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OPTIMAL GOVERNMENT REGULATIONS AND RED TAPE IN AN ECONOMY WITH CORRUPTION*

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Abstract

We study an economy where agents are heterogeneous in entrepreneurial ability, and may decide to become workers or entrepreneurs. The government is motivated by a production externality to impose regulations on entrepreneurship, and sets a level of red tape to test regulation compliance. In an environment where some officials are corrupt, we characterize the optimal levels of regulations and red tape, and to what extent such policies reduce the welfare losses created by corruption. For each level of externalities, high and low levels of corruption create qualitatively different distortions, which in turn changes the nature and reach of optimal policies.

Keywords: corruption, red tape, government policy *JEL Classification Codes*: H1, H3

I. Introduction

In The Other Path (de Soto [1990]), Hernando de Soto presents a rendition of the effects of bureaucratic corruption and red tape on entrepreneurship, describing how burdensome requirements and delays caused by government mandated red tape discourage the poorest

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entrepreneurs from setting up a shop. A large part of the academic literature on corruption focuses on the same issues: How regulations, red tape, and corruption interact to affect growth, investment, and economic efficiency in general. The image of corrupt economies with high levels of regulatory burden transpires throughout.

However, a summary look at the country level data on the level of regulations, understood as government mandated restrictions on emissions levels, zoning regulations, and the like, as well as red tape, taken to be the permits and paperwork required to accredit that regulations have been complied with, suggests a different picture: Developed economies with low levels of corruption display typically very high levels of regulation, and relatively low levels of red tape, while corrupt economies tend to have low levels of regulations, but high red tape. New EU car emission standards, for instance, are implemented in Asian countries with a median lag of up to nine years (see IADB [2003]) with respect to European countries. At the same time, the levels of red tape tend to decrease with development. Djankov et al. [2002] describe the time delays and number of procedures necessary to start a business in a cross section of countries. In their data, countries in the first quartile of the income distribution require 7.17 procedures, taking up 43.17 days in average, while countries in the fourth quartile require 11.21 procedures which take an average of 73 days.

China's recent history of food and drug safety problems provide a case study to highlight the interplay between regulations, red tape, and corruption. A newspaper article in CBS [2007] reports on a survey by the food and drug quality inspection administration. The survey found that a third of China's food producers had no licenses, and 60% did not conduct safety tests. The same newspaper article consigned that China's former chief of the State Food and Drug Administration was sentenced to death for taking bribes to approve substandard medicines.

It seems clear that China should upgrade both its food safety standards and the enforcement capabilities of its regulatory agency. But with corruption within the regulator, how should China, compared with a country with similar per capita income but less corruption, set both its regulatory standards and devote resources to test regulation compliance? Our model seeks to provide answers to these questions. We are motivated by the question of what are the optimal choices with regard to regulations standards and red tape in a corrupt economy, and to what extent a judicious choice of these policy variables may reduce the distortions caused by corruption.

We present a model with agents that are heterogeneous in entrepreneurial ability, and may choose to become either salaried workers —for the public bureaucracy or the private sector or entrepreneurs. The existence of the public bureaucracy is motivated by a Pigovian role: Investment projects create negative externalities, government mandated regulations aim to impose private abatement of these externalities, and public bureaucrats test that such regulations have been complied with. Some officials are corrupt, and will ask for a bribe in exchange for extending the investment permit. Officials are assigned randomly to entrepreneurs, who may choose to abide by the regulations or not beforehand. Entrepreneurs also have the choice of searching for a different official, making the problem effectively dynamic for them. In this context, regulations take the form of a fixed cost to entrepreneurs, while red tape is the number of investment permits necessary to start operations, and therefore its cost is in the form of time delays between investment and production.

Although the distortions caused by corruption are endogenous to policy choices, our paper takes the corrupt behavior of some officials as given, and is silent on the effects of policies destined at penalizing such behavior. This approach recognizes the fact that corruption is persistent and difficult to eradicate, and examines alternative policy tools that can be used to limit its effects.

While our main focus is to examine the normative properties of regulations and red tape in economies with differing levels of corruption, we do so using a model that reproduces one central stylized fact concerning growth and governance: developed, low corruption economies, have high levels of regulation and low red tape relative to developing, high corruption economies. As explained below, this dichotomy will have important implications for our results.

A common theme reappears through our results: high and low corruption, measured by the proportion of public officials who take bribes, give rise to qualitatively different economies. We obtain that not only the nature of optimal government policies is different in both cases, but also the extent to which such policies reduce the deadweight losses caused by corruption. Going back to China's food standards, if corruption is low and the externalities generated in the absence of standards are small, we predict that all entrepreneurs follow the regulations, but investment is inefficiently low if regulations are set at their no-corruption level. In this case, a minimal level of red tape, and a level of regulations lower than with no corruption is optimal, and such policies actually achieve the first best. When corruption and externalities are above a threshold, entrepreneurs at the lower end of the ability distribution choose not to follow the regulations. The optimal policies in this equilibrium cannot achieve the first best, and may include a higher-than-minimal level of red tape. In particular, when production externalities are large, a higher level of red tape will improve welfare by discouraging inefficient entrepreneurs.

This paper has five other sections. The next section places our contribution within the literature. Section three presents the model and defines the equilibrium concept. Section four examines the equilibrium, while section five studies what are the socially optimal policies. Section six concludes.

II. Literature Review

This paper falls within a growing theoretical literature on the economics of corruption. Cadot [1987] presents a model where agents need to be granted a permit to invest and are assigned government officials randomly. The stage game of our model borrows the basic idea of random assignment of officials to entrepreneurs. Acemoglu and Verdier [1998] present a model where the bureaucrats' role is to enforce property rights. While both these papers focus on bureaucrats wages as the relevant policy tool, Bliss and Di Tella [1997] examine the effects of changes in the level of competition on the effects of corruption. In contrast, our paper focuses on the level of regulations and red tape as tools to limit the effects of government mandated red tape in an economy with corruption. In that model, red tape is costly, but serves to disclose information to bureaucrats about the project type. In contrast with most of the literature, excepting Acemoglu and Verdier [1998], we adopt a general equilibrium approach, where the size of the public sector is endogenous to the need for public officials.

There is a small empirical literature that examines the nature of corruption at the firm and individual level. Svensson [2003] reports on the nature of bribery in a sample of Ugandan firms, and finds evidence for bribes being related to profits and to the outside options of the

firms. Hunt and Laszlo [2005] study individual level bribery using responses from a Peruvian household survey. They also find that officials are price discriminators, and bribes are a function of income. Our model is broadly consistent with these facts. The study by Djankov et al. [2002] mentioned above is also of direct relevance to our paper. In that work, the authors find that stricter regulation of entry is not associated with better public goods across countries, but is associated with higher corruption. They conclude that the evidence points to regulations and red tape being installed by corrupt officials to their own benefit. In this paper, while allowing officials to be corrupt, we give a benevolent government the possibility of determining the levels of such variables, and focus on the normative aspect of the problem.

III. Model

We study an economy with a continuum of infinitely lived agents of size one. Each agent is endowed with a unit of labor supply and with a level of entrepreneurial ability R, drawn from a distribution with c.d.f. G(R). We assume that G(R) is once differentiable with G'=g.

Agents may choose to use their skills in one of two different occupations. They may be workers -either for the government or the private sector- and supply labor at the market wage w, or they can become entrepreneurs.

