

# Vested Interests and Technology Adoption\*

Benjamin R. Bridgman

Bureau of Economic Analysis

Igor D. Livshits

University of Western Ontario, CIAR

James C. MacGee<sup>†</sup>

University of Western Ontario

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## Abstract

The asymmetric ability of different interest groups to exclude non-members and the concentrated benefits and diffused costs of policies favoring vested interests matters for technology adoption. We analyze a political economy model where coalitions of workers in many small industries lobby government for a prohibition on the adoption of superior technologies. For reasonable parameter values, the “smallness” of industry lobbies leads to barriers to the adoption of technologies that would make *all* workers more productive. Higher government corruption can lead to lower levels of TFP and per capita output. The model can generate TFP growth cycles.

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<sup>†</sup>Corresponding author. Department of Economics, University of Western Ontario, London, Ontario, N6A 5C2, Canada. Tel.: + 1-519-661-2111, ext 85207; fax: + 1-519-661-3666. E-mail: jmacgee@uwo.ca

# 1 Introduction

Do the asymmetric ability of different interest groups to exclude non-members and the concentrated benefits and diffused costs of policies favoring vested interests matter for technology adoption? Both of these elements figured prominently in Olson’s (1982) seminal work on vested interests and growth, where he argued that policies that benefit small groups at the expense of the general public can exist because small groups are better able to organize themselves. They also feature prominently in the numerous examples of vested interests successfully blocking the adoption of superior technologies that have been documented by economic historians (Mokyr (1990, 1992)) and the McKinsey Global Institute.<sup>1</sup> Surprisingly, however, these features have been largely ignored by the recent theoretical literature which has argued that vested interests may account for a significant fraction of observed differences in cross-country productivity (Holmes and Schmitz (1995), Parente and Prescott (1999, 2000), Herrendorf and Teixeira (2005)).

To investigate their importance, we incorporate the asymmetric ability of different interest groups to exclude non-members and concentrated benefits and diffused costs into a political economy model of vested interests and technology adoption that includes many features emphasized in the recent literature. We find that the “smallness” of industry lobbies amplifies the incentive of vested interests to lobby for barriers to the adoption of superior technologies. When combined with the asymmetric ability of different interest groups to exclude members, this can lead to barriers to the adoption of technologies that would make *all*

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<sup>1</sup>The following quote from *Unlocking Economic Growth in Russia*, McKinsey Global Institute (1999) provides an example of their view:

“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...”

workers more productive. This suggests that abstracting from the concentrated benefits and diffused costs of industry specific policies is likely to significantly underestimate the harmful effects of vested interests on technology adoption and productivity.

The production structure of the model we examine has three key elements. First, as we see protection arising in both small and large industries, we assume that there are (infinitely) many ex-ante identical industries. This assumption plays a key role in generating the concentrated benefits and diffused costs of policies favoring specific industries. Second, we abstract from innovation, and assume that new, more productive vintages become available for adoption in each industry each period. This focus on technology adoption rather than innovation seems natural, as the large differences in productivity across countries appear to be largely due to the non-adoption of best practice technologies (Jovanovic (1997)).<sup>2</sup> Finally, to capture the idea that people are affected asymmetrically by the adoption of new technology, we build on the vintage human capital model of Chari and Hopenhayn (1991). Workers are two-period lived and are skilled when old in the technology they used when young. These skills cannot be transferred across industries or vintages. Hence, skilled workers have a vested interest in incumbent technologies, since the adoption of new technology renders their skills obsolete. As a result, the benefits from the non-adoption of new technology in an industry are highly concentrated, while the costs are broadly spread among all other workers.

The political economy side of the model features (vested) interest groups that lobby the government for desired policy. For simplicity, the only policy dimension in which the government is active is the decision of whether or not to prohibit technology adoption at the industry level. The lobbying game builds upon Grossman and Helpman (1994). The government's payoff is a weighted sum of real GDP (a measure of social welfare) and contributions (bribes) from lobby groups. Workers (households) choose whether or not to form coalitions

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<sup>2</sup>Differences in adoption exist between developed countries with similar relative factor prices. Bailey and Gersback (1995) examine manufacturing industries in the U.S., Germany and Japan and argue that much of the variation in relative productivities is due to the non-adoption of best practice technologies.

to lobby (bribe) the government to block (or not) the adoption of new technologies. A novel element of the political economy environment is that coalitions vary in their ability to overcome free rider problems. Specifically, coalitions of workers in an industry have the power to exclude workers who fail to make contributions towards the bribe from working in that industry. In contrast, “broad based” lobby groups which oppose protection are unable to exclude non-contributing members from the benefits of lower protection. This captures the fact that while it is typically difficult to exclude people from purchasing goods, exclusion from certain workplaces (e.g. closed union shops) is common in many countries. This assumption plays a key role in generating the endogenous formation of only industry-based vested interest groups in the model.

Our analysis suggests that the differential ability of interest groups to overcome free rider problems and concentrated benefits and diffused costs play an essential role in the ability of vested interests to block the adoption of superior technologies. Perhaps the most important finding is the *big* effect of “smallness” (of industries). In a one industry world, the industry lobby bears a significant part of the cost of protection. In contrast, when industry lobbies are “small”, they bear a trivial fraction of the costs (higher product prices) of their own protection. The diffused nature of the cost across *all* consumers means that industry based lobbies have an incentive to lobby for protection even when these public costs exceed their private benefit. We show – for reasonable parameter values – that these features lead to vested interests successfully lobbying to block the adoption of technologies which would make *all* workers more productive. This is a striking result! Indeed, it implies that models that abstract from “smallness” are likely to substantially understate the extent to which vested interests block dramatically superior technologies.

