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For Sale: Barriers to Riches*

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Abstract

This paper formalizes stories linking vested interests to the non-adoption of superior technologies. Coalitions of workers skilled in the operation of incumbent technologies lobby government for a prohibition on the adoption of better technologies. For reasonable parameter values, we find that the model generates significant levels of protection in equilibrium. The model also generates protection cycles that lead to TFP growth cycles. Protection has a level effect on per capita output. "Productivity slowdowns" lead to increased levels of protection. The level of protection is increasing in the venality of governments. Increased population growth rates increase the value of protection, and can lead to an increase in the level of protection.

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> "Unequal conditions of competition at the sector level, caused by the existing economic policies, are the most important reason for the lack of restructuring and productive investment. These inequalities tend to favor low productivity incumbents, protecting them from takeovers and productive new entrants. These policies are often put in place to achieve social objectives, namely protecting existing jobs, but in many cases, the suspicion is that they also serve the personal financial interests of government officials..."

Unlocking Economic Growth in Russia, McKinsey Global Institute (1999).

1 Introduction

Why are there such wide variations in productivity at both the sectoral and aggregate level across nations despite the fact that best practice technologies appear to be available for adoption by firms in all countries? A common answer is that vested interests - acting in their own self-interest - block the adoption of superior technologies. This view is most strongly associated with the work of Mancur Olson (1982), who argued that economic growth itself leads to the creation of vested interests which act to hinder further growth. This story is based on the premise that the process of economic growth involves the destruction of some assets. The "losers" from growth - those whose assets are destroyed - thus have an incentive to seek ways in which to stop the process of growth from taking place.

Proponents of the vested interest story often cite various case studies which document vested interests successfully blocking the adoption of superior technology. For example, Mokyr (1990) and Parente and Prescott (1999, 2000) provide a number of historical examples of vested interests hindering the adoption of new technology. More recently, several McKinsey Global Institute (1999) reports have argued that economic policies favoring low productivity incumbents play a significant role in the low productivity of numerous industries in a variety of countries - including Japan, Russia, the United Kingdom and Brazil. In several cases, they argue that these policies are implemented in exchange for financial payments to government officials. The McKinsey studies identify a number of barriers - ranging from explicit barriers to entry into a market, to arbitrary enforcement of taxes and other laws which hinder the effort of firms to adopt new technology[1].

In this paper, we step away from the case study approach and specify a dynamic model which formalizes the role of vested interests in blocking the adoption of superior technologies. We analyze a small open economy where vested interests arise endogenously and lobby for

[1] One can also identify examples of explicit prohibitions on technology transfer by non-incumbent firms. For example, until the capital market reforms beginning in 1985, Mexican law required foreign firms to obtain government permission before they were allowed to transfer technology from abroad (Harrison and Hanson (1999)).

the non-adoption of superior technologies. Our model incorporates the two key components of Olson's arguments. First, interest groups - once organized - have an incentive to lobby government for the imposition of policies which lead to barriers to the adoption of new (more efficient) technology. The second is that there are asymmetries in the ability of agents to form interest groups. Given these two factors, the political process is likely to generate policies which hinder technology adoption.

To capture the destruction of assets associated with growth, we build on Chari and Hopenhayn (1991) and model production via a vintage technology. Workers are two period lived and are skilled when old in the technology they used when young. As newer, more productive technologies become available, coalitions of workers who are skilled in the operation of incumbent technologies (old workers) have an incentive to offer contributions to the government in exchange for a ban on the new technology.

We model the asymmetries in interest group formation in an intuitive manner. Lobby groups comprised of skilled workers have the ability to exclude members who fail to pay their specified contributions to the group from working in the industry in which they are skilled. All agents are free to join lobby groups which oppose protection. However, lobby groups lack the power to exclude members from the benefits of lower protection, and are rendered ineffective by a free rider problem[2].

As in Grossman and Helpman (1994), the government maximizes a weighted sum of real GDP (a measure of social welfare) and contributions by lobby groups to the government. The only policy dimension in which the government is active is the decision to provide barriers to technology adoption in each industry. In our model, domestic barriers to technology adoption are accompanied by trade barriers[3]. Otherwise, firms which are forced to utilize inefficient technologies would be unable to compete with foreign firms which are free to adopt the new technologies[4].

We find - for reasonable parameter values - that the model generates significant levels of protection as an equilibrium outcome. We analyze two classes of equilibria: constant protection equilibria and protection cycles equilibria. In the constant protection equilibria, a constant fraction of industries protected each period. In a protection cycle, the economy has no protection in alternating periods, with substantial protection in the intervening periods. In both of these classes of equilibria, variations in the level of protection causes changes in the level of per capita output and productivity, but does not change the long run growth

[2]Recent work by Kocherlakota (2001) has argued that limited enforcement plays a key role in the emergence of barriers to the adoption of superior technology.

[3]This assumption follows from the implicit assumption that all goods are freely traded. Naturally, if some goods were non-traded, then this link between domestic and international protection would be weakened.

[4]This feature is shared with Holmes and Schmitz (1995) who also illustrate that trade restrictions are necessary for the implementation of policies which prevent the domestic adoption of better technology.

rate of either of these variables.

The protection cycle equilibria capture Olson's (1982) intuition that rapid growth can lead to the creation of vested interests which in turn block future growth. The basic intuition for the protection cycle equilibria is as follows. Consider a period where a large number of industries using the same vintage are protected. Old agents work in the protected industries while young agents work in unprotected industries. In the next period, there is a large number of agents skilled in the same vintage concentrated in relatively few industries. The large number of skilled workers in this vintage drives the skill premium to zero. Therefore, skilled workers do not lobby for protection, and the economy opens. Once a country has jumped to the technology frontier, the cycle of non-adoption begins again.

The model generates several interesting - and in some cases surprising - predictions about the impact of productivity, population growth and corruption on the level of protection. If the size of the technology jump between vintages decreases, the level of protection increases. In other words, "productivity slowdowns" lead to an increase in protection. The intuition for this result turns out to be very simple. The cost of protection to the government is the decrease in output resulting from blocking the adoption of new technology, and thus productivity slowdowns decrease the cost of protection. The model also predicts that corruption can adversely impact the level of per capita income. However, in the model there is no relationship between corruption and the average growth rate of per capita income. As we discuss below, this appears to match empirical observations, as the correlation between indices of corruption and the level of per capita income is much higher than the correlation between corruption and the growth of per capita income. We find that population growth can adversely impact the level of productivity. As population growth increases, the fraction of the workforce which is skilled in the operation of existing technologies decreases. This increases the return to skilled workers (the old in our model) to blocking technology adoption. For reasonable parameter values, this translates into an increase in the equilibrium level of protection.