To simplify the analysis, we have the government choose its officials among the workers who are at the lower end of the distribution of entrepreneurial ability, beginning with the lowest ability worker and until all public administration vacancies have been filled. A proportion p of these officials is inherently corrupt and will demand a bribe in exchange for their services. Because the wage rates in the government and private sectors are equal, expected utility suggests that some workers —as well as some entrepreneurs— would prefer to become government officials and obtain a higher income through bribes. The hiring assumption simplifies the analysis by making the choice of becoming a public official exogenous to the agents. In turn, this ensures that the choice of becoming a worker/entrepreneur is not affected by the possibility of earning bribes in the public sector.¹

Empirically, asking for a bribe is clearly a choice constrained by a number of factors, among which wages, penalties, and morals. At the same time, corruption incidence is at best slow to control, so it is sensible to take the corrupt nature of some agents as given and study what government policies will limit the effects of such corruption on efficiency. This is the approach we take in this paper.

If an agent decides to become an entrepreneur, she incurs an investment cost of *i*, and must have the project certified for regulations compliance by government officials. Such regulations, if followed, impose a cost α on investors. To obtain certifications for their projects, investors get a random draw of a government official. Officials are of two types: A proportion 1-p of them is honest, and verify that regulations have been followed. If they have not, the certification is simply not given. The remaining officials are corrupt and ask for a bribe β in exchange of the certification. When faced with either type of official, investors may accept the official's offer (possibly including a bribe), or may decide to keep searching for a different

¹ An alternative assumption would be to penalize corrupt officials with an amount and a frequency that makes their expected income equal to the competitive wage.



FIG. 1. STAGE DECISION TREE

type². We assume for simplicity that each official reviews one project.

Through the paper, we refer to corruption as the level of p, unless specified otherwise. An economy with high corruption is then one with a high proportion of public officials willing to take bribes, were "high" will be context specific.

After investing and obtaining a certification, entrepreneurs organize production by hiring labor (L) and using their own entrepreneurial ability (R_j) according to the production function

$$F(R_i, L) = L + R_i, \tag{1}$$

Once the project becomes operational and produces output, it depreciates completely. We adopt a linear technology for simplicity, the wage rate in this case being 1. After paying wages, entrepreneurs obtain a gross profit of $F - F_L = R_j$.

Figure 1 illustrates the possible choices available to private agents, together with the respective expected payoffs, which are defined below. Although the choices of investing vs. working and abiding vs. circumventing the regulations are made at the same time, we choose to present them in a sequential form for clarity of exposition. The initial node of the tree is at the decision of *work* vs. *invest*, then investors must decide on regulation compliance, after which nature gives them a draft of a government official. Honest officials will deny the certification to non-compliant projects (upper-left branch), so the only choice in this case is to search for a different government official.

Modeling the certification process as a search process is one way to introduce the frictions that arise in the dealings with a corrupt bureaucracy. We believe that it is also well founded empirically. More than 80% of firms from around 160 countries who participated in the World Bank's World Business Environment Survey (see Bank [2000]) reported having some degree of access to other officials when being asked for a bribe. In some countries the search choice may also take the form of registering the company in a different administrative zone.³

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 $^{^{2}}$ Investors may also choose to withdraw from the process altogether, but we disregard this possibility as it is never chosen in equilibrium

³ Question 31 is phrased as follows: "How often is the following statement true? If a government agent acts against the rules I can usually go to another official or to his superior and get the correct treatment without recourse to

1. The Role of Government

The government finances the public wage bill by levying a lump sum tax τ on all agents, since it maintains a balanced budget, and there are as many officials as projects, we have:

$$\tau_i = \int_{i \text{ is entrepreneur}} dG(i) \tag{2}$$

The existence of the government is motivated by a Pigovian role: Each investment project creates a negative externality of γ when it becomes operational; a technology is available that corrects this externality, and the government mandates its use by imposing restrictions to investment in the form of government regulations. As mentioned above, such regulations imply a cost α on projects. The net externality created by an individual investment project takes the form

$$x = \gamma - \alpha \tag{3}$$

Where α is a policy variable for the government, and we take $\alpha = 0$ if the entrepreneur decides not to follow the regulations. The externality as perceived by the agents is naturally the integral of *x* over all operational projects.

$$X_i = \int_{i \text{ is entrepreneur}} x_i \, dG(i) \tag{4}$$

The second policy tool available to the government is the amount of red tape. Our measure of red tape is the number of certifications needed to make a project operational. Since certifications can only be obtained sequentially, red tape imposes a burden in terms of a time delay between the time of investment and that of production. In the current framework investors may only manage one project at a time and, as will become clear below, even with the lowest level of red tape investment and production will not necessarily take place in the same period. In this paper we study the case of Low red tape, where only one certification is needed, and that of High red tape, where two certifications are needed. In this section we describe the model for a Low red tape economy, the extension to a High red tape environment being mechanic.

2. Private Agent's Decisions

Agents have preferences for consumption c and a public good X represented by

$$U = E \sum_{i=0}^{\infty} \delta^{i} \{ c_i - X_i \}$$
⁽⁵⁾

Subject to the constraint

$$a_{i}(1+r_{i})+income_{i}=c_{i}+a_{i+1}+\tau$$
 (6)

Where δ is a discount factor, a_t are assets at the beginning of period t, and τ is a lump sum tax. The variable *income* depends on the agents occupation:

unofficial payments."

$$income_{t} = \begin{cases} 1 & \text{if work, honest official} \\ 1 + \beta_{t} & \text{if corrupt official} \\ \pi_{t}(R) & \text{if entrepreneur} \end{cases}$$
(7)

Where β is the bribe and we use the convention that $\beta_t = 0$ if it is not paid, and $\pi_t(R)$ are the net profits for an entrepreneur of type *R* at time *t*. Note that β_t is a random variable for the official, who will be given a draw of an entrepreneur. For the entrepreneur, net profits π_t are also random, as they depend on the draw of government officials.

The agents' problem is then to maximize the utility function in (5) subject to the budget constraint (6), with *income* defined by (7), taking X as given.

We use the recursive nature of the problem to obtain solutions for the agent's optimal choices. To recast the agent's problem in a recursive framework, we begin by defining \hat{v} as the individual's value function

$$\hat{v} = \max E \sum_{i=0}^{\infty} \delta^{i} \{c_{i} - X_{i}\}$$
(8)

subject to (6), (7), and given X. This is the expected utility level of an individual at the initial decision node in figure 1 who makes optimal decisions thereafter. Moreover, we can simplify the problem by imposing the equilibrium condition that $\frac{1}{1+r_t} = \delta$. Substitution of the budget constraint in the utility function yields, after canceling terms and using $a_0=0$ and $\lim_{t \to inf} \delta^t a_{t+1} = 0$:

$$\hat{v} = \max E \sum_{i=0}^{\infty} \delta^{i} \{income_{i} - \tau_{i} - X_{i}\}$$
(9)

Since the agent takes both the tax and the externality as given, we find it useful to define a value function based only on the income stream:

$$v = \hat{v} + \sum_{t=0}^{\infty} \delta^t \{\tau_t + X_t\}$$
(10)

$$=\max E\sum_{i=0}^{\infty} \delta^{i} income_{i}$$
(11)

We begin by focusing on the agents' decisions to invest vs. work. The value function for an individual who has to decide whether to work or become an entrepreneur is the solution to

$$v = \max\{v_e, 1 + \delta v\} \tag{12}$$

where 1 is the wage rate, and v_e is the value of becoming an entrepreneur and following the optimal policies thereafter. A solution to (12) is a function $\Pi:\mathbb{R}^+ \rightarrow \{1,0\}$ that maps values of R to an occupational choice: Whether to become an entrepreneur (1), or a worker (0). In order to define v_e , we proceed to discuss the problem faced by entrepreneurs.