The asymmetric ability of interest groups to exclude people from the benefits of their lobbying efforts leads to the endogenous failure of broad coalitions of consumers to effectively oppose narrow vested interests. The benefit of successfully lobbying against protection of any given industry is a lower price of that good. Since anti-protection lobbies cannot prevent consumers from purchasing goods, they cannot punish individuals who chose not to

contribute to lobbying. In contrast, coalitions of workers can exclude people from working in the industry, providing a punishment for those who do not contribute to lobbying.

“Smallness” and asymmetric interest group formation also lead to new insights into how government corruption can have large effects on economic performance. If all lobby groups – both those in favor of protection and those opposed – were able to exclude people who did not make contributions, then corruption would simply lead to a transfer of wealth to the government. When lobby groups differ in their ability to overcome free rider problems, corruption can lead to policies which block the adoption of superior technologies. As a result, increased levels of corruption can lead to lower levels of TFP and per capita income. This insight complements the current view of the costs of corruption, which argues that corruption acts as an inefficient tax on production (Shleifer and Vishny (1993)).<sup>3</sup>

“Smallness” also enriches the analysis, as it allows us to consider the *extent* of protection. In a one industry world, adoption is either allowed or not. When there are many small industries, most equilibria feature partial protection, which facilitates comparative static analysis. We characterize both constant protection level equilibria and cycles.

Although Olson’s (1982) work is well known, there have been few attempts to formalize the interaction between the political process and vested interests. In an important contribution, Krusell and Rios-Rull (1996) construct an overlapping generations model in which agents vote on whether to allow innovation to take place (Aghion and Howitt (1998) present a variation of this model). Bellettini and Ottaviano (2005) examine a lobbying model in which skilled workers lobby a government regulator for a ban on the adoption of new technology. In these papers, the political conflict is primarily between generations, as older skilled workers resist the adoption (innovation) of new technologies that would lower their productivity while increasing the productivity of the young. They show that this generational conflict can lead to cycles in adoption (innovation). In contrast to this paper, however, barriers to new technologies arise in Krusell and Rios-Rull (1996) and Bellettini and Ottaviano (2005)

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<sup>3</sup>Our results also complement work by Besley and Coate (1998) by highlighting an additional source of “political failure”.

only when some workers are rendered less productive by new technologies.

The paper is organized as follows. The next section outlines the model. The third section specifies our equilibrium concept. In the fourth section, we examine a one period version of the model to develop intuition before continuing on to characterize dynamic equilibria. The fifth section discusses the key insights and implications of our model. The sixth section concludes.

## 2 Model

The economy is populated by two-period lived overlapping generations households and a government. There is a continuum of measure one of consumption goods. All variables are in per capita terms.

### 2.1 Technology

There is 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  $v_t$  employed at date  $t$ . A new vintage,  $\gamma > 1$  times more productive than the previous, arrives exogenously at the beginning of each period for each industry. Output of industry  $i$  is:

$$y_t(i) = \gamma^{v_t(i)} (\lambda s_t(i) + l_t(i)). \quad (1)$$

Skilled labor is industry and vintage specific, and is  $\lambda > 1$  times as productive as unskilled labor. Skill in a particular industry and vintage can only be acquired by working as an unskilled worker in that industry using that vintage.

### 2.2 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:

$$u^t(c^t) = \int_0^1 \ln c_t^t(i) di + \beta \int_0^1 \ln c_{t+1}^t(i) di \quad (2)$$

We assume Cobb-Douglas utility for analytical tractability. Households choose which industry to work in and the quantity of each good to consume.

### 2.3 Lobby Groups

Each period, all workers (both skilled and unskilled) can form coalitions to lobby the government. Lobbying is an offer of a bribe payment  $b$  to the government in exchange for enacting a desired policy. Lobby groups behave non-cooperatively with respect to each other.

A key issue is the ability of coalitions to force individual members to make contributions towards the bribe payment  $b$ . We assume that industry specific coalitions can exclude members who fail to pay the bribe from working in the industry.<sup>4</sup> Hence, these coalitions can potentially overcome free rider problems.

It is worth emphasizing that all workers are free to form coalition(s) to lobby against industry protection. Such lobbies, however, are unable to exclude members from working in any industry or punish them in any other fashion for failure to contribute towards the bribe.

### 2.4 Government

The government consists of a positive measure of agents who 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. A government policy is given by an integrable function  $\pi : [0, 1] \rightarrow \{0, 1\}$  where  $\pi(i)$  takes the value 1 if industry  $i$  is protected and 0, if it is not protected.

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<sup>4</sup>In an earlier version of this paper, we also considered the case where only skilled workers could be excluded from an industry for failing to contribute to a bribe, while unskilled workers were free to work in any industry. The main results of the paper are qualitatively the same in both environments.

The government acts myopically. It has preferences over social welfare and the bribes it receives. The income received by the government as bribes ( $B$ ) is used to purchase consumption goods. The government's preferences over consumption goods are identical to those of households. Its objective is:

$$U^G = \frac{Y + \phi B}{P} \quad (3)$$

where  $Y$  is nominal GDP,  $B$  is total bribes and  $P$  is the price index. The price index  $P$  is given by  $\ln P = \int_0^1 \ln p(i) di$ . The parameter  $\phi$  denotes the venality of the government. Note that since bribes are included in GDP, the parameter  $\phi$  is the *extra* weight that government places on its own consumption. Taking government preferences to be the weighted sum of real GDP and real bribes (also used by Grossman and Helpman (1994)) provides us with a tractable way of varying the relative weight the government puts on private gains versus social welfare.

## 2.5 Timing

At the beginning of each period, new agents are born and new vintages become available. The number (density) of skilled workers in industry  $i$ ,  $\bar{s}_t(i)$ , is the number (density) of old workers who worked in that industry at  $t - 1$ .