Another interesting implication of the model is that protection leads to the decline of an industry. In the model, the protection of an industry causes the productivity of this industry relative to unprotected industries to decline. When protection is removed from the industry, it is able to adopt the latest technology and thus experiences rapid productivity growth. This prediction of the model appears to accord well with industry level studies of the impact of increased competition due to a reduction in trade barriers on productivity.

Although the Olson argument is widely known, there have been few attempts to formalize the role political economy factors play in explaining cross-country income differences. One of the few exceptions to this is Krusell and Rios-Rull (1996) (Aghion and Howitt (1998, Chapter 9) present an interesting exposition of a variation of this model.). Whereas Krusell

and Rios-Rull (1996) analyze a voting model with endogenous innovation, we analyze a lobbying model with technology adoption. Closer in spirit to our work is that of Bellettini and Ottaviano (2003), who examine a model in which skilled workers lobby a (government) regulator for a ban on the adoption of new technology. Our work differs from both these papers in that we have many small industries rather than a representative industry. As we emphasize in Bridgman et al (2004), this dramatically increases the scope and cost of political economy factors. A second key difference between this paper and that of Bellettini and Ottaviano (2003) and Bridgman et al (2004) is that we relax the assumption that skilled and unskilled workers are perfectly substitutable in production. Relaxing this assumption turns out to be important, as it leads to an interrelationship between the population growth rate and the value and level of protection.

2 Model

The economy is populated by two period lived overlapping generations households and a government. There is a continuum of measure one of tradeable consumption goods. We analyze a small open economy where world prices are determined by the productivity of the most recent vintage. The world price of each consumption good is normalized to 1 in each period. All variables are in per capita terms.

2.1 Technology

There are a continuum of industries of measure one. Each industry produces a distinct consumption good and takes as inputs unskilled labor l and skilled labor s. Productivity is determined by the vintage of the technology $v_t(i)$ employed at date t and the productivity growth factor γ. Output of industry i is given by:

$$y_t(i) = \gamma^{v_t(i)} s_t(i)^{\alpha} l_t(i)^{1-\alpha} \tag{2.1}$$

A new vintage arrives exogenously at the beginning of each period for each industry. Firms may costlessly adopt the new vintage.

2.2 Labor

Skilled labor is industry and vintage specific. Workers may become skilled in a vintage of a technology through learning-by-doing. If an unskilled worker chooses to work as a skilled worker, she is able to provide $(1-\kappa) \in (0,1)$ units of skilled labor. If an agent works in industry i in period t, she becomes skilled in vintage $v_t(i)$ next period.

2.3 Households

At the beginning of each period t, a continuum of measure $(1+n)^t$ of generation t households is born. Each household lives for two periods and is endowed with one unit of time in each period. The household inelastically supplies labor to firms and consumes consumption goods $c_t(i)$. Households have identical preferences represented by:

$$u^t(c^t) = \int_0^1 \ln c_t^t(i)di + \int_0^1 \ln c_{t+1}^t(i)di \tag{2.2}$$

In each period, consumers must choose which industry to work in, whether to work in a skilled or unskilled position, and the quantity of each good to consume.

2.4 Coalitions

2.4.1 Coalitions of Industry Insiders

At the beginning of each period t, the skilled workers in each industry form a lobby group. The number (density) of skilled workers $\overline{s}_t(i)$ is equal to the number (density) of old workers at t who worked in industry i during period $t-1$. In the model, members of each lobby group have identical interests. We assume that lobby groups behave non-cooperatively with respect to each other. Each lobby group can offer a per member bribe $b(i)$ to the government in exchange for protection. Protection for an industry consists of a ban on the adoption of a new vintage and the importation of that industry's good. The lobby group can exclude members who fail to pay the bribe from working in the industry, and hence, does not face a free rider problem.

2.4.2 Coalitions of Industry Outsiders (Young Agents)

Unskilled workers are allowed to form coalition(s) to lobby for a ban on protection for individual industries, or for all industries. This coalition(s) can offer a bribe b_y per member. This lobby group is unable to exclude members from working in any sector or punish them in any other fashion for failure to pay the bribe. This inability to exclude workers implies that this coalition faces a free rider problem.

2.5 Government

The government consists of a positive measure of agents. These agents cannot provide labor to firms. The government may provide protection to industries. Protection for an industry consists of a ban on the adoption of a new vintage and the importation of that industry's

good. A government policy is given by an integrable function $\pi : [0,1] \to \{0,1\}$ with the property that:

$$\pi(i) = \begin{cases} 1, & \text{if industry } i \text{ is protected} \\ 0, & \text{if industry } i \text{ is not protected} \end{cases}$$

We assume that the government acts myopically. The government has preferences over social welfare and the bribes it receives. Its objective is:

$$U^G = \frac{GDP + \phi B}{P} \tag{2.3}$$

where B is total bribes and P is the domestic price index. The price index P is given by[5] $\ln P = \int_0^1 \ln p(i) di$. GDP is measured in current prices. The income received by the government as bribes (B) is spent on purchasing consumption goods on domestic market. The government's preferences over these consumption good are identical to consumers' preferences.

2.6 Timing

At the beginning of each period, new agents are born and new vintages become available. The game in each period proceeds as follows. First, each lobby group simultaneously presents a bribe offer to the government. The government either accepts or declines each bribe offer. After the policy is announced, adoption occurs where permitted, and people decide where to work. As production occurs, the government collects bribes from lobby groups whose industries were protected.

3 Equilibrium

3.1 Competitive Equilibrium

The state variables for the economy at the beginning of the period are the distribution of vintages v and the density of skilled workers $\overline{s}$. $v_t(i)$ is the vintage of industry i. $\overline{s}_t(i)$ is the (per capita) density of skilled workers in an industry i that are skilled in $v_t(i)$.

Firms act competitively, and choose inputs and vintages so as to maximize profits, taking prices and policies as given. If adoption is not prohibited ($\pi_t(i) = 0$), a firm in industry i solves:

$$\begin{aligned} & \max_{(v',s,l,y)} \left[p_t(i)\, y - w_{l,t}(v',i)\, l - w_{s,t}(v',i)\, s\right] \\ \text{s.t.} \quad & y = \gamma^{v'} s^{\alpha} l^{1-\alpha} \\ & 0 \leq v' \leq t \end{aligned} \tag{3.1}$$

[5]To derive the price index, consider the indirect period utility U of nominal income W and prices $\mathbf{P}$: $U(W,\mathbf{P}) = \int \ln c(j)\, dj = \int \ln\left(\frac{W}{p(j)}\right) dj = \ln(W) - \int \ln p(j)\, dj = \ln(W) - \ln(P) = \ln\left(\frac{W}{P}\right)$

If the industry is protected ($\pi_t(i) = 1$), then the firm can no longer choose whether to adopt or not. In this case, its choice problem is analogous to equation (3.1), except that the second constraint becomes $v' = v_t(i)$.

