

PETTY CORRUPTION AND CITIZEN REPORTS*

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Abstract

Offering incentive schemes to low-ranking officials is difficult in corrupt environments. As is well known, there exists a tension between the dual goals of enforcing regulations and preventing corruption. Recent efforts to curb abuses have inspired interest in using new communication technologies to collect information directly from citizens. In our model, entrepreneurs must comply with regulations before undertaking a risky activity. Officials verify their compliance and may engage in corruption. The government tolerates corruption and weak enforcement when it does not communicate directly with entrepreneurs. We show that a simple self-reporting scheme in which entrepreneurs can report their own noncompliance to the government is optimal, and both deters corruption and improves regulatory enforcement.

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1 Introduction

Petty corruption is widespread in the developing world and affects the lowest levels of government, where ordinary citizens and firms are most likely to interact with public officials.¹ Corruption undermines the enforcement of regulations designed to protect society from risks and hazards, but offering incentive schemes to low-ranking officials is notoriously difficult in corrupt environments (see, e.g., Mookherjee (1998)). Two issues give rise to this challenge. First, public officials often have significant discretionary power, and their decisions are not generally transparent. Second, officials who misbehave often have a low probability of being sanctioned, and face weak penalties when they are caught. As a result, even benevolent governments may have no choice but to tolerate corruption and weak regulations (see, e.g., Khalil et al. (2010), and Finan et al. (2015)).

To improve oversight of public officials, it is increasingly common for governments to gather information at the receiving end of public services. In particular, a number of countries have leveraged recent improvements in communication technologies to implement feedback schemes that allow users of public services to file complaints about government officials.^{2,3} In this paper, we explore the optimal approach to gathering and exploiting citizen-provided information, and argue in favor of a simple self-reporting scheme. Specifically, we make the case that communicating with citizens about their *own* behavior can also help efforts to reduce corruption. We show that allowing individuals or companies to report their failure to comply with rules and tying government officials' pay to these reports can help prevent corruption in public administrations and ensure that regulations are properly enforced. A virtue of our self-reporting scheme is its simplicity: it does not require the intervention of monitors or courts, nor does the government need to verify the accuracy of the reports.

We develop a model in which a population of entrepreneurs is required to comply with some regulation (e.g., environmental law) upon undertaking an activity (e.g., the production of a good).⁴

¹See Olken and Pande (2012) and Banerjee et al. (2012) for recent surveys.

²For instance, see Ghana's Whistleblower Act and Punjab's Citizen Feedback Model (Callen and Hasanain (2011)). Another example is the anti-corruption website recently created in Kenya (www.president.go.ke/en/category/corruption.php), where people can report cases of malfeasance. On the link between ICT improvements and the dramatic reduction in the cost of filing, registering, and processing feedback, see, for instance, *The Economist* (September 24th, 2009).

³See Amegashie (2016) on whether complaints can discipline officials. Mookherjee and Png (1992) consider complaints in a model without bribery. Prendergast (2003) looks at complaints as a means of bureaucratic oversight.

⁴We refer to citizens as entrepreneurs, but our analysis is more general. It applies, for instance, to the issuance of drivers' licenses (e.g., Bertrand et al., 2007). We provide further examples in Section 3.

Compliance with regulation is privately costly, but avoids generating negative externalities (e.g., pollution). Government officials are matched with entrepreneurs to perform a screening function. They verify whether entrepreneurs comply, and either grant or deny the permit necessary to carry out the activity.⁵ The government observes whether an official grants a permit, but not the information upon which the decision is based. As a result, officials can engage in (i) *bribery*, by obtaining money from noncompliant entrepreneurs in exchange for the permit, and (ii) *extortion*, by forcing compliant entrepreneurs to pay a bribe to be issued the permit. Whereas bribery weakens the effectiveness of regulation, extortion deters entrepreneurs from applying for the permit. Finally, the expected sanctions officials face when misbehaving are insufficient to deter corruption.

To highlight the well-known tension that arises when trying to deter both bribery and extortion, we first analyze the case in which the government is unable to communicate with the entrepreneurs, perhaps because communication technologies are prohibitively costly. To deter bribery, the government must reward officials who deny permits. However, such a policy invites extortion: it makes systematically refusing permits in the officials' interest. As a result, the government cannot do better than to offer low-powered incentives, and tolerate bribery in order to deter extortion (see, for instance, Hindriks et al. (1999) and Khalil et al. (2010)). The enforcement of regulation is then weak, because noncompliant entrepreneurs are able to receive a permit in exchange for a bribe.

We then allow the government to communicate with the entrepreneurs and show that doing so deters both bribery and extortion. Importantly given our wish to influence policy-making, the optimal mechanism can be implemented with a simple self-reporting scheme. Under the scheme, entrepreneurs are allowed to report their noncompliance to the government before their officials' decision regarding whether to grant the permit. The government denies the permit to the entrepreneurs who self-report, possibly in exchange for a small compensation. Finally, officials receive a bonus when the entrepreneur they are paired with self-reports, and otherwise receive a flat payment independent of their decision regarding the permit. Absent a bribe, officials whose entrepreneurs do not self-report are then better off granting (denying) permits to compliant (noncompliant) entrepreneurs to avoid possible sanctions, even if sanctions are rare and weak. Also, the entrepreneurs who anticipate being denied the permit by their officials may as well self-report. Such a scheme prevents extortion because it is enough for

⁵In the model, the government may as well delegate the decision to issue permits to officials.

a compliant entrepreneur to refuse to pay a bribe and to *not* self-report to make it in the official's interest to grant the permit. Moreover, officials have no desire to engage in bribery, (i) because the bonus the government promises them if their entrepreneur self-reports is larger than the bribe the entrepreneur is willing to pay and (ii) because they anticipate that noncompliant entrepreneurs indeed prefer to self-report when unable to bribe their way to the permit.⁶

By deterring corruption, the scheme we propose makes regulation more effective. Nevertheless, adopting this mechanism is not always socially optimal. Because it entails the payment of bonuses to officials, the budget needed to maintain the administration is expanded. As a result, for our self-reporting scheme to be valuable, the cost of allocating the necessary resources must be relatively small compared to the negative externalities society can avoid by taming corruption.

The "citizen feedback" programs recently developed in several countries, such as Punjab's Feedback Model, inspire the mechanism we propose. However, in such programs, feedback is collected with the primary goals of guiding investigations against dishonest officials and administering sanctions. We explore a different, and possibly complementary, use of citizen-provided information. A novelty of our proposal is to empower citizens with the ability to directly influence the pay of the officials with whom they interact.⁷ By doing so, the government is able to offer officials a high-powered incentive scheme that does not invite extortion or overzealous enforcement. This feature of our scheme is particularly relevant, given that the lack of transparency surrounding officials' decisions often hampers the implementation of effective anti-corruption incentives (OECD (2013, p. 110), Finan et (2015)).⁸ An additional practical concern is that incentive systems may be ineffective if they provide broad discretion to higher-level supervisors, for instance by requiring them to assess citizen reports. However, one strength of our scheme is precisely that ascertaining the accuracy of

⁶The logic behind this scheme is not unprecedented and resembles plea bargaining schemes in spirit. For instance, several municipalities in the UK outsource enforcement of parking meters to private companies. To limit abuses, incentive contracts for enforcers stipulate bonuses tied to *uncontested* tickets. Furthermore, offenders who agree to settle early (thereby admitting their fault) are often entitled to discounts on fines (<http://www.economist.com/node/16847086/print>, retrieved June 2015).

