From Bad Institutions to Worse: The Role of History in Development

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October 2, 2002

Abstract

This paper considers the role of history in the evolution of a country's institutions and development. In particular, 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. 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 to a smaller group of workers.

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1 Introduction

This paper considers the role of history in the evolution of a country's institutions and development. More specifically, it traces the development paths of two economies, one that starts with a group of politically powerful landed elites and another that does not. It shows that the existence of a politically influential group of landed elites retards an economy's development in two ways. First, by being able to enact policy that makes it costly for people 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, who 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.

The intuition for these results is as follows. Because industrialization will lead to a reduction in the rental price of land, landowners benefit from policies that increase the cost of starting a new industry and the cost of improving the production process in an established industry. A country that starts with landed elites in power will, therefore, have fewer industries operating at any point in time compared to a country that does not begin with such a powerful interest group. In established industries, innovations will occur less frequently in the high innovation cost country, as innovators there must wait for the frontier technology in their industry to advance further before they upgrade the industry's technology. This implies that each time an industry innovates in the economy with powerful landed elites, the new technology is a very significant improvement over the old one. This leads to an industrial sector that is far more disparate in the levels of technology used.

This is the key to understanding why factor suppliers are more likely to form insider groups and exists for longer periods in the economy initially dominated by landed elites. The profits associated with monopolizing an industry are larger the greater is that industry's technology level relative to other industries. A worker group, by organizing, is able to capture the industry's profits through setting the payments for its member services. As organizing and maintaining the industry group is costly, a group will form only when the benefit, i.e., monopoly profits, is sufficiently high. In the economy that does not begin with powerful political elites, the benefit to workers in any established industry is low relative to the cost of forming and maintaining a union. Thus, insider groups are less likely to form, and when they do form, they are short-lived.

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) [4], Sokoloff and Engerman (2000)[9], and Acemoglu et al. (2001.a[2] and 2001.b[1]) all make this point. Our work differentiates itself from these important works in two ways. First, our work is theoretical and uses a general equilibrium framework. 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 institutions or policies over time. We do. Acemoglu et al. 2001.a, for example, posit a change in the growth effect of the institutions over time, not the institutions per se. The negative effect of these institutions increases over time because use of new technology requires investment over a broader range of society today compared to two centuries ago.

Our paper also relates to the work of Parente and Prescott (1999)[7] that shows how industry insider groups with monopoly rights over supplies to current production processes block the adoption of better technology. Our work contributes to this literature by offering an explanation as to why such groups are more prevalent in some countries. There are some important differences in the results between these works on account of differences in the structure. Most importantly, in our model, these groups delay the adoption of better technologies, but do not block it forever. This is in contrast to Parente and Prescott where adoptions are forever blocked. The reason for this different result is that we allow for the frontier technology in each industry to increase over time. Insider groups eventually always dissolve in our model because innovation will occur in industries not controlled by insider groups. As result, the competitive wage rate increases to a point where the insider group is better off dissolving. The growth inhibiting effects of these groups are, thus, much smaller compared to Parente and Prescott.

The question we study dictates that we employ a model that allows for both new industries and new technologies over time. Our model thus combines elements from the expanded variety model of Romer (1990)[8] and the quality ladder model of Aghion and Howitt (1993)[3] and Grossman and Helpman (1991)[6]. In terms of this literature, the most closely related paper to ours is Dinopoulos and Syropoulos (2000)[5], 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 are unaware of any other paper that allows for increases along both horizontal and vertical dimensions. Allowing for increases along both dimensions introduces a number of complexities to the model. Additionally, the complexity is increased by the need to explicitly model an agricultural sector that differs in its production technology from the industrialized goods. For these reasons, the model is simplified along a number of dimensions, most notably by abstracting from physical capital.