Households take the sequence of policies $\{\pi_t\}_{t=0}^{\infty}$, bribe offers $\{b_t\}_{t=0}^{\infty}$, wages $\{w_{s,t}, w_{l,t}\}_{t=0}^{\infty}$, firms adoption decisions $\{v_t'\}_{t=0}^{\infty}$, and prices $\{p_t\}_{t=0}^{\infty}$ as given. At the beginning of each period, consumers decide which industry to work in. In addition to the aggregate state variables, an old agent's state is determined by the industry (i) she is skilled in. The value function $\left(V_t^O\right)$ for an old agent is

$$V_t^O(\pi_t, b_t, w_t, v_t', p_t, i) = \max \int_0^1 \ln c_t(i)\, di \tag{3.2}$$
$$\text{s.t.} \quad \int_0^1 c_t(j) p_t(j)\, dj \leq \max\{\max_{i'}\{w_{l,t}(i')\}; \mathbf{1}_{v_t'(i)=v_t(i)}\left(w_{s,t}(i) - b_t(i)\right)\}$$

where $w_{l,t}(i)$ and $w_{s,t}(i)$ are the wages paid to an unskilled and skilled worker in industry i respectively, and $\mathbf{1}_{v_t'(i)=v_t(i)}$ is an indicator function that takes the value of 1 when $v_t'(i) = v_t(i)$ and 0 otherwise. We let $\sigma_t(i)$ denote the density (number) of old people skilled in industry i, who chose to work in that industry in period t ($\sigma_t(i) \leq \overline{s}_t(i)$).

The problem of a young agent is to choose the industry i and $\{c_t(j)\}_{j=0}^{1}$ so as to:

$$\max_{(i,c)} \int_0^1 \ln c_t(j) dj + E_t V_{t+1}^O \left(\pi_{t+1}, b_{t+1}, w_{t+1}, v_{t+1}', p_{t+1}, i\right) \tag{3.3}$$
$$\text{s.t.}: \quad \int_0^1 c_t(j) p_t(j) dj \leq W_t(i)$$

where $W_t(i)$ is the young agent's labor income at date t.

In equilibrium, labor markets clear: If $\pi_t(i) = 1$, $\sigma_t(i) = s_t(i)$, and

$$\int_0^1 \left(\frac{(1 - \pi_t(i))\, s_t(i)}{1 - \kappa} + l_t(i)\right) di = 1 - \int_0^1 \pi_t(i)\, s_t(i)\, di \tag{3.4}$$

This follows from our normalization of population each period to one.

Goods market clearing is given by:

$$\int_0^1 c_t(i, \omega) d\omega = y_t(i) \tag{3.5}$$

where ω's are consumers' names.

A competitive equilibrium is defined as follows.

Definition 3.1. *Given sequences of government policy functions $\{\pi_t\}$, bribes $\{b_t\}$ and initial state $(\overline{s}_0, v_0)$, a Competitive Equilibrium is sequences of states $\{\overline{s_t}, v_t\}$, prices $\{p_t(i)\}$, wages $\{w_{s,t}(i), w_{l,t}(i)\}$, and allocations $\{c_t(i,\omega), i_t(\omega)\}$ and $\{l_t(i), s_t(i), y_t(i), v_t'(i)\}$ such that*

1. *Given policy, bribes, state, prices, and wages, each household's allocation* $\{c_t(i,\omega), i_t(\omega)\}$ *solves the household's problem.*

2. *Given policy, state, prices, and wages, each firm's allocation* $\{l_t(i), s_t(i), y_t(i), v'_t(i)\}$ *solves the firm's problem.*

3. *Markets clear.*

4. *The state variables* $\overline{s}_{t+1}(i)$ *evolve according to the density of young people working in industry* i *at time* t*, and* $v_{t+1}(i) = v'_t(i)$*.*

3.2 Game between the Government and Industry Insiders

The problem of coalition(s) of young agents is quite simple in our model. Since the coalition is unable to "punish" members who do not pay the agreed bribe, all members of the coalition will choose not to pay the bribe. This implies that the amount that each agent is willing to pay for no protection is zero. Since the coalition of industry outsiders faces a severe free rider problem, in equilibrium it will be unable to make a positive bribe offer. For this reason, in the game specified below, we do not explicitly model the coalitions of industry outsiders as players.

Policy and contributions are determined by a game between the government and the coalitions of industry insiders. Coalitions of industry insiders, taking the state and the government's policy decision rule as given, simultaneously select bribe offers to maximize the skill premium, net of those bribes, for their members. The value of protection to a member of lobby group i is the difference between the wage that worker could earn if adoption of the new vintage in their industry was prohibited and the wage they could otherwise. Formally, the value of protection for an insider of industry i, $V(i)$, is:

$$V_t(i) = w_{s,t}(i) - \max_j w_{l,t}(j) \tag{3.6}$$

For a given state and schedule of bribes $b(i)$, each government policy induces a competitive equilibrium. In turn, each competitive equilibrium generates a price index $P(\pi)$, skilled wages $w_s(i)(\pi)$, and nominal output $GDP(\pi)$. The total amount of bribes collected is

$$B = \int_0^1 \pi(i)b(i)\sigma(i)di \tag{3.7}$$

The government chooses a policy, taking the bribe offers announced by coalitions of industry insiders as given, to maximize its objective function. Formally, an equilibrium:

Definition 3.2. *A Markov Perfect Equilibrium is*

1. *a policy function* $\Pi^*(\overline{s}, v, \mathbf{B})$ *which solves*

$$\max_{\pi} \frac{GDP(\pi) + \phi \int \pi(i) B(i) di}{P(\pi)} \tag{3.8}$$

for all $(\overline{s}, v, \mathbf{B})$, *and*

2. *a contribution function for each coalition of industry insiders* $B_i^*(\overline{s}, v)$ *that solves*

$$\max_{B_i} w_s(i)(\Pi^*(\overline{s}, v, B_{-i}^*, B_i)) - \frac{B_i}{\overline{s}_i} \tag{3.9}$$

s.t. $w_s(i)(\Pi^*(\overline{s}, v, B_{-i}^*, B_i)) - \frac{B_i}{\overline{s}_i} \geq \max_j w_{l,t}(j)(\Pi^*(\overline{s}, v, B^*))$

for all $(\overline{s}, v)$.

We restrict our attention to Symmetric Markov Perfect Equilibria. The symmetry restriction imposes the condition that all industries which operate the same vintage are identical. A sufficient condition for this is that the allocation of industry insiders is the same.

Definition 3.3. *A Markov Perfect Equilibrium is symmetric if along the equilibrium path: All industries of the same vintage are indistinguishable, that is,*
$\overline{s}_t(i) = \overline{s}_t(j)$ *whenever* $v_t(i) = v_t(j)$.