⁷In a broader perspective, the spirit of our proposed scheme relates to recent initiatives by governments of developing countries, meant to empower citizens dealing with corrupt bureaucrats. See, for example, the *tatkal* system adopted by the Indian railways to reduce waiting times and bribery.

⁸Several scholars have argued in favor of linking officials' rewards to their performance (see, e.g., Polinsky and Shavell (2000)). Existing evidence on the effectiveness of these measures suggests they can be effective if carefully designed (Olken and Pande (2012)). Kahn et al. (2001) study an incentive program for tax collectors in Brazil and find evidence that the program restrained bribery. Khan, Khwaja, and Olken (2014) conduct a field experiment that tests financial incentives for property tax inspectors. They find evidence that incentives make tax collection more effective by reducing bribery. See also Furnivall (1956, p.270) for evidence on the role of citizen reports in disciplining officials.

citizen feedback is unnecessary (the messages sent by citizens contain no information *per se*), so that the administrators in charge of implementing it are left with little discretion to exercise. Finally, because of the limited informational content required for citizen self-reporting, these reports can be transmitted via very simple and inexpensive communication technologies (e.g., making or receiving a phonecall, or sending an SMS). We discuss the strengths and the caveats of this scheme.

In the final part of the paper, we discuss the results of a series of extensions included in an online appendix. We first introduce budgetary or financial constraints for the entrepreneurs. In particular, these constraints imply that the bribes they are able to pay are limited. In a second extension, we assume entrepreneurs have some bargaining power when dealing with officials, and let the size of bribes be determined by the Nash bargaining solution concept. Our main results are robust to both modifications. In a third extension, we introduce intermediaries (e.g. paralegals, brokers, facilitators, etc.). Intermediaries specialize in assisting individuals who must deal with administrations, and are common in developing countries (Bertrand et al. (2007), Fredriksson (2014)).⁹ We focus on their ability to facilitate bribery. Our results suggest the pervasiveness of intermediaries is a by-product of the low-powered incentives provided to officials. We also show that, if properly exploited, the self-reporting scheme may allow the government to deter officials from dealing with intermediaries.

Related Literature. A vast literature explores the causes and consequences of corruption in public administrations (see, e.g., Aidt (2009), Banerjee et al. (2012), and Olken and Pande (2012) for surveys). One particularly relevant strand of this literature studies how the design of incentive schemes affects the performance of public officials.¹⁰ For instance, Burlando and Motta (2016) show how legalizing and taxing harmful behavior can allow governments to costlessly offer high-powered incentive schemes to officials. In their setting, citizens also communicate directly with the government.¹¹ Many studies have highlighted a central tension between the dual goals of enforcing regulations and preventing corruption (e.g., Mookherjee (1998), Hindriks et al. (1999), Polinsky

⁹See also Bose and Gangopadhyay (2009) and Dusha (2015).

¹⁰See Besley and McLaren (1993) and Mookherjee and Png (1995) for early contributions. This issue has also been investigated in settings such as law enforcement (e.g., Polinsky and Shavell (2000), Mishra and Mookherjee (2013), Burlando and Motta (2016)) and tax collection (e.g., Hindriks, et al. (1999)).

¹¹Our settings differ on several critical dimensions. Most importantly, the tension between bribery and extortion (a central feature of our analysis) does not arise in their framework because information is assumed verifiable.

and Shavell (2000), Andrianova and Melissas (2008), Khalil et al. (2010)). On the one hand, the government must grant public officials sufficient power to properly enforce regulations; on the other hand, officials may have incentives to abuse their discretionary power and engage in bribery or extortion. This tension can be so strong that tolerating some forms of corruption in order to deter others is optimal. Our contribution is to show how the government can deter all forms of corruption by implementing a simple self-reporting scheme.

Our model is also related to a strand of the literature that investigates schemes in which individuals can report having paid or accepted a bribe. For instance, Bucirossi and Spagnolo (2001, 2006) study the consequences of leniency policies on corruption, and Dufwenberg and Spagnolo (2015) examine Basu's (2011) proposal to "legalize bribe giving."¹² Contrary to these models, our focus is on the reporting by citizens of their own choice of whether to comply with public rules, and on how to formally incorporate such reports into public officials' incentive pay. In addition, in our model, corruption is explicitly embedded in a regulatory framework. More generally, self-reporting schemes have been analyzed in the law enforcement and cartel literatures (see, e.g., Innes (1990), Kaplow and Shavell (1994), Motta and Polo (2003), Spagnolo (2005), and Harrington (2008)).¹³

The literature on collusion within organizations has extensively investigated the consequences of bribery and extortion on supervisors' incentive schemes. Moreover, this literature has highlighted how communicating with supervisees can be helpful in deterring abuses. In a principal/supervisor/agent setting, Baliga (1999) shows that, by appropriately communicating with the agent, the supervisor can be useful to the principal even when her information is fully manipulable. In Celik (2009)'s setting, the supervisor is useful only if the principal provides the agent with the possibility of blowing the whistle. Felli and Hortala-Vallve (2014) show the principal can design a whistleblowing program to deter bribery, which, unless designed carefully, may invite extortion. Burlando and Motta (2015) show how, in response to potential collusion, organizational choices depend on the agent's messages to the principal. Further, Khalil et al. (2010) show that letting bribery occur to deter extortion is optimal in the absence of communication with the agent, and Vafai (2012) shows that deterring both forms of corruption is possible if information is verifiable. Finally, see Chassang and Padró i Miquel (2016)

¹²See also Oak (2015) and Wu and Abbink (2013) for, respectively, theoretical and experimental evidence on the reporting of corruption. See Abbink, et al. (2014) on the choice of liability rules to deter extortion. Finally, see Perrotta Berlin and Spagnolo (2015) on self-reporting schemes and corruption in China.

¹³For more recent work, see references in Angelucci and Han (2016).

on the use of unverifiable information provided by whistleblowers. In our setting, communicating with the entrepreneurs can only help in the fight against corruption. Our contribution is rather to identify a simple scheme that implements the optimal mechanism in a regulatory context in which the tension between bribery and extortion is severe.

The remainder of the paper is organized as follows. Section 2 presents the model. Section 3 solves the game by first assuming the government does not rely on entrepreneur reports, and then allowing for it. Section 4 discusses several extensions. Section 5 concludes. Proofs of all propositions and lemmas are relegated to the Appendix. Proofs of additional results and extensions can be found in the Supplementary Appendix.

2 The Setup

Consider a government and a continuum of pairs of entrepreneurs and officials of size 1. All players are risk neutral. Entrepreneurs wish to engage in an activity that generates a private benefit G . The activity is socially risky in that it imposes damages $D > G$ onto third parties (e.g., pollution) unless entrepreneurs comply with some regulation. If the government allows the activity, it requests that all entrepreneurs comply with regulation and hires officials to verify compliance. Upon verification, entrepreneurs are either granted or denied the permit necessary to undertake the activity.¹⁴

Actions and Information. Each entrepreneur decides whether to apply for the permit. Applying is costless, but entrepreneurs apply only if their expected payoff is strictly positive. Moreover, entrepreneurs unobservably choose whether to comply ($e = h$) or not comply ($e = l$) with regulation.¹⁵ An entrepreneur imposes damages D on third parties if she has chosen not to comply and yet is granted the permit. In case of damages, the government is unable to infer which entrepreneur is liable. Choosing $e = h$ implies a cost ψ to entrepreneurs, where ψ is i.i.d. across entrepreneurs according to the cumulative distribution function $H(\cdot)$ with support $[0, \bar{\psi}]$. The cost ψ is private information to the entrepreneurs and must be sustained regardless of whether the permit is granted.