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, and people decide where to work. Finally, the government collects bribes from lobby groups whose industries were protected.

## 3 Equilibrium

This section defines political economy equilibrium. We begin by defining a competitive equilibrium for any given outcome of the lobbying game. This determines the payoffs to agents for any outcome of the lobbying game. We then define our equilibrium concept for the lobbying game.

### 3.1 Competitive Equilibrium

The state of the economy at the beginning of the period is the distribution of vintages  $v$  and the density of skilled workers  $\bar{s}$ .  $v_t(i)$  denotes the vintage of industry  $i$  while  $\bar{s}_t(i)$  denotes the (per capita) density of skilled workers in 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 ( $\pi_t(i) = 0$ ), industry  $i$  solves:

$$\begin{aligned} \max_{y,s,l,v'} [p_t(i)y - w_{l,t}(i)l - w_{s,t}(i)s] \\ \text{s.t. } y = \gamma^{v'} (\lambda s + l) \quad 0 \leq v' \leq t \end{aligned} \quad (4)$$

where  $w_{l,t}(i)$  and  $w_{s,t}(i)$  are the wages paid to an unskilled and skilled worker in industry  $i$ , respectively. If the industry is protected ( $\pi_t(i) = 1$ ), then the firm can no longer choose whether to adopt. In this case, the last constraint becomes  $v' = v_t(i)$ .

Households take the sequence of policies  $\{\pi_t\}_{t=0}^\infty$ , bribe offers  $\{b_t\}_{t=0}^\infty$ , prices  $\{p_t\}_{t=0}^\infty$ , wages  $\{(w_{s,t}, w_{l,t})\}_{t=0}^\infty$ , and firm's adoption decisions  $\{v'_t\}_{t=0}^\infty$  as given. Each period, households decide in which industry to work. In addition to the aggregate state variables, an old agent's state is determined by the industry ( $i$ ) she is skilled in. The old agent's value function is

$$\begin{aligned} V_t^O(\pi_t, b_t, w_t, p_t, i) = \max_c \int_0^1 \ln c_t(j) dj \\ \text{s.t. } \int_0^1 c_t(j) p_t(j) dj \leq \max \{ \pi_t(i) (w_{s,t}(i) - b_t(i)); \bar{w}_{l,t} \}, \end{aligned} \quad (5)$$

where  $\bar{w}_{l,t} = \max_i [w_{l,t}(i) - \pi_t(i)b_t(i)]$  is the highest (after bribe) unskilled wage.

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

$$\begin{aligned} \max_{i,c} \int_0^1 \ln c_t(j) dj + \beta E_t V_{t+1}^O(\pi_{t+1}, b_{t+1}, w_{t+1}, p_{t+1}, i) \\ \text{s.t. } \int_0^1 c_t(j) p_t(j) dj \leq w_{l,t}(i) - \pi_t(i)b_t(i). \end{aligned} \quad (6)$$

The density (number) of old people skilled in industry  $i$  who choose to work in  $i$  in period  $t$  is denoted  $\sigma_t(i)$  ( $\sigma_t(i) \leq \bar{s}_t(i)$ ). Similarly, the density (number) of people who choose to

work as unskilled in industry  $i$  is  $\vartheta_t(i)$ . In equilibrium, labor markets clear:  $\vartheta_t(i) = l_t(i)$  and  $\sigma_t(i) = s_t(i)$ . Since the population each period is normalized to one:

$$\int_0^1 l_t(i) di + \int_0^1 \pi_t(i) s_t(i) di = 1 . \quad (7)$$

Goods markets clear:  $\int c_t(i, \omega) d\omega = y_t(i)$  for all  $i \in [0, 1]$ , where  $\omega$ 's are consumers' names.

**Definition 1** *Given sequences of government policy functions  $\{\pi_t\}$ , bribes  $\{b_t\}$  and initial state  $(\bar{s}_0, v_0)$ , a Competitive Equilibrium is sequences of states  $\{\bar{s}_t(i), v_t(i)\}$ , prices  $\{p_t(i)\}$ , wages  $\{w_{s,t}(i), w_{l,t}(i)\}$ , and household allocations  $\{(c_\tau(\omega), i_\tau(\omega))_{\tau=t, t+1}\}$  and firm allocations  $\{l_t(i), s_t(i), y_t(i), v'_t(i)\}$  such that*

1. *Given the state, policy, bribes, prices and wages, each household's allocation solves the household's problem.*
2. *Given policy, state, prices, and wages, each firm's allocation solves the firm's problem.*
3. *Markets clear.*
4. *The state variables  $\bar{s}_{t+1}(i)$  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

Free rider problems prevent many possible coalitions from making a credible bribe offer. This follows from their inability to “punish” members who do not contribute towards the bribe. For this reason, in the game specified below, we do not explicitly model coalitions other than those of skilled (old) workers in a given industry. These coalitions of industry insiders are able to exclude non-paying members from working in the industry, which allows them to overcome the free rider problem.

Policy and contributions are determined by a game between the government and the coalitions of industry insiders. Coalitions of industry insiders simultaneously select bribe offers to maximize the expected value of the skill premium, net of bribes, for their members.