In choosing whether to follow the regulations, the entrepreneur chooses the compliance

policy that solves

$$v_e = -i + \max\{v_s(0), -\alpha + v_s(1)\}$$
(13)

, where $v_s(1_{[\alpha]})$ is the expected value of searching for an official. The argument in $v_s(.)$ is an indicator that takes the value one when the regulations have been followed. A solution to (13) is a policy function $\Lambda:\mathbb{R}^+\to\{0,1\}$ that maps values of *R* to a decision of whether to comply (1) or not (0) with the regulations The function v_s is defined as

$$v_s(0) = pv_c(0) + (1-p)v_h(0) \tag{14}$$

$$v_s(1) = pv_c(1) + (1-p)v_h(1)$$
(15)

The functions v_c and v_h in turn represent value functions for agents who have already drawn an official from the lottery, where the subscript of the value functions refers to the type of official (corrupt or honest). They are solutions to the following Bellman equations:

$$v_c(0) = \max\{R_j - \beta + \delta v, \, \delta v_s(0)\}$$
(16)

$$v_c(1) = \max\{R_j - \beta + \delta v, \, \delta v_s(1)\}$$
(17)

$$v_h(0) = \delta v_s(0) \tag{18}$$

$$v_h(1) = \max\{R_j + \delta v, \, \delta v_s(1)\} \tag{19}$$

where the first element inside the *max* operator of the equations represents the payoff of accepting the official's offer, and the second element is the payoff of searching. In the case of $v_h(0)$ the only possibility is to search.

In expressions (16) and (18) we also impose the equilibrium feature that, if no compliance was optimal at time zero, it will remain the optimal choice regardless of the history of draws⁴. Equilibrium search costs are then constant over time and proportional to δ . The solution to $\{v_{c,v_h}\}$ in (16) to (19) is a pair of policy functions $s_{c,h}: \{1,0\} \times \mathbb{R}^+ \rightarrow \{accept, search\}$ that map a value of R and a compliance choice Λ to a decision of whether to accept the official's offer (*accept*) or keep searching for a different official (*search*). Note that the decision to accept the offer involves paying a bribe if the official is corrupt, and simply accepting the certification if it is honest.

3. The Bribe

We now describe how the bribe level (β) is determined. When the investor draws a corrupt official, the bribe will be determined by Nash bargaining, where the bargaining power of the official is θ . While the reservation value for the corrupt official is zero, the reservation value for the investor is the discounted value of searching (δv_s). The bribe is then determined by solving

$$\max_{\beta} \left(\beta\right)^{\theta} \left(R_{j} - \beta + \delta v_{e} - \delta v_{s}\right)^{1-\theta}$$
(20)

So the equilibrium bribe will be a function of the return of the project R_j and the (sunk) compliance decision, both of which are observable by the official⁵. Using Nash bargaining as

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⁴ Otherwise we would substitute $\delta v_s(0)$ for the equivalent, but more cumbersome $\delta max\{v_s(0), -\alpha + v_s(1)\}$.

the solution concept for the bribe game allows for a simple rule of surplus sharing between corrupt officials and investors:

$$\beta(R, \Lambda) = \theta(R_i + \delta(v_e - v_s)) \tag{21}$$

4. Definition of Equilibrium

The equilibrium objects for this economy are a set of Bellman equations for $\{v, v_e, v_c, v_h\}$, along with a bribe function $\beta : \mathbb{R}^+ \to \mathbb{R}^+$ that solves (20), a rule to determine the agent's occupation $\Pi : \mathbb{R}^+ \to \{1, 0\}$ that solves (12), a set of search policies for honest and corrupt officials contingent on *R*, and the compliance choice $\{s_h, s_c\} : \{0,1\} \times \mathbb{R}^+ \to \{accept, search\}$ that solves (16) to (19), and a compliance rule $\Lambda : \mathbb{R}^+ \to \{0,1\}$ that solves (13).

This environment may be seen as a repeated game between corrupt officials and entrepreneurs, with nature determining the type of official. It is natural in this case to impose subgame perfection on the equilibrium policies. In particular, when the bribe is bargained we restrict the reservation value for the entrepreneur to be that which is derived from policies that are optimal in the subgame that starts from next period on (if the entrepreneur keeps on searching). We refer to this as the threat points being credible.

Equilibrium An equilibrium is a set of Bellman equations for $\{v, v_e, v_c, v_h\}$, a bribe function β , an investment rule Π , a rule for following regulations Λ and a set of search policies $\{s_h, s_c\}$, that satisfy:

- 1. The bribe function β is a solution to problem (20), where the threat points δv_s are credible.
- 2. Given β , the search policy functions $\{s_h, s_c\}$ solve the Bellman equations $\{v_h, v_c\}$ in (16) to (19).
- 3. Given $\{\beta, s_h, s_c\}$, the investment rule Π solve the Bellman equation v in (12).
- 4. The compliance rule Λ solves Bellman equation v_e in (13).
- 5. The government budget given by (2) is balanced.
- 6. The level of the externality follows 4.

In the next section we characterize the equilibrium.

IV. Equilibrium

We consider stationary equilibria of the model, where the proportion of entrepreneurs who follow a given optimal plan, as well as workers, are both constant. For the model just described, focusing on the stationary equilibrium involves little loss of generality, as the economy would jump to this equilibrium starting from an initial condition with no sunk investments. We begin by noting that the interest rate in this competitive environment is

$$r = \frac{1 - \delta}{\delta} \tag{22}$$

Which, together with w=1, define the equilibrium prices. Expression (22) follows from both

⁵ We use v and v_e interchangeably for investors, as they will be equal in all future periods

the linearity of preferences and the linearity of the production function.

1. Equilibrium under Low Red Tape

To characterize the optimal strategies⁶, we proceed by backwards induction, first deriving the optimal choices and payoffs of an agent who chose to invest, and then deriving the conditions under which investing is an optimal decision. We begin by noting that, because of the recursive nature of the problem, we can focus on time invariant plans. For an agent who has become entrepreneur by investing *i*, a plan is a compliance choice plus a search policy $\{\Lambda, s_h, s_c\}$. Note that there is potentially a large number of candidate plans to consider. As the next result shows however, we can limit our attention to two such plans.

Lemma 1 For entrepreneurs, at most two plans are used in equilibrium

$$\{\Lambda, s_h, s_c\} \in \{\{1, accept, accept\}, \{0, search, accept\}\}$$
(23)

The proof is in appendix A. For simplicity we will refer to $\{1, accept, accept\}$ as plan 1, and $\{0, search, accept\}$ as plan 2. An immediate consequence of there being two observed plans is that there will be two bribes (as functions of *R*), since the threat points δv_s -the value of searching- will be different for both plans.

For plan 1, the entrepreneur decides to follow the regulations, in which case she will receive the certification if facing an honest official in the draw. If she draws a corrupt official on the other hand, she will pay the bribe. Note that in this case all investment projects become operational in the same period the investment takes place.

For plan 2, the investor does not comply with the regulations, so she will search for a corrupt official that can be bribed. Only a fraction p of the projects following this strategy will become operational every period.

Some intuition can be offered for this lemma. Note that searching when the agent draws a corrupt official cannot be optimal, as Nash bargaining by definition gives the agent a share of the surplus *above* the payoff from searching. On the other hand, searching if an honest official is drawn is the only possibility when $\Lambda=0$, and could not be optimal if $\Lambda=1$, since accepting the certification is done at no marginal cost.

To complete the characterization of the optimal choices by investors and workers, we need to map the values of R to a choice of plan. Because of the linear structure of the model, the optimal choices between pairs of plans can be simply characterized in terms of cutoff points in R.

Lemma 2 There are three levels of R, {R1, R2, R3}, such that

1. Strategy 1 is preferred to strategy 2 for all $R_j > R_1$.

2. Strategy 2 is preferred to working for all $R_j > R_2$, and

3. Strategy 1 is preferred to working for all $R_j > R3$.

With R1, R2 and R3 given by:

$$R1 = i\delta + \alpha \frac{1 - p\theta\delta}{1 - p} \tag{24}$$

⁶ We use 'strategy' and 'plan' interchangeably.



