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INTERMEDIATED CORRUPTION*

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I model the role of intermediaries in corruption and examine the effects of policy on the level of intermediated corruption, price of permits, and welfare. Intermediaries with a history of being honest earn higher premiums. The frequency of corrupt transactions is inversely related to income levels. When the government increases the fraction of profits that it extracts from entrepreneurs, intermediation intensifies, as entrepreneurs are reluctant to obtain licenses through legal means. Therefore, when business costs are high, measures to combat corruption transfer value to intermediaries. Increasing the frequency of governments audits can increase the equilibrium price of permits.

1. INTRODUCTION

The issue of bribery is ubiquitous around the world. The *World Bank Enterprise Survey* reports that nearly 30% of firms worldwide expect to pay bribes to public officials to "get things done." Researchers at the World Bank estimate that the size of the bribery market is at least $1 trillion per year (Rose-Ackerman, 2004), which amounts to nearly 3% of the world's GDP. Bribes paid by private citizens in search of a government good or service quite often reach corrupt bureaucrats by way of intermediaries, who facilitate this exchange of governmental services in return for a fee.[2] The use of intermediaries arises as both private citizens and officials attempt to shield themselves from anticorruption measures and audits.[3] By employing a third party, officials can make the process of uncovering corrupt activities increasingly difficult, because no direct contact between a briber and bribee can be established.

The prevalence of intermediated corruption raises several questions. What determines the number of active intermediaries? How do intermediaries affect the transaction price of a license inclusive of bribes? How do policies such as corruption monitoring affect the size of intermediation, price, and welfare? To address these questions, I first construct a search-theoretic model with history dependence to generate intermediated corruption as an equilibrium outcome. An interesting implication of the model is that where business costs associated with obtaining government permits are sufficiently high, auditing government bureaucrats more diligently increases the level and payoffs to intermediation. From this point of view, corruption tends to be

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[2] For example, Bertrand et al. (2007) find that all individuals who bribed a government official to obtain a driver's license did so through an intermediary. See the online appendix for individual cases.

[3] Here, corruption is defined as in Shleifer and Vishny (1993), i.e., the sale by government officials of government property for private gain. Licensing is clearly such a case, where an official earns illegal profits from the sale of government property.

obstinate; by redistributing income to individuals who are neither bureaucrats nor direct end users of government services, it creates a service industry that is difficult to uproot.

The choice of search with frictions is a natural environment for the study of intermediated corruption. Purchasing a service or a license in the illegal market involves substantial effort devoted to finding the appropriate party. Because of its illicit nature, the corruption "market" is unable to reduce these frictions through the public domain. Moreover, the natural lack of contract enforcement adds a layer of complexity to the interactions between intermediaries and bureaucrats. In this model, an intermediary takes possession of a license from a bureaucrat after negotiating a price and delivers the agreed upon price only after having sold the license to an entrepreneur.[4] In this manner, the model allows for intermediaries to renege on an agreement with a bureaucrat and keep the proceeds of a sale. The choice to take this course of action depends on the value of having a history as an honest intermediary. Because of search frictions, such a history delivers more value, but if the value of building a history is sufficiently low for entrant intermediaries, they will cheat. If this is the case, bureaucrats will insure themselves against breach by demanding prohibitively high prices, thus making intermediation impossible in equilibrium.

The decision of an individual to become an intermediary depends on his outside option, i.e., the wage he can obtain by choosing to spend his time working instead. Higher wages imply a higher continuation value needed for the individual to become an intermediary, and, keeping licensing costs constant, higher wages reduce the size of the corruption "market" as measured by the number of active intermediaries. Through this channel, the model can explain the well-known negative relationship between corruption and income per capita, i.e., as income per capita increases, intermediation wanes, which makes corrupt activities less feasible and less frequent. In addition, if the value of building a history of honest transactions is sufficiently high to induce entry into intermediation, then the model suggests that intermediaries with such a history can extract a higher premium (the difference between the price they are paid for the license and the one they pay for it) because in any negotiations, they must be compensated for being honest middlemen.

I conduct quantitative exercises to study the comparative statics associated with changes in the policy parameters of interest. First, I find that when the costs of obtaining permits legally are relatively high, increasing the frequency with which the government audits bureaucrats leads to an increase in the level of intermediation. The first effect of an increase in the frequency of auditing is to reduce the probability that an intermediary gets to engage in the exchange of permits in the corruption "market." However, if the costs of procuring licenses legally are relatively high, entrepreneurs are reluctant to do so and are willing to give up more value to obtain them illegally. This increases the premium that intermediaries extract from entrepreneurs, making intermediation more lucrative and inducing more entry. Second, this exercise suggests that reducing licensing costs, which include both compliance and red tape costs, is a substantially more efficient way of rooting out corruption than increasing the frequency of audits.

With the exception of Hasker and Okten (2008), who microfound the use of intermediaries, since the seminal work by Becker (1968), most of the theoretical treatment of corruption has focused on the interaction between the government bureaucrat and the party paying the bribe (see, for example, Acemoglu and Verdier, 2000; Banerjee, 1997; and, in the case of private sector collusion, Tirole, 1986). Also, since the work of Mauro (1995), many empirical studies have attempted to document the effects of corruption on various aspects of the economy (Fisman, 2001; Fisman and Edward, 2007; among others). This article contributes to the existing literature on corruption by studying intermediation and its effects on prices and welfare. Bertrand et al. (2007) find that the driving ability of those that obtained their licenses through corrupt means was substantially lower than the driving ability of those who did so through legal channels. This fact supports the modeling choice in this article. That is, the compliance/red tape costs are bypassed when licenses are purchased through corrupt means. Shi and Temzelides (2004) also

[4] This is what Rubinstein and Wolinsky (1987) define as *consignment*. See below for a detailed explanation.

take a search-based approach to the study of corruption and find that bribery arises because an official's trading decisions are immaterial in their consumption outcomes and they only bear a small fraction of the cost of production. Bribery then induces bureaucrats to accept lower quality goods that may increase their production. In this article, however, corruption arises purely because bureaucrats hold a monopoly on licensing and search frictions exist only in the corruption "market." Shleifer and Vishny (1993) suggest that increasing the size of the bureaucracy may reduce the size of bribes as competition between bureaucrats increases. One of the key results of this article is that in the presence of intermediaries, increasing the size of the bureaucracy may actually intensify the frequency of corrupt activities by increasing the size of the intermediation market and has no effect on the average price entrepreneurs pay to obtain permits. In fact, the only party to benefit from an increase in the size of the bureaucracy is the intermediaries, as they can extract higher prices for their services given that they are more likely to make a connection with a bureaucrat.

This article follows the *consignment* framework of Rubinstein and Wolinsky (1987; see also Shevchenko, 2004), where intermediaries decide whether or not to deliver the agreed upon price after having sold the license to an entrepreneur. This theoretical choice reflects the fact that quite often, in interactions between an intermediary and a government official, the intermediary has an informational advantage, since the bureaucrat might not negotiate the price of the license with the entrepreneur directly.[5] In this manner, the intermediary can capture a larger share of the value of the license at the expense of the bureaucrat. Given this environment, consignment is a simplified theoretical instrument to denote the fact that intermediaries have a chance to "steal" from bureaucrats. The simplifying assumption of nonpayment is made for analytical tractability, but it captures the advantage that the intermediary has in an environment where intermediation is useful in avoiding detection. In this light, allowing for history building, where intermediaries that have not cheated in their last interaction have nonzero histories, is a natural setting since it gives bureaucrats a way to protect themselves against cheating intermediaries. This gives rise to an implicit trade-off that intermediaries make; not repaying the bureaucrat results in losing history, while being honest is costly.

One implicit assumption I make is that any auditing body has a limited scope of search for illegal activity. Even more strongly, I assume that the cost of uncovering illegal activity when intermediaries are involved is prohibitively high. This is not an extreme assumption; proving malfeasance in cases where intermediaries are involved is difficult. However, the results of the article are not qualitatively affected by this assumption; all that is needed for the results to continue to hold is the assumption that the probability of uncovering a corrupt transaction is lower when intermediation is present.

In this setting, the role of government is limited to a collection of rules and regulations, and bureaucrats are the individuals charged with enforcing them. The issue of corrupt auditors and complete corruption is not addressed here. The starting point is that the potential for corruption exists, which enables me to focus on issues of intermediation and the division of the proceeds of corruption between individuals.