¹⁴In practice, entrepreneurs may be able to do business without permits (e.g., by operating in the informal sector). Our results are robust to this modification, as long as the gain obtained without a permit is (weakly) smaller than G , and as long as the expected harm imposed on society is not excessively larger than D .

¹⁵We model the decision to comply with regulation to capture the distinct consequences of bribery and extortion on welfare. The notation $e \in \{l, h\}$ is meant to capture an effort decision on the part of the entrepreneurs.

Each applicant entrepreneur (she) is randomly paired with an official (he). Within each pair, the official and entrepreneur observe a signal σ correlated with the latter's effort choice $e \in \{l, h\}$. Specifically, σ can take two values: either $\sigma = c$ ("compliance") or $\sigma = n$ ("non-compliance"). We assume $\Pr(\sigma = c \mid e = h) = 1$ and $\Pr(\sigma = n \mid e = l) = \rho$, where $\rho \in (0, 1)$. Officials fail to detect all noncompliant entrepreneurs, but compliant entrepreneurs are never detected as noncompliant.¹⁶ The signal σ is observable only to the given official-entrepreneur pair.¹⁷

For each pair, after having observed σ , and leaving aside the issue of corruption for the moment, the entrepreneur first communicates with the government by sending a publicly observable message $m_E \in M_E$. Subsequently, either her associated official or the government—depending on the allocation of authority—publicly rules whether to grant ($r = g$) or deny ($r = d$) the permit. When the government retains authority over permits, officials are also requested to send a message $m_O \in M_O$ prior to the ruling r . In these instances, we suppose officials send their message m_O after having observed their entrepreneurs' message m_E .¹⁸ For simplicity, we restrict message spaces to contain only two messages: $M_E \equiv \{m_{E1}, m_{E2}\}$ and $M_O \equiv \{m_{O1}, m_{O2}\}$. This restriction is without loss of generality, as shown in the Appendix. In what follows, let $m \equiv (m_O, m_E)$. Entrepreneurs and officials can send any message independently of σ . Similarly, when delegated authority over permits, officials enjoy full discretionary power and can choose $r \in \{g, d\}$ independently of σ .

Mechanisms. For every pair, the government does not observe the associated signal σ , but it observes (i) the entrepreneur's message $m_E \in \{m_{E1}, m_{E2}\}$ and (ii), depending on the allocation of authority, either the official's message $m_O \in \{m_{O1}, m_{O2}\}$ or the official's ruling $r \in \{g, d\}$. Because all officials are identical and randomly matched with entrepreneurs, the government designs and

¹⁶Allowing for false positives will imply that, even if bribery is deterred, entrepreneurs who choose not to comply with regulation may apply for the permit in the hope of being undetected. We allow this behavior to avoid unrealistic predictions regarding the government's equilibrium wage bill (which would be equal to zero if the technology were perfectly accurate). Conversely, allowing for false negatives would not add interesting insights, nor affect our main results. We rule out this possibility for notational convenience.

¹⁷The assumption that σ is observable to the entrepreneur best fits situations in which little margin exists for interpretation regarding compliance. An example is the regulation of truck weight (Olken and Barron (2009)). A threshold exists, known to both officials and drivers, above which a truck is considered overweight. If the driver knows the amount of cargo on the truck, he is also aware the official observes noncompliance when the truck is weighed. The assumption also avoids complications by ensuring bargaining between officials and entrepreneurs takes place under symmetric information.

¹⁸We let the message m_O be sent after the publicly-observable message m_E because we wish entrepreneurs to influence the government's decision whether to delegate authority over the choice $r \in \{g, d\}$ to the officials. Indeed, as we explain shortly, the government designs a delegation-rule that assigns authority possibly as a function of m_E .

commits to a mechanism that provides identical incentives to all pairs. Also, we suppose wages must be nonnegative, and restrict our attention to deterministic mechanisms. Finally, we do not assume that either retaining or delegating authority over permits (i.e., over the choice $r \in \{g, d\}$) is optimal, and instead let the government decide.

Formally, the government specifies a delegation-rule $x(m_E) : M_E \rightarrow \{0, 1\}$ which allocates authority over the choice $r \in \{g, d\}$, where $x(m_E) = 1$ means that the government chooses $r \in \{g, d\}$ (the government “retains authority”) and $x(m_E) = 0$ means that the official chooses $r \in \{g, d\}$ (the government “delegates authority”). Notice that whether a given official has authority over the issuance of the permit may depend on his associated entrepreneur’s message m_E .

The government also specifies, for all the pairs for which it retains authority, (i) a decision-rule $r(m_O, m_E) : M_O \times M_E \rightarrow \{g, d\}$ which determines under which pairs of messages it issues the permit and (ii) the officials’ schedule of wages $s(m_O, m_E) : M_O \times M_E \rightarrow \mathbb{R}^+$, where s_{m_O, m_E} is the wage paid when official and entrepreneur send, respectively, messages m_O and m_E . Further, for all the pairs in which the official is delegated authority, the government specifies the officials’ schedule of wages $s(r, m_E) : M_E \times \{g, d\} \rightarrow \mathbb{R}^+$, where s_{r, m_E} is the wage paid when the entrepreneur sends message m_E and the official chooses r .

In the course of the analysis, we will show the government is indifferent between retaining and delegating authority over the choice $r \in \{g, d\}$. The rule we adopt then consists of reporting the notationally simplest mechanism. For the sake of conciseness, in the remainder of this section, we suppose the government delegates authority over permits to the officials (i.e., $x(m_E) = 0, \forall m_E$).

The government also affects officials’ payoffs by making action recommendations. For instance, the government may recommend that officials grant permits when observing $\sigma = c$ and deny them when observing $\sigma = n$. Not surprisingly, the government will always recommend not to collect bribes. Officials who deviate from these recommendations face an exogenous expected sanction $\gamma \geq 0$. To capture the fact that officials operate in an environment of low accountability, we assume γ to be small; specifically, $0 \leq \gamma < \frac{G}{2}$. As we argue below, when $\gamma > \frac{G}{2}$, the government can deter all forms of corruption without the need to communicate with entrepreneurs.

We end with a brief discussion devoted to the method we employ to characterize the optimal mechanism. We (i) compute an upper bound on the level of welfare any mechanism within

the considered class of mechanisms can achieve and (ii) analyze a specific self-reporting scheme which achieves this upper bound (and is thus optimal). Under the scheme, entrepreneurs are given the opportunity—after observing σ but before the ruling r is made—to report their possible noncompliance with regulation to the government. An entrepreneur who “self-reports” is systematically denied the permit, and whether an entrepreneur who does not self-report obtains the permit depends on her official’s ruling $r \in \{g, d\}$.

Payoffs. $U(\psi, e, r, m, b)$ denotes an entrepreneur’s ex-post payoff. $U(\cdot)$ is additively separable in the gain G (if $r = g$), the cost of compliance ψ (if $e = h$), and the bribe b (if any). For instance, $U = G - b - \psi$ if an entrepreneur is issued a permit after having paid a bribe despite $e = h$.

Similarly, $V(\sigma, r, m, b)$ denotes an official’s ex-post payoff. $V(\cdot)$ is additively separable in the wage s , the sanction γ (if any), and the bribe b (if any). For instance, $V = s_g - \gamma + b$ if an official collects a bribe b from the entrepreneur he is paired with, and grants her a permit.¹⁹

Finally, the government designs and commits to its mechanism to maximize the expected level of welfare, which is equal to the sum of all entrepreneur and officials’ expected payoffs, minus the expected level of damages and the wage bill. Moreover, we assume a cost $\lambda \geq 1$ to society of making transfers to officials.²⁰ Finally, the government always has the option of banning the activity, in which case welfare is equal to zero. Throughout, we assume $G \leq \bar{\psi} < D$. Requesting that, upon undertaking the activity, entrepreneurs comply with regulation is socially optimal. However, undertaking the activity when requested to comply with regulation may not be socially (and privately) optimal. If the government could observe signal realizations, setting $r = g$ when $\sigma = c$ and $r = d$ when $\sigma = n$ would maximize expected welfare.²¹ We refer to this policy as the “first-best” policy.