FIG. 2. EXPECTED UTILITY

$$R2 = i\left(\frac{1-\delta}{p(1-\theta)} + \delta\right) + \frac{1}{p(1-\theta)}$$
(25)

$$R3 = (i+\alpha)\frac{1-p\theta\delta}{1-p\theta} + \frac{1}{1-p\theta}$$
(26)

The proof is in appendix C and uses the linear structure of the indirect utility functions. Figure 2 illustrates this result. The figure shows the discounted expected payoffs for agents who choose to work, for agents who choose to become entrepreneurs and follow the regulations (strategy 1), and for entrepreneurs who choose not to follow the regulations (strategy 2)⁷. In the figure, individuals with a type lower than R^2 will become workers and draw a wage in every period. Individuals with types in (R_2 , R_1) will become entrepreneurs and will not comply with the regulations, and individuals with a type larger than R_1 will become entrepreneurs and follow the regulations.

In the figure, both strategy 1 and strategy 2 are followed in equilibrium, but this needs not be the case. Since *R* is unbounded, and strategy 1 is optimal for all $R > \max\{R1, R3\}$, strategy 1 will always be observed in equilibrium. The following corollary defines the conditions under which strategy 2 will also be observed.

Corollary 1 Strategy 2 is observed iff $R_1 > R_2$. This implies the following condition on the parameters

⁷ For simplicity we do not show the expected utility of corrupt individuals who become government officials, this choice being exogenous to them.



Fig. 3. Equilibria in the Low Red Tape Economy ($i=1, \theta=.6, \delta=.9$)

The proof is in appendix B, and the condition is plotted in figure 3 for selected values of $\{i, \delta, \theta\}$. Note that plan 2 is observed for $\{\alpha, p\}$ above a convex threshold. Agents who follow plan 2 effectively trade in lower investment costs, as they do not incur in the costs of complying with the regulations, for a lower probability (p) of being given a certification. This implies a reduced expected level of profits, which comes from two sources: First, the expected delay in implementing the project is now $\frac{1}{p}$, reducing the present value of profits. Second, the bribe to be paid is higher if the agent follows plan 2. Indeed, the value of searching (v_s) is lower if this plan is followed, so the rents to be divided between the entrepreneur and the corrupt official are higher, and the bribe is an increasing function of these rents. For entrepreneurs who follow plan 1 on the other hand, the reduction in costs from not

For entrepreneurs who follow plan 1 on the other hand, the reduction in costs from not following the regulations, which are proportional to the payoffs, would be dominated by the expected costs of waiting for a corrupt official, plus the higher bribes to be paid in this case.

As expected, entrepreneurs following plan 2 will have lower ability than those following plan 1. In equilibrium, they will be observed if the economy displays high costs of regulations α , and low bargaining power of corrupt officials ($h_{\theta} > 0$). High corruption p raise expected costs by increasing the bribe level, but also decrease such costs by reducing the expected time until a corrupt official is drawn. In this case the latter effect dominates and higher p is associated with more entrepreneurs following this plan ($h_p > 0$). Finally, the effect of δ is ambiguous.

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We can now summarize the characterization of the equilibrium of the model. We do this in the following proposition, which implicitly describes the optimal policies {s, Π , Λ }.

Proposition 1 (Equilibria) In the model with Low red tape there are two types of equilibria.

- **Equilibrium 1** If condition 27 does not hold, agents with $R \in (0, R3)$ will choose to work. Agents with $R \in [R3, \infty)$ will become entrepreneurs, abide by the regulations, and choose to pay bribes if they draw a corrupt official.
- **Equilibrium 2** If condition 27 holds, agents in $R \in (0, R2)$ will choose to work, agents with $R \in [R2, R1)$ will invest, not abide by the regulations, and search for a corrupt official. Finally, agents with $R \in [R1, \infty)$ will follow the regulations, and pay the bribe if they draw a corrupt official.

The proof follows from previous results. In this model, high corruption and high levels of regulations contribute to both reducing the number of complying entrepreneurs, and to the emergence of a new class of entrepreneurs -the second equilibrium- who choose to bypass the regulatory framework and engage in a form of free riding of the public good.

While we chose to focus on p as our measure of corruption, our model provides alternative measures that are of interest in their own. One such measure is the level of bribes. Bribes are higher by an amount $\partial \delta a$ for entrepreneurs who do not abide by the regulations (see appendix A), as their outside option -waiting- has a higher expected cost. As p increases and the economy switches to the second equilibrium, then, those who were entrepreneurs under equilibrium 1 will pay (weakly) higher bribes, and the proportion of projects that will require a bribe also increase. Because the set of entrepreneurs is different under both equilibria, however, no clear results emerge as to whether the aggregate amount of bribes is higher under either equilibrium.

As will be discussed below, the two equilibria have very different policy and welfare implications. The first equilibrium, which is observed under low corruption, describes an economy where corruption has similar effects to those of a capital earnings tax. In the second equilibrium, the fact that some investors do not abide by the regulations implies that the distortions caused by corruption are more complex than those of a tax. In this sense the model provides a formal interpretation of the common observation that low and high corruption are associated with different types of deadweight losses.

2. Equilibrium under High Red Tape

Before examining the nature of optimal policies in the next section, it will be useful to state here the main characteristics of the equilibrium under high red tape. In the economy with high red tape, entrepreneurs are required to obtain two certifications from public officials, and do so sequentially, as only one official can be drawn per period. In appendix E we derive explicitly the expressions characterizing this equilibrium. The first result we obtain is that, as in the previous economy, at most two plans are used in equilibrium.

Lemma 3 In an economy with High Red Tape,

1. There are two non dominated plans:

$$\{\Lambda, s_h, s_c\} \in \{\{1, accept, accept\}, \{0, search, accept\}\}$$
(28)

2. There are three levels of R, {R4, R5, R6}, such that:
(a) Plan 1 is preferred to plan 2 for all R>R4.
(b) Plan 2 is preferred to working for all R>R5.
(c) Plan 1 is preferred to working for all R>R6.

Proof: See appendix E.

We are interested in comparing the cutoff points R4 to R6 with the respective cutoff points for the Low red tape economy. These cutoff points have the same structure as R1 to R3: linear in α , R, and i, and nonlinear in the parameters $\{\delta, p, \theta\}$, but they are cumbersome and hard to compare analytically with the equivalent expressions for the equilibrium under Low red tape. We resort to simulations in order to compare the coefficients in the equilibrium expressions. Note that these coefficients are functions of $\{\delta, p, \theta\}$ and therefore map the bounded set $(0, 1)^3$ into \mathbb{R} . We use a fine grid for the domain in obtaining the numerical results that follow, so they must be understood to hold for all parameter values.

Numerical Result 1 In the economy with High red tape we have R4 > R1, R5 > R2, and R6 > R3.

Appendix E documents the derivation of this result. In the High red tape economy there are fewer entrepreneurs, as expected. There are also fewer entrepreneurs who abide by the regulations, compared to the situation with Low red tape. It is not clear however whether the number of plan 2 entrepreneurs is larger or smaller than in the benchmark economy.

As mentioned above, the structure of optimal plans with High red tape is the same as in the economy with Low red tape, because the draws of officials are independent. It is natural then that the equilibria are similar.