2. A MODEL OF INTERMEDIATED CORRUPTION

2.1. *The Model Environment.* Consider a setting with a continuum of risk-neutral agents of mass one. Time is continuous. There are three types of agents: bureaucrats with time-invariant mass B, entrepreneurs with constant mass E, and workers with mass $1 - B - E$. All agents discount the future at a common discount rate ρ. There is an arrival rate of death (exit) λ and an exiting agent is replaced with a newborn.[6] Denote by $r = \rho + \lambda$ the effective discount rate. Entrepreneurs are endowed with a project that yields a lifetime discounted value of A.[7] In order

[5] See the online appendix for some anecdotal evidence of such intermediation and a more detailed discussion of consignment.

[6] All rates are Poisson arrival rates.

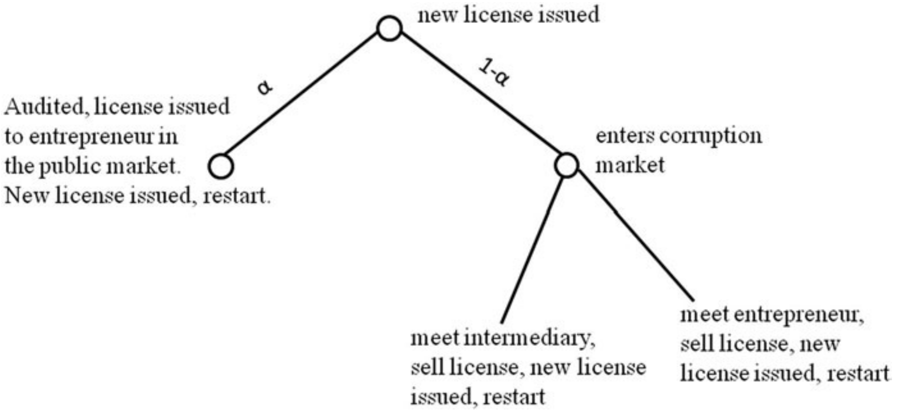
[7] Neither the bureaucrat nor the worker can operate the project.

to operate the project, an entrepreneur must obtain a license. Bureaucrats are the only agents in possession of a license.

A bureaucrat holding a license is randomly audited by the government with probability α.[8] If the bureaucrat is audited by the government, he must issue the license without asking for a bribe and must enforce all of the legal requirements of licensing because he is under direct observation. Denote by $b < A$ the cost to the entrepreneur of procuring the license under auditing. The constant b represents a composite of red tape costs and investment costs that must be paid if the entrepreneur is to be equipped with the license under auditing. The red tape costs can be attributed to bureaucratic congestion, although investment costs are license requirements that the entrepreneur has to fulfill if he obtains the license legally, but are foregone when the bureaucrat is bribed. On the other hand, if the bureaucrat is not directly audited, he has the opportunity to sell the license in the corruption market and earn a fee.[9] Therefore, ex ante, a license has a probability of $1 - \alpha$ of being sold in the corruption market for a bribe.

In the corruption market, an entrepreneur can match with either a bureaucrat or an intermediary holding a license. The flow arrival rate of a match between an entrepreneur and a bureaucrat is μ.[10] Once a bureaucrat issues a license, he is immediately endowed with another one that he can issue at will, whereas an entrepreneur who has obtained a license exits the market and is immediately replaced by another.

To further clarify the timing structure of the market, suppose a bureaucrat is holding a license. With probability α, the bureaucrat is forced to give away the license through audit, in which case another license is issued to him and the process restarts. With probability $1 - \alpha$ instead, he is given a chance to enter the corruption market and sell the license at a price to either an entrepreneur or an intermediary. The figure below is a visual depiction of the time line for the bureaucrat.



Bureaucrat Timeline

Workers earn the constant wage w but can also choose to enter the corruption market and become intermediaries who obtain a license from the bureaucrat and sell it to entrepreneurs.[11] However, workers are resource-constrained and cannot pay for the license up front. In a match between a bureaucrat and an intermediary, the two negotiate a price and, if there is agreement, the bureaucrat issues the license to the intermediary, but the agreed upon price is not immediately paid. Instead, the intermediary pays the bureaucrat only after he has actually sold the license (see Rubinstein and Wolinsky, 1987).

[8] The bureaucrat does not have a priori knowledge of whether he will be audited.

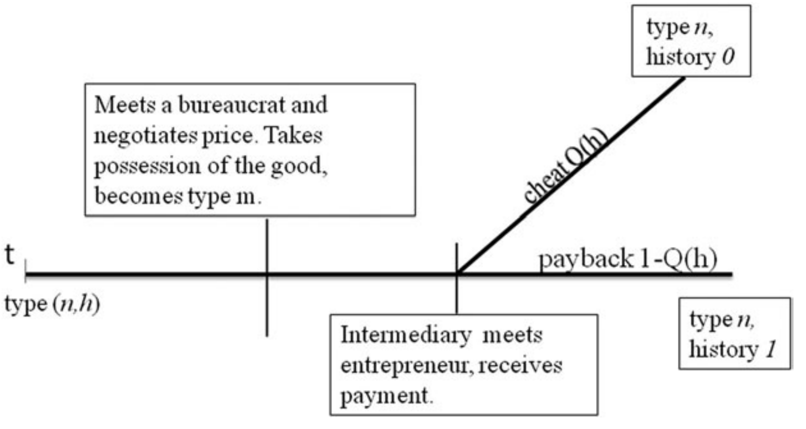
[9] When a bureaucrat is not audited, he immediately enters the corruption market. The entrepreneur who was applying for a license is thus in need of one and enters the corruption market as well.

[10] The entrepreneur will always try to obtain the license legally first. Therefore, the rate at which an entrepreneur obtains the license in the corruption market is $(1 - \alpha)\mu$.

[11] A worker can either be an intermediary or a worker, not both.

Denote an intermediary who is in search of a license as an n-type and one that is in search of an entrepreneur as an m-type. The rate of a match between an m-type intermediary and an entrepreneur is γ. Once an m-type intermediary has sold the license to an entrepreneur, he has the choice to either pay back the agreed upon price to the bureaucrat or cheat and keep all of the proceeds of the sale to himself. There are no informational asymmetries here, and the decision of the intermediary is a binary one: pay or not. There is, however, a cost to cheating. Denote by $h \in \{0, 1\}$ the history of an active intermediary. A history marks an intermediary's decision in the last transaction. If during the last transaction, an intermediary cheated, his history is $h = 0$; if not, $h = 1$. Histories are publicly observable and $h = 0$ for new entrants.

The time line for an intermediary is depicted below. Note that the decision of whether to cheat or not determines the future history of an intermediary; if after selling the license to an entrepreneur, an intermediary decides to cheat, he becomes a type n intermediary with history 0. If not, $h = 1$.



Denote by $n(h)$ and $m(h)$ the mass of n- and m-type intermediaries of history h and by $Q(h)$ the probability that a representative intermediary of history h will cheat. Also, denote the rate with which an intermediary of history h meets a bureaucrat by $\pi(h)$, where $\pi(0) = \frac{B}{n(0)+B}$ and $\pi(h) = \tau$, for $h = 1$. Therefore, the only history for which the distribution is instrumental in determining the rate of a match is history zero. For $h = 1$, the rate with which an intermediary meets a bureaucrat is constant. Denote by $\eta(h)$ the rate with which a bureaucrat meets an intermediary of history h.[12]

Let s and e represent the bureaucrat and the entrepreneur, respectively. Denote by V_i agent i's expected value of being unmatched in the corruption market, by Z_{ij} the total value created by a match between agents i and j, and by P_{ij} the price paid by agent j to i in the event of an agreement, where $i, j \in \{s, m, n, e\}$. The matches where a good is potentially exchanged are those between a bureaucrat and entrepreneur (se), a bureaucrat and an n-type intermediary (sn), and between an m-type intermediary and an entrepreneur (me). At any random point in time a bureaucrat can be in one of two states. Either he is holding a license, in which case his value of being unmatched in the market is V_s, or he is holding a license *and* is waiting for payment from an intermediary, in which case his value of being unmatched in the market is $R_s(h) + V_s$, where $R_s(\cdot)$ represents the residual value of a *consignment* sale. Note that R_s depends on h since the equilibrium probability of cheating will depend on histories.

The total values created by each match are as follows:

$$Z_{se} = A + V_s,$$

[12] Given the matching function $\eta(0) = \frac{n(0)}{n(0)+B}$.

$$Z_{sn}(h) = V_m(h) + R_s(h) + V_s,$$

$$Z_{me}(h) = A + (1 - Q(h))\,(V_n(1) - P_{sn}(h)) + Q(h)V_n(0).$$

The last identity comes from the fact that when an entrepreneur and m-type intermediary meet, there is the value of the project to the entrepreneur A, and the expected value of the intermediary given some probability of cheating $Q(h)$. In this case, if the intermediary decides not to cheat, his history will be 1, but he has to pay the agreed upon price to the bureaucrat $P_{sn}(h)$. If instead he decides to cheat, he is endowed with a zero history but keeps the price $P_{sn}(h)$.