The advantage of restricting attention to symmetric equilibria is that it dramatically reduces the state space. Instead of tracking allocations for each industry, we merely have to track allocations for a finite number of classes of industries, where each class is indexed by the distance d of the vintage operated from the most advanced vintage available at date t. Formally, $d_t(i) = t - v_t(i)$. The state becomes $(\overline{s}(d), x(d))$, where $x(d)$ is the measure of industries d vintages behind at the beginning of the period.

In a symmetric equilibrium, all coalitions of industry insiders whose skill is d vintages behind offer the same bribe $B(d)$. The government's policy is fully specified by $\mu(d) \in [0, x(d)]$ - the measure of industries d vintages behind that are protected. For notational convenience, $\mu(0)$ denotes the measure of industries that were not granted protection.

A symmetric equilibrium path is fully specified by the sequences of state variables $\{x_t, \overline{s}_t\}_{t=0}^{\infty}$ and strategies $\{\mu_t\}_{t=0}^{\infty}, \{B_t\}_{t=0}^{\infty}$. The measure of industries that adopted the frontier technology last period is given by $x_t(1)$. The law of motion of $x(d)$ is:

$$\begin{aligned} x_t(d) &= \mu_{t-1}(d-1) \quad \forall d \geq 1 \\ x_t(0) &= 0 \end{aligned} \tag{3.10}$$

The other aggregate state variable - $\overline{s}_t(d)$ - evolves according to the number of young workers who worked in industries $d-1$ vintages behind at $t-1$. In our discussion of the equilibria below, we specify the distribution of young workers across industries, and then use this to construct $\overline{s}_t(d)$. Note that $\sum_{d=1,2,..} \overline{s}(d) x(d) = \frac{1}{2+n}$.

3.3 Characteristics of Equilibria

In this section, we present characteristics that are shared by all classes of equilibria. We restrict attention to parameters such that, in the absence of political economy factors, adoption is optimal. A sufficient condition for adoption to be optimal is that $1 < \gamma (1-\kappa)^{\alpha}$. Throughout the paper, we assume that $1 < \gamma \ (1-\kappa)^{\alpha}$.

In order for coalitions of industry insiders have an incentive to offer bribes in exchange for protection, there cannot be too many skilled workers in a coalition ($\overline{s}(d) \geq \alpha$). Otherwise the skill premium is zero. In other words, skilled workers need to be relatively scarce for the value of protection to be positive. Formally:

Lemma 3.4. *If $\mu(0) > 0$ and $w_l(d) = w_l(0)$ for all d, then the value of protection $V(d) > 0$ whenever $\overline{s}(d') < \alpha \ \forall d'$.*

Proof. See Appendix. □

In equilibrium, wages in unprotected industries are pinned by no-arbitrage condition. Households can choose to work as unskilled workers or work as skilled workers and provide $(1-\kappa)$ units of skilled labor services. Hence:

$$w_{s,t}(0)(1-\kappa) = w_{l,t}(0) = \gamma^t \left((1-\kappa)\,\alpha\right)^{\alpha} (1-\alpha)^{1-\alpha} \tag{3.11}$$

The skilled wage in protected industries depends upon the number of industry insiders and is equal to the value of the marginal product of a skilled worker.

In most of the equilibria we consider, the entire surplus from protection is extracted by the government. Formally:

Lemma 3.5. *If $0 < \mu(d) < x(d)$ for $d \geq 1$, then $b(d) = w_s(d) - w_l$, where $w_l = \max\limits_{d} w_l(d)$*

Proof. See Appendix. □

When the lemma holds, the income of all agents is the same whether or not they work in a protected industry.

4 Classes of Equilibria

Since we cannot get closed form solutions, we are unable to fully characterize the set of equilibria. We are able to numerically solve for three different classes of equilibria[6]: No Protection Equilibrium, Constant Protection Levels, and Two Period Cycles. On the basis

[6] We conjecture that for higher levels of venality longer period cycles with multiple vintages operated concurrently also exist, although we have not constructed one.

of our simulations, we can place these equilibria in the parameter space. No Protection Equilibrium occurs when venality of the government is low. As we increase the venality of the government, we move first to Constant Protection Level equilibrium, and then Two Period Cycles. While there is no overlap in parameter values supporting No Protection Equilibrium and Constant Protection Levels, such overlap may exist between Constant Protection Levels and Two Period Cycles (see Table 3). Where an overlap exists, the class of equilibrium depends upon the initial distribution of the old agents across industries.

4.1 No Protection Equilibrium

The no protection equilibrium serves as a useful benchmark for assessing the effects of protection. The no protection equilibrium always exists for some parameter values[7], and is easily characterized. No arbitrage implies that all workers receive the same wage (equation 3.11). Each consumer has the same wealth available to purchase consumption, since the skilled workers must allocate fraction κ of their time to acquire the skill. We follow the convention that old and young workers are evenly distributed across industries. The labor allocations and per capita consumption:

$$\begin{aligned} l_t &= (1-\alpha) \\ s_t &= (1-\kappa)\,\alpha \\ c_t &= y_t = \gamma^t\left((1-\kappa)\,\alpha\right)^\alpha (1-\alpha)^{1-\alpha} \end{aligned} \tag{4.1}$$

In this equilibrium per capita output and consumption both grow at the constant rate $(\gamma - 1)$.

It is worth noting that protection is not granted because the costs to the government exceed the value they place on bribes. Industry insiders place a positive value on protection in this equilibrium. The value of protection is the difference between the skilled wage that a worker could earn if their industry is protected, and the unskilled wage. In this case, this is given by:

$$V_t(1) = \gamma^t \alpha^\alpha (1-\kappa)^\alpha (1-\alpha)^{1-\alpha}\left(\frac{\alpha}{\overline{s}_t(1)} - 1\right) \tag{4.2}$$

Observe that Lemma 3.4 holds as an if and only if statement.

4.2 Constant Protection Levels

The easiest equilibria with protection to characterize are *constant protection levels*. In this class of equilibria, less than half the industries are protected in every period and no vintage

[7] For example, $\phi = 0$ is a sufficient parameter restriction.

more than one period behind the frontier is operated. Formally, $\mu(1) \in (0, 0.5)$ and $\mu(d) = 0\ \forall d \geq 2$. While equilibria of this nature are stationary in the sense that a constant fraction of industries are protected each period, the specific industries which are protected vary from period to period.

A key issue that arises in constructing this equilibrium is the allocation of workers across industries. In our simulations, we restrict attention to equilibria where young workers are spread evenly across unprotected industries and old workers work in both the protected and unprotected sector. Thus, the density of skilled workers in the protected industries is given by $\overline{s}_t(1) = \frac{1}{(2+n)(1-\mu(1))}$[8]. Furthermore, this assignment rule implies that $\overline{s}_t(2) = 0$. This trivially implies that $\mu(2) = 0$, since no agents have a vested interest in protecting technologies two generations behind the most advanced vintage.