Corollary 2 Equilibria with High red tape

In an economy with High red tape there are two types of equilibria, and the condition separating them is

$$\alpha > \left(\frac{\delta(1-p\theta)^{2}}{(1-p\theta\delta)^{2}} \frac{(1-\delta)+2\delta p(1-\theta)}{\delta p^{2}(1-\theta)^{2}} - \frac{(1-p\theta\delta)^{2}-\delta^{2}(1-p\theta)^{2}}{(1-\delta)(1-p\theta\delta)^{2}}\right) + i\left(\frac{\delta(1-p\theta)^{2}}{(1-p\theta\delta)^{2}} \frac{(1-\delta)^{2}+2\delta p(1-\delta)(1-\theta)}{\delta p^{2}(1-\theta)^{2}} - \frac{(1-p\theta\delta)^{2}-\delta^{2}(1-p\theta)^{2}}{(1-p\theta\delta)^{2}}\right).$$
(29)

This condition separates the equilibria as follows:

- **Equilibrium 1** If (29) does not hold, agents with $R \in (0, R6)$ will choose to work. Agents with $R \in [R6, \infty)$ will become entrepreneurs, abide by the regulations, and choose to pay bribes if they draw a corrupt official.
- **Equilibrium 2** If (29) holds, agents in $R \in (0, R5)$ will choose to work, agents with $R \in [R5, R4)$ will invest, not abide by the regulations, and search for a corrupt official. Finally, agents with $R \in [R4, \infty)$ will follow the regulations, and pay the bribe if they draw a corrupt official.

Note that the condition on the parameters that separates the two equilibria has the same structure as condition (27) for the Low red tape economy. The main effect of red tape in this

model is to create a time delay between investment and production. The tradeoffs between the costs of waiting and those of complying that drove choice of optimal plan in the Low red tape economy are the same that drive such choice in this economy.

V. Optimal Government Policies

We are interested in characterizing the socially optimal levels of regulations and red tape in economies with corruption, and comparing them with the optimal policies in a no corruption economy. In particular, we are interested in whether the level of regulations can be used effectively to reduce the deadweight loss caused by corruption, and whether -and in which conditions- a higher level of red tape can be used as a second best policy.

The social welfare function used here gives all agents, including corrupt officials, the same weight. It can be represented by aggregate output minus the externality:

$$W = Y - X. \tag{30}$$

We begin by studying the optimal level of regulations in an economy with low red tape. In an economy with no corruption everyone finds in their interest to comply with the regulations. In this case the planner solves

$$\max_{\alpha} \int_{R^{*}}^{\infty} (R-i) dG(R) + (2G(R^{*})-1) - \gamma(1-G(R^{*}))$$
(31)

With $R^* = \alpha + i + 1$. The first two elements represent entrepreneurial rents and private wage income respectively, and the third element represents the externality. Note that with no corruption, agents with a type higher than $\alpha + i + 1$ will become entrepreneurs. This level of entrepreneurial ability makes them indifferent between either occupation, as it accounts for the costs of regulation compliance and of the investment project, and for the opportunity cost of entrepreneurship, given by the wage and equal to one. In this case, the optimal level of regulations is

$$\alpha_0 = \gamma + 1 \tag{32}$$

At this level of α entrepreneurs internalize the marginal social costs of entrepreneurship on both the public good (γ), and the size of the government bureaucracy (w=1). This is of course a standard Pigovian result: the optimal level of regulations achieves the first best by aligning social and private costs. Note that in this case, as everyone complies with the regulations, further testing of regulation compliance using an extra layer of red tape cannot be Pareto improving.

In an economy with corruption, we need to distinguish optimal regulations under the two types of equilibrium. The optimal level of regulations, at the interior of the parameter space for each Equilibrium, takes the following form:

$$\alpha_{p} = \begin{cases} \gamma \frac{1-p\theta}{1-p\theta\delta} + i \frac{-p\theta(1-\delta)}{1-p\theta\delta} + \frac{1-p\theta}{1-p\theta\delta} \left(2 - \frac{1}{1-p\theta}\right) & \text{in Eq. 1} \\ \gamma \frac{1-p}{1-p\theta\delta} + i \frac{(1-\delta)(1-p)}{1-p\theta\delta} & \text{in Eq. 2} \end{cases}$$
(33)

The planner solves qualitatively different problems in the two equilibria. In equilibrium 1, where all entrepreneurs follow the regulations, corruption acts as a tax on the returns of entrepreneurship. In this case, the costs of regulations -given by α - can be lowered from its no corruption level to align social and private costs of investing. Indeed, α_p is lower than α_0 in this equilibrium, and replacing α_p in the cutoff value for entrepreneurship (R_3) yields $R_3 = R^*$, the first best cutoff value.⁸

In equilibrium 2, the planner cannot affect -through α - the work/invest margin, since entrepreneurs at this margin do not follow the regulations. In this case the planner can only modify the plan 1 vs. plan 2 margin, and sets α so that $R1 = \gamma + i$. This cutoff level between plan 1 and plan 2 makes plan 1 entrepreneurs internalize the full marginal social cost of their decision: Since their alternative at the margin is to follow plan 2, the wages of government bureaucrats are not in this case part of their social marginal costs. Note that $R1 < R^*$, so all plan 2 entrepreneurs, as well as some plan 1 entrepreneurs, are socially inefficient, but α cannot be used as a policy tool to drive marginal entrepreneurs out of the market.

From the previous discussion, it should be clear that optimal policies will be able to achieve the first best in the case of equilibrium 1 alone, as in the second equilibrium, plan 2 entrepreneurs do not internalize the cost of the public good. We summarize this result in the following proposition, which we state without proof.

Proposition 2 Correcting the distortions caused by corruption using the level of regulations: The optimal level of regulations, α_{p} , is lower than the no corruption level α_{0} .

- 1. In Equilibrium 1, α_p achieves the first best allocation
- 2. In Equilibrium 2, α_p achieves a second best allocation

Clearly, the result for Equilibrium 1 is not without distributional implications. In setting the level of α lower than in the first best, the planner corrects for the underinvestment caused by the costs of bribes, and aligns the prices faced by entrepreneurs with the socially optimal prices. The consequence is that the level of the public good worsens, as X is higher, and therefore workers are worse off.

Figure 4 depicts α_p for given parameter values in the { γ , p} space. A higher externality is associated to a higher optimal level of regulations, through a standard Pigovian argument. By contrast, optimal regulations are decreasing in corruption, p, except for the jump where the economy switches from equilibrium 1 to 2, as corruption curtails the ability of regulations to align private and social costs.⁹ In this figure, the two equilibria are clearly defined: equilibrium 2 appears as a convex plateau at the north east corner of the (γ , p) space; equilibrium 1 lies south and west of the second equilibrium, and is separated from equilibrium 1 by a discrete jump in the optimal level of α . As discussed above, optimal regulations solve qualitatively different problems in both equilibria.

$$\max_{\alpha} \int_{R^{33}}^{\infty} (R-i) dG(R) + (2G(R^3) - 1) - \gamma (1 - G(R^3))$$
(34)

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⁸ To see this, note that in equilibrium 1, the objective function is

And substitution of the optimal level of regulations in R3 gives $R3=i+\gamma+1$, which is the socially optimal cutoff point in the economy without corruption. The social welfare function in (34) is therefore the same as that with no corruption, in (31).

⁹ For a small interval of γ neither solution given by (33) falls on the interior of the parameter space for the respective equilibrium. In this case the solution is at a corner, and given by $h(i, p, \theta, \delta)$ in expression (27).



Fig. 4. Optimal Level of Regulations in the Low Red Tape Economy $(\theta = .6, \delta = .9, i = 10)$

We now consider the joint choice of α and Red Tape by the planner. We have in mind a comparison of stationary states after a policy change from a Low to a High red tape environment. Because searching takes time, an entrepreneur in a High red tape environment will be able to produce at most at a frequency of one half periods (or every two periods). Hence, to obtain a stationary level of output and the public good, we assume that the policy transition occurs as follows: At the time of the policy change from a Low to a High red tape environment, the government awards half of the agents with one of the two certifications. In appendix D we show that this is sufficient to guarantee a stationary level of aggregate outcomes, as well as convergence to this level after a transition. This allows us to make welfare comparisons by focusing on steady state differences.