The value functions of individuals are given as follows:

$$rV_n(h) = \pi(h)\,[V_m(h) - V_n(h)]\,, \tag{1}$$

$$rV_m(h) = \gamma \begin{bmatrix} P_{me}(h) + (1 - Q(h))[V_n(1) - P_{sn}(h)] \\ + Q(h)V_n(0) - V_m(h) \end{bmatrix}, \tag{2}$$

$$\begin{aligned} rV_e = {} & (1-\alpha)\left(\gamma \sum_h (A - P_{me}(h) - V_e)\,\frac{m(h)}{M} + \mu[A - P_{se} - V_e]\right) \\ & + \alpha[A - b - V_e], \end{aligned} \tag{3}$$

$$rV_s(h) = (1-\alpha)\left\{\mu P_{se} + \sum_h \eta(h)R_s(h)\right\}, \tag{4}$$

$$rR_s(h) = \gamma\left\{(1 - Q(h))P_{sn}(h) - R_s(h)\right\}. \tag{5}$$

Equation (3) is the recursive equation for the entrepreneur where $M \equiv \sum_h m(h)$. Note that the rate with which an entrepreneur meets an intermediary of history h is $\gamma\frac{m(h)}{M}$, and the total expected surplus value of the match to the entrepreneur is $A - P_{me}(h) - V_e$.

Here, bargaining is modeled as Nash bargaining with equal weights.[13] In any negotiation between two agents, the surplus that goes to each agent is simply half of the total surplus created by the match. Consider, for example, (6) below.

$$\begin{aligned} P_{me}(h) + (1 - Q(h))(V_n(1) - P_{sn}(h)) + Q(h)V_n(0) - V_m(h) & \\ = \frac{1}{2}[Z_{me}(h) - V_m(h) - V_n(h)]. & \end{aligned} \tag{6}$$

The left-hand side (LHS) of the equation is equal to the net surplus going to the intermediary with the license, which is composed of the price paid to the intermediary of type m by the entrepreneur (P_{me}) plus the expected value of the intermediary after the sale based on the cheating decision. The right-hand side represents the net surplus of the match. Equations (7) and (8) are similarly derived and represent the bargaining outcomes of the (ns) and (se) matches, respectively:

$$V_m(h) - V_n(h) = \frac{1}{2}[Z_{sn}(h) - V_n(h) - V_s], \tag{7}$$

[13] The assumption of equal weights is relaxed in the quantitative section. In Section 4.2, more general values of the bargaining parameter are explored.

$$A - V_e - P_{se} = \frac{1}{2}[Z_{se} - V_e - V_s]. \tag{8}$$

2.2. *The Intermediary's Decision.* After an intermediary of history h has sold a license to an entrepreneur, he makes the decision on whether to cheat, i.e., whether to pay the bureaucrat the agreed upon price. The decision whether to cheat depends on the relative size of the continuation payoff. Denote by $q(h)$ the probability with which an intermediary chooses to cheat and by $D(Q(h), h) \equiv V_n(1) - P_{sn}(h) - V_n(0)$.[14] Then, this decision can be summarized as follows:[15]

$$q(h) \begin{cases} = 0 & \text{iff } D(Q(h), h) > 0 \\ = 1 & \text{iff } D(Q(h), h) < 0 \\ \in [0, 1] & \text{iff } D(Q(h), h) = 0. \end{cases} \tag{9}$$

2.3. *Distributions.* In equilibrium, an agent of history $h \in \{0, 1\}$ can move to (remain in) history 1 only through completing a transaction and not cheating. Only m-type agents can become n-types of history 1 since only an m-type agent has a good to exchange. An n-type agent of history 1 moves out of that history either through death (with rate λ) or through meeting a bureaucrat and becoming an m-type (with rate $\pi(1)$). An m-type agent exits the group if he meets an entrepreneur (with rate γ) or through death. The only entry in the group of m-type agents is through n-type agents of history h who meet a bureaucrat. Thus, the dynamics of the measures of the m-type and n-type individuals are (the derivation is similar to Green and Zhou, 1998):

$$\dot{n}(1) = \gamma m(0)(1 - Q(0)) - (\lambda + \pi(1))n(1), \tag{10}$$

$$\dot{m}(h) = \pi(h)n(h) - (\gamma + \lambda)m(h) \quad \forall h \in \{0, 1\}. \tag{11}$$

The equation of motion for the mass of n-type agents of history zero is represented by (12) below. The mass of n-type agents who enter history zero is the total mass of agents that cheat, represented by the first term in the equation and the mass of new entrants, represented by δ. Note that the first term is the sum of all agents who meet entrepreneurs and decide to cheat with probability $Q(h)$. As in (10), exit is decided by death or meeting a bureaucrat. In a stationary equilibrium, the inflow into history h must equal outflow, which implies that the rates of change for each history and type will equal zero:

$$\dot{n}(0) = \gamma \sum_h Q(h)m(h) - n(0)(\lambda + \pi(0)) + \delta. \tag{12}$$

3. EQUILIBRIUM

Definition. A stationary symmetric equilibrium consists of a triplet $\{q(h), Q(h), n(h)\}_{h\in\{0,1\}}$, value functions, prices, and distributions such that given $\{Q(h)\}_{h\in\{0,1\}}$, $(i) - (vii)$ hold,

(i) The value functions satisfy (1)–(8).
(ii) $q(h)$ satisfies (9) for all h.

[14] Here, I chose lower case letters to represent an agent's decision and upper case letters to represent all other agents' decisions. This is in line with a Nash equilibrium notation, and a symmetric equilibrium will require $q(h) = Q(h)$ for all h.

[15] In the notation $q(h)$, I have suppressed the dependence on the aggregate state that should appear through $V_n(0)$. This dependence will be made explicit later when I analyze the equilibrium.

(iii) $\dot{n}(h) = \dot{m}(h) = 0 \; \forall h$.
(iv) $V_i \geqslant 0 \; \forall i$, $R_s \geqslant 0$.
(v) $P_{ij} \geqslant 0 \; \forall \{ij\}$.
(vi) $V_n(0) = w$.
(vii) $q(h) = Q(h) \; \forall h$.

The equilibrium concept that is being applied here is that of a stationary Nash equilibrium, where an intermediary takes others' decisions ($Q(h)$) as given and chooses the probability of cheating according to the best response function in (9). I concentrate on symmetric equilibria to simplify the analysis. Conditions (iv) and (v) are necessary for participation in the market by all agents. Condition (vi) is the free entry condition, where the value of an entrant is equal to his outside option w. In equilibrium, this condition determines the number of new entrants δ.

Solving for the equilibrium, we get

$$V_n(h) = \frac{\gamma \pi(h)}{\psi(h)} \left(X + (1 - Q(h))V_n(1) + Q(h)V_n(0)\right), \tag{13}$$

where $\psi(h) \equiv (2r + \gamma)(r + \pi(h)) + r(r + \gamma)$, $X = (x + (1 - \alpha)\gamma \sum_h P_{me}(h)\frac{m(h)}{M})/\phi$, and $\phi \equiv r + (1 - \alpha)\gamma + (1 - \alpha)\mu/2 + \alpha$. Equations (10) and (11) imply the following equilibrium distribution equations:

$$n^*(0) = \frac{1}{\lambda + \pi(0)} \left(\gamma \sum_h Q(h)m(h) + \delta\right). \tag{14}$$

Substituting for $\pi(h)$, we get the following equations:

$$n^*(1) = n^*(0) \left(\frac{\gamma}{\gamma + \lambda}\right) \left(\frac{\pi(0)}{\lambda + \pi(0)}\right) (1 - Q(0))(1 - Q(1)), \tag{15}$$

$$m^*(h) = \frac{\pi(h)}{\gamma + \lambda} n^*(h) \qquad \forall h. \tag{16}$$

Given the Nash structure of the equilibrium described above, a result where $Q(h) = 1 \; \forall h$ and where intermediaries are not active is always possible. In this equilibrium, the bargaining between the bureaucrat and intermediary breaks down and no good exchanges hands because $\lim_{Q(h)\to 1} P_{sn}(h) = \infty$ since the bureaucrat must fully insure against the probability of cheating. As this probability approaches one, the only way the bureaucrat can insure against this occurrence is by requesting a prohibitively large price, which results in the breakdown of the match.[16]

In any equilibrium, an entrepreneur has two settings in which to purchase the license, in the public setting, where she will have to pay the red tape cost b, or the corruption market, where the red tape costs are not paid. In both cases, a license is procured (discounted by the rate of time preference r). Therefore, the "savings" produced by this match are $b\alpha + rA$. The amount $b\alpha + rA$ is an essential component of the bargaining process, and therefore, in any negotiation, it will represent the size of the "pie" to be shared between agents. Let $x \equiv b\alpha + rA$.