Given the distribution of old workers across industries, one can compute the labor allocation of each industry using the first order conditions of the firm's problem and market clearing. Each unprotected industry employs

$$s_t(0) = \alpha(1-\kappa)\frac{1-\mu(1)\overline{s}_t(1)}{1-\alpha\mu(1)} \tag{4.3}$$

of skilled labor, and each protected and unprotected industry employs

$$l_t(0) = l_t(1) = (1-\alpha)\frac{1-\mu(1)\overline{s}_t(1)}{1-\alpha\mu(1)} \tag{4.4}$$

The price of goods produced in protected industries is:

$$p_t(1) = \left[\frac{\alpha(1-\kappa)(1-\mu_t(1)\overline{s}_t(1))}{(1-\alpha\mu_t(1))\overline{s}_t(1)}\right]^{\alpha}\gamma \tag{4.5}$$

Cursory inspection reveals that $p_t(1) > 1$, so that one effect of protection is to increase the domestic price of protected goods relative to the price of goods produced in unprotected sectors. The price index is given by $P_t = p_t(1)^{\mu(1)}$.

Nominal per capita GDP is given by

$$GDP_t = \gamma^t(1-\alpha)^{1-\alpha}\alpha^{\alpha}(1-\kappa)^{\alpha}\frac{1-\mu(1)\overline{s}_t(1)}{1-\alpha\mu(1)} \tag{4.6}$$

Protection lowers the level of output in the protected sector, while increasing the output of industries in the unprotected sectors. The intuition for this result is that the size of protected industries is limited by the number of skilled workers. As a result, there are more workers left to work in the unprotected sector. At the aggregate level, the effect of protection is to decrease the level of real GDP relative to the no-protection equilibrium.

[8] Labor markets clear for this assignment rule so long as the fraction of industries protected ($\mu(1)$) is relatively small (we verify labor market clearing in our algorithm).

The value of protection to a skilled worker in an industry that adopted in the previous period is

$$V_t(1) = w_{s,t}(1) - w_{l,t} = \gamma^t \alpha^\alpha (1-\alpha)^{1-\alpha} (1-\kappa)^\alpha \frac{\alpha - \overline{s}_t(1)}{(1-\alpha\mu_t(1))\overline{s}_t(i)} \tag{4.7}$$

Each lobby group makes a bribe offer for protection at the beginning of the period. The equilibrium bribe offer from each coalition is given by $B^* = V_t(1)\,\overline{s}_t(1)$.

The government strategy in equilibrium is as follows. It will provide protection to any coalition (industry) which offers a bribe $B > B^*$, it will not provide protection to any coalition (industry) which offers a bribe $B < B^*$, and it will protect a measure $\mu(1)$ of coalitions (industries) which offer bribe $B = B^*$. The government chooses $\mu(1)$ in each period to maximize:

$$U^G = \frac{\gamma^t(1-\alpha)^{1-\alpha}\alpha^\alpha(1-\kappa)^\alpha \frac{1-\mu(1)\overline{s}}{1-\alpha\mu(1)}}{\left[\left(\frac{\alpha(1-\kappa)(1-\mu(1)\overline{s}(1))}{(1-\alpha\mu(1))\overline{s}(1)}\right)^\alpha \gamma\right]^{\mu(1)}} + \phi \frac{B^*\mu(1)}{\left[\left(\frac{\alpha(1-\kappa)(1-\mu(1)\overline{s}(1))}{(1-\alpha\mu(1))\overline{s}(1)}\right)^\alpha \gamma\right]^{\mu(1)}} \tag{4.8}$$

In general, we will not be able to find a closed form solution to the problem. A solution can be numerically approximated using the following algorithm. First, we guess a candidate value of $\mu(1)$ and compute the value of protection V. Then we enter the bribe offer $B = V\overline{s}$ in the government's objective function. Next, numerically search for the value $\mu'(1)$ that maximizes the government's objective function. If the resulting value of $\mu'(1)$ is within the desired tolerance of $\mu(1)$, then $\mu(1)$ is the equilibrium level of protection. All other equilibrium quantities and prices can be found as functions of parameters and the level of protection.

4.3 Two Period Cycles

The model also generates equilibria with stationary cycles in the aggregate level of protection, called *two period cycles*. There is a period of relatively high protection followed by a period with no protection. In these cycles, a fraction of industries are prohibited from adopting every second period, while in the intervening period the economy is completely open and all industries adopt the most advanced technology. In these equilibria, the oldest technology operated is 1 generation behind the frontier (i.e. $d \in \{0,1\}$). For notational convenience, we adopt the convention that the economy is completely open during odd periods, and partially closed during even periods.

The labor allocation is as follows. During periods of no-protection, young (and old) workers are evenly distributed across industries. Thus, the density of skilled workers in the ensuing period is $\overline{s}_{even}(1) = \frac{1}{2+n}$. During even periods, old workers, whose skill is in protected industries, work as skilled in those industries, while old workers who are skilled in unprotected

industries work as unskilled in both protected and unprotected industries. Young workers work solely in the unprotected sector. In the following period, $\overline{s}_{odd}(1) = \frac{1}{(2+n)(1-\mu^{even}(1))} > \alpha$. This condition is a crucial feature of these equilibria, and implies that the value of protection is zero in odd periods - which in turn implies that the equilibrium level of protection during odd periods is zero.

The labor market allocations and output during odd periods (no protection) are the same as those in the no protection equilibrium (equation (4.1)). Similarly, the labor market allocations and output during even periods are analogous to those of the one period cycle, and are given by equations (4.3), (4.4) and (4.6).

The two period cycle of protection generates a corresponding cycle in productivity and per capita output growth. The growth rate of productivity as one moves from odd to even periods is lower than the growth rate of productivity from even to odd periods. This result follows from the fact that in even periods, a positive measure μ of industries are prevented from adopting the latest technology. In the following period, however, these industries adopt the newest vintage (2 generations above the one used) while the remaining industries also adopt. However, long run average productivity growth is the same as in economies which never implement protection.

Proposition 4.1. *Policy cycles generate corresponding cycles in productivity growth.*

Proof. In periods of protection, productivity increases by the factor $\gamma (1 - \mu^{even}(1))$, while during open periods the productivity increases by factor $\gamma (1 - \mu^{even}(1)) + \gamma^2 \mu^{even}(1)$. □

We have also constructed equilibria where the economy is completely closed ($\mu^{even} = 1$) during even periods. One set of parameters that generates this outcome is:

$\alpha = 0.59$	$\gamma = 1.65$	$\kappa = 0.28$	$\varphi = 9$	$n = 0$

One thing to note about this example is that the government is extremely venal, and there are large costs to having unskilled workers work as skilled workers. These two factors combine to generate the wild swings from open to closed.