From the discussion in the previous section, it should be clear that, if no structure is placed on the level of regulations, there is scope for more Red Tape to improve welfare. We are interested rather in the conditions, if any, under which more Red Tape can improve on the allocation in an economy where the level of regulations is already optimal. From the previous proposition we know that this will not happen if the economy is in Equilibrium 1. If the economy starts in Equilibrium 2 however, high levels of externalities (γ), which in turn imply high optimal levels of regulations, will turn red tape into a Pareto improving policy. These results are formalized below

Proposition 3 Red Tape and welfare under optimal regulations:

- 1. If the economy is in Equilibrium 1 Red Tape will always decrease welfare.
- 2. There is a threshold $\overline{\gamma}$ such that, if $\gamma > \overline{\gamma}$ more red tape increases welfare. In this

case, the economy is in equilibrium 2.

Proof: Point 1 follows from the fact that in Equilibrium 1 optimal regulations can achieve the first best. For point 2, note that the derivative of $\frac{\Delta W}{\Delta RT}$ with respect to γ is

$$\frac{\partial \frac{\Delta W}{\Delta RT}}{\partial \gamma} = -\frac{1}{2} (G(R4) - G(R5)) - \frac{1}{2} (1 - G(R4)) + p(G(R1) - G(R2)) + (1 - G(R1))$$
(35)

The limit of this expression as $\gamma \to \infty$ is $p(1-G(R2)) - \frac{1}{2}p(1-G(R5)) > 0$, so increasing the

level of red tape improves welfare for γ above a threshold. Appendix F describes the proof in detail.

When the economy is initially in the second equilibrium, the level of regulations is a poor policy tool to restrict the number of inefficient firms from operating, as it only affects the margin of the optimal plan for entrepreneurs. If the negative externality is large enough, there will be a large number of inefficient firms operating. In this case it may be efficient to drive some firms out of the market by increasing the costs associated with red tape, even if this creates large inframarginal losses to the remaining firms. It is worth recalling that this case will occur under a high incidence of corruption for a given γ .

Making the incidence of corruption (p) endogenous would not change the second -and novel- result in Proposition 3. This is because red tape is decentralized, so the two bribes to be paid in the case of High red tape are received by different officials. Moreover, since the profitability of investing is lower in this case, the two bribes would be smaller than the bribe in the Low red tape case. The incentives for becoming a corrupt official are then lower in the case of High red tape, which reinforces the second result in the above Proposition.

VI. Conclusion

We present an economy where the government sets up regulations to correct a production externality. Red tape is imposed as a mechanism to test regulation compliance, and is administered by government officials. In an environment where some officials are corrupt, we derive positive and normative results regarding the two policy tools the government has access to.

For a given level of externalities, we find that high and low corruption create distortions that are qualitatively different, and call for government policies that are also different in nature and reach. In our model, the equilibrium is characterized by a convex threshold in the externalities and corruption space, below which the government can mandate levels of regulations and (minimal) levels of red tape such that the economy is first best efficient. Above this threshold, optimal policies cannot achieve the first best. Moreover, we obtain the somewhat surprising result that , with the levels of externalities above a second threshold, more red tape is Pareto improving. In this case, a large class of entrepreneurs choose to operate without abiding by the regulations, so the level of these is ineffective to increase the cost and drive socially

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inefficient producers out of the market .

This paper provides an analysis of the normative properties of the two policy tools under study. This is not to imply that we see regulations, red tape, and other government policy choices as being defined on the basis of efficiency. As discussed in Joel S. Hellman and Kaufmann [2000] and Djankov et al. [2002], in highly corrupt economies the correlations between corruption, regulations, and red tape need to be understood as a political economy equilibrium where corrupt bureaucrats seek to manipulate institutional rules to their advantage. Because corruption itself is slow to get rid of, however, the analysis in this paper provides a normative benchmark to the studies just cited.

Appendix

A There are two policies that are not dominated

The list of possible plans $\{A, s_h, s_c\}$ is

- 1. {1, *accept*, *accept*}
- 2. {0, search, accept}
- 3. {1, search, accept}
- 4. {1, *accept*, *search*}
- 5. {1, search, search}
- 6. {0, search, search}

Plans 5 and 6 can be eliminated, since they lead to negative profits of $-i-\alpha$ and -i respectively, which are dominated by working.

We first derive the payoffs for plans 1 to 4.

• Plan 1: {1, accept, accept}

The value functions take the form

$$v_c(1) = R - \beta + \delta v_e \tag{36}$$

$$v_h(1) = R + \delta v_e \tag{37}$$

$$v_s(1) = pv_c + (1-p)v_h \tag{38}$$

$$v_e = -i - \alpha + v_s(1) \tag{39}$$

Substitution of v_c and v_h in v_s , and v_s in v yields

$$v_{e}(R) = \frac{1}{1-\delta}(R-i-\alpha-p\beta)$$
(40)

For the bribe, the problem is

$$\max_{\beta} \beta^{\theta} (R - \beta + \delta_{V_e} - \delta_{V_s})^{1-\theta}$$
(41)

Which yields

$$\beta = \theta(R + \delta(v_e - v_s)) \tag{42}$$

Since $v_e - v_s = -i - \alpha$, we have

$$\beta = \theta \left(R - \delta(i + \alpha) \right) \tag{43}$$

and

$$v_e(R) = R \frac{1 - p\theta}{1 - \delta} - (i + \alpha) \frac{1 - p\theta\delta}{1 - \delta}$$
(44)

• Plan 2: {0, *search*, *accept*}

The value functions take the form

$$v_c(0) = R_j - \beta + \delta v_e \tag{45}$$

$$v_h(0) = \delta v_e \tag{46}$$

$$v_s(0) = pv_c + (1-p)v_h \tag{47}$$

$$v_e = -i + v_s(0)$$
 (48)

The bribe is

$$\beta = \theta(R - \delta i) \tag{49}$$

Substitution of v_c and v_h in v_s yields

$$v_s = \frac{p}{1 - \delta(1 - p)} (R - \beta + \delta v_e) \tag{50}$$

Substitution of β in v_s and v_s in v_e yields

$$v_e(R) = R \frac{p(1-\theta)}{1-\delta} - i \left(1 + \frac{\delta p(1-\theta)}{1-\delta}\right)$$
(51)

• Plan 3: {1, *search*, *accept*}

The value functions take the form

$$v_c(1) = R_j - \beta + \delta v \tag{52}$$

$$v_h(1) = \delta v_e \tag{53}$$

$$v_s(1) = pv_c + (1-p)v_h \tag{54}$$

$$v_e = -i - \delta + v_s(1) \tag{55}$$

The bribe is

$$\beta = \theta(R - \delta(i + \delta)) \tag{56}$$

which implies

$$v_e(R) = R \frac{p(1-\theta)}{1-\delta} - (i+\alpha)(1+\frac{\delta p(1-\theta)}{1-\delta})$$
(57)

• Plan 4: {1, accept, search}

The value functions take the form

$$v_c(1) = \delta v_s \tag{58}$$

$$v_h(1) = R + \delta v_e \tag{59}$$

$$v_s(1) = pv_c + (1-p)v_h \tag{60}$$

$$v_e = -i - \delta + v_s(1) \tag{61}$$

The bribe offered is

$$\beta = \theta(R - \delta(i + \delta)) \tag{62}$$

and we have

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$$v_s(1) = v_h \frac{1-p}{1-\delta p} \tag{63}$$

which implies

$$v_e(R) = R \frac{1-p}{1-\delta} - (i+\alpha) \frac{1-\delta p}{1-\delta}$$
(64)

Note that plan 3 is dominated by plan 2:

$$v_e(plan \ 2) - v_e(plan \ 3) = \alpha \ (1 + \frac{\delta p(1-\theta)}{1-\delta})$$

Plan 4 is dominated by plan 1 for all *R* such that work is not the dominant choice. Plan 1 dominates plan 4 for all $R > \delta(i+\alpha)$. In turn, under the following condition plan 4 dominates work

$$R(1-p) - (i+\alpha)(1-p\delta) > 1$$
(65)

$$R > (i+\alpha)\frac{1-p\delta}{1-p} + \frac{1}{1-p} \tag{66}$$

$$> i + \alpha$$
 (67)

$$>\delta(i+\alpha)$$
 (68)

So plan 4 dominates plan 1 only for R such that work is the dominant plan.