We also abstract from the political economy side of the problem. We do not explicitly model a powerful group of landed elites or the process by which insider groups gain political influence. The exercise we undertake is as follows. First, we assume an initial policy that implies a specific fixed cost associated with innovation in an economy. We then solve out the equilibrium development paths associated with a high fixed cost and low fixed cost country over the 1750 to 1950 period. We then simply assume an unexpected change in political power in 1950, which is favorable to industrial workers. The change in political power allows workers in each existing industry to unionize. We determine in both economies whether industry insider groups will or will not form, and what are the consequences of their formation.

The paper is organized as follows. Section 2 describes the basic economic environment. Section 3 defines an equilibrium and characterize the optimal decisions of the economic agents in economies where insider groups are unable to form. Section 4 presents the numerical experiments. Section 5 analyzes the case where there is a change in the political environment that gives insider groups the opportunity to form. Section 6 concludes.

2 The Model Economy

There are three sectors: an agricultural sector, an industrial sector, and a household sector. 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. In each industry, there is a frontier technology that increases over time. A fixed cost is associated with starting a new industry as well as advancing the technology in an existing industry. This 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.

Agriculture 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 in agricultural production, and $L_{0,t}$ is land employed in agricultural production.

Industrial Sector: Differentiated goods are 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, i. We make this assumption so as to ensure that along the equilibrium path higher indexed industries will be started-up only later. Higher indexed industries will not be started early on because the best available technology in that technology will not be productive enough relative to the cost of labor to warrant its use. Only after time as the frontier technologies in these industries increase, will higher indexed industries be started.

Both the start-up of an industry and the advancement of technology in an established industry use up resources. The start-up of an industry and the adoption of a technology are the same action in our model. This resource costs is assumed 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. As we shall show in the next section, a natural consequence of the development process is a decline in the rental price of land. Landowners will therefore have the incentive to slow down the process of industrialization. We do not model the existence of this group or the concentration of land holdings among households. Instead, we simply assume that part of the fixed costs reflects whether land holdings are concentrated in the hands of small politically influential group.

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 household. 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. In the analysis that follows, we assume a sufficiently high elasticity of substitution between goods. More specifically, we assume $0 < \rho < 1$. The reason for this assumption will become apparent later. Essentially, the assumption is needed to guarantee non-negative profits of industrial 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. The ownership of land and firms does not matter for our analysis. This is because the homothetic preference allows for perfect aggregation of individual demand.

3 Equilibrium

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 industrial insider groups. The numeraire for the economy is the agricultural good.

On account of the assumptions made, the problems of the households, agricultural firms, and industrial firms are static. The dynamic elements in the economy are the change in the number of industries and the change in 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 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 denote the rental price of land, and π_t denote 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 each consumption good at time t. The price of agriculture good, $p_{0,t}$, is normalized to 1. The utility maximizing consumption bundle satisfies the following conditions:

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

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 (7) 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 each 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

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

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

Since land and population are fixed in our economy, it follows immediately from (10) and (11), that industrialization, which has the effect of taking labor out of agriculture, reduces the rental price of land. 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

In the case of the industrial sector, the static maximization problem regarding input and outputs 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 who has competitors with 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 decides not to improve its current technology in this 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 competitive industry with a higher level of technology charges a lower price, produces more output and employs more workers.

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

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

subject to

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

It follows from the above maximization problem 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. At 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.

<u>New Industry</u>

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

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

From equation (22), the assumption of $0 < \rho < 1$ should now be apparent. if $\rho > 1$, profits associated with establishing a new industry would be negative, and no industry would be established. As long as this restriction is applied, 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 denoted 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 agriculture sector variables $\{Y_{0,t}, N_{0,t}\}_{t=0}^{\infty}$, a sequence of industry 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 an additional comment. Condition (vi) states that all start-ups and innovators find that 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 exist yet. 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.

Notice that 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 equation (7)–(22). We describe the algorithm used to compute these values, in detail, in the appendix. Effectively, the algorithm is one-dimensional search over the equilibrium wage rate. Since the supply of the labor is inelastic and the demand for labor is decreasing in the wage, the algorithm finds the unique equilibrium wage.