Corruption. Because corruption involves agreements that are illicit, no straightforward approach to modelling it exists. We suppose each official, after having observed σ , possibly makes a take-it-or-leave-it offer to the entrepreneur that specifies a ruling r , a message m_E , and a bribe b , to be paid as soon as the deal is struck. We assume the entrepreneur cannot commit to the message m_E specified in

¹⁹For simplicity, we ignore officials’ participation constraints.

²⁰When $\lambda > 1$, wages generate deadweight losses. See Laffont and Tirole (1993) on the cost of public transfers.

²¹Systematically denying permits would lead to no entrepreneur applying, and thus no economic activity. Systematically granting permits would lead to no entrepreneur opting for compliance, which is undesirable, because $D > G$. Finally, choosing $r = g$ when $\sigma = n$ and $r = d$ when $\sigma = c$ would also lead to no entrepreneur opting to comply.

the deal, and thus require that it be chosen in a sequentially rational way. Furthermore, we assume the official, when designing the deal, cannot commit to a ruling r that occurs out-of-equilibrium (it can, however, commit to the ruling specified in the deal). In other words, should the entrepreneur deviate from the message m_E specified in the deal, the official chooses r in a sequentially rational way.²² We assume officials have full bargaining power when offering deals to entrepreneurs. This assumption is consistent with situations in which citizens have little protection vis-à-vis officials. Moreover, our main results do not depend on this allocation of bargaining power: a more general treatment, in which we let the bargaining outcome be determined by the Nash Bargaining solution concept, is presented in the Supplementary Appendix. Further, an entrepreneur accepts a deal if and only if the payoff it guarantees her is higher than her payoff when she rejects the deal, in which case both players play in a sequentially rational way.

Anticipating the analysis to come, the only deal an entrepreneur and an official may enter involves granting the permit in exchange for a bribe. Formally, after observing σ , an official solves

$$\begin{aligned} \max_{\{b, m_E\}} \quad & V(\sigma, g, m_E, b) \\ \text{s.t.} \quad & U(\psi, e, g, m_E, b) \geq U'_\sigma, \end{aligned} \tag{1}$$

and subject to the entrepreneur being better off sending message m_E . Notationally, $U'_\sigma \equiv U(\psi, e, r'_\sigma, m'_\sigma, 0)$, where r'_σ and m'_σ denote, respectively, the official's ruling and the message the entrepreneur sends in the absence of a deal, and for a given σ .

We distinguish between *bribery* and *extortion*. Bribery occurs when an official obtains a payment from an entrepreneur found noncompliant (i.e., when $\sigma = n$) in return for the permit. Extortion occurs when an official obtains a payment from an entrepreneur found compliant (i.e., when $\sigma = c$) in return for the permit. In the baseline version of the model, officials cannot commit to the bribes they will request from the entrepreneurs prior to their interaction with the latter. As a result, officials fail to internalize the impact of corruption on the entrepreneurs' decision whether to apply for the

²²These assumptions simplify the exposition of the results because they limit the set of agreements officials and entrepreneurs can enter. However, assuming they can enter contracts that specify binding transfers and actions contingent on all possible scenarios leads to identical results (see, for instance, Faure-Grimaud et al. (2003) for such a modeling approach). A previous version of this paper with this alternative contractual assumption is available upon request.

permit. Note that, in addition, officials can also abuse their power without taking bribes: to pocket as high a wage as possible, officials may be tempted to make a decision r that contrasts with the government's recommendation.

Finally, to economize on notation, we assume there is no constraint on the size of bribes. In reality, though, the amount bribes can take may be limited; for instance, because of financial constraints (Banerjee, 1997). In the Supplementary Appendix, we show that introducing these constraints would not change our main results.

Timing. We summarize the model by presenting the timing of moves:²³

1. The government decides whether to allow the activity. If the activity is allowed, the government chooses and commits to a schedule of wages $s(r, m_E)$.
2. The entrepreneurs simultaneously decide whether to apply for the permit. If an entrepreneur applies, she chooses her effort level $e \in \{l, h\}$ and is randomly paired with an official. For each pair, a signal $\sigma \in \{c, n\}$ is realized.
3. Each entrepreneur-official pair possibly enters a deal. If a deal is struck, the entrepreneur pays a bribe b to the official. All entrepreneurs send message m_E to the government and, subsequently, officials choose $r \in \{g, d\}$.
4. The government observes the entrepreneurs' messages and the officials' decisions, and pays officials' wages according to the schedule $s(r, m_E)$.

We conclude with some final considerations. First, our focus is on pure-strategy equilibria. Second, as in any moral hazard setting, we must address the issue of players' behavior when indifferent between several actions, an issue which in our framework is made slightly more intricate than usual by the fact that entrepreneurs interact with two "principals." We suppose that an official who is indifferent between several actions (or deals to offer his entrepreneur) selects the government's recommended option. As it turns out, as long as $\gamma > 0$, this assumption is qualitatively innocuous: a government concerned about the robustness of its mechanism can always break officials' indifference by raising one

²³In the exposition of the timing, we anticipate the fact that the only deals officials and entrepreneurs contemplate involve granting the permit in exchange for a bribe. We are also anticipating that delegating authority over the permits to the officials is optimal.

payment by an arbitrarily small amount. Similarly, we assume that an entrepreneur who is indifferent between accepting her official’s deal or rejecting it chooses to accept it. Again, officials can always ensure that entrepreneurs accept their deal by decreasing the bribe they request by an arbitrarily small amount. Other than the decision to accept a deal, however, we assume that an entrepreneur who is indifferent between several actions chooses the government’s preferred action.²⁴

3 Solving the Model

We first consider the case of no corruption. Next, we introduce corruption, and characterize the government’s optimal policy both when it communicates and when it does not communicate with the entrepreneurs.

3.1 Uncorruptible Government Officials

Suppose the officials never make deals with the entrepreneurs. Suppose further the government delegates authority over the permits (i.e., over the choice $r \in \{g, d\}$) to the officials, and instructs them to grant (deny) permits when they observe $\sigma = c$ ($\sigma = n$). Officials who grant the permit receive s_g , and those who deny it receive s_d . In order to ensure that officials choose $r = g$ when $\sigma = c$ and $r = d$ when $\sigma = n$, the government does not need to communicate with the entrepreneurs and simply sets all wages equal to zero.²⁵ As a result, a given entrepreneur intent on applying for the permit complies with regulation if and only if $G - \psi \geq (1 - \rho)G$, which simplifies to $\psi \leq \rho G$. The gross benefit of complying is equal to ρG , that is, the increase in the probability that the official observes $\sigma = c$ multiplied by the value of the permit.