5 Results and Implications

The following subsections contain a more detailed discussion of several interesting results. As we have noted above, the political economy features of our model make it difficult to obtain analytic results. Hence, several of our results take the form of numerical examples for what we feel are reasonable parameter values. Given our demographic structure, we assume that each period corresponds to 20 years. The population growth rate is chosen to be $n = 0.35$, which corresponds to 1.5% annual growth rate; and the technology growth factor $\gamma = 1.5$ corresponds to 2% annual growth rate. The adoption cost $\kappa = 0.1$ is chosen to match the

income loss of long term workers who are displaced[9]. We have also experimented with other parameter values, and found that we obtain similar results to those reported below.

5.1 Population Growth and Protection

An interesting implication of the model is that high population growth rates can adversely impact both productivity and per capita income. This result is driven by the fact that population growth has two effects in the model. First, it increases the costs to the government of providing protection, as the resulting distortion is increasing in the size of the population. At the same time, higher rates of population growth increase the value of protection for skilled workers. The intuition for this is straightforward. The larger is the growth rate of population, the more scarce are skilled workers in protected industries. This means that the relative wage of skilled workers in protected industries is higher, which increases the value of protection to skilled workers.

To illustrate the interaction between population growth and the level of protection we conducted a number of numerical experiments. We report the results of one such experiment in Table 1.

Table 1.

As this example illustrates, higher growth rates of population can lead to increases in the level of protection. The population growth rates given above are comparable to population growth rates observed in different regions of the world over the post 1950 period.[10]

We conducted similar experiments for a variety of parameter values, and in most cases found similar results to those reported above. However, for some combinations of parameters, we found the opposite result - namely, that increases in population growth can lower the level of protection. The intuition for this result is that both the value of protection to coalitions of skilled workers and the welfare cost of granting protection are dependent upon the difference between the measure of skilled workers in each lobby group ($\overline{s}(1)$) and the share of skilled workers in output (α). For some parameter values, particularly when $\overline{s}(1)$ is much less than α, the increase in the bribe offer is outweighed by the increase in the distortion caused by higher population growth. In these cases, higher population growth rates can lead to lower levels of protection and an increased level of GDP[11].

[9] See Kletzer (1998) for references on the cost of separations.

[10] Kelley (1988) lists average population growth rates by region.

[11] However, these equilibria are unstable in the sense that there is no incentive for young workers to spread evenly across industries, on the contrary - it pays to join the industry that has relatively many young workers as that is the industry most likely to be protected. The equilibria where higher population growth (and lower $\overline{s}(1)$) lead to higher levels of protection do not share this instability, because young workers have

This result is particularly interesting, as other models of barriers to technology such as Krusell and Rios Rull (1996) and Aghion and Howitt (1998), share the prediction that barriers to technology adoption (innovation) are decreasing in the rate of population growth. This prediction also matches the simple intuition that population growth increases the value of future consumption relative to consumption today, and thus increases the cost of barriers to technology adoption. However, as we discuss below, the implication of our model qualitatively matches the empirical evidence.

5.2 Productivity Slowdowns

An unexpected prediction of the model is that productivity slowdowns can lead to an increased level of protection. The intuition for this result turns out to be very simple. During periods of slower productivity growth, the output loss associated with protecting an industry decreases. Since this is the cost to the government of providing protection, the equilibrium level of protection is decreasing in γ.

Unfortunately, we cannot analytically prove this result since multiple equilibria may exist. However, we are able to numerically compute the change in the level of protection as we vary the productivity factor γ. The results of this experiment are reported in Table 2. The numerical results show that relatively small changes in productivity growth rates can have substantial effects on the level of protection and on welfare.

Table 2.

We find this result to be very interesting, as it points to a mechanism through which changes in the long run growth rate can translate into additional level effects. In the model, an increase in the size of the jump between vintages provides an incentive for governments to lower barriers to technology adoption which leads to jump in the level of output. This result indicates that periods of higher productivity growth should also be accompanied by lower barriers to trade and technology adoption. However, the causality runs not from lower barriers to higher productivity growth, but rather in the reverse direction!

5.3 Corruption and Wealth

An interesting question is the link between corruption and growth. In our model, higher levels of protection do not influence average growth rates of per capita GDP, but rather have solely a level effect. In other words, while corruption is not harmful for growth it does have a negative impact on the level of per capita GDP. Table 3 reports the results of increasing

every incentive to spread across industries as the industries with fewer young workers today are more likely to be protected next period.

the venality of the government. In addition to illustrating the (un-surprising) results that the level of protection is non-decreasing in venality, the table also provides an example of multiple equilibria. For intermediate values of venality, one can construct both constant protection equilibria and two period cycle equilibria. For extremely venal governments, however, the only equilibria we are able to construct are two period cycles. This suggests that very corrupt countries should have more volatile policy and TFP growth rates.

Table 3.

5.4 Other Implications of the Model

5.4.1 Declining Industries and Protection

The model provides an interesting insight into the question of how to interpret government policies which limit technology adoption. In the equilibria analyzed in this paper, protected firms employ inferior (antiquated) technologies. However, the causality runs from industries insiders successfully obtaining protection to the use of inferior technology. This is interesting, as the more common interpretation of the empirical observation that protected firms use less productive technologies is that lower productivity firms lobby for protection in lieu of exiting an industry. The model also implies that after protection is removed, an industry experiences rapid growth in productivity relative to previously unprotected industries as it is able to adopt the frontier vintage. As we mentioned earlier, this prediction seems to match a number of case studies which find that industry level productivity increases rapidly after barriers to competition are removed.

The model also predicts that the ratio of skilled to unskilled workers in the protected sector is lower than that of the unprotected sector. Note that the amount of skilled labor services $s(0)$ is smaller than the number of skilled workers in the unprotected sector. The ratio of skilled to unskilled workers in the unprotected sector is $\frac{s(0)}{(1-\kappa)l(0)} = \frac{\alpha}{1-\alpha}$, while in the protected sector $\frac{\bar{s}(1)}{l(1)} = \frac{\bar{s}(1)}{(1-\alpha)} \frac{1-\alpha\mu(1)}{1-\mu(1)\bar{s}_t(1)} < \frac{\bar{s}(1)}{1-\alpha} < \frac{\alpha}{1-\alpha}$. This labor market allocation implies that protected industries employ fewer workers than unprotected industries. This result matches the observation that declining industries are protected, although in the model the causality runs from protection to a decline in size.

5.4.2 Free Trade: Gains from Commitment

The model also sheds light on one role of trade agreement - namely, it's ability to serve as commitment device to prevent individual lobby groups from acting in ways which are individually rational but self-destructive when all lobby groups follow the same strategy. In the model, each industry lobby is willing to offer contributions for protection since the cost

of protection takes the form of a higher price for the good which is paid by other consumers in the economy. However, coalitions face a prisoners dilemma as the political equilibrium results in the gains from protection being paid to the government as bribes, and each worker in the economy receives a lower level of consumption due to the distortions induced by protection. Thus, if all lobby groups in the economy could commit to not seek protection, then workers would be better off, as output and consumption would be strictly higher[12].