3.1. *Equilibrium with Intermediaries.* An equilibrium with intermediaries is one in which $n(h) > 0$ for some $h \in \{0, 1\}$, which is equivalent to the probability of cheating at history zero being less than one (see the lemma below). Given the large set of possible equilibria, it is

[16] See Appendix A for a detailed exposition of an equilibrium without intermediaries.

necessary to derive some equilibrium properties in order to give some structure to equilibria with intermediaries. Furthermore, although an equilibrium without intermediaries always exists, this may not be the case for equilibria in which intermediaries are active. In fact, as we will see in Section 3.3, there are constraints on parameters that determine the existence of such an equilibrium.

The following result reduces the set of possible equilibria by ruling out instances where an equilibrium with intermediaries exists, and the probability of cheating is one for $h = 1$.

LEMMA 1. *In any equilibrium with intermediaries,* $q(0) = Q(0) < 1 \Rightarrow q(1) = Q(1) < 1$.[17]

The above result implies that if an equilibrium with intermediaries exists, i.e., $Q(0) < 1$, then it will never be optimal for an intermediary to cheat with probability 1. This is an intuitive result. If an entrant intermediary does not find it optimal to cheat with probability 1, then, given that the probability of meeting a bureaucrat at $h = 1$ is higher, it must be that it is never optimal to cheat with probability 1. Furthermore, the above result suggests that the only pure-strategy equilibrium with intermediation is one in which $Q(h) = 0\ \forall h$. In the following section, we proceed with the description of this equilibrium and the conditions for its existence.

3.2. *Pure-Strategy Equilibrium with Intermediaries.* In order for such an equilibrium to exist, it must be that it is optimal for all agents to choose $q(h) = 0$ for all h, given a sequence $\{Q(h)\}_{h\in\{0,1\}}$ such that $Q(h) = 0$ for all h. However, first, we must describe the entry distribution. Since no intermediaries cheat, the free entry condition, $V_n(0) = w$, uniquely determines a value of the probability of a match at history zero ($\pi^*(0)$). In equilibrium, this probability pins down the mass of new entrants that satisfies the free entry conditions where $n^*(0) = \delta^*$ and $n^*(0)$ is such that $\pi^*(0) = \frac{B}{B+n^*(0)}$.[18] Using (1)–(8), we find the following result.

PROPOSITION. *In any pure-strategy equilibrium with intermediaries, the following must hold:*

(i) $\frac{r}{\tau} < \frac{\gamma}{r+\gamma}$.
(ii) $\tau > \pi(0)$.
(iii) $P_{sn}(1) < P_{sn}(0)$.
(iv) $P_{me}(1) - P_{sn}(1) > P_{me}(0) - P_{sn}(0)$.

The first condition relates the two search periods of an intermediary. If the probability of meeting a bureaucrat ($\pi(1) = \tau$) is too low, for such an equilibrium to exist, it must be that the probability of meeting an entrepreneur is high to compensate. The second condition is intuitive: Intermediaries with $h = 1$ must have a higher rate of match with bureaucrats; otherwise, there would be no incentive to acquire a history.

The third condition relates the fact that in this equilibrium, intermediaries with $h = 1$ pay a lower *consignment* price even though no intermediaries cheat. This result is due to the fact that an intermediary of $h = 1$ has a higher value of being unmatched because his probability of finding a bureaucrat is higher, so in any negotiation between a bureaucrat and an intermediary, the bureaucrat must compensate for this higher value. This result would suggest that in the corruption market, experience matters and that intermediaries with higher histories can command higher premiums for their services. The fourth result in the above proposition is the expression of that intuition. The difference between the sale and purchase prices (i.e., the premium) for more experienced intermediaries is higher.

Another parameter of interest is the size of the corruption market as measured by the mass of active intermediaries in equilibrium. Lemma 2 establishes the link between the relative outside option and the intensity of intermediation.

[17] All proofs can be found in the Appendix.
[18] See the Appendix for a more detailed discussion.

Lemma 2. *If w/x increases, then the mass of intermediaries falls for all histories.*

The above lemma describes a salient feature of the corruption market. As workers become richer (or the proceeds from corruption fall), the total number of workers that choose to become intermediaries falls. This straightforward result follows from the free entry condition. Since the relative outside option of workers increases, the value of a new entrant must increase to reflect the change. This implies that the probability that a new entrant meets a bureaucrat in the corruption market must, in turn, increase. This can only be achieved if the total mass of entrants falls. Since there are now fewer entrants, there must be fewer intermediaries at each history in equilibrium.

It is clear from the discussion of equilibrium above that any increase in the size of the bureaucracy will only result in a larger mass of entrants in the market, but, *all else equal*, the price that entrepreneurs pay will remain unchanged. This result is not an artifact of the constant rate of matching for intermediaries of $h = 1$. Consider what happens to the market of history zero; when the size of the bureaucracy increases, the probability of a match for an entrant intermediary increases as well, which induces more entry, up to the point where the rate of a match remains unaffected. For workers, the equilibrium with intermediaries is clearly Pareto superior, given that a fraction of them earn a higher lifetime value, and the rest remain workers with a wage of w.

In terms of efficiency, the rate at which a license is issued to an entrepreneur increases to $\alpha + (1 - \alpha)(\mu + \gamma)$, and the number of projects approved during an arbitrary time period t increases. Depending on the reasoning behind licensing, this fact can have various implications for welfare. Note that the increase in the number of licenses issued is solely due to an increase in the number of licenses issued in the corruption market, where presumably the necessary quality controls are bypassed (remember the entrepreneur does not pay the red tape cost b in this market). Thus, the projects approved in the corruption market may result in poor quality of implementation, which can cause substantial economic losses in the long run.

3.3. *Equilibrium Selection.* As was mentioned previously, an equilibrium where intermediaries are not used is always possible. Since the policy parameters α and b are a main point of focus for the quantitative analysis that follows in Section 4, it would be appropriate at this point to discuss how they affect equilibrium selection. Figure 1 depicts the combinations of α and b over which an equilibrium with intermediaries becomes feasible.[19]

It is important to note that the graph depicts combinations of α and b where intermediation is *feasible*, which does not imply that it is the only outcome of the model. The section in the graph labeled “no intermediation” depicts combinations of α and b that do not incentivize intermediation and thus will always induce $q(h) = Q(h) = 1$ for all histories. The section labeled “active intermediaries” depicts combinations of α and b where both types of pure strategy as well as mixed strategy equilibria coexist given the Nash equilibrium concept employed here.

When both b and α are relatively low, the “threat point” of intermediaries in their bargaining with entrepreneurs is also low. Therefore, the “savings” provided by the corruption market are small, as is the share of these savings that can be appropriated by intermediaries. This is because when business costs are low, entrepreneurs are more willing to purchase the license legally and less willing to part with a larger share of the surplus. For larger values of b, the probability of audit α that induces intermediation falls significantly. This is due to the fact that as b increases, entrepreneurs will have to part with a larger share of the project if they purchase the license legally; therefore, even when the probability of such an occurrence is relatively low, they are willing to give up a larger share of their profits to prevent it from happening, which increases the returns to intermediation.

The combinations of α and b in Figure 1 determine the expected loss to the entrepreneur in case the license has to be purchased legally. Entering the corruption market is a way of shielding

[19] See the online appendix for the source of parameter values.