Because $\max[G - \psi, (1 - \rho)G] > 0$ for $\forall \psi$, all entrepreneurs apply for the permit but only a fraction $H(\rho G)$ of them choose to comply. Therefore, if the activity is allowed, the expected level of

²⁴Because the class of mechanisms we consider precludes transfers from the government to the entrepreneurs, formally speaking, the government cannot break an entrepreneur’s indifference by making an arbitrarily small transfer. We disregard transfers to entrepreneurs for the sake of tractability and because, in many contexts, it would be difficult for governments to offer incentive contracts to citizens/entrepreneurs. However, in practice, governments may influence citizens/entrepreneurs’ payoffs (and break their possible indifference between several actions) with very simple rewards or punishments (e.g., by speeding up the application process). We discuss this issue at greater length and provide specific examples in Section 3. In the Appendix, we show our main insights are unaffected—if anything, they are strengthened—if we allow the government to make a small transfer to the entrepreneurs.

²⁵Because the government induces the “first-best” decision rule at zero cost, it follows that retaining authority over the permits cannot improve welfare.

social welfare—hereafter the “no-corruption” level of welfare—is equal to

$$W^{NC} = \int_0^{\rho G} (G - \psi) dH(\psi) + (1 - \rho) \int_{\rho G}^{\bar{\psi}} (G - D) dH(\psi). \quad (2)$$

Officials fail to deny the permit to all entrepreneurs who chose $e = l$. It follows that the expected level of damages is positive, and that social welfare is nonnegative if and only if

$$D \leq D_0^{NC} \equiv \frac{G(1 - \rho + \rho H(\rho G)) - \int_0^{\rho G} \psi dH(\psi)}{(1 - \rho)(1 - H(\rho G))}.$$

When $D > D_0^{NC}$, the government cannot do better than ban the activity.

3.2 Corruptible Government Officials

3.2.1 No Self-Reporting Scheme

Suppose now that the officials are corruptible, but that, for exogenous reasons, the government does not communicate with the entrepreneurs. Analyzing this case is useful to highlight the tension that arises when wishing to deter both bribery and extortion, as identified by the existing literature. In what follows, we anticipate that it is weakly optimal for the government to delegate authority over the permits to the officials. The proof of this result can be found together with the proof of Proposition 1 in the Appendix. We show that deterring *both* bribery and extortion is impossible. As a result, either tolerating bribery so as to deter extortion or forbidding the activity is optimal.

Bribery. Consider an official whose signal indicates non-compliance (i.e., $\sigma = n$). Ignoring possible bribes, if the official denies the permit, his payoff is equal to s_d and the entrepreneur’s is equal to 0. By contrast, if the official unduly grants the permit, his payoff is equal to $s_g - \gamma$ and the entrepreneur’s is equal to G . The pair is thus better off choosing $r = g$ if $s_g - \gamma + G > s_d$. Suppose this inequality holds. If, moreover, $s_g - \gamma > s_d$, the official chooses $r = g$ without exchanging money: the entrepreneur would reject any request for a bribe, anticipating that granting the permit is in the official’s interest. By contrast, if $s_g - \gamma \leq s_d$, the wage s_d is high enough that, absent a bribe, denying the permit is in the official’s interest. As a result, and because the official has full bargaining power, he is able to extract a bribe equal to G . Finally, if $s_d \geq s_g - \gamma + G$, no bribe exists that the entrepreneur is willing

to pay and that would lead to the official choosing $r = g$. Therefore, for the government to ensure permits are denied when $\sigma = n$, it must necessarily set

$$s_d \geq s_g - \gamma + G. \quad (3)$$

Because $G - \gamma > 0$, for the government to deter bribery, it must reward officials who make decisions unfavorable to the entrepreneurs.

Extortion or Framing. Consider now an official whose signal indicates compliance (i.e., $\sigma = c$). The pair is better off choosing $r = g$ if $s_g + G \geq s_d - \gamma$. Suppose this inequality holds. If, moreover, $s_g \geq s_d - \gamma$, the official chooses $r = g$ without extracting a bribe. Indeed, the wage s_g is high enough that granting the permit is in the official's interest: the entrepreneur would reject any request for a bribe. By contrast, if $s_d - \gamma > s_g$, denying the permit is in the official's interest. As a result, the official extorts a bribe equal to G . Thus, if $s_g + G \geq s_d - \gamma$, the official always chooses $r = g$ when observing $\sigma = c$, but does so without engaging in extortion only if $s_g \geq s_d - \gamma$.

Finally, if $s_d - \gamma > s_g + G$, there does not exist a bribe that the entrepreneur is willing to pay and would lead to the official choosing $r = g$. The official frames the entrepreneur by choosing $r = d$. Summing up, for the government to ensure that officials grant permits without engaging in extortion, it must necessarily set

$$s_g \geq s_d - \gamma. \quad (4)$$

Note that, to deter extortion, setting $s_g = s_d$ is sufficient.

Rearranging (3) and (4) leads to: $\gamma \geq s_d - s_g \geq G - \gamma$, which cannot hold, because $\frac{G}{2} > \gamma$. To prevent bribery, the government must reward officials who deny permits by setting s_d sufficiently high. However, doing so means systematically denying permits is in the officials' best interest, thereby paving the way to either extortion or framing.²⁶

To establish which corrupt behavior should be deterred, let us briefly comment on the distinct consequences of having either (3) or (4) hold. Suppose (3) holds. Officials deny permits when $\sigma = n$, but either frame or extort entrepreneurs when $\sigma = c$. Because officials who engage in extortion extract

²⁶In case $\frac{G}{2} \leq \gamma$, the government can deter both bribery and extortion by setting wages appropriately.

the entire value of a permit, the entrepreneurs' gross payoff is equal to zero both in case $\sigma = c$ and $\sigma = n$, and applying for the permit is of no value. As a result, social welfare is equal to zero.

Now suppose (4) holds. Officials grant permits without extracting bribes when $\sigma = c$. By contrast, because (3) does not hold, officials grant permits in exchange for bribes equal to G when $\sigma = n$. An entrepreneur intent on applying thus complies with regulation if and only if $G - \psi \geq (1 - \rho)G$, which simplifies to $\psi \leq \rho G$. Because $\max[G - \psi, (1 - \rho)G] > 0$ for $\forall \psi$, all entrepreneurs apply for the permit, but only a fraction $H(\rho G)$ chooses to comply with regulation. Specifically, those who comply do so because their cost of compliance ψ is smaller than the expected bribe ρG they would pay to obtain the permit if they chose $e = l$. For the remaining entrepreneurs, ψ is large enough that not complying, and running the risk of having to pay the bribe if detected, is rational. Given that bribery is not deterred, all entrepreneurs who choose not to comply obtain the permit.

The next proposition states the government's optimal policy when it does not communicate with the entrepreneurs. In what follows, let $D_0^{NS} \equiv \frac{G - \int_0^{\rho G} \psi dH(\psi)}{1 - H(\rho G)} - \rho\gamma$.

Proposition 1. *Suppose the government does not communicate with the entrepreneurs. If $D \leq D_0^{NS}$, allowing the activity, delegating authority to the officials, and tolerating bribery so as to prevent extortion is optimal. The officials' optimal wages are $s_g = 0$ and $s_d \in [0, \gamma]$, and the associated level of social welfare is equal to*

$$W^{NS} = \int_0^{\rho G} (G - \psi) dH(\psi) + \int_{\rho G}^{\bar{\psi}} (G - D - \rho\gamma) dH(\psi). \quad (5)$$

If $D > D_0^{NS}$, banning the activity is optimal.

As the above discussion attests, tolerating extortion is not a viable option. If bribery is tolerated, making the officials' wages unresponsive to their decisions (see (4)) is then sufficient, and the government may as well set $s_d = s_g = 0$. It follows that tolerating bribery minimizes the wage bill. Moreover, bribery has a disciplining effect on entrepreneurs. Because those who are detected as noncompliant enjoy a lower payoff than those who are not, many entrepreneurs choose to comply with regulation. The key social cost of allowing bribery is therefore that entrepreneurs who choose not to comply impose damages D onto third parties.