B Plan 2 is observed if and only if R1 > R2

The proof:

 \Rightarrow If plan 2 is observed, then $R_1 > R_2$. Let R_0 be such that plan 2 dominates both working and plan 1. Since plan 2 dominates working, we must have $R_0 > R_2$. Since plan 2 dominates plan 1, we must have $R_0 < R_1$. This implies $R_1 > R_2$.

 \leftarrow If $R_1 > R_2$ there is an R such that plan 2 dominates both plan 1 and work. Take $R_0 \in (R_2, R_1)$. Since $R_0 > R_2$, plan 2 dominates work. Since $R_0 < R_1$, plan 2 dominates plan 1.

C Proof of Lemma 2

The proof: The payoffs are, for not investing

$$U = \frac{1 - X}{1 - \delta} \tag{69}$$

From following strategy 1,

$$U = -\frac{1-p\theta\delta}{1-\delta}(i+\alpha) + \frac{1-p\theta}{1-\delta}R - \frac{X}{1-\delta}$$
(70)

$$\equiv a_1 + a_2 R_j - a_3 X$$

From following strategy 2,

$$U = -i(1 + \delta p \frac{1-\theta}{1-\delta}) + \frac{p(1-\theta)}{1-\delta} R - \frac{X}{1-\delta}$$

$$\equiv d_1 + d_2 R_j - d_3 X$$
(71)

For 2, note that $a_1 \le d_1$, $a_2 \ge d_2$, and $a_3 = d_3$. Since $R \in \mathbb{R}^+$, there is a cutoff point such that strategy 1 is preferred to strategy 2 for all R that are higher. Simple algebra shows that this point is R1. For 2, note that $d_1 \le 1$ and $d_2 \ge 0$, so a cutoff point for the choice between strategy 2 and working exists. Again simple algebra shows that it is R2. For 2, a similar argument to 2 applies.

D Stationary distribution in the model with high Red Tape

There is a unique stationary equilibrium with one half of the entrepreneurs holding zero certifications.

- We need to look separately at both types of equilibria in the environment with high red tape.
- 1. In Equilibrium 1, all entrepreneurs obtain one certification each period, and those with $v_s(.,1)$ at the beginning of the period produce, so the only stationary equilibrium is to have 1/2 of the entrepreneurs in $v_s(.,0)$, and 1/2 in $v_s(.,1)$.
- 2. In equilibrium 2, the above argument holds for entrepreneurs who choose plan 1. For entrepreneurs who follow plan 2, only a fraction p of them will obtain a new certification each period. The Markov process for the proportion of plan 2 entrepreneurs in states $v_s(.,0)$ and is

$$\begin{array}{ccc} 1-p & p \\ p & 1-p \end{array}$$

which has a stationary distribution $\{1/2, 1/2\}$.

E Equilibrium in the model with high Red Tape

We begin by stating the problem. We let the arguments in $v_{c,h,s}(...)$ be the number of certifications held (0 or 1) and the indicator function for compliance with the regulations (1 if complied, 0 otherwise).

The Bellman equations are, for entrepreneurs with zero certifications,

$$v_{c}(0,0) = \max\{\delta v_{s}(1,0) - \beta_{1}, \, \delta v_{s}(0,0)\}$$
(72)

$$v_{c}(0,1) = \max\{\delta v_{s}(1,1) - \beta_{1}, \, \delta v_{s}(0,1)\}$$
(73)

$$v_h(0,0) = \delta v_s(0,0)$$
 (74)

$$v_h(0,1) = \max\{\delta v_s(0,1), \delta v_s(1,1)\}$$
(75)

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For entrepreneurs with one certification,

$$v_{c}(1,0) = \max\{R_{j} - \beta_{2} + \delta v_{e}, \delta v_{s}(1,0)\}$$
(76)

$$v_{c}(1,1) = \max\{R_{j} - \beta_{2} + \delta v_{e}, \, \delta v_{s}(1,1)\}$$
(77)

$$v_h(1,0) = \delta v_s(1,0)$$
 (78)

$$v_h(1,1) = max\{R_j + \delta v_e, \, \delta v_s(1,1)\}$$
(79)

For v_s

$$v_{s}(.,.) = pv_{c}(.,.) + (1-p)v_{h}(.,.)$$
(80)

For v_e

$$v_{e}(R) = \max\{-i + v_{s}(0,0), -i - \alpha + v_{s}(0,1), \frac{1}{1 - \delta}\}$$
(81)

Note that there will be a different bribe for entrepreneurs who have not obtained a certification yet (β_1), and one for entrepreneurs with one certification (β_2). These bribes take the following general form

$$\beta_1 = \theta \delta(v_e - v_s(1, .)) \tag{82}$$

$$\beta_2 = \theta(R + \delta_{V_e} - \delta_{V_s}(1, .)) \tag{83}$$

In what follows we characterize the equilibrium.

1. Two plans are not dominated.

Note that, because draws of government officials are independent for the first and second certification, optimal plans will not be made contingent on the history of draws. This implies that we have to look at the same four plans as in the model with low red tape. These plans are:

- (a) {1, accept, accept}
- (b) {0, search, accept}
- (c) {1, search, accept}
- (d) {1, accept, search}

We compute the payoffs of these plans for completeness. Then we show that plans 3 and 4 are dominated.

(a) Plan 1: {1, accept, accept}

$$v_s(1,1) = (R - \delta(i+\alpha)) \frac{(1-p\theta\delta)(1-p\theta)}{(1-p\theta\delta)^2 - \delta^2(1-p\theta)^2}$$
(84)

$$v_s(0,1) = (R - \delta(i+\alpha)) \frac{\delta(1-p\theta)^2}{(1-p\theta\delta)^2 - \delta^2(1-p\theta)^2}$$
(85)

$$v_e = R \frac{\delta(1-p\theta)^2}{(1-p\theta\delta)^2 - \delta^2(1-p\theta)^2} - (i+\alpha)(1 + \frac{\delta^2(1-p\theta)^2}{(1-p\theta\delta)^2 - \delta^2(1-p\theta)^2})$$
(86)

(b) Plan 2: {0, *search*, *accept*}

$$v_s(1,0) = (R - \delta i) \frac{p(1-\theta)(1-\delta p\theta - (\delta(1-p)))}{(1-\delta)^2 + 2p\delta(1-\delta)(1-\theta)}$$
(87)

$$v_{s}(0,0) = (R - \delta i) \frac{\delta p^{2} (1 - \theta)^{2}}{(1 - \delta)^{2} + 2p\delta(1 - \delta)(1 - \theta)}$$
(88)

$$v_{e} = R \frac{\delta p^{2}(1-\theta)^{2}}{(1-\delta)^{2}+2p\delta(1-\delta)(1-\theta)} -i \left(1 + \frac{\delta^{2}p^{2}(1-\theta)^{2}}{(1-\delta)^{2}+2p\delta(1-\delta)(1-\theta)}\right)$$
(89)