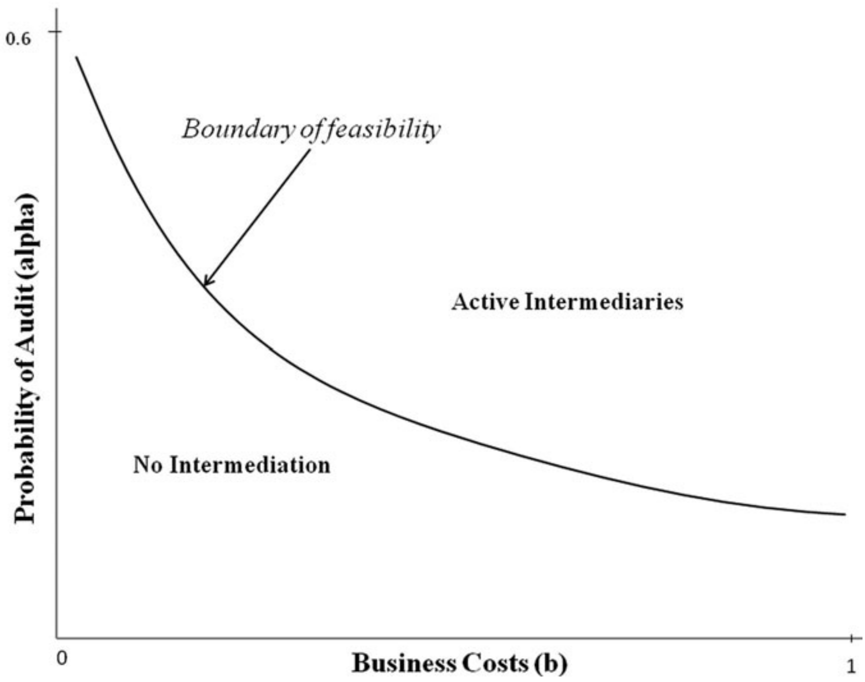


FIGURE 1

EQUILIBRIUM SELECTION

oneself from such a loss. If this expected loss is sufficiently large, the entrepreneur will be willing to compensate an intermediary in possession of a license. Where intermediation is feasible, this compensation surpasses the threshold value an intermediary needs to remain honest. When both α and b are very high, there is a high return to being an intermediary, so cheating is not optimal. It is also worth noting that the relationship of α and b along the boundary of feasibility is nonlinear. This is due to the fact that at high values of b, intermediation becomes more frequent, and a significant proportion of the licenses for sale in the market are in the hands of intermediaries. Implicitly, this means more negotiating power on the side of an intermediary. In this way, the fall in α that is needed to keep the intermediary indifferent between cheating and being honest at high levels of b is smaller.

4. QUANTITATIVE EVALUATION AND POLICY ANALYSIS

The purpose of this section is to quantify some of the model's comparative static predictions and to analyze the model's sensitivity to some of the exogenous parameters. The main policy parameters of interest here are the audit probability α and the legal costs of obtaining permits b. In fact, the following exercises will compare responses of key variables to both these parameters, with the goal of giving some insight as to what would constitute effective policy in reducing the negative effects (if any) of the size of the corruption market.[20] In the quantitative section, I will allow for two departures from the theoretical model outlined above: First, bargaining power will be allowed to vary. Second, the matching function for matches between bureaucrats and intermediaries of history 0 will be slightly amended to $M(n(0), B) = \frac{B\sigma n(0)}{\sigma n(0)+B}$, where σ represents

[20] Since the space of policy analysis is two-dimensional, a theoretical treatment of the comparative static results is cumbersome, as the welfare equation (17) can easily attest to. The numerical analysis is just as illustrative in this case and sheds light on all of the responses of the pertinent variables.

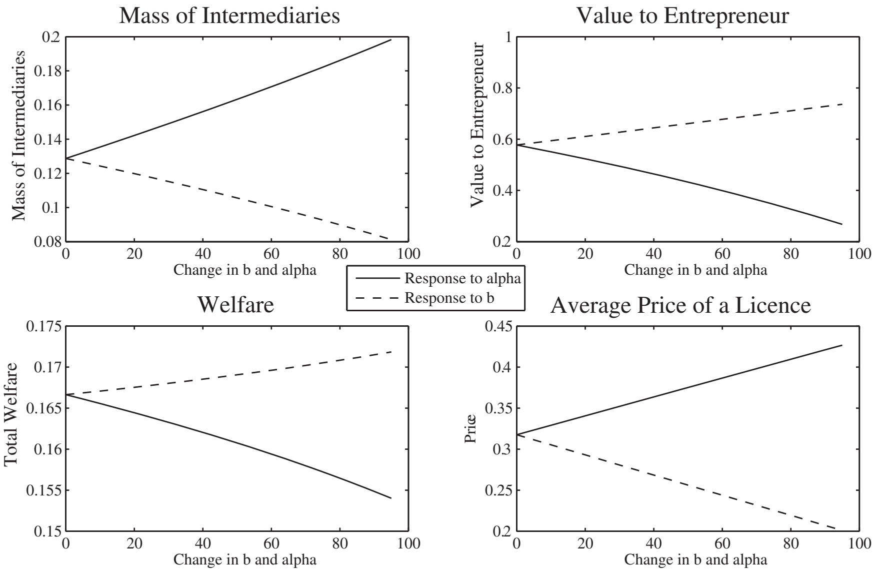


FIGURE 2

POLICY RESPONSE (PART 1)

the intensity of search on the part of intermediaries. I will then use these two parameters to perform a sensitivity analysis on the key results.[21]

4.1. *Policy Effects*. I define welfare as the weighted sum of the discounted value of agents in the economy. I analyze the response of average prices for licenses, the mass of intermediaries, individual payoffs and welfare to the policy parameter α, the probability that the government performs an audit, as well as the parameter b, the fraction of the project's value that the government legally extracts from entrepreneurs. Equation (17) is a mathematical representation of this notion of welfare. The key observation is that not only do α and b influence the values of each agent, but they also affect the number of intermediaries that are active in the corruption market, thus influencing the welfare of potential intermediaries (workers).

$$W(\alpha, b) = BV_s(\alpha, b) + EV_e(\alpha, b) + \sum_h n(h, \alpha, b)V_n(h, \alpha, b) + \sum_h m(h, \alpha, b)V_m(h, \alpha, b) + \left(1 - E - B - \sum_h \{n(h, \alpha, b) + m(h, \alpha, b)\}\right) w. \tag{17}$$

The parameters α and b can be thought of as two possible mechanisms of reducing the incidence of corrupt transactions. The parameter $1 - \alpha$ represents the probability that a license will be sold in the illicit market, and b represents the costs an entrepreneur must incur for the license if it is obtained legally. The effects are summarized in Figure 2 and Table 1.

The first graph in Figure 2 relates the number of intermediaries as a percentage of the total population to both parameters.[22] The first observation is that intermediation is strictly increasing in b; as the red tape costs fall, the payoff to intermediation is strictly decreasing.

[21] See the online appendix for sources of parameter values. The project value A is normalized to one and b is in percentage terms.

[22] In Figure 2, α is increasing on the x axis, whereas b is decreasing. For example, 0.3 on the x-axis implies a 30% increase in α or a 30% fall in b from benchmark values.

TABLE 1
INCREASING AUDITS VERSUS REDUCING RED TAPE

	$b = 50\%$	$\alpha = 150\%$
I	−8.5%	+26%
V_e	+3.15%	−10.5%
W	+0.8%	−4.76%
$Avg\ P$	−7.34%	+24.46%

The more striking feature of the figure, however, is the positive effect that the probability of an audit has on the mass of intermediaries. When the costs of licensing legally (b) are large, the payoff to intermediation is equally large. As the probability of an audit (α) increases, so does the expected loss that an entrepreneur faces, since she is much more likely to have to purchase the license legally. This, in turn, induces a larger share of the surplus to be transferred to intermediaries, which increases the value of intermediation and therefore the fraction of the populations that practices it. The above result suggests that increasing the frequency of audits merely transfers corrupt activities and the resulting revenue into the hands of intermediaries since the mass of bureaucrats remains unchanged. This result holds only when compliance costs are particularly onerous and suggests that reducing these costs may be a more effective way of eliminating corruption. In this case, reducing the costs of doing business by 50% results in a fall of 8.5% in intermediation, whereas increasing α by the same magnitude only exacerbates the problem (see Table 1).

The second graph in Figure 2 clearly shows that entrepreneurs are made worse off with a higher frequency of audits when intermediaries are active. This is entirely due to the fact that the costs of procuring the license through the legal process are prohibitive (b is relatively large), and forcing the entrepreneurs to incur these costs through audit is welfare reducing. Inherently, this results in a seemingly perverse vicious cycle of corruption; in countries that have the highest red tape costs, where fighting corruption is critical, doing so worsens the outcome for entrepreneurs and presumably for the larger economy as projects become less profitable. Table 1 gives a quantitative picture of these effects; a reduction of b is clearly far more preferable than an increase in the frequency of audits.

A fall in b reduces the welfare of potential intermediaries as the surplus to be negotiated over falls, which reduces the prices intermediaries can fetch for their services.[23] However, entrepreneurs are made strictly better off, because the price that they have to pay is falling. As Table 1 shows, welfare increases with a reduction in b and falls with an increase in α, because entrepreneurs are strictly better off in the first instance.

The last graph in Figure 2 explores the relationship between prices and the policy parameters b and α. As in the analysis above, increasing α when b is relatively high actually increases the average price an entrepreneur pays in an intermediated equilibrium, because when costs are relatively high, intermediaries have higher threat points with higher α and can extract higher proportions of the surplus in a match with the entrepreneur. Reducing b, on the other hand, is far more effective (see Table 1), as it greatly reduces the price both bureaucrats and intermediaries command in the corruption market.