3.2.2 The Self-Reporting Scheme

We now allow the government to communicate with the entrepreneurs by asking them to send a message $m_E \in \{m_{E1}, m_{E2}\}$ after having observed $\sigma \in \{c, n\}$ but prior to the ruling $r \in \{g, d\}$.

We focus on a specific mechanism—a self-reporting scheme—and analyze its properties. First, we show the government is able to deter both bribery and extortion by implementing this scheme, albeit at the cost of a higher wage bill. Second, we compare the level of welfare achieved under the self-reporting scheme to the level of welfare achieved in the absence of communication with the entrepreneurs, and derive conditions under which the scheme raises welfare. In the Appendix, we compute an upper bound on the welfare level any mechanism within the class we consider can achieve and show that the self-reporting scheme achieves this upper bound (and is thus optimal) whenever communicating with the entrepreneurs is valuable.

The Scheme. Entrepreneurs found noncompliant are instructed to report their noncompliance (or, more precisely, to report having observed $\sigma = n$) by sending message m_{E1} . The government denies the permit to all entrepreneurs who “self-report.” By contrast, whether the entrepreneurs who do not self-report (i.e., those who send message m_{E2}) obtain the permit is left to the discretion of their associated officials. In other words, officials are granted authority over permits whenever their associated entrepreneurs do not self-report. Finally, the government pays the wage $s_a \equiv s_{m_{O1}, m_{E1}} = s_{m_{O2}, m_{E1}}$ to the officials whose entrepreneurs self-report, the wage $s_g \equiv s_{g, m_{E2}}$ to the officials who grant permits, and the wage $s_d \equiv s_{d, m_{E2}}$ to the officials who deny permits.

We revisit officials’ incentives to engage in corruption. Consider extortion first, and recall that, to deter it, the government must set wages in such a way that the threat of framing is not credible. Assume an official and an entrepreneur have not entered into a deal. If the entrepreneur chose not to self-report, choosing $r = g$ when $\sigma = c$ is in the official’s best interest if and only if

$$s_g \geq s_d - \gamma. \tag{6}$$

Now consider bribery. If the entrepreneur chose not to self-report, when $\sigma = n$, an official prefers to deny the permit rather than collect a bribe if and only if

$$s_d \geq s_g - \gamma + G, \tag{7}$$

where the right-hand side of (7) represents the official's payoff in case of bribery.

As shown in the previous section, satisfying both (6) and (7) is impossible. However, the government can now leverage the wage s_a to prevent bribery. To see this, suppose $s_a = G - \gamma$ and $s_g = s_d = 0$. The government rewards the officials whose entrepreneurs self-report. Because $s_g = s_d$, extortion is deterred: it is enough for the compliant entrepreneur *not* to self-report to make it subsequently rational for her official to grant the permit. By contrast, when $\sigma = n$, entrepreneurs who did not enter a deal with their official are denied the permit regardless of whether they self-report, and may thus just as well self-report. Anticipating this outcome, and because s_a is larger than their payoff when engaging in bribery, officials choose not to offer a deal and pocket the wage s_a .^{27,28}

Notice that, when $\sigma = n$, entrepreneurs do not strictly gain from self-reporting. They are indifferent between self-reporting and not self-reporting, and choose to self-report because it is the government's recommended action. To help intuition, however, one can think of the entrepreneurs who self-report as receiving a small reward from the government. In the appendix, we formally show that our results continue to hold (if anything, they are strengthened) if we modify the model to allow the government to reward self-reporting.²⁹ In practice, a government can compensate an applicant in several ways. For instance, if applicants are required to pay an application fee, they can be made eligible for a refund. Alternatively, unsuccessful applicants wishing to apply again could become eligible to have the process expedited, be exempt from future application fees, and so on.

²⁷One could be concerned about officials and entrepreneurs agreeing on sending $m_E = m_{E1}$ in order to share $s_a = G - \gamma$ when $\sigma = c$. However, (i) such a deal is not feasible because sending m_{E1} would not be sequentially rational for an entrepreneur after having pocketed b and (ii), even if entrepreneurs could somehow commit to $m_E = m_{E1}$, they would refuse the deal because $s_a - \gamma = G - 2\gamma < G$ (that is, officials could not compensate the entrepreneurs for forgoing the permit).

²⁸In an extension, available in the Supplementary Appendix, we show that if the size of bribes is limited by budgetary constraints for the entrepreneur, so is the level s_a needs to attain in order to deter bribery. Our main results are qualitatively unaffected.

²⁹Specifically, in the appendix, we allow the government to make a transfer $t \geq 0$ to the entrepreneurs who self-report. In this modified setup, the self-reporting scheme remains identical except for s_a which becomes $s_a = G - t - \gamma$.

Lemma 1. *The government can deter both bribery and extortion by implementing a self-reporting scheme such that*

1. *the permit is denied to all the entrepreneurs who self-report,*
2. *whether the entrepreneurs who do not self-report obtain the permit is left to the discretion of their officials, and*
3. *officials' wages are such that $s_g = s_d = 0 < s_a = G - \gamma$.*

The value of an entrepreneur's report does not lie in its informational content, but in how it affects incentives. On the one hand, entrepreneurs found compliant never self-report. Thus, extortion is deterred, because the officials' pay is then flat. On the other hand, officials know entrepreneurs found noncompliant are better off self-reporting, and thus prefer to pocket the bonus rather than a bribe.

The scheme we propose resembles institutional arrangements featured in many regulatory systems. Schemes whereby individuals acknowledge noncompliance (often in exchange for a compensation) are common. For instance, in traffic law enforcement, several countries (e.g., France, Italy, and the UK) allow drivers who are issued fines to receive discounts if they acknowledge their wrongdoing. Furthermore, enforcers' wages are often tied to *uncontested* tickets. Although the original purpose of these arrangements may be to reduce the administrative costs of collecting fines, one of our contributions is to show how they can help in the fight against corruption also.

We believe a virtue of our self-reporting scheme is its simplicity, primarily because it does not require the government to assess the validity of the reports. As a result, these reports can consist of very simple and inexpensive actions, such as making a phone call or sending text messages from mobile phones.³⁰ In addition, because the mechanism disciplines officials simply by conditioning their wage on the entrepreneur's decision to self-report, it minimizes the need to rely on monitors (who may also be corruptible; see, e.g., Duflo et al. (2013) and Mishra (2006)).

Before proceeding further, discussing some features critical for the successful implementation of our scheme is worthwhile. First, we assumed entrepreneurs cannot commit to their message m_E while interacting with their official. Noncompliant applicants may otherwise be inclined to commit not to self-report, to make bribery tempting to the officials. Ensuring the entrepreneurs cannot commit

³⁰As the Punjab Feedback Model suggests, governments can keep track of officials' decisions and communicate with citizens with the aid of basic communication technologies (Callen and Hasanain (2011)).

not to self-report seems easily achievable. For instance, the scheme can be designed such that the entrepreneurs have the possibility to self-report only after a certain amount of time has elapsed since the end of their interaction with the official. Second, we have assumed entrepreneurs can self-report only prior to their officials' decision regarding whether to grant the permit. This assumption implies that officials cannot abuse the scheme by committing to deny the permit. Such a threat, if credible, would make self-reporting rational for compliant entrepreneurs. This outcome can be avoided by ensuring the officials file their final decision only once the interaction with the entrepreneurs has ended, and the latter has decided not to self-report.