The value of protection to a member of lobby group  $i$  is the difference between the wage that workers could earn if adoption of the new vintage in their industry was prohibited and the wage they could otherwise earn as an unskilled worker:

$$V_t^P(i) = w_{s,t}(i) - \bar{w}_{l,t} \quad (8)$$

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 GDP  $Y(\pi)$ . The total amount of bribes collected is

$$B = \int_0^1 \pi(i)b(i) (s(i) + l(i)) di. \quad (9)$$

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 is:

**Definition 2** *A Markov Perfect Equilibrium is strategies  $\Pi^*$ ,  $(B_i^*)_{i \in [0,1]}$  such that*

1. *For every vector of bribe offers  $\mathbf{B}$ , the government policy function  $\Pi^*(\mathbf{B})$  solves*

$$\max_{\pi} \frac{Y(\pi) + \phi \int \pi(i)B_i di}{P(\pi)} \quad (10)$$

2. *The bribe function for each coalition of industry insiders  $B_i^*(\bar{s}, v)$  solves*

$$\max_{B_i} E \left[ \Pi_i^*(B_{-i}^*, B_i) \left( w_s(i) - \bar{w}_l - \frac{B_i}{\bar{s}(i) + l(i)} \right) \right]. \quad (11)$$

We restrict our attention to Symmetric Markov Perfect Equilibria. The symmetry restriction we impose is that all industries which operated the same vintage in the previous period have the same number of skilled workers. This implies that industries which operate the same vintage are identical.

**Definition 3** *A Markov Perfect Equilibrium is symmetric if along the equilibrium path all industries of the same vintage are indistinguishable:  $\bar{s}_t(i) = \bar{s}_t(j)$  whenever  $v_t(i) = v_t(j)$ .*

Restricting attention to symmetric equilibria dramatically reduces the state space. Instead of tracking allocations for each industry, we merely track allocations for a finite number of classes of industries, where each class is indexed by the distance  $d_t(i) = t - v_t(i)$  of the vintage operated from the most advanced vintage available. The state becomes  $(\bar{s}(d), x(d))$ , 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 the measure of industries  $d$  vintages behind that are protected ( $\mu(d) \in [0, x(d)]$ ). Since all unprotected industries adopt,  $\mu(0)$  denotes the measure of industries not granted protection.

A symmetric equilibrium path is fully specified by the sequences of state variables  $\{x_t, \bar{s}_t\}_{t=0}^{\infty}$  and strategies  $\{\mu_t\}_{t=0}^{\infty}, \{B_t\}_{t=0}^{\infty}$ . The law of motion of  $x(d)$  is:

$$x_t(d) = \mu_{t-1}(d-1) \quad \forall d \geq 1, \quad x_t(0) = 0. \quad (12)$$

$\bar{s}_t(d)$  evolves according to the number of young workers who worked in industries  $d-1$  vintages behind at  $t-1$ . In characterizing equilibria, we specify the distribution of young workers across industries, and use this to construct  $\bar{s}_t(d)$ . Note that  $\sum_{d=1,2,\dots} \bar{s}_t(d)x(d) = \frac{1}{2+n}$ .

## 4 Characterizing Equilibria

To illustrate the underlying mechanics of the model, we begin by analyzing the (static) game between the government and the industry lobbies in period  $t$ . We then present several classes of dynamic equilibria: *Constant Protection Levels (CPL)* and *Cycles*.<sup>5</sup> CPL occur when the government venality ( $\phi$ ) is low, with zero protection as a special case. As the government's venality increases, cycles arise.

We restrict attention to symmetric Markov perfect equilibria of the lobbying game. Subgame perfection implies that an industry lobby will never offer a bribe more than minimally sufficient to guarantee protection. When not all industries  $d$  vintages behind are protected, the government extracts all of the surplus from protection of these industries. This results

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<sup>5</sup>We do not fully characterize the set of equilibria.

from the “Bertrand-type” competition between industries. In this case, the per member bribe offer equals the value of protection (equation (8)). Note that a lobby knows that its actions cannot affect the aggregate protection level.

We assume that  $\gamma > \lambda$ . In words, we restrict attention to cases where the new technology strictly dominates the previous vintage. This implies that unskilled workers using the new vintage are always strictly more productive than a skilled worker using an older vintage.

#### 4.1 Understanding Equilibria: (Static) Lobbying Game

To illustrate the workings of the dynamic equilibria, we begin by characterizing the equilibrium of the (static) lobbying game in period  $t$ , taking the aggregate state  $(x_t(d), \bar{s}_t(d))$  as given. We assume that all old workers are skilled in vintage  $t - 1$  (we focus on dynamic equilibria where this is the case).

For a given government policy  $\mu$  (the fraction of industries protected) and lobby contribution  $b(1)$  (bribe per worker), it is straightforward to solve for the competitive equilibrium. We normalize the price of unprotected goods to 1. Since workers are paid their marginal products, the unskilled wage in unprotected industries is  $w_{l,t}(d = 0) = \gamma^t$ , and the skilled wage in protected industries is  $w_{s,t}(1) = \gamma^{t-1}\lambda p_t(1)$ . In all the equilibria we analyze, workers are employed either as skilled workers in a protected industry or as unskilled workers in an unprotected industry. The unskilled wage in a protected industry would be  $w_{l,t}(1) = \gamma^{t-1}p_t(1)$ . We verify that unskilled workers do not want to work in protected industries:  $w_{l,t}(1) - b(1) \leq w_{l,t}(0)$ .<sup>6</sup>

The number of unskilled workers in each unprotected industry is

$$l_t(0) = \frac{1 - \mu_t(1)\bar{s}_t(1)}{1 - \mu_t(1)}. \quad (13)$$

Given consumers preferences, in a competitive equilibrium, the value of output is the same

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<sup>6</sup>In most equilibria, the entire surplus from protection is extracted, so  $w_{s,t}(1) - b(1) = w_{l,t}(0)$ . Since  $w_{s,t}(1) = \lambda w_{l,t}(1)$ , unskilled workers strictly prefer working in unprotected industries.

for all industries. It follows that

$$p_t(1) = \frac{\gamma}{\lambda \bar{s}_t(1)} l_t(0) \quad (14)$$

and the price index is  $P_t = p_t(1)^{\mu_t(1)}$ . When  $\bar{s}_t(1) < 1$ , protection increases the relative price of protected goods. Protection also lowers the level of output in protected sectors, while increasing the output in unprotected industries. This is primarily driven by the young workers being spread across fewer (unprotected) industries.