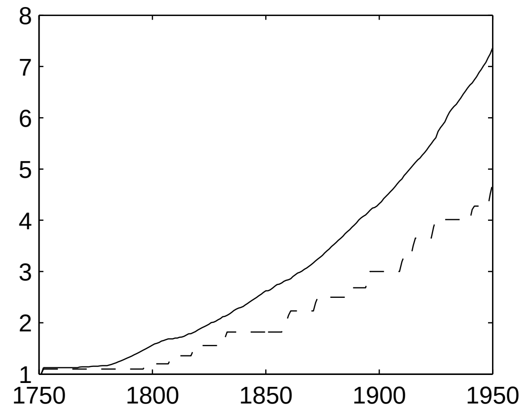
For sure, the most difficult part of the computation is to find the equilibrium set of indexes (I_t^C, I_t^M, I_t^N) in each period. It is very inefficient and unnecessary to go through all possibilities. What we did is first guess the candidates in the established industry that are likely to innovate (I_t^M) and the industry candidates that are most likely to be started (I_t^N). All those candidates are ordered by the potential profits from innovation or starting, from the highest to the lowest. Then we sequentially allow more and more candidates to innovate or to enter until condition (vi), (vii) and (viii) are all satisfied.

4 Numerical Experiments

We now compute the equilibrium path for a parameterized version of the model. The objective of the computational experiment is to exam whether the barrier to industrialization slows down growth and industrialization, and whether it leads to to an industrial structure that is vulnerable to political changes and other unfavorable shocks.

The following parameter values are used. 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 share in agriculture sector. 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). The fixed cost is an institutional parameter. We compare two economies. Economy A has low fixed cost $F = 0.02$, which means that the cost of starting a new industry is 2 percent of agriculture output in the pre-industrialization era. The fixed cost in Economy B is $F = 0.1$. Economy A is interpreted as one, which 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, both economies produce only the agricultural good, and the possibility of industrialization starts in both economies only in 1750.

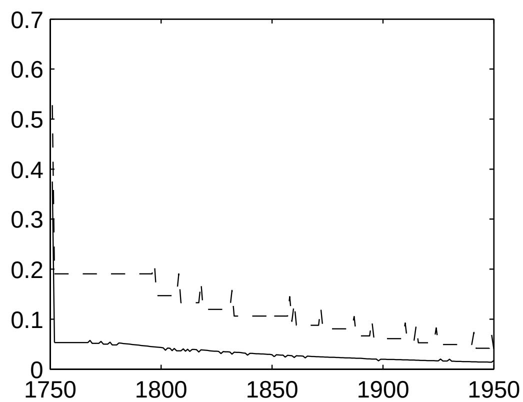
Figure 1: Chain-weighted GDP: 1750–1950



— Economy A with low fixed cost

- - Economy B with high fixed cost

Figure 2: Employment in Agriculture Sector: 1750–1950



— Economy A with low fixed cost

- - Economy B with high fixed cost

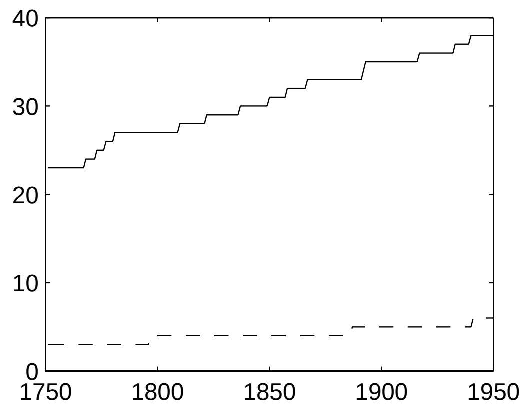
Figures 1–5 plot the development paths for the two economies over the 1750-1950 period. Figure 1 shows per capita real output in both economies relative to their 1750 values. It is the chain-weighted[1] output index with the 1750 value normalized to 1. Figure 2 depicts the importance of agriculture as measured by its employment share in the two economies. Figure 3 shows the development of industrial sector in both economies over this period as measured by the number of established industries at each date. Finally, Figures 4 and 5 plot the rental prices of labor and land in both economies.