Finally, in order to collect bonuses from the government, officials may be tempted to abuse the scheme by recruiting bogus applicants with the promise of a compensation in exchange for self-reporting. Although such an abuse would require public officials to make transfers to citizens, and to do so outside of their working hours and offices – thereby constituting a particularly sophisticated conspiracy, the government can take measures to reduce its likelihood. For instance, the government can, as we assume in the model, ensure that officials are randomly paired with applicants. Although randomizing the allocation of applications to officials admittedly requires some “state capacity,” which suggests our scheme may not be applicable in every context, casual observation of its practice leads us to conclude that it is plausible in a wide range of settings.³¹ The government could also deal with potential abuses by capping the number of applications per official, and setting the cap at the normal quantity of applications that would prevail absent abuses. Furthermore, this kind of abuse is unlikely to constitute a valid concern when applying for the permit is time-consuming or costly for the applicant. Finally, note that our scheme is also applicable to situations where noncompliance is punished with fines. The presence of fines makes this type of abuses less likely, because they raise the compensation the official would have to promise a fake applicant.³²

Welfare analysis. In the Appendix, we show that the self-reporting scheme is optimal whenever communicating with the entrepreneurs is valuable, that is, whenever the government can raise welfare above the level achieved under the policy outlined in Proposition 1 by communicating with the entrepreneurs. The next proposition states the conditions under which implementing the self-reporting

³¹In some contexts, making applications anonymous can also contribute to making this scenario unlikely.

³²The main results of our analysis are robust to the introduction of positive costs to apply for the permit, as well as to the introduction of fines punishing noncompliance.

scheme is socially optimal. Let $D^S \equiv \lambda(G - \gamma)$ and $D_0^S \equiv \frac{D_0^{NS} - \lambda\rho(G - \gamma)}{1 - \rho}$, where S and NS stand, respectively, for “scheme” and “no scheme.”

Proposition 2. *Suppose the cost of public funds is such that $1 \leq \lambda < \frac{D_0^{NS}}{G - \gamma}$; then*

1. *When $D \leq D^S$, not communicating with the entrepreneurs, and tolerating bribery so as to prevent extortion by setting $s_g = s_d = 0$, is optimal.*
2. *When $D^S < D \leq D_0^S$, implementing the self-reporting scheme stated in Lemma 1 is optimal.*
3. *When $D > D_0^S$, banning the activity is optimal.*

When $\lambda \geq \frac{D_0^{NS}}{G - \gamma}$, not communicating with the entrepreneurs, and tolerating bribery so as to prevent extortion by setting $s_g = s_d = 0$, is optimal if and only if $D < D_0^{NS}$. Otherwise, banning the activity is optimal.

A review of the advantages and drawbacks of the self-reporting scheme is useful. First, it allows the government to deter not only extortion, but also bribery. As a result, no entrepreneur found ineligible obtains the permit. Also, the government provides incentives to comply with regulation as strong as in the no-corruption benchmark, because an entrepreneur’s payoff is equal to G when $\sigma = c$ and to 0 when $\sigma = n$.³³ Thus, the expected level of gains and damages the activity generates is identical to that when corruption is infeasible. The drawback is that the government must promise a positive wage s_a , which increases the government’s wage bill. When the self-reporting scheme is implemented, social welfare is equal to

$$W^F = \int_0^{\rho G} (G - \psi) dH(\psi) + (1 - \rho) \int_{\rho G}^{\bar{\psi}} (G - D) dH(\psi) - (1 - H(\rho G)) \rho(\lambda - 1)(G - \gamma). \quad (8)$$

Because of the additional wage bill, the cost λ cannot be excessively high for the scheme to be optimal. We find that if $\lambda \leq \frac{D_0^{NS}}{G - \gamma}$, the self-reporting scheme dominates the “low-powered” scheme that tolerates bribery stated in Proposition 1, as long as the damages D are large enough but not excessively so (i.e., $D^S < D \leq D_0^S$).³⁴ Paying high wages in order to deter bribery is worthwhile only if the damages

³³An entrepreneur chooses $e = h$ if and only if $G - \psi \geq (1 - \rho)G$. Because $\max[G - \psi, (1 - \rho)G] > 0$, all entrepreneurs apply and the share of compliant entrepreneurs is $H(\rho G)$.

³⁴To show that $\frac{D_0^{NS}}{G - \gamma} > 1$, observe that the inequality $G - \gamma < \frac{G - \int_0^{\rho G} \psi dH(\psi)}{1 - H(\rho G)} - \rho\gamma$ simplifies to $(G - (1 - \rho)\gamma)(1 - H(\rho G)) < G - \int_0^{\rho G} \psi dH(\psi)$. This last inequality holds because $\int_0^{\rho G} \psi dH(\psi) < GH(\rho G)$ implies $G - \int_0^{\rho G} \psi dH(\psi) > G(1 - H(\rho G))$.

the government avoids are large enough. Nevertheless, because the officials' verification technology is imperfect, denying permits to all entrepreneurs who chose $e = l$ is not possible even with the self-reporting scheme. As a result, the government cannot do better than to ban the activity when damages are very high (i.e., $D > D_0^S$). Finally, if λ is high (i.e., $\lambda > \frac{D_0^{NS}}{G-\gamma}$), exploiting entrepreneur reports is never optimal. The government then adopts the same policy as in Proposition 1.

Note that our model most likely overstates the size of the bonuses that the government has to commit to, and hence the cost of implementing the scheme, because we ignore the fact that officials may not be able to extract the full value of a permit via bribes. In reality, entrepreneurs may be financially constrained, because the full benefits of the activity materialize only some time after the permit is granted. Thus, the bribe that entrepreneurs are actually able to pay is smaller than G (Banerjee (1997)). We consider this issue in an extension (see below). Furthermore, in practice the parties involved in corruption face transaction costs to avoid bribes being detected by the government or denounced by the public. By making bribery less profitable, these costs reduce the size of bonuses that the government needs to pay (Emerson (2006), Tirole (1992)).

We do not argue that our scheme is the optimal response to corruption when considering all instruments at the disposal of governments. There could be other instruments to tackle the problem, such as increasing the expected punishment for official misbehavior, captured by γ in our model. In a more general framework, one could allow the government to choose this parameter as well. Nevertheless, even if improvements in internal monitoring were available, the self-reporting scheme would remain qualitatively unchanged as long as $\gamma \leq \frac{G}{2}$.³⁵

Other examples. The scheme we have developed can be helpful in various other settings. One example is the issuance of driver's licenses or low-emissions permits for vehicles. Both examples involve some unobservable compliance decision by applicants (e.g., learning to drive) and verification by officials (e.g., administering some driving skill tests) who may engage in corruption (Bertrand et al. (2007)). A further example is the collection of taxes and customs duties, where inspectors may be tempted to both collect bribes from violators and extort money from compliant tax payers (Hindriks et al. (1999), Sequeira and Djankov (2013)). An additional example is the enforcement of traffic law.

³⁵More generally, one can interpret our problem as a necessary step in a larger optimization problem. To determine where to devote its budget, the government must first determine the returns to the various policies available.

Trucking firms are generally required to respect ceilings on truck weight, and officials manning the weigh stations are often corrupt (Olken and Barron (2009), Foltz and Bromley (2014)). Presumably, the scheme we propose could allow the government to deter corruption and increase compliance with weight requirements. When implementing the self-reporting scheme, the government could promise reduced sanctions to firms or drivers acknowledging their own noncompliance. Note also that our analysis can easily be recast in the context of law enforcement, where ψ is interpreted as the gain from the harmful act and G as the sanction imposed on detected violators. Although the welfare analysis would change slightly, the spirit of our findings would remain unchanged.

4 Extensions

In this section, we discuss the extensions to our model that are present in the Online Appendix.