We now turn to the payoffs of the lobbying game players. The value of protection to an old worker is

$$V_t^p(1) = w_{s,t}(1) - w_{l,t} = \gamma^t \frac{1 - \bar{s}_t(1)}{\bar{s}_t(1)(1 - \mu_t(1))} \quad (15)$$

Clearly, skilled workers demand protection only if  $\bar{s}_t(1) < 1$ . In a symmetric environment, this holds whenever  $x_t(1) > \frac{1}{2+n}$ . Otherwise, no protection is the unique equilibrium outcome. For the remainder of this subsection, we only consider  $x_t(1) > \frac{1}{2+n}$ .

Taking into account the effects of its policy choice on the competitive equilibrium, the government chooses  $\mu_t(1)$  to maximize:

$$U^G(\mu_t(1)) = \frac{\gamma^t \left( \frac{1 - \mu_t(1) \bar{s}_t(1)}{1 - \mu_t(1)} \right) + \phi B_t(1) \mu_t(1)}{\left[ \frac{\gamma}{\lambda \bar{s}_t(1)} \left( \frac{1 - \mu_t(1) \bar{s}_t(1)}{1 - \mu_t(1)} \right) \right]^{\mu_t(1)}}. \quad (16)$$

Protection increases nominal GDP and nominal bribes, but also increases the price index. In fact, a sufficient condition for real GDP to be decreasing in the level of protection is  $\gamma > \lambda$ . Hence, the unique equilibrium for  $\phi = 0$  is no protection.

The first order condition with respect to  $\mu_t(1)$  yields,

$$\phi B_t(1) + \phi B_t(1) \mu_t(1) D(\mu_t(1)) = Y_t(\mu_t(1)) D(\mu_t(1)) - \frac{dY_t(\mu_t(1))}{d\mu_t(1)}, \quad (17)$$

where  $D(\cdot)$  is the marginal (price) distortion of added protection, and  $Y_t(\cdot)$  is nominal GDP as a function of the level of protection. In words, the government equates its marginal weighted benefit of added protection from bribes (the left-hand side) and the marginal social cost (the right-hand side). Here,

$$D(\mu) = \ln p(\mu) + \frac{\mu p'(\mu)}{p(\mu)}, \quad (18)$$

where  $p(\mu)$  represents price  $p_t(1)$  as a function of  $\mu_t(1)$ ; that is,  $p(\mu) = \frac{\gamma}{\lambda \bar{s}_t(1)} \left( \frac{1 - \mu \bar{s}_t(1)}{1 - \mu} \right)$ . Lastly,  $Y_t(\mu) = \gamma^t \left( \frac{1 - \mu \bar{s}_t(1)}{1 - \mu} \right)$ . Equation (17) has a unique solution  $\tilde{\mu}$ . Moreover,  $\frac{dU^G}{d\mu_t(1)} > 0$  for  $\mu_t(1) < \tilde{\mu}$  and  $\frac{dU^G}{d\mu_t(1)} < 0$  for  $\mu_t(1) > \tilde{\mu}$ . Hence,  $\tilde{\mu}$  is the unique global maximum.

If some industries one vintage behind are not protected in equilibrium, then the government extracts all of the surplus from protection. In other words, the contribution of each industry insider to the bribe equals the value of protection. The bribe offer from each lobby is the product of the value of protection to each worker and the number of workers:

$$B_t(1) = V_t^p(1) \bar{s}_t(1) = \frac{\gamma^t}{(1 - \mu_t(1))} (1 - \bar{s}_t(1)). \quad (19)$$

While larger lobbies have more members, the amount each member is willing to contribute is lower. As a result, the bribe is decreasing in the number of old workers  $\bar{s}_t(1)$ .

Substituting the equilibrium bribe functions into (17) yields

$$\frac{\phi(1 - \bar{s}_t(1))}{1 - \mu_t(1) \bar{s}_t(1)} (1 + \mu_t(1) D(\mu_t(1))) = \ln p(\mu_t(1)) - \frac{1 - \bar{s}_t(1)}{1 - \mu_t(1) \bar{s}_t(1)}. \quad (20)$$

This equation pins down the equilibrium level of protection  $\mu_t^*(1)$ . Uniqueness of equilibrium is not obvious. Since protection depresses the unskilled real wage, the value of protection (and bribes) are increasing in  $\mu$ . However, if  $\bar{s}_t(1) \leq \ln \left( \frac{\gamma}{\lambda \bar{s}_t(1)} \right)$ , then the equilibrium of this static game is unique: either equality is obtained at  $\mu_t^*(1) \in (0, 1)$ , or  $\mu_t^*(1) = 0$ .<sup>7</sup> Furthermore, there is an open set of parameter values for which not all industries one vintage behind are protected ( $\mu_t^*(1) < x_t(1)$ ) and equation (19) holds.

We can gain some insight into the effect of the government's venality ( $\phi$ ) and the magnitude of the productivity jump ( $\frac{\gamma}{\lambda}$ ) on the equilibrium level of protection by examining equation (20). The equilibrium level of protection is increasing in  $\phi$  and decreasing in  $\frac{\gamma}{\lambda}$ . As  $\phi$  increases, the weight the government places on bribes relative to real GDP increases. As  $\frac{\gamma}{\lambda}$  decreases, a given level of protection leads to a smaller decline in real GDP. However, this leads to higher equilibrium levels of protection. This implies that "productivity slowdowns" – periods with lower  $\gamma$  – lead to higher levels of protection.