As can be seen, the model generates a pattern of industrialization that is roughly consistent with observation. 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. Industrialization improves the conditions of labor but worsens the condition of landowners. The change in these series is not smooth; there are spikes in the rental price series. These spikes are the direct consequence of innovations in the economy, particularly in established industries. More specifically, industries that innovate in the period are monopolistic. As monopolies restrict output, labor demanded by industry may

[1]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.

Figure 3: Industrial development 1750–1950



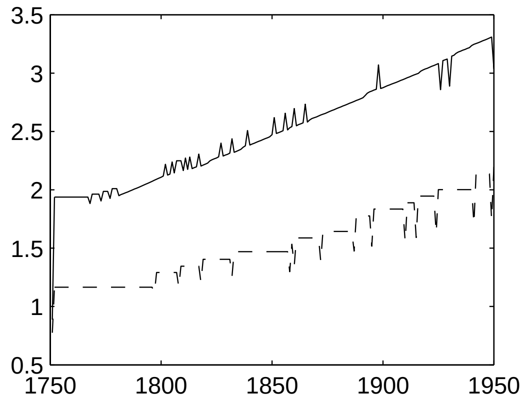
— Economy A with low fixed cost

- - Economy B with high fixed cost

actually fall in the period in which some industry innovates. This decrease in labor demand has the effect of lowering the real wage and increasing the rental price of land in the period. In the next period, these industries become competitive (assuming no innovation occurs). Because these industries are the most productive, they will produce more output relative to other industries and demand more labor. This has the effect of raising the real wage above the level that existed both one period and two periods before.

Industrialization for the high-fixed cost economy is slower compared to the low-fixed cost economy. In 1950, real per capita output in Economy A is only 18 percent higher using an arithmetic average of 1950 prices of each good. The difference in agriculture's share of employment in 1950 is about a factor 2. Whereas the rental price of land falls in both economies, the level is always higher in the high fixed cost economy. It follows that landowner groups would certainly like to have large barriers to innovation erected in the economy.

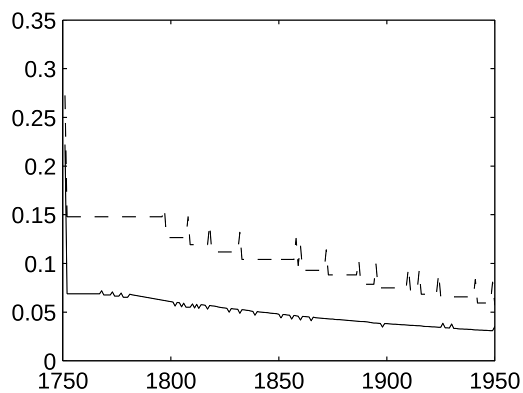
Figure 4: Real Wage:1750–1950



— Economy A with low fixed cost

- - Economy B with high fixed cost

Figure 5: Rental Price of Land: 1750–1950



— Economy A with low fixed cost

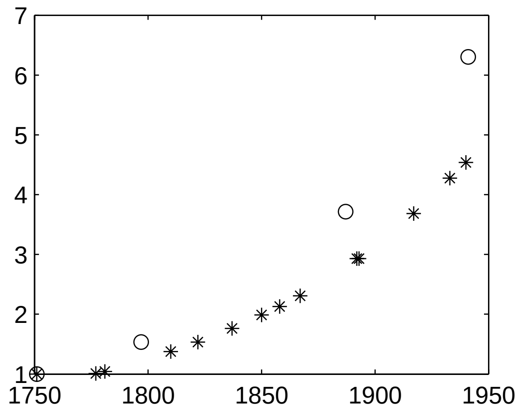
- - Economy B with high fixed cost

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

There are other important differences in these 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 6 and 7 attempt to sharpen the nature of these industrial differences. Figure 6 shows the productivity or technology of each new industry at the date it starts up, whereas Figure 7 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. The intuition for these differences is obvious; because of the smaller fixed cost, firms in Economy A do not have to wait for the technology frontier to advance that much before it is profitable to innovate or to start up. Firms in Economy B do have to wait, and so their adoptions and start-ups are less frequent and each technology improvement is larger in size.