This observation also points out the difficulties involved in coalitions of agents forming to support free trade. Each coalition of industry insiders would prefer a world where their industry was protected and all other industries were unprotected. Moreover, each young agent derives no benefit from opposing the protection of any one industry - since each industry is of measure zero. Finally, any payments made to undo protection for some industries would leave the government free to resell protection to other industries. These facts combine to imply that the only set of bribes that could be offered by a coalition of all agents is that of free trade. However, as we show, any coalitions which support free trade are subject to a free rider problem which drastically weakens their ability to lobby for free trade.

6 Empirical Evidence

In this section, we argue that the predictions of the model are qualitatively consistent with the data.

6.1 Population

The model predicts that, in general, population growth is associated with higher levels of protection and lower levels of output. Long term growth rates are unaffected. Higher population growth is associated with interventionist policies. The correlation between the official cost of starting a business in Djankov, et al. (2000) and average population growth is 0.41[13]. The correlation between openness as measured by number of years open using the Sachs and Warner (1995) indicator and population growth is -0.58. There is a strong negative correlation (-0.68) between population growth and the level of GDP per worker. This relationship holds even if we exclude the OECD nations (-0.40). This suggests that this correlation is not driven solely by a demographic transition, whereby an increase in per capita income causes a decrease in fertility. Consistent with Kelley (1988) and Temple (1999), population growth's correlation with GDP growth is weaker than the correlation with GDP levels, with a correlation coefficient of -0.33 (-0.18 without OECD).

[12]This insight is similar to that made by Holmes and Schmitz (1995).

[13]A correlation matrix of the variables discussed is reported in Table 4. All variables are taken from the Penn World Tables unless otherwise noted.

Table 4.

6.2 Corruption

The model predicts that corruption is associated with higher levels of protection and lower levels of output, while long term growth rates are unaffected. These predictions are consistent with Mauro (1995) and Shleifer and Vishny (1993), among others, who have argued that corruption is detrimental to an economy. An unfortunate limitation of the data is that there are no measures of government corruption that correspond exactly to the definition of corruption in our model. Hence, to assess the empirical impact of corruption, we are forced to use imperfect proxies for corruption. Less corrupt governments are less interventionist. The perception of governmental honesty as measured in IRIS International Country Risk data and openness are strongly correlated (0.67[14].) The correlation between entry costs and honesty is -0.48. The correlation between honesty and GDP per worker is strong (0.67.) Honesty is also associated with higher growth rates (0.35.) Note that governmental honesty's correlation with GDP growth is lower than its correlation with levels.

The model predicts that more corrupt countries are more likely to be in two period cycle equilibria. Therefore, countries with more corrupt governments should have more volatile growth. The correlation between the corruption index and the standard deviation of the growth rate of GDP per capita, calculated from the World Bank's Global Development Network Growth Database, is -0.48. We regress volatility of per capita GDP growth on the corruption index controlling for initial income. The results are reported in Table 5.

Table 5.

Even controlling for initial income, the coefficient on governmental honesty is negative and significant.

6.3 Cycles

In the model, cycles in government policy lead to cycles in productivity growth. The data suggest that such cycles exist. Fajnzylber and Lederman (1999) document that a number of the Latin America economies which undertook policy reforms in the 1990's also undertook *temporary* liberalizations during the 1950's. Using the Sachs and Warner (1995) measure, there were 15 (developing) nations that both opened and closed in the period 1950 to 1994. While they are measuring trade openness, Sachs and Warner (1995) emphasize that "trade reform is almost always accompanied by a much broader range of reforms, including macroeconomic

[14]The IRIS index is decreasing in corruption.

stabilization, internal liberalization...and often extensive privatization." These reforms typically make importation and adoption of new technologies easier. Developing nations also show cycles in growth rates (Pritchett 2000).

The model predicts that productivity growth should increase when an economy opens. In the data, the period after a liberalization is associated with faster GDP growth than the period before. Papageorgiou, et al. (1991) document the impact of trade liberalization on GDP growth rates in 31 liberalization episodes. They find that on average GDP growth was 1.2 percent higher in the three years after liberalization than in the three years before. We perform this experiment using as liberalization dates the year that the Sachs and Warner (1995) indicator moves from "closed" to "open." The results are reported in Table 6.

Table 6.

We find that on average GDP per worker grew 1.79 percent faster in the three years after opening. A large number of openings are European nations returning to convertibility of their currency after World War Two. To check that the result is not driven by this, we did the experiment excluding the current members of the European Union. GDP per worker grew 1.93 percent faster after liberalization for the restricted sample. For their sample of Latin American nations, Fajnzylber and Lederman (1999) find that total factor productivity growth was on average 1.5 percent higher during periods of reform than otherwise.

The model also predicts that closing an economy reduces productivity growth. This result is consistent with the data. The period after moving to a restrictive trade policy is associated with a decrease in GDP growth. Similar to the exercise above, we define closing dates as the year that the Sachs and Warner (1995) indicator moves from "open" to "closed." We find that GDP per worker grows 1.45 percent slower after closing than before.

7 Conclusion

We find that blocking the adoption of superior technologies is an equilibrium outcome of a game between coalitions of industry insiders with vested interests in incumbent technologies and a corrupt government. Barriers to technology adoption - which we term protection - involve both a prohibition on domestic adoption of new technology and import barriers. We analyze two classes of equilibria: constant protection and two period cycles. We find that while protection lowers the level of per capita income (and TFP), it does not effect (long run) average growth rates.

The model also generates a number of other interesting and in some cases surprising results. We find that the protection of an industry causes the relative decline of that industry. This result is counter to the common view that declining industries seek and are granted

protection. “Productivity slowdowns” lead to an increase in the level of protection, and thus causes a further reduction in short run productivity growth. Not surprisingly, we also find that corruption can adversely impact per capita income. Finally, we show that increased population growth increases the value of protection and can lead to an increase in the level of protection. These predictions are qualitatively consistent with the data.

We find that the welfare costs of protection are larger than those measured by Harbarger triangles. Since protection is so detrimental to welfare, an important question is why agents who are harmed by protection are unable to successfully lobby the government to prevent the implementation of these policies. In our model, this inability to organize can be attributed to a free rider problem. Individuals have an incentive to renege on their contribution to the coalition since the benefits of an open economy are non-excludable. Therefore, there is no equilibrium in which a coalition of industry outsiders successfully bribes the government (or industry insiders) to keep the economy unprotected. Conversely, coalitions of industry insiders are able to solve the free rider problem as they may punish coalition members who renege on their contribution to the government by excluding them from collecting the rent associated with protection (the skill premium in protected industries).