<sup>7</sup>In this case, the left-hand side of (20) is decreasing, while the right-hand side is increasing in  $\mu_t(1)$ . Furthermore, as  $\mu_t(1)$  tends to one, the left-hand side tends to  $-\infty$ , while the right-hand side tends to  $\infty$ .

## 4.2 Dynamic Equilibria

The dynamic aspect is the endogeneity of the state variables – the number of old workers in each industry  $\{\bar{s}_t(d)\}$  and the measure of industries  $d$  vintages behind  $\{x_t(d)\}$ . Since all workers in a protected industry have to pay the same bribe, it is never in the best interest of unskilled workers to join a protected industry. Hence, in equilibrium, all of the young work in unprotected industries, and there are no workers skilled in vintages more than one generation behind the frontier ( $\bar{s}_t(d) = 0 \forall d > 1$ ). Thus there is no one with a vested interest in any technology more than 1 vintage behind the frontier. This implies  $x_t(d) = 0 \forall d > 2$  and  $\mu_t(1) + \mu_t(0) = 1$ . Using the law of motion (12),  $x_t(1) = 1 - \mu_{t-1}(1)$  and  $x_t(2) = \mu_{t-1}(1)$ .

Below we characterize *stationary* symmetric Markov perfect equilibria. In analyzing symmetric equilibria, we abstract from strategic considerations of young workers regarding their concentration in any given unprotected industry. This is a reasonable assumption, since larger coalitions offer smaller bribes (see equation (19)), and hence may be less likely to successfully purchase protection. Furthermore, the real wage young receive in an unprotected industry is decreasing in the number of workers in that industry (since the price of good  $i$  is decreasing in the quantity produced). As a result, young workers wish to be members of small coalitions, which leads them to spread evenly across unprotected industries, and

$$\bar{s}_t(1) = \frac{1}{(2+n)\mu_{t-1}(0)} = \frac{1}{(2+n)(1-\mu_{t-1}(1))}. \quad (21)$$

In equilibrium, old workers who were not granted protection also spread evenly across the unprotected industries.

### 4.2.1 Constant Protection Levels

The easiest equilibria to characterize are *Constant Protection Levels (CPL)*. While a constant fraction of industries (less than half) are protected each period, the specific industries protected vary from period to period. Since  $\mu_t(1) < 0.5$ , the equilibrium bribe offers are equal to the value of protection and the equations given in section 4.1 apply. To solve for the stationary equilibrium, substitute (21) into (20). While stationary equilibrium may not

be unique, the equilibrium path is pinned down by the initial condition.<sup>8</sup> A special case is zero protection equilibrium, which occurs when  $\phi \leq \frac{2+n}{1+n} \ln \left( \frac{(2+n)\gamma}{\lambda} \right) - 1$  (see equation (20)).

### 4.2.2 Cycles

Cycles are driven by the endogeneity of the state variables. The “size” of vested interest groups ( $\bar{s}_t(1)$ ) is pinned down by the allocation of young workers in the previous period, which in turn is determined by the extent of protection in that period ( $\mu_{t-1}(1)$ ). This dynamic relationship can generate several different types of cycles.

The easiest cycles to characterize are *Two-Period Cycles (TPC)*. Two distinct types of TPC are possible. In both types, the oldest technology operated is 1 generation behind the frontier. One type features periods of zero protection alternating with periods of extensive, but not complete, protection. The other type features positive protection in every period, with the industries not protected in one period being protected in the following period.

Two period cycles where periods of zero protection alternate with periods of extensive, but not complete, protection work as follows. Suppose that all industries adopted in the previous period ( $x_t(1) = 1$ ,  $\bar{s}_t(1) = \frac{1}{2+n}$ ). A sufficiently venal government would then choose to protect a large fraction of industries. If  $\mu_t(1) \geq 1 - \frac{1}{2+n}$ , then the young are squeezed into so few industries that in the following period  $\bar{s}_{t+1}(1) \geq 1$ , and hence protection is not demanded (see equation (15)). This leads to a period of no protection, which confirms our conjectured equilibrium. A similar equilibrium arises for slightly lower levels of protection as large coalitions of skilled workers ( $\bar{s}_t(1)$  near one) fail to purchase protection. So long as not all industries one vintage behind the frontier are protected, the government extracts the entire surplus from protection and the equations in section 4.1 apply. Equilibria of this type are unique whenever equation (20) has a unique solution for  $\bar{s}_t(1) = \frac{1}{2+n}$ . This is true when population growth is not strongly negative:  $\ln \left( \frac{\gamma(2+n)}{\lambda} \right) \geq \frac{1}{(2+n)}$ .

The workings of the second type of TPC are as follows. Suppose that roughly half of

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<sup>8</sup>Since the solution  $\mu_t^*(1)$  of equation (20) is increasing in  $\bar{s}_t(1)$ , and  $\bar{s}_t(1)$  is increasing in  $\mu_{t-1}(1)$ , the stationary equilibrium may not be unique.

the industries are protected ( $\mu_t(1) < 1 - \frac{1}{2+n}$ ), and all of the young work in the unprotected industries. In the ensuing period, the now (old) skilled demand protection, which a sufficiently venal government is willing to grant to all of them. All industries which were not protected the previous period are now protected. If  $\mu_{t+1}(1) = 1 - \mu_t(1) < 1 - \frac{1}{2+n}$ , then the situation can repeat itself. A special case is an equilibrium where exactly half the industries are protected every period. Note that since all industries one vintage behind are protected in every period, the government may not extract the entire surplus and hence equation (19) need not hold. While there are often many of these stationary equilibria, the equilibrium path is pinned down by the initial condition.