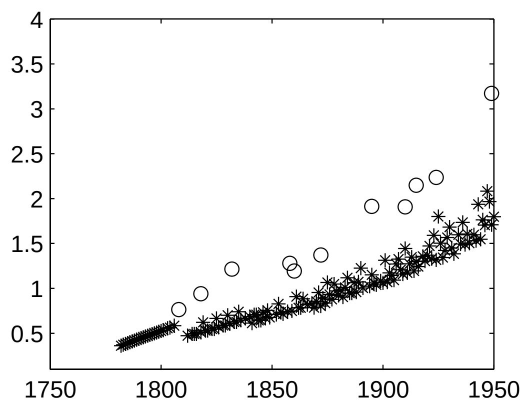
Figure 6: The Productivity of Industry at the Point of Entry



* Economy A with low fixed cost

o Economy B with high fixed cost

Figure 7: Technology Improvement of Innovation over Time



* Economy A with low fixed cost

o Economy B with high fixed cost

Another feature of Figures 6 and 7 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. 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 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 the 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.

5 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)[7]. As the only factor of production in our model is labor, we refer to an organized group as a union.

Following Parente and Prescott, we assume that a group of individuals that organize and acquire 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[2]. 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. Moreover, we assume that no innovation in an established industry can occur while the industry is unionized. [3]

Monopoly rights cannot be acquired in the period an innovation occurs. The group of individuals who worked in the industry the previous period are those who are entitled to the monopoly rights. No individual from this group can be excluded from the union should it form. This implies that the membership size 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.

To simplify the analysis, we assume that the individuals who end up working in a new industry or an established one that undergoes innovation are randomly chosen from the competitive labor market. In effect, an individual in the economy who is not

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

[3]In the future, we plan to consider the case where the monopoly right is less restrictive. Namely, the group has control only over the current technology, and innovation can occur even if the union exists. In that case, the existing union will dissolve when some firm decides to innovate.

part of a union 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' problems 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 union wages. If he should be so lucky to end up in an industry for which the conditions for unionization 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 unionized wage and $\lambda_{i,t}$ denote the size of the labor union in industry i at time t. The income of a non-union worker is $w_t + r_t + \pi_t$ and the income of a union worker in industry i is $\tilde{w}_{i,t} + r_t + \pi_t$. Since preferences are homothetic, the distribution of income does not add much to the complexity of the model[4]. The aggregate demand for any good is still a function of aggregate income. 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

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

With the change in the political environment, an established industry is either unionized or non-unionized. Non-unionized industries are either competitive or mo-

[4]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.

nopolistic. A new industry is non-unionized and monopolistic. Let I_t^U be the set of industries that are unionized at date t. Then the set of industries that exist at date t is decomposed as follows: $I_t = \{0\} \cup I_t^C \cup I_t^M \cup I_t^U \cup I_t^N$.

We assume that there is a cost to maintaining the union in each period the union exists. This cost is assumed to be in units of the agricultural good. We assume that the maintenance cost is a decreasing function of the union's size. Thus, a bigger union is easier to maintain. We denote the maintenance cost by $\Phi(\lambda_{i,t})$, with $\Phi' \leq 0$. The maintenance cost makes it less likely that insider groups will form. The motivation for the assumption that the maintenance cost is decreasing in the group's size is that a larger group may have greater political leverage, and thus may need not spend as much to gain government support. Our results are not sensitive to the functional form of the cost function.