The welfare impact of changes in the policy parameters in Figure 2 is the result of the interplay between the welfare effects on entrepreneurs and intermediaries and depends on the fraction of the population that is engaged in either activity. Bureaucrats' welfare is decreasing in both parameters (see Figure 3) and is a small proportion of the total. However, as Figure 3 shows, the value to intermediation increases significantly with an increase in α at high levels of b, where the

[23] Overall, any such discussion of welfare is limited by the partial equilibrium nature of this analysis. It is worth noting that this model omits questions of externalities and the reasons for issuing licenses, which, in most cases, are used to correct perceived market failures. However, one must also remember that corrupt governments often increase the amount of red tape and licensing to increase corruption proceeds that they collect, so it is not always clear that license issuance is intended to correct for these failures.

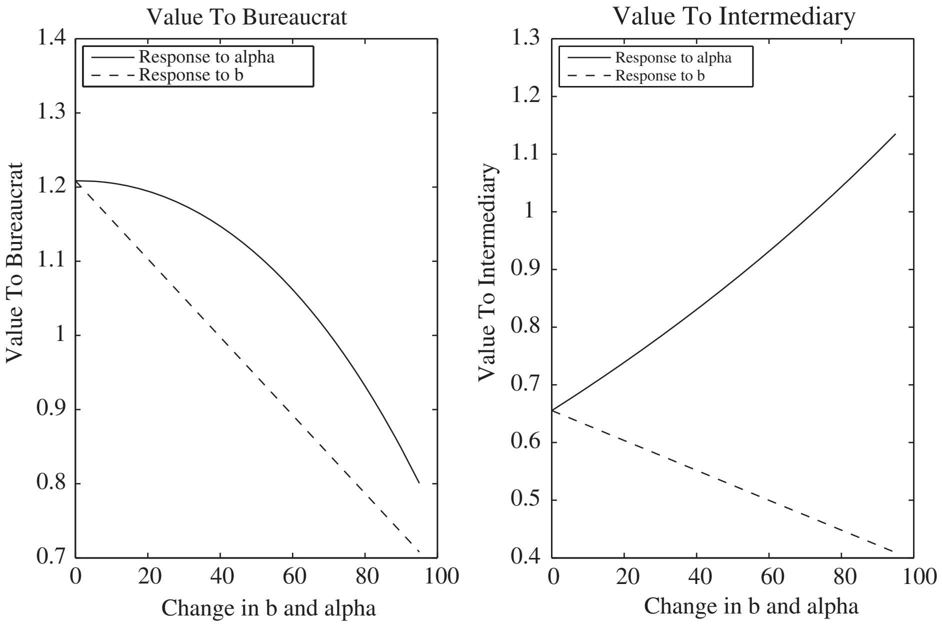


FIGURE 3

POLICY RESPONSE (PART 2)

reasons for this increase are laid out in the discussion above. When the fraction of entrepreneurs and intermediaries in the population are similar, total welfare falls with an increase in α. This is due to the fact that the fall in entrepreneurial welfare is quite significant, whereas the rise in intermediary welfare is moderated by the increase in the extensive margin of intermediation. Note that when intermediation surpasses entrepreneurship as an activity, total welfare increases in α, as intermediaries become the dominant group.

4.2. *Sensitivity Analysis.* In this section, I explore how sensitive the results of the policy effects exercise in Section 4.1 are to changes in two exogenously given parameters of the model: the bargaining power parameter θ as well as the search intensity parameter σ. This choice reflects the fact that both parameters are more likely to vary in cross-country comparisons. The bargaining power parameter could be thought of as a second dimension to the level of corruption in a country. Where corruption is pervasive, bureaucrats are less likely to be reported when engaged in corrupt activities and are therefore more likely to set the terms in any negotiation, thus having higher negotiating power. On the other hand, the search intensity parameter captures the ease with which a match with a bureaucrat can be achieved by an intermediary. When σ is relatively low, bureaucrats are more accessible by intermediaries and so access to licenses is less cumbersome.

There are three matches where bargaining is relevant. For the sake of brevity, bargaining power is collapsed to a single parameter θ as described in the table below. The first column lists the matching agents (bureaucrats [S], entrepreneurs [E], and intermediaries [I]) and the second column lists the bargaining power of the corresponding agent.

Match	Bargaining Power
S, E	$(1-\theta), \theta$
S, I	$(1-\theta), \theta$
E, I	$\theta, (1-\theta)$

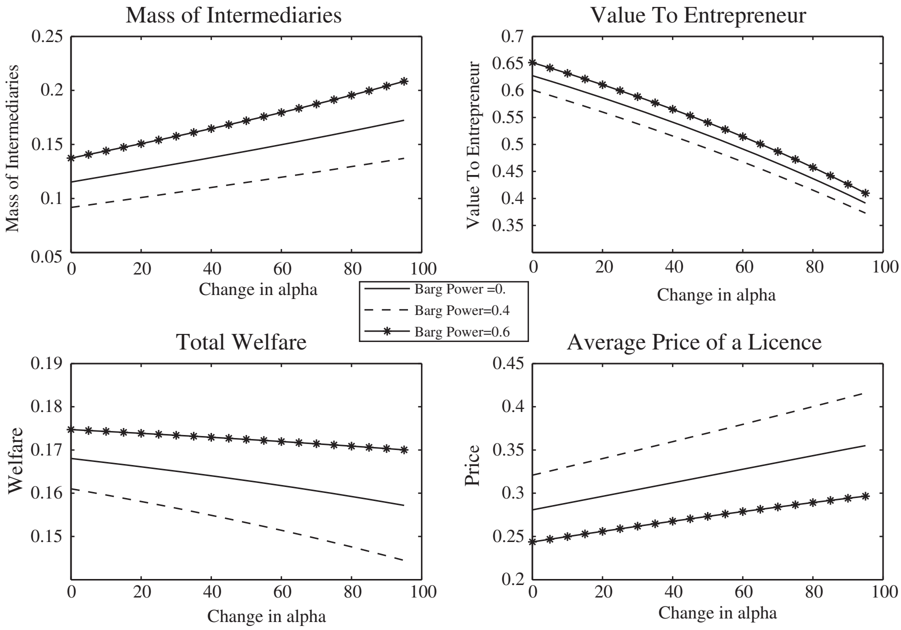


FIGURE 4

SENSITIVITY TO BARGAINING POWER (PART 1)

Figure 4 reproduces Figure 2 at different levels of the bargaining power parameter.[24] Note that when θ increases, the entrepreneur is better off in both of her matches and therefore entrepreneurial value increases in θ. For the same reasons, as θ increases, the average price of a license paid by the entrepreneur falls as well, while maintaining the magnitude of its first-order response to α. On the other hand, the behavior of the number of intermediaries as a response to θ is more subtle. There are two effects in operation here. First, an increase in θ reduces an intermediary's bargaining power when he sells the license to an entrepreneur, but increases it when said license is purchased from the bureaucrat. The first effect decreases intermediation value, whereas the second increases it. There is, however, a third effect. When θ increases, the bureaucrat's bargaining power is reduced in *all* of his matches, which reduces his negotiating position even further when matched with an intermediary. This then increases the value to being an intermediary even further, thus inducing more entry. It is also interesting to note that an increase in the bargaining power parameter θ not only shifts aggregate welfare up due to an increase in entrepreneurial value, but also reduces the first order effect α has on welfare.

Figure 5 depicts the response of the level of intermediation and total welfare to changes in the search intensity parameter σ. As expected, when search intensity is low, bureaucrats are more accessible, which induces entry into intermediation. Since entrepreneurial welfare is not very sensitive to search intensity, a reduction in σ causes an increase in total welfare due to the fact that the value to intermediation has increased, as illustrated by the increase in the number of intermediaries.

5. DISCUSSION AND CONCLUSION

This article constructs a basic model of corruption with intermediation. I find that an equilibrium without intermediaries is always present given the self-fulfilling nature of individuals'

[24] In the interest of space, I have omitted the response of these variables to a fall in b. The variables respond in a similar manner.