Stationary symmetric equilibria with longer cycles also exist. These cycles feature several periods of gradually increasing protection, followed by a period of no protection. Only industries one vintage behind are protected. As the extent of protection increases, skilled workers are increasingly more concentrated in industries one vintage behind: as  $\mu_t(1)$  increases, so does  $\bar{s}_{t+1}(1)$  (see equation 21). Skilled workers eventually become so concentrated that protection is either not demanded or not granted. The first type of two-period cycles described above is a special case of these type of cycles.

While there may be other stationary symmetric equilibria, none of them features a period of full protection. Regardless of the initial conditions (state variables), even the most venal government will never want to protect *all* industries. As protection approaches one, roughly half of the population (all of the young) are crammed into the vanishing set of unprotected industries. This drives the price of unprotected goods relative to protected goods to zero. In effect, the young's contribution to real GDP goes to zero. Although the share of output going to bribes converges to one, the real value of bribes declines as  $\mu_t(1)$  nears one.

All protection cycles generate corresponding cycles in productivity and per capita output growth. However, the long run average productivity growth rate is the same as in economies which never implement protection.

## 5 Results and Implications

This section discusses the main insights of the paper. It also presents numerical examples to illustrate the main findings.

### 5.1 The Big Effect of Smallness

The smallness of industry lobbies is essential for barriers to technology adoption. To see this, consider the one industry case. With the parameter restriction  $\gamma > \lambda$ , protection can never be an equilibrium outcome in the one industry case. The reason is that the value of protection,  $V_t^p(1) = (\lambda - \gamma)\gamma^{t-1}$ , is negative. Hence, protection is never demanded in the one industry case. This is a striking contrast to the many industry case, and illustrates the essential role that “small” industry lobbies play in generating protection when adoption makes *all workers* more productive.

Why does smallness lead to workers resisting the adoption of technologies that make them more productive? So long as incumbents are sufficiently scarce ( $\bar{s}_t(1) < 1$ ), non-adoption increases the relative price of protected goods so much that the skilled wage in the protected industry increases. Protection ensures that any entrants will be less productive than skilled incumbents. As a result, the entry of outsiders cannot eliminate the skill premium. Unlike the benefit of protection, the cost is diffused across *all* consumers. Whenever there are many small interest groups, each group bears an insignificant share of the cost of non-adoption in their industry. In effect, the lobbying game is a prisoners dilemma, as the political equilibrium results in the gains from protection being paid to the government as bribes, while workers are made worse off due to the distortions induced by protection. Hence, lobbying actions by vested interests are individually rational but self-destructive.

The result that the government implements policies that reduces real GDP is surprising. Since adoption increases the size of the economic pie, a standard “Coasian” argument suggests that the losers should be able to outbid the winners – so that the government chooses not to protect any industries. What causes this “political failure”?

The “political failure” stems from the inability of coalitions opposed to protection to overcome a free rider problem. The benefit of successfully lobbying against protection of any given industry is a lower price of that good. Since anti-protection lobbies cannot prevent consumers from purchasing goods, they cannot punish individuals who chose not to contribute to bribe offers to the government.

This highlights an important channel through which corruption can negatively influence productivity. When coalitions have differential ability to form, government corruption need not involve merely the redistribution of income (through bribes), but can also take the form of inefficient policies which lower the size of aggregate output. This channel is substantively different from the common stories that corruption reduces economic output by acting as a (potentially inefficient) tax (Shleifer and Vishny (1993)). This relationship is also consistent with cross country data, as there is a positive correlation between the level of productivity and corruption across countries.<sup>9</sup>

It is important to acknowledge that asymmetric interest group formation and “smallness” (concentrated benefits and diffused costs) were emphasized by Olson (1982). However, these factors have not been featured in either the recent work on political economy and growth nor in the literature on corruption and economic growth. Krusell and Rios-Rull (1996), Aghion and Howitt (1998) and Bellettini and Ottaviano (2005) all analyze environments where the (sunk) costs are so large that vested interests are made less productive by new technology (although the average level of productivity in society increases). In contrast, we show that “smallness” can generate barriers to the adoption of technology that makes *all workers* more productive.

## 5.2 Numerical Example

The political economy features of our model make it impossible to obtain analytic results. To illustrate the workings of the model, we examine a numerical example. Given our demo-

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<sup>9</sup>The correlation between TFP computed by Hall and Jones (1999) and the ICRG index of governmental honesty in 1982 described by Knack and Keefer (1995) is 0.48.

graphic structure, we assume that each period corresponds to 20 years. As our benchmark, we choose the following reasonable parameter values. The population growth rate is  $n = 0.35$ , which corresponds to 1.5% annual growth rate, and the technology growth factor  $\gamma = 1.35$  corresponds to a 1.5% annual growth rate.  $\lambda = 1.15$ , which implies that skilled workers are 15% more productive than unskilled workers.<sup>10</sup> The venality of government is  $\phi = 1.25$ , which implies that the government values its own consumption 2.25 times as much as the consumption of others. In all equilibria we analyze, the discount factor is irrelevant since all members of the same generation have the same net income and intergenerational trade is impossible. For simplicity, we set  $\beta = 1$ .

Table 1 reports the stationary equilibrium of the benchmark economy and comparative statics with respect to  $n$ ,  $\gamma$  and  $\phi$ . All of the equilibria reported in Table 1 are CPL. For each experiment, we report three values: the fraction of industries protected, the loss in real GDP relative to no protection, and the share of GDP received by the government as bribes.

Table 1.

The benchmark economy exhibits substantial protection in equilibrium.