The objective of the union is to choose its size and output so as to maximize per member income subject to its production capacity, 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

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

Given the size of the union, the 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 unionized industry 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 worker in the union 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 union wage increases with the productivity of the current technology and decreases with the size of the union over the set of feasible choices of union size. It follows that the union will never take on any new members. Thus,

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

An equilibrium after the change in the political environment is the set of industrial indices $\{I_t^C, I_t^M, I_t^U, I_t^N\}_{t=0}^{\infty}$, 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 unionized industries $\{(\lambda_{i,t}, Y_{i,t}, \tilde{w}_{i,t}, p_{i,t})_{i\in I_t^U}\}_{t=0}^{\infty}$ satisfying equation (24)–(27). These variables satisfy all the conditions i–viii plus the following additional conditions:

- ix(a) $I_t^U = \emptyset$ for $t \leq 1950$,
- ix(b) for any $i \in I_t^U$, $w_{i,t} > w_t$,
- 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.

Multiple equilibria are possible in this environment. The intuition for this is rather simple. The supply of labor to the competitive labor market increases with the number of industries that unionize. Consequently, the competitive wage rate is lower when more unions form. This makes it more likely for an individual industry to unionize when a large number of other industries unionize. In the numerical experiments that follow, we compute the equilibrium associated with the smallest fraction of unionized industries if multiple equilibria do exist.[5]

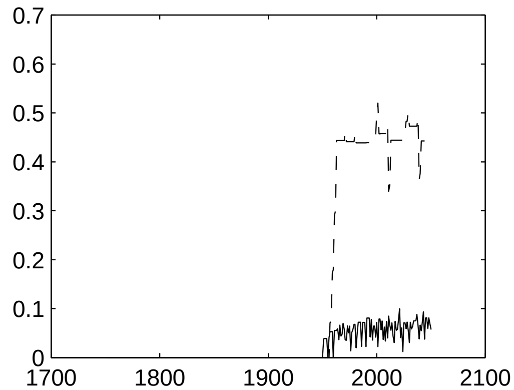
We now compute the post-1950 equilibrium paths corresponding to Economy A and Economy B from the proceeding section under the new political environment.[6] In order to do so we must specify the maintenance cost function. The union maintenance cost is linear in its size, that is $\Phi(\lambda) = \phi_0 - \phi_1\lambda$ with $\phi_0 = 0.02$ and $\phi_1 = 0.05$. We set $\phi_0 = 0.02$ so as to have the fixed cost to innovation in Economy A be larger than the fixed cost to unionization. For both economies we take the initial industrial structure to be the 1950 structures associated with each economy's equilibrium computed in Section 4. In the first set of numerical experiments, unionization is not assumed to affect the size of the fixed cost to innovation.

Figure 8 plots the percentage of workers that are unionized in each economy. As can be seen, a smaller fraction of factor suppliers to industry chooses to form unions in Economy A – the low fixed cost to innovation. If we increase the cost of union maintenance slightly, say $\phi_0 = 0.025$, the equilibrium with the smallest fraction of unionized industries in Economy A is characterized by $I_t^U = \emptyset$ for all t. In contrast, there is no equilibrium without unions for Economy B – the high fixed cost to innovation. This shows that bad initial institutions facilitate the formation of industry insiders with monopoly rights over the supply of inputs to the current

[5]In the future, we plan to compute the equilibrium associated with the largest fraction of unionized industries for the low-fixed cost economy and compare it to the equilibrium associated with the smallest fraction of unionized industries for the high-fixed cost economy. If we find that the rate of unionization in the low-fixed cost economy is lower than the rate of unionization in the high-fixed economy, we can unambiguously conclude that institutions worsen in an economy originally controlled by powerful landed elites. Our preliminary work suggest that this is indeed the case.

