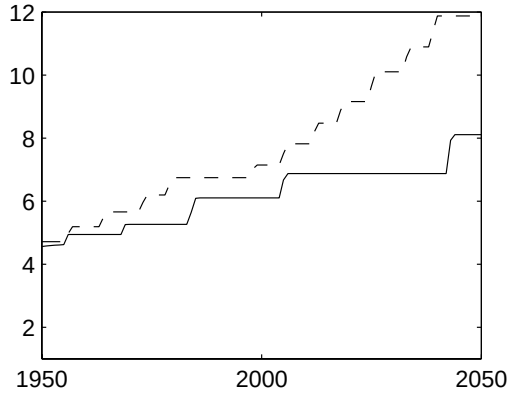
— Low fixed cost - - High fixed cost

Figure VIII: Percentage of Worker in Insider Groups



— With political change - - Without political change

Figure IX: GDP Index of Economy B: No Added Protection



— With political change - - Without political change

Figure X: GDP index of Economy B: Added Protection

Endnotes

[1]Some of these other works do assume a change in the growth effect of these institutions over time. Acemoglu et al. [2002], for example, posit an increase in the negative effect of these institutions over time because efficient use of technology requires investments over a broader range of society today compared to two centuries ago.

[2]We abstract from capital for analytical reasons. None of our conclusions would change if we were to introduce it in the model. Suppliers of capital to industry would similarly form insider groups.

[3]We describe the algorithm used to compute these values, in detail, in the appendix.

[4]We use a chain-weighted index to compare a country's output between two points in time because of the dramatic change in the relative price structure as industries start up and innovate. For comparison of output across the two countries at a point in time we use arithmetic averages of prices in the two economies.

[5]The absolute decline in the rental price of land predicted by the model should not be taken as a failure of the model. Presumably, the rental price would not decline if one allowed for technological change in agriculture. The model would still predict a loss in economic status of landowners because of rising real wages and a declining value of land relative to GDP.

[6]As will be shown, the right to set productivity is inconsequential in our structure.

[7]In the "Weak Insider" case the rights pertain only to the current technology used in the industry, and an innovation can occur even when the group exists. In

the numerical experiments we conducted, we found no significant differences between strong and weak cases.

[8]Our results are not sensitive to this assumption.

[9]In this case, incomes of individual households can differ from each other and vary over time. Households would like to borrow and lend to smooth consumption. But the operation of any asset market is equivalent to a redistribution of income, which has an effect on individual household welfare but no consequences for aggregate demand.

[10]See appendix.

[11]The formation of insider groups, in fact, actually facilitates both innovation and new industry start-ups because it depresses the competitive wage rate, thereby tempering their growth-inhibiting effects.

[12]The added protection does not, however, lead to a significant change in the prevalence of these groups in the economy.

[13]The policies that have been identified as being implemented by landed elites to protect their political and economic status include: restrictions on labor migration and land ownership, incomplete protection of property rights, barrier to development of financial institutions, and unequal access to education.

[14]For a thorough discussion of the successful attempts of insider groups in Argentina blocking reforms see Etchemendy [2001].

[15]The middle class consisted of small to medium industrialists, small and medium merchants, functional elites, small landowners, liberal professionals and public and private white-collar workers. For details, see Malloy [1997]

[16]For a review of these concepts see Collier and Collier [1979].

[17]Rajan and Zingales [forthcoming book, p. 281] make a similar point.

APPENDIX: Algorithm in Details

Algorithm to find Equilibrium Variables given Industry Structure

Given the industrial structure (I_t^C, I_t^M, I_t^N), the following iterative algorithm computes the equilibrium wage:

1. Guess w_t
2. Use equation (13) to find the rental price of land.
3. Use equations (14), (20) and (17) to compute the price of ith good for all $i \in I_t$ and use (7) to compute the general price level.
4. Guess $pi_t = 0$ and compute aggregate income $E_t = w_t + r_t + \pi_t$. For each subsequent iteration $\pi_{i,t}$ is given by equations (19) and (22) from previous round of iteration. Sum over all $i \in I_t^N \cup I_t^M$ to get π_t.
5. Use equations (12), (16), (21), and (18) to compute labor demand of agriculture sector and various industries.
6. If the total demand of labor is greater than 1, increase wage rate; if smaller, decrease wage rate.
7. Repeat till demand of labor equals 1

Algorithm to determine Equilibrium Industry Structure

We use the following algorithm to determine the equilibrium industrial structure when there are no unionization possibilities.

1. Innovation in an established industry decreases the competitive wage, thus facilitating innovations in other industries and start-ups of new industries, whereas

new industry start-up increases the competitive wage, thus discouraging innovations and other start-ups. Based on this observation, we search for candidates of innovations first, and candidates of start-ups second.

2. For all established industries, compute the profits if all existing industries move up to the world technology frontier. Order industries based on their profitability, from highest to the lowest. Next, consider the decision to innovate sequentially, starting from the highest ranked industry. Determine the industry's profit if it innovates, assuming lower ranked ones do not innovate. Stop when the profit of the most recently added innovators has negative profits.

3. Next allow new industries to start-up. The first possible candidate must be industry $I_{t-1} + 1$. Check profits of the existing industries after a new industry starts-up. If all industries have non-negative profit, next industry in line starts-up. If any of the existing industry has negative profit, do the following: if the industry with lowest profit is the new start-up, this new industry doesn't start-up and stop; if industry with the lowest profit is an existing industry that innovates, that industry will not adopt the better technology and recompute. Continue the adjustment until all industry has non-negative profit.

To compute the equilibrium industry structure with the smallest fraction of industries with insider groups, add the following search algorithm: Order the existing industries by its potential monopoly wage, from highest to the lowest. Sequentially allow each industry to from insider groups. The rest of the industry structure is determined as described above. After each iteration, compare the monopoly wage with the competitive wage and also compare the competitive wage with the would-be monopoly wage of industries without insider groups. Stop if none of the would-be monopoly wage is

greater than the competitive wage and all actual monopoly wages are larger than the competitive wage.

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