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Appendix 1: Proofs.

Lemma 3.4. *If $\mu(0) > 0$ and $w_l(d) = w_l(0)$ for all d, then the value of protection $V(d) > 0$ whenever $\overline{s}(d') < \alpha\ \forall d'$.*

Proof. Since $\mu(0) > 0$, the unskilled wage in the unprotected sector is $w_l(0) = \gamma^t(1-\alpha)^{1-\alpha}\alpha^\alpha(1-\kappa)^\alpha$.

Now, since $w_l(d) = w_l(0)$ for all d,

$$w_s(d) = \gamma^t \left(p(d)\gamma^{-d}\right)^{1/\alpha} \alpha^\alpha (1-\kappa)^{\alpha-1}(1-\alpha)^{1-\alpha} \tag{7.1}$$

and from the goods market clearing conditions

$$p(d) = \left[\frac{\alpha(1-\kappa)(1-\sum\mu(d')\,\overline{s}_t(d'))}{\overline{s}(d)(1-\sum\alpha\mu(d'))}\right]^\alpha \gamma^d \tag{7.2}$$

Substituting this into the formula for skilled wage, we get

$$w_s(d) = \gamma^t\alpha^\alpha(1-\kappa)^\alpha(1-\alpha)^{1-\alpha}\frac{\alpha(1-\sum\mu(d')\,\overline{s}_t(d'))}{\overline{s}(d)(1-\sum\alpha\mu(d'))} \tag{7.3}$$

and the value of protection is
$V_t(d) = w_s(d) - w_l = \gamma^t\alpha^\alpha(1-\kappa)^\alpha(1-\alpha)^{1-\alpha}\left(\frac{\alpha(1-\sum\mu(d')\overline{s}_t(d'))}{\overline{s}(d)(1-\sum\alpha\mu(d'))} - 1\right)$.

Finally, since $\overline{s}_t(d') < \alpha\ \forall d'$, $V_t(d) > 0$. □

Lemma 3.5. *If $0 < \mu(d) < x(d)$ for $d \geq 1$, then $b(d) = w_s(d) - w_l$, where $w_l = \max_d w_l(d)$*

Proof. Suppose not.

If $b(d) < w_s(d) - w_l$, then an individual industry's lobby would benefit from increasing the bid by a small $\varepsilon > 0$, because the probability of receiving protection goes from $\frac{\mu(d)}{x(d)}$ to 1, while the positive net (of bribe) value of receiving protection decreases only by ε.

If $b(d) > w_s(d) - w_l$, then an individual industry's lobby prefers not receiving protection, and would benefit from decreasing the bid, thus bringing the probability of receiving protection from $\frac{\mu(d)}{x(d)}$ to 0.

Hence, in any symmetric Markov perfect equilibrium with $0 < \mu(d) < x(d)$, $b(d) = w_s(d) - w_l$. □

Tables.

Table 1.

$\alpha = 0.75$	$\gamma = 1.5$	$\kappa = 0.1$	$\phi = 2$

Population Growth		Fraction of Industries	Loss in Real GDP	Bribes as
Rate (n)	Annual	Protected ($\mu(1)$)	Relative to Open*	Share of GDP
0	0%	0.126	4.4%	2.4%
0.22	1%	0.208	7.1%	4.3%
0.35	1.5%	0.245	8.4%	5.3%
0.5	2%	0.284	9.8%	6.5%
0.8	3%	0.341	11.9%	8.7%

* Bribe payments are included in our measure of GDP. This is consistent with the definition of GDP given above, and the fact that bribes are merely a reallocation of claims on goods between members of society.

Table 2.

$\alpha = 0.75$	$\kappa = 0.1$	$\phi = 2$	$n = 0.35$

Productivity Growth		Fraction of Industries	Loss in Real GDP	Bribes as
Factor (γ)	Annual	Protected ($\mu(1)$)	Relative to Open	Share of GDP
1.8	3%	0.042	2.5%	1.3%
1.65	2.5%	0.139	6.5%	3.8%
1.5	2%	0.245	8.4%	5.3%
1.45	1.9%	0.279	8.5%	5.3%
1.4	1.7%	0.310	8.2%	5.1%

Table 3.

$\alpha = 0.75$	$\gamma = 1.5$	$\kappa = 0.1$	$n = 0.35$

Government's Venality (ϕ)	Constant Protection Levels			Two Period Cycles (even t)		
	$\mu(1)$	Real GDP Loss	Bribes	$\mu(1)$	Real GDP Loss	Bribes
1.3	0	0	0			
1.35	0.022	0.9%	0.7%			
1.4	0.050	2.0%	1.5%			
1.5	0.102	4.0%	3.0%			
2	0.245	8.4%	5.3%			
2.4	0.297	9.8%	5.2%	0.440	18.2%	17.6%
2.5	0.305	10.0%	5.2%	0.453	18.8%	18.2%
2.75	0.323	10.4%	4.9%	0.479	19.8%	19.5%
3				0.500	20.7%	20.6%
3.5				0.530	21.9%	22.2%
4				0.551	22.7%	23.4%
4.25				0.560	23.1%	23.9%

Table 4.

	DPOP	OPEN	LGDPW	ENTRY	CORRUP	DGDPW
DPOP	1.00					
OPEN	-0.58	1.00				
LGDPW	-0.68	0.68	1.00			
ENTRY	0.41	-0.32	-0.46	1.00		
CORRUP	-0.59	0.67	0.67	-0.48	1.00	
DGDPW	-0.33	0.51	0.49	-0.16	0.35	1.00

Variables:

DPOP: Average population growth rate, 1960-1990.

OPEN: Percentage of years open, 1960-1990.

LGDPW: Log GDP per worker, 1988.

ENTRY: Official entry costs.

CORRUP: Index of corruption perception, 1982.

DGDPW: Average growth rate of GDP per worker, 1960-1990.

Table 5.

Dependent variable: Standard deviation of GDP per capita growth rate, 1961-1999

	Coefficient (Std. Error)	**t-Statistic**
Constant	5.78 (0.40)	14.31
GDP per Worker, 1960	-1.24 (0.99)	-1.25
Corruption Index, 1982	-0.38 (0.13)	-3.08
Observations	73	
Adjusted R^2	0.23	

Table 6.

Openings	Avg. Growth GDP per Worker	Change
Three Years Before Opening	1.99%	
Three Year After Opening	3.78	1.79%
Opening Year+Three Years After	3.83	1.84
Openings: Non-EU Sample		
Three Years Before Opening	0.96	
Three Year After Opening	2.89	1.93
Opening Year+Three Years After	2.82	1.86
Closings		
Three Years Before Closing	4.19	
Three Years After Closing	2.75	-1.45
Closing Year+Three Years After	1.99	-2.20