[6]See appendix about the algorithm

Figure 8: Percentage of Unionized Worker



— Economy A with low fixed cost

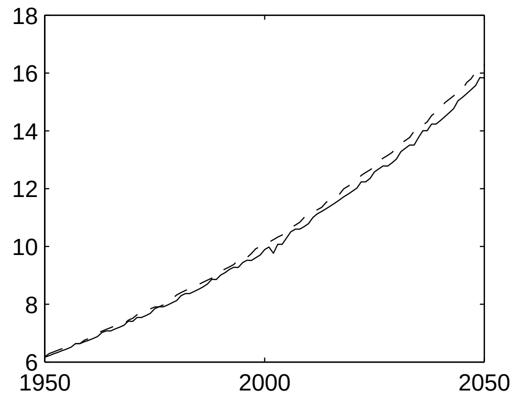
- - Economy B with high fixed cost

production process.

The reason why unions 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 a likely candidate for unionization in the current period. The best candidates, therefore, are industries that just innovated and new industries. Those favorable conditions for union formation 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 unionize.

In Economy A with a diversified and uniform industrial structure unionization is less likely to occur, as there is little incentive for workers in an individual industry to separate themselves from the general labor pool. Moreover, even when these groups

Figure 9: Chain-Weighted GDP Index of Economy A: 1950–2050



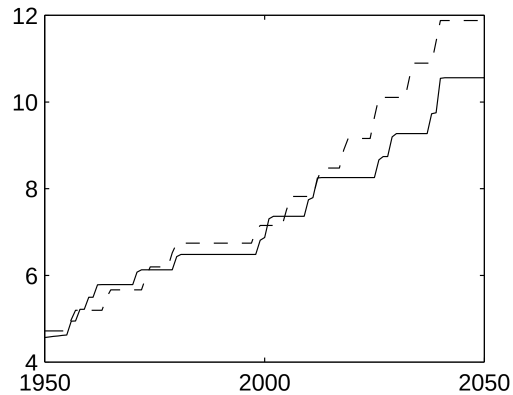
— Economy A with unionization

- - Economy A without unionization

form, they quickly dissolve due to the high frequency of innovations, which increase the competitive wage rate. For this reason the effect of these industrial inside groups on the development path of the low-fixed cost economy is rather small. Figure 9 compares the post-1950 path of per capita output for the low cost economy with and without unionization possibilities.

Figure 10 compares the post-1950 path of per capita output for the high-fixed cost economy with and without unionization possibilities. Here the effect of the insider groups is more notable. In most of periods, the economy without unionization is ahead of the one with unionization, but the lead is not large, especially right after the change in political environment. The gap increases over time as a larger percentage of workers unionize in the economy with unionization possibilities. Unions are harmful to economic growth both by delaying the adoption of better technology in their own industry and by limiting the use of better technology to a small group. Both effects are larger the longer is the union's life. With the more uneven industrial structure,

Figure 10: Chain-Weighted GDP Index of Economy B: 1950–2050



— Economy B with unionization

- - Economy B without unionization

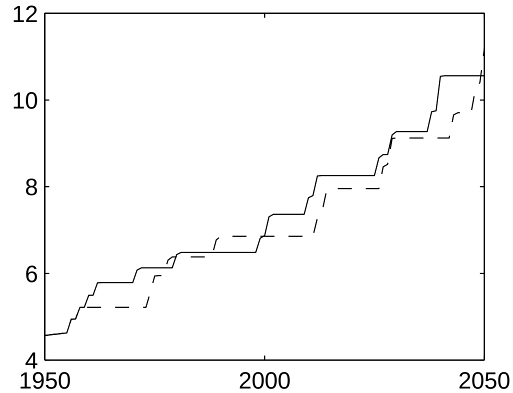
unions last longer in the high-fixed cost economy. This is the reason why the growth effects of these groups are larger in the high-cost economy.

Still, the effects are not so large. Even in Economy B, unions will eventually dissolve because of innovations elsewhere in the economy. Union formation in fact actually facilitates both innovation and new industry start-ups because it depresses the competitive wage rate, thereby tempering their growth inhibiting effects.

There is actually an output and union cycle to the economy. Periodically, the economy with unions catches up. This corresponds to a massive break-up of unions. Note, the gap in output between the unionized and non-unionized economies widens with each cycle.