Holding other parameters fixed, we consider three other population growth rates. The main message from this experiment is that while protection in general is decreasing in population growth, this relationship does not hold everywhere.<sup>11</sup> Furthermore, the distortions from protection are, in general, increasing in population growth. A similar exercise with respect to productivity growth shows that lower productivity growth rates lead to higher levels of protection. This confirms the intuition outlined in section 4.1. The final experiment regards venality. Once again, the example confirms our earlier intuition that increased corruption (as measured by venality parameter  $\phi$ ) leads to higher protection. Note however, that not only do government bribes come from a shrinking pie as venality increases, but after some point the government's share of the pie starts to shrink.

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<sup>10</sup>This value is within the range of implied losses for displaced workers (see Kletzer (1998)).

<sup>11</sup>Bridgman, et al. (2004) show that this relationship can change when skilled and unskilled workers are imperfect substitutes.

Modest variation of just one parameter from the benchmark leads to cycles:  $\gamma = 1.3$ . This economy has both TPC of the second kind and multi-period cycles. In fact, there is a continuum of TPC indexed by  $\mu_{even}(1) = x_{even}(1) \in [0.48, 0.52]$ , where all vintages one period behind are protected while other industries adopt. The multi-period cycle is five periods long. This cycle features a period of zero protection, followed by periods with protection levels of 26.1%, 37.7%, 45.8% and 53.5%. In the ensuing period, the cycle begins anew with zero protection. In this cycle, at no time are all industries one vintage behind protected.

In order to construct TPC of the first kind, we need to take a further step away from the benchmark parameter values. Setting  $\gamma = 1.35$ ,  $n = 0$ , and  $\phi = 25$ , we find a TPC where exactly half the industries are protected every other period. In the alternating periods, protection is not demanded as the old, skilled workers are so highly concentrated that the value of protection is zero. With  $\phi = 15$ , TPC features 49.5% of the industries protected every other period. In this case, protection is demanded in the alternating periods but is not granted to any industries.

## 6 Conclusion

Vested interest stories featuring a disconnect between those who receive the benefits and those who bear the costs are often cited to explain policies which reduce real GDP (e.g. Olson (1982)). Two fundamental forces lie at the heart of these stories. First, asymmetric interest groups formation limits the ability of those harmed by protection to overcome the lobbying efforts of the winners. Second, small, concentrated groups reap the benefits from these policies, and do not internalize the costs imposed on other members of society. This paper incorporates these two elements into a political economy model of technology adoption.

The paper does much more than simply formalize a well known vested interest story – it also uncovers new insights. The first key insight is how perverse protection can be. When governments value interest group support, these two elements generate equilibria where

barriers are erected that block the adoption of technologies that make *all* workers more productive. This is especially shocking, as existing models can only generate protection when some workers are made less productive by the adoption of new technologies (Krusell and Rios-Rull (1996), Bellettini and Ottaviano (2005)). The second key insight is the link between government corruption and TFP. This provides an additional channel through which corruption can retard economic growth. This channel is complementary to both the existing theoretical (Shleifer and Vishny (1993)) and empirical (Mauro (1995)) work on corruption and growth.

The costs of protection discussed in the paper are substantial, and are much larger than those implied by Harberger triangles. However, most of the equilibria discussed in the model generate TFP gaps (relative to the frontier) that are small relative to those observed in the data. This does not imply that the forces identified in this paper do not play a significant role in accounting for cross-country TFP differences. Natural extensions of the model – such as increasing costs of adopting technologies more than one vintage ahead and vintage specific physical capital – would generate much larger effects on TFP. These extensions, however, would not affect the basic points emphasized by this paper.

Although we consider a closed economy, it is straightforward to extend the model to multiple countries. In such a world, protection of (potentially) tradeable goods would have to include both domestic barriers to technology adoption and trade barriers. 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. Such an extension would provide a natural explanation for why people may support free trade agreements while lobbying for protection of their own industry. Each coalition of industry insiders prefers a world where *only* their industry is protected. However, all coalitions strictly prefer a world with no protection to a world with a positive measure of protected industries since protection lowers the welfare of *all* workers. Hence, all lobbies are willing to commit to not seek protection if all other lobbies make the same commitment. A free trade agreement is a natural solution, as it commits the government to not provide protection to any lobby group.

The results suggest that long time horizon studies of the relative performance of industries and protection would be interesting. A stylized fact in the trade literature is that “decline” makes industries both more likely to lobby and to receive protection from foreign competition (Rodrik (1995)). In this paper, causality runs in the opposite direction. Industry insiders lobby for protection, which allows them to continue to employ inferior (antiquated) technologies. When protection is removed, the “decline” of an industry ends as its productivity relative to previously unprotected industries increases. This prediction is consistent with a number of case studies which find that industry level productivity increases rapidly after barriers to competition in that industry are removed. Disentangling these stories, however, requires long data series that trace why and how different industries rise and decline.

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## Tables.

Table 1.

Benchmark parameter values:					
	$\gamma = 1.5$	$\lambda = 1.15$	$n = 0.35$	$\beta = 1$	$\phi = 1.25$
Experiment title, Changed parameter	Share of industries protected ( $\mu(1)$ )	Loss in real GDP* relative to no protection		Bribes as share of GDP	
Benchmark	23.2%	9.7%		11.9%	
Higher population growth, $n = 0.5$	20.6%	9.5%		11.4%	
Lower population growth I, $n = 0.04$	26.8%	9.1%		10.8%	
Lower population growth II, $n = 0$	26.7%	8.9%		10.4%	
Lower productivity growth I, $\gamma = 1.45$	29.7%	10.4%		14.3%	
Lower productivity growth II, $\gamma = 1.4$	38.6%	10.3%		16.2%	
Lower venality $\phi = 1$	5%	2.6%		2.8%	
Higher venality I $\phi = 1.5$	35.2%	12.3%		15.7%	
Higher venality II $\phi = 2$	49.8%	13.4%		13.2%	

\* GDP includes bribe payments.