(c) Plan 3: {1, *search*, *accept*}

$$v_{s}(1,1) = (R - \delta (i + \delta) \frac{p(1 - \theta)}{1 - \delta(1 - p + p\theta)} + v_{s}(0,1) \frac{\delta p(1 - \theta)}{1 - \delta(1 - p + p\theta)}$$
(90)

$$v_{s}(0,1) = (R - \delta(i + \delta)) \frac{\delta p^{2}(1 - \theta)^{2}}{(1 - \delta(1 - p + p\theta))^{2} - \delta^{2}(1 - \theta)^{2}}$$
(91)

$$v_{e} = R \frac{\delta p^{2} (1-\theta)^{2}}{(1-\delta(1-p+p\theta))^{2}-\delta^{2}(1-\theta)^{2}} - (i+\delta) \frac{(1-\delta(1-p+p\theta))^{2}}{(1-\delta(1-p+p\theta))^{2}-\delta^{2}(1-\theta)^{2}}$$
(92)

(d) Plan 4: {1, accept, search}

$$v_{s}(1,1) = (R - \delta(i + \alpha)) \frac{(1-p)(1-p\delta)}{(1-p\delta)^{2} - \delta^{2}(1-p)^{2}}$$
(93)

$$v_{s}(0,1) = (R - \delta(i + \alpha)) \frac{(1-p)^{2} \delta(1-p\delta)}{(1-p\delta)^{2} - \delta^{2}(1-p)^{2}}$$
(94)

$$v_{e} = R \frac{(1-p)^{2} \delta(1-p\delta)}{(1-p\delta)^{2} - \delta^{2}(1-p)^{2}} - (i+\alpha)(1 + \frac{(1-p)^{2} \delta^{2}(1-p\delta)}{(1-p\delta)^{2} - \delta^{2}(1-p)^{2}}$$
(95)

2. Plans 3 and 4 are dominated

For plan 3 {1, search, accept}, we show that it cannot be optimal. Note that in this case

$$v_h(0,1) = \max\{\delta v_s(0,1), \delta v_s(1,1)\}$$

For this plan to be optimal it is necessary that $v_s(0,1) > v_s(1,1)$, but we know that $v_s(0,1) < v_s(1,1)$, because someone with one certification can always mimic the search behavior of someone with zero certifications, and obtain the payoff $R_j + \delta v$ in a lower expected time.

For plan 4 {1, accept, search} to be optimal, it must be that

$$v_{c}(1,1) = \max\{(1-\theta)(R+\delta v) + \theta \delta v_{s}(1,1), \ \delta v_{s}(1,1)\}$$
(96)

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$$=\delta_{\mathcal{V}_s}(1,1) \tag{97}$$

But note that

$$v_{s}(1,1) = pv_{c}(1,1) + (1-p)v_{h}(1,1)$$
(98)

$$< v_h(1,1)$$
 (99)

$$=R + \delta v \tag{100}$$

Since
$$\delta < 1$$
 we have (101)

$$\delta v_s(1,1) < R + \delta v \tag{102}$$

$$\delta v_s(1,1)(1-\theta) < (1-\theta)(R+\delta v) \tag{103}$$

$$(1-\theta)(R+\delta_{\nu})+\theta\delta_{\nu_s}(1,1) > \delta_{\nu_s}(1,1)$$
(104)

Which implies that $v_c(1,1) = (1-\theta)(R+\delta v) + \theta \delta v_s(1,1)$: Search if facing a corrupt official cannot be optimal.

- 3. The cutoff points
 - (a) Plan 1 is preferred to plan 2

$$R4 = i\delta + \alpha \frac{1 + \frac{\delta^2 (1 - p\theta)^2}{(1 - p\delta\theta)^2 - \delta^2 (1 - p\theta)^2}}{\frac{\delta (1 - p\theta)^2}{(1 - p\delta\theta)^2 - \delta^2 (1 - p\theta)^2} - \frac{\delta p^2 (1 - \theta)^2}{(1 - \delta)^2 + (1 - \delta) + 2p\delta (1 - \delta)(1 - \theta)}}$$
(105)

(b) Plan 2 is preferred to working

$$R5 = i \left(\delta + \frac{(1-\delta)^2 + 2p\delta(1-\delta)(1-\theta)}{\delta p^2(1-\theta)^2}\right) + \frac{(1-\delta) + 2p\delta(1-\theta)}{\delta p^2(1-\theta)^2}$$
(106)

(c) Plan 1 is preferred to working

$$R6 = (i+\alpha)\frac{(1-p\theta\delta)^2}{\delta(1-p\theta)^2} + \frac{(1-p\theta\delta)^2}{\delta(1-\delta)(1-p\theta)^2} - \frac{\delta}{1-\delta}$$
(107)

4. Numerical result 1

We perform pairwise numerical comparisons of the coefficients on *R* and $(i+\alpha)$, which are functions of $\{p, \alpha, \delta\}$, by using a discrete grid for the parameters, which lie in $(0,1)^3$. We use a 30³ point grid.

F Proof of proposition 3, part 2.

We begin by defining welfare under equilibrium 2 in both the low and high red tape environments. In both cases, we define welfare in the stationary state, which by risk neutrality is equivalent to discounted net returns plus wages of private workers minusthe externality. In the low red tape environment, the expression is

$$W_{L} = \frac{1}{1-\delta} \{ p \int_{R^{2}}^{R^{1}} (R-i-\gamma) dG(R) + \int_{R^{1}}^{\infty} (R-i-\gamma) dG(R) + 2G(R^{2}) - 1 \}$$
(108)

The first term within the brackets is the contribution to welfare of type 2 entrepreneurs; the second term is the contribution of type 1 entrepreneurs; the third term is wages of private sector workers. In the high red tape environment, the expression is

$$W_{H} = \frac{1}{1-\delta} \left\{ \frac{p}{2} \int_{R_{5}}^{R_{4}} (R-i-\gamma) dG(R) + \frac{1}{2} \int_{R_{4}}^{\infty} (R-i-\gamma) dG(R) + 2G(R_{5}) - 1 \right\}$$
(109)

The above expression is valid in the stationary state, where one half of entrepreneurs hold one permit, and the other half hold zero. at this point, it is useful to recall that only R2 and R5 are functions of α . The optimal level of regulations under low red tape is given by expression 33. For the high red tape economy, the optimal level of regulations is given by

$$\alpha = i \left(1 - \delta \right) \phi^{-1} + \gamma \phi^{-1}, \tag{110}$$

where ϕ is the expression accompanying α in equation 105. Substitution of these optimal expressions in R1 and R4 respectively yields $R1 = R4 = i + \gamma$. Using leibnitz rule to take the derivative of $(W_H - W_L)$ with respect to γ yields

$$\frac{\partial (W_H - W_L)}{\partial \gamma} = \frac{1}{1 - \delta} \left\{ \frac{p}{2} \frac{\partial R4}{\partial \gamma} (R4 - i - \gamma) - \frac{p}{2} \int_{R^5}^{R^4} dG(x) - \frac{1}{2} \frac{\partial R4}{\partial \gamma} (R4 - i - \gamma) - \frac{1}{2} \int_{R^4}^{\infty} dG(x) - \frac{\partial R1}{\partial \gamma} (R1 - i - \gamma) + p \int_{R^2}^{R^1} dG(x) + \frac{\partial R1}{\partial \gamma} (R1 - i - \gamma) + \int_{R^2}^{\infty} dG(x) \right\}$$

Substitution of $i+\gamma$ for R1 and R4 in this expression yields (35). Taking limits as $\gamma \rightarrow \infty$ and using the fact that $\lim_{\gamma \rightarrow \infty} G(R1) = \lim_{\gamma \rightarrow \infty} G(R4) = 1$ yields the expression in the text: $p(1-G(R2)) - \frac{1}{2}p(1-G(R5))$. Simple algebra can be used to establish that R2 < R5, and therefore that the expression is positive.

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