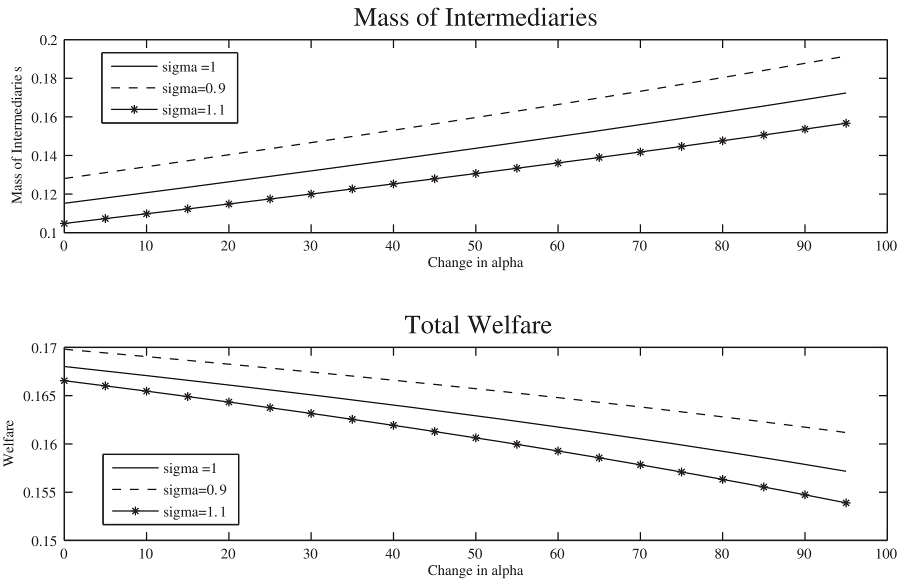


FIGURE 5

SENSITIVITY TO BARGAINING POWER (PART 2)

beliefs. In a pure-strategy equilibrium, intermediaries of nonzero histories ($h = 1$) earn higher premiums. Changes in wages relative to the potential proceeds from corruption affect both the size of the corruption market as measured by the mass of active intermediaries as well as payoffs to intermediaries. An increase in the probability of an audit reduces welfare for bureaucrats, whereas its effects on entrepreneurs and intermediaries depend on the size of the compliance/red tape costs. When these are relatively high, increasing the frequency of audits (fighting corruption) increases intermediaries' welfare and reduces that of entrepreneurs. This reduction in entrepreneurial welfare is a result of their aversion to obtaining permits legally given the high costs, which induces them to accept a higher ask price from intermediaries and bureaucrats. Increasing auditing frequency acts as a revenue redistribution mechanism from bureaucrats and entrepreneurs to intermediaries.

From a modeling perspective, one feature of note is the assumption that a cheating intermediary is immediately downgraded to a history of zero. This is not a necessary condition for the existence of the equilibrium above, although it makes the analysis more tractable. However, it is possible to admit a partial loss of history so that a cheating intermediary has a history of 1 with some positive probability.[25] Naturally, this form of punishment is more general and could be applied to the model without great complication. However, in any such extension of the model, the pure-strategy equilibrium with intermediaries is identical to the one described in detail in the article. The differences between the two versions of the model are seen in the variety of mixed strategy equilibria not analyzed here.

The choice of consignment as a modeling tool is deliberate here. Anecdotal evidence suggests that intermediaries meet with licensees privately.[26] In that event, and given that contract enforcement is difficult in illicit markets, intermediaries have ample opportunity to cheat bureaucrats out of corruption revenue. This article then addresses endogenous intermediation. The goal, as stated in the introduction, is to generate intermediation as an equilibrium outcome. The cheating probability in the model can be thought of as the fraction of corruption revenue that an intermediary decides to keep for himself by reneging on the agreement with

[25] This extension is dealt with in detail in the online appendix.
[26] See the online appendix for some examples.

the bureaucrat. The goal here is to allow the intermediaries an avenue to do so and understand the mechanics that would result in an intermediated equilibrium even when cheating is a possibility.

From a more general political economy perspective, it is important to stress that corruption is not an isolated phenomenon that involves only the government official and the end user of government service, but rather a market in itself that takes time and resources to operate. This market is innovative and becomes embedded in the economy and is difficult to uproot. Viewed from this angle, corruption is a structure that, through its redistributive power, thrives by giving a larger number of agents a real stake in its survival. Thus, corruption becomes an implicit political bribe. In a corrupt country that holds free elections, government officials who have a record of being corrupt may not be thrown out of office because a substantial fraction of the population may have a real economic interest in the status quo (as in Bobonis et al., 2010). In this way, corruption makes society myopic by overemphasizing the short-term gains and ignoring long-term losses.

APPENDIX

A.1. *Equilibrium without Intermediation.* Let us consider the equilibrium without intermediaries. Given the Nash structure of the equilibrium and given a sequence $\mathbf{Q}$ such that $Q(h) = 1$ $\forall h$, the optimal sequence q that satisfies (6) is such that $q(h) = 1$ $\forall h$. Therefore, the sequence $Q(h) = 1$ $\forall h$ is a Nash equilibrium. This establishes the following lemma:

LEMMA 3. *An equilibrium without intermediaries always exists.*

In fact, there are multiple equilibria in which intermediaries are not active, where an equilibrium without intermediaries is one in which $n(h) = m(h) = 0$ $\forall h$. However, there is one feature that these equilibria have in common, $Q(0) = 1$. If it is optimal for entrants to cheat, and since histories evolve one step at a time, the mass of intermediaries of history 0 will be zero, resulting in a degenerate distribution of zero mass for $h = 1$. Furthermore, any sequence of cheating probabilities $\{Q(h)\}_{h\in\{0,1\}}$, combined with $Q(0) = 1$, is an equilibrium without intermediaries.

The price and value functions in this equilibrium can be solved as

$$V_e = \frac{\alpha(A-b) + A(1-\alpha)\mu/2}{r + (1-\alpha)\mu/2 + \alpha}, \tag{A.1}$$

$$P_{se} = \frac{1}{2}\frac{b\alpha + rA}{r + (1-\alpha)\mu/2 + \alpha}, \tag{A.2}$$

$$V_s = \frac{1}{2r}(1-\alpha)\mu\frac{b\alpha + rA}{r + (1-\alpha)\mu/2 + \alpha}. \tag{A.3}$$

The price paid by the entrepreneur (A.1) reflects the outside option that the entrepreneur has if she refuses to accept the offer at hand. In an equilibrium without intermediaries, an entrepreneur has only two settings in which to purchase the license: in the public setting, where she will have to pay the red tape cost b with probability α, or the corruption market, where the red tape costs are not paid. In both cases, a license is procured (discounted by the rate of time preference r). Therefore, the "savings" produced by this match are x. The effective discount rate for an entrepreneur looking for a license in an equilibrium without intermediaries is $\theta = r + (1-\alpha)\mu/2 + \alpha$, and therefore the total "savings" produced by this match are $\frac{b\alpha+rA}{r+(1-\alpha)\mu/2+\alpha}$. Note that if $\theta < 1$, then the "savings" are magnified, given that an actual discount would be applied to any future successful bargaining, and when $\theta > 1$, the price paid by an entrepreneur is a fraction of the total "savings" produced by the match since the effective discount is larger than one.

A.2. *Determining the Pure Strategy Intermediated Equilibrium.* The equilibrium values of $n(0)$ and $\pi(0)$ are uniquely linked by the following equations:

$$n(0) = \frac{\delta}{\lambda + \pi(0)},$$

$$\pi(0) = \frac{B}{B + n(0)}.$$

Once the value of $\pi(0)$ that satisfies the equilibrium clearing condition of free entry is determined, then this determines the unique value of $n(0)$ and thus the fraction of new entrants δ. Also, note that once the value of $n(0)$ is determined, the values of $m(0)$, $m(1)$, and $n(1)$ are also uniquely determined by (15) and (16).

In order to clarify the determination of the value for $\pi(0)$, solving (1)–(8) determines the equilibrium prices paid by entrepreneurs to intermediaries for both histories.[27] More specifically,

$$P_{me}(0) = \kappa_0 X,$$

$$P_{me}(1) = \frac{\kappa_1}{2} X,$$

where κ_0, κ_1, X, $\psi(h)$, and ϕ are defined as follows:

$$\kappa_0 \equiv \frac{1}{(\psi(1) - \gamma\pi(1))}\left(\psi(1) - \gamma\pi(1) - \frac{\psi(1)r(2r+\gamma)}{2\psi(0)}\right),$$

$$1 < \kappa_1 \equiv \left(\frac{\psi(1) - 2\gamma\pi(1) + \gamma(r + \pi(1)) + r(r+\gamma)}{\psi(1) - \gamma\pi(1)}\right) < 2,$$

$$\begin{aligned} X &\equiv \left(\frac{x + (1-\alpha)\gamma\left[P_{me}(0)\frac{m(0)}{M} + P_{me}(1)\frac{m(1)}{M}\right]}{\phi}\right) \\ &= \frac{x}{\phi} + \frac{(1-\alpha)\gamma}{2\phi}\left(2P_{me}(0)\frac{m(0)}{M} + 2P_{me}(1)\left(1 - \frac{m(0)}{M}\right)\right), \end{aligned}$$

$$\psi(h) \equiv (2r+\gamma)(r + \pi(h)) + r(r+\gamma),$$

$$\phi \equiv r + (1-\alpha)\gamma + (1-\alpha)\mu/2 + \alpha.$$

Note that plugging in for $P_{me}(h)$ gives the following solution for X:

$$X = \frac{x}{\phi} + \frac{(1-\alpha)\gamma}{\phi} X\left(\kappa_0\frac{m(0)}{M} + \frac{\kappa_1}{2}\left(1 - \frac{m(0)}{M}\right)\right). \tag{A.4}$$

[27] See the online appendix for a more detailed derivation.