The effects of unions 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

Figure 11: Chain-weighted GDP index of Economy B: 1950–2050



— Economy B with Unchanged Fixed Cost

- - Economy B with Increased Fixed Cost

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.

An alternative scenario suggested by Parente and Prescott (1999) allows for the cost of innovation to increase with union formation. 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 consider this case. More specifically, we assume that the size of the fixed cost for every industry at time t is $F + 0.2 \times \sum_{i \in I^U_{t-1}} \lambda_{i,t-1}$.

We now recompute the equilibrium with this alternative cost structure and compare it to the previous results. Figure 11 plots chain-weighted GDP index of the high-cost economy where union formation does not increase the fixed cost to innovation and where it does. The development of the economy with the increasing fixed cost is delayed further. There is not much difference in terms of the size of the unionized labor force in the two economies. The important difference is that unions last on average longer when the fixed cost to innovation is increased, which results in even less frequent innovation. The longer life of unions worsen growth by delaying the adoption of better technology and by limiting the use of better technology to small groups for a longer time. But even in the economy with increased fixed cost, unions eventually break up.

6 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 after adoption 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 that we plan to take in this research. Obviously, we would like to provide some empirical support for our theory. A prediction of our model is that countries with more concentrated landholdings initially will end up with more and long-lived insider groups. There are number of simplifying assumption that we made that make it difficult to directly test this prediction. For one, we treated economies as being closed. For the period we considered, most countries were not closed economies. In particular, the massive movement of labor, both voluntary and involuntary, was important for early development of institutions in a large number of countries. An extension of the model would allow for growth of labor supply over time.

Another additional future direction of research is to introduce the political economy to the model. Modeling how the political environment changes from one where land owners make policy to one where industries and their workers make policy is surely important for understanding current differences in international income.

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 unionized industries when unionization is possible, add the following search algorithm: Order the existing industries by its potential union wage, from highest to the lowest. Sequentially allow each industry to unionize. The rest of the industry structure is determined as described above. After each iteration, compare the union wage for all unionization candidates with the competitive wage and also compare the competitive wage with the would-be union wage of non-unionized industries. Stop if none of the would-be union wage is greater than the competitive wage and all union wages of unionization candidates are larger than the competitive wage.

References

[1] Daron Acemoglu, Simon Johnson, and James A. Robinso. The colonial origins of comparative development: An empirical investigation. *American Economic Review*, 91(5):1369–1401, December 2001.

[2] Daron Acemoglu, Simon Johnson, and James. A. Robinson. Reversal of fortune: Geography and institutions in the making o fthe mordern world income distribution. MIT Unpublished Manuscript, 2001.

[3] Philippe Aghion and Peter Howitt. The schumpeterian approach to technical change and growth. In Horst Siebert, editor, *Economic Growth in the World Economy: Symposium 1992*. 1993.

[4] Lee J. Alston and Joseph P. Ferrie. Paternalism in agriculture labor contracts in the u.s. south: Implications for the growth of the welfare state. *American Economic Review*, 83(4):852–876, September 1993.

[5] Elias Dinopoulos and Constantinos Syropoulos. Innovation and rent protection in the theory of schumpeterian growth. University of Florida Working Paper, 2000.

[6] Gene M. Grossman and Elhanan Helpman. Quality ladders and product cycles. *Quarterly Journal of Economics*, 106(2):557–586, May 1991.

[7] Stephen. L. Parente and Edward. C. Prescott. Monopoly rights: A barrier to riches. *American Economic Review*, 89(5):1216–1233, December 1999.

[8] Paul M. Romer. Endogenous technological change. *Journal of Political Economy*, 98(5):S71–S102, October 1990.

[9] Kenneth L. Sokoloff and Stanley L. Engerman. Institutions, factor endowments, and paths of development in the new world. *Journal of Economic Perspectives*, 14(3):217–232, 2000.