It can be shown that $\kappa_0 < \frac{\kappa_1}{2} < 1$ so that the expression $\kappa_0 \frac{m(0)}{M} + \frac{\kappa_1}{2}(1 - \frac{m(0)}{M}) < 1$.[28] Therefore, for a given value for $\pi(0)$, X is uniquely determined since it can be written as $X = \kappa(x/\phi)$ where

$$\kappa = \left[1 - \frac{(1-\alpha)\gamma}{\phi}\left(\kappa_0 \frac{m(0)}{M} + \frac{\kappa_1}{2}\left(1 - \frac{m(0)}{M}\right)\right)\right]^{-1} > 0.$$

Now, with $Q(0) = 0$, (13) implies the following value function for new entrants:

$$V_n(0) = \frac{\gamma\pi(0)}{\psi(0)}\left[X + V_n(1)\right],$$

and with $Q(1) = 0$, $V_n(1)$ can be written as

$$V_n(1) = \frac{\gamma\pi(1)}{\psi(1)}\left[X + V_n(1)\right]. \tag{A.5}$$

Using these expressions and the free entry condition ($V_n(0) = w$), we get

$$X = \frac{\psi(0)}{\gamma\pi(0)} \frac{\psi(1) - \gamma\pi(1)}{\psi(1)} w. \tag{A.6}$$

Equations (A.4) and (A.6) define a system of equations that solves for the entrant's probability of matching with the bureaucrat. Note that the matching rates at history 1 are fixed so that the only necessary determination here is that of $\pi(0)$. Also, note that (A.6) determines $\pi(0)$ uniquely given X and that (A.4) determines X uniquely given $\pi(0)$.

A.3. *Proofs.*

A.3.1. *Lemma 1.*

PROOF. The lemma states that $q(0) = Q(0) < 1 \Rightarrow q(1) = Q(1) < 1$. Suppose instead that $q(1) = Q(1) = 1$. This would imply that $D(Q(0), 0) \geq 0$ and that $D(1, 1) < 0$. First, we derive an expression for $P_{sn}(h)$. Equation (5) and the expression for Z_{sn} imply the following:

$$V_m(h) - V_n(h) = R_s(h) = \frac{\gamma}{r+\gamma}(1 - Q(h))P_{bn}(h).$$

Using Equation (1), we have that

$$V_n(h) = \frac{\pi(h)}{r}\left[V_m(h) - V_n(h)\right] = \frac{\pi(h)}{r}\frac{\gamma}{r+\gamma}(1 - Q(h))P_{sn}(h).$$

However, in this case, $Q(1) = 1$ implies $V_n(1) = 0$. From the equation for $D(Q(h), h) = V_n(1) - P_{sn}(h) - V_n(0)$ and the free entry condition $V_n(0) = w$, we have

$$D(Q(0), 0) = V_n(1) - \left[1 + \frac{r(r+\gamma)}{(1 - Q(0))\gamma\pi(0)}\right] w < 0,$$

which is a contradiction. ■

[28] See the online appendix section 4.

A.3.2. *Proposition.*

PROOF. Here are the proofs for each part of the proposition.

i. For $D(0,1) > 0$, we must have that $V_n(1) - P_{sn}(1) - w > 0$. Plugging in for $P_{sn}(1) = \frac{r(r+\gamma)}{\gamma\pi(1)} V_n(1)$, we get

$$V_n(1)\left(\frac{\gamma\pi(1) - r(r+\gamma)}{\gamma\pi(1)}\right) - w > 0 \Rightarrow \frac{r}{\pi(1)} < \frac{\gamma}{r+\gamma}.$$

ii. We find the conditions for $D(0,0) > 0$. We have that $D(0,0) = V_n(1) - P_{sn}(0) - V_n(0)$. From the proof of Lemma 1, we know that $P_{sn}(0) = \frac{r(r+\gamma)}{\gamma\pi(0)} V_n(0)$. Equation (A.5) defines $V_n(1) = \frac{\gamma\pi(1)}{\psi(1) - \gamma\pi(1)} X$. Using (A.6) to replace for X and the free entry condition $V_n(0) = w$, we have

$$D(0,0) = w\left(\frac{\psi(0)}{\gamma\pi(0)} \frac{\gamma\pi(1)}{\psi(1)} - \left[1 + \frac{r(r+\gamma)}{\gamma\pi(0)}\right]\right) > 0.$$

Now in order for this condition to be satisfied, it is necessary that $\frac{\psi(0)}{\gamma\pi(0)} \frac{\gamma\pi(1)}{\psi(1)} > 1$, or that $\frac{\psi(0)}{\psi(1)} > \frac{\pi(0)}{\pi(1)}$. Given the expression for $\psi(h) = (2r+\gamma)(r+\pi(h)) + r(r+\gamma)$, we have

$$\frac{\psi(0)}{\psi(1)} = \frac{r(3r+2\gamma) + (2r+\gamma)\pi(0)}{r(3r+2\gamma) + (2r+\gamma)\pi(1)} > \frac{\pi(0)}{\pi(1)},$$

which implies $\pi(1) > \pi(0)$.

iii. Note that $P_{sn}(1) = \frac{r(r+\gamma)}{\gamma\pi(h)} V_n(1)$ and $P_{sn}(0) = \frac{r(r+\gamma)}{\gamma\pi(0)} w$. Therefore, $\frac{P_{sn}(0)}{P_{sn}(1)} = \frac{\pi(1)}{\pi(0)} \frac{w}{V_n(1)}$. The free entry condition implies that $w = \frac{\gamma\pi(0)}{\psi(0)} (\frac{\psi(1)}{\gamma\pi(1)} V_n(1))$. Plugging this condition into the equation for $\frac{P_{sn}(0)}{P_{sn}(1)}$, we get $\frac{P_{sn}(0)}{P_{sn}(1)} = \frac{\psi(1)}{\psi(0)} > 1$, where the last inequality comes from ii.

iv. First, we note that

$$2P_{me}(h) = A - V_n(h') + V_m(h) + P_{sn}(h) - V_e \forall h \Rightarrow$$

$$2\left(P_{me}(1) - P_{me}(0)\right) = (V_m(1) + P_{sn}(1)) - (V_m(0) + P_{sn}(0)) \Rightarrow$$

$$(P_{me}(1) - P_{sn}(1)) - (P_{me}(0) - P_{sn}(0)) = \frac{1}{2}\left[V_m(1) - V_m(0)\right] + \frac{1}{2}\left[P_{sn}(0) - P_{sn}(1)\right] > 0,$$

where the last inequality results from i and the fact that $V_m(1) > V_m(0)$. ■

A.3.3. *Lemma 2.*

PROOF. Putting (A.4) and (A.6) together, we have

$$\kappa(x/\phi) = \frac{\psi(0)}{\gamma\pi(0)} \frac{\psi(1) - \gamma\pi(1)}{\psi(1)} w,$$

$$\kappa \frac{\gamma\pi(0)}{\psi(0)} = \frac{\psi(1) - \gamma\pi(1)}{\phi\psi(1)} (w/x), \tag{A.7}$$

where

$$\kappa = \left[1 - \frac{(1-\alpha)\gamma}{\phi}\left(\frac{\kappa_1}{2} - \frac{m(0)}{M}\left(\frac{\kappa_1}{2} - \kappa_0\right)\right)\right]^{-1}.$$

For the proof, it is useful to reiterate the following comparative statics: $\frac{\partial}{\partial n(0)}\pi(0) < 0$, $\frac{\partial}{\partial n(0)}\psi(0) < 0$, $\frac{\partial}{\partial n(0)}m(0) > 0$, $\frac{\partial}{\partial n(0)}m(1) > 0$, $\frac{\partial}{\partial n(0)}\frac{m(0)}{M} > 0$, $\frac{\partial}{\partial n(0)}\kappa_0 < 0$, and $\frac{\partial}{\partial n(0)}\kappa < 0$. Finally, $\frac{\partial}{\partial n(0)}\frac{\gamma\pi(0)}{\psi(0)} < 0$. In this case, the LHS of (A.7) is decreasing with $n(0)$, which implies that any increase in w/x must result in a decrease of $n^*(0)$ in equilibrium. ■

SUPPORTING INFORMATION

Additional Supporting Information may be found in the online version of this article at the publisher's website:

Online Appendix

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