Limited Ability to Pay. In a first extension, we relax the assumption whereby entrepreneurs are able to pay the officials the entire private benefit G they obtain from the permit. Specifically, we assume that the size of the bribe the entrepreneurs are able to pay is capped below G , for example because of financial constraints. The properties of the self-reporting scheme remain unchanged, and the size of the budget the government must devote to it is lowered.

Nash Bargaining. In a second extension, we relax the assumption whereby officials enjoy full bargaining power. Rather, we let the size of the bribes be determined by the Nash bargaining solution concept. Although in this environment extortion is less of an issue, the properties of our self-reporting scheme remain qualitatively unaffected.

Intermediaries. In a third extension, we consider the possible indirect interaction between officials and entrepreneurs, mediated by intermediaries (e.g., paralegals, brokers, facilitators, etc.). This extension is of interest because intermediaries are ubiquitous in developing countries (Bertrand et al. (2007), Fredriksson (2014)). Anecdotal evidence suggests intermediaries perform several functions. On the one hand, they reduce the transaction costs of dealing with the administration. On the other hand, intermediaries also facilitate corruption; by developing relationships with officials, they guarantee a preferential treatment to their customers. Our results suggest that that presence of

intermediaries is a by-product of the low-powered incentives provided to officials, which in turn are often due to corruption and the lack of feedback from citizens at the receiving end of public services. We also show that, if properly exploited, the self-reporting scheme may allow the government to deter officials from dealing with intermediaries, thereby strengthening the enforcement of regulation.

5 Conclusion

One of the most detrimental consequences of corruption is that it undermines regulations aiming to protect society from risks and hazards. In this paper, we have made the case for a simple self-reporting scheme that enables the government to dampen the powerful tension between the dual goals of enforcing regulations and preventing corruption.

As with most policy interventions fighting corruption, we note the importance of educating the general public about the properties of the scheme. Not only should individuals and firms know about the possibility of admitting noncompliance with rules, they should also be made aware of both the timing of the application process and the incentive scheme facing public officials.

We discussed several potential applications of our scheme, all involving situations where the government delegates the task of monitoring citizen behavior to self-interested officials. However, we also believe the mechanism we propose can be applied to tackle collusion and abuses of authority within firms. As previous literature has pointed out (see, e.g., Tirole (1992), Khalil et al. (2010)), it is not uncommon for supervisors to collude with, and harass, subordinates. Although the ultimate objective of a firm might be to maximize profit rather than social welfare, we believe the mechanism we propose can also help deter abuses by supervisors.

We conclude by briefly discussing directions for future research. First, it would be valuable to endow the government with more instruments. For instance, the government could invest in improving the legal system and the state's ability to sanction officials. Although ultimately an empirical question, a theoretical analysis could clarify the conditions under which implementing a feedback scheme is more effective than improving the legal enforcement directly. Second, we assumed all officials are self-interested. While the assumption may be a good approximation of the most corrupt environments, in many other instances a share of officials may be unwilling to engage in corruption. In those cases, although the scheme may protect from overzealous officials, it may also crowd-out intrinsic motivation.

Appendix

Preliminaries

Suppose the government has delegated authority over permits to the officials, and consider a given entrepreneur-official pair. Because the government does not communicate with the officials, we let m denote a given message sent by the entrepreneur. We introduce the following notation.

- We denote by r'_σ (m'_σ) the official's equilibrium ruling (the entrepreneur's equilibrium message) played in the subgame that follows the entrepreneur's rejection of the official's deal, given σ .
- We write $U(\psi, e, r, m, b) \equiv u(r, m) - \psi I(e) - b$, where $I(h) = 1$ and $I(l) = 0$. We denote by $u'_\sigma \equiv u(r'_\sigma, m'_\sigma)$ the payoff obtained by the entrepreneur in the absence of a deal with the official and $V'_\sigma \equiv V(\sigma, r'_\sigma, m'_\sigma)$ the corresponding payoff of the official.
- We denote by b_σ the equilibrium bribe following the entrepreneur's acceptance of the official's deal, for a given σ . The bribe b_σ is the solution to problem (1).

Lemma A.1 is useful in limiting the number of cases to consider in the proofs to come.

Lemma A.1

Any schedule of wages that leads to $u'_c = u'_n$ results in a nonpositive level of social welfare. Therefore, any such schedule cannot be optimal.

Proof. The problem of an official when offering a deal to an entrepreneur can be written as follows:

$$\begin{aligned} \max_{\{r, m, b\}} \quad & s_{r, m} - \gamma + b \quad \text{subject to} \\ & u(r, m) - \psi I(e) - b \geq u'_\sigma - \psi I(e), \end{aligned}$$

and also subject to m being chosen in a sequentially rational way. Clearly, if a deal exists, $b_\sigma = u(r, m) - u'_\sigma$, $\forall \sigma$, and the payoff of an entrepreneur as a result of the deal is u'_σ , regardless of

r and m . Recall also that, when no deal is struck, the payoff of an entrepreneur is u'_σ by definition. It follows that if $u'_c = u'_n$, no entrepreneur chooses to comply, because her payoff is independent of σ (and thus also independent of e), so that social welfare is bounded from above by zero.

□

Proof of Proposition 1

We first prove that it is (weakly) optimal to delegate authority over permits to the officials. We then characterize the government's optimal policy.

Proof that Delegating Authority to Officials is Weakly Optimal

Suppose the government retains authority and communicates with the officials. Recall $M_O \in \{m_{O1}, m_{O2}\}$ denotes the officials' message space and m_O denotes a given message. The government chooses $s(m_O) : M_O \rightarrow \mathbb{R}^+$ and $r(m_O) : M_O \rightarrow \{g, d\}$. We first show setting $r_{m_{O1}} \neq r_{m_{O2}}$ is optimal. Suppose $r_{m_{O1}} = r_{m_{O2}} = g$. Under this policy, all entrepreneurs apply for the permit, all choose $e = l$, and all obtain the permit without paying bribes. As a result, welfare is negative (because $G < D$), and the government would be better off, for instance, by forbidding the activity. Now suppose $r_{m_{O1}} = r_{m_{O2}} = d$. Under this policy, no entrepreneur applies for the permit and welfare is equal to zero. It follows setting $r_{m_{O1}} \neq r_{m_{O2}}$ is weakly optimal. Because, when $r_{m_{O1}} \neq r_{m_{O2}}$, officials de facto exercise full discretion over permits, the government may as well delegate authority to them, and let the schedule of wages be a mapping such that $s(r) : \{g, d\} \rightarrow \mathbb{R}^+$.

Computing the Government's Optimal Policy

Suppose the government delegates authority over the permits. We first describe the outcome of the subgame that takes place in the absence of a deal. Next, we describe the conditions under which the two parties strike a deal, and the resulting outcome. Finally, we characterize the optimal wage schedule.

No deal

We first compute r'_σ and u'_σ for $\forall\sigma$. In the absence of a deal, an official obtains $s_g - l(\sigma, g)\gamma$ if $r = g$ and $s_d - l(\sigma, d)\gamma$ if $r = d$, where $l(\sigma, g) = 1$ (resp. $l(\sigma, d) = 1$) if $\sigma = n$ (resp. $\sigma = c$), and zero otherwise. Therefore, if $s_d > s_g + \gamma$, then $r'_\sigma = d$ for $\forall\sigma$, and thus $u'_\sigma = 0$ for $\forall\sigma$. If $s_g + \gamma \geq s_d \geq s_g - \gamma$, then $r'_c = g$ and $r'_n = d$. Thus, $u'_c = G$ and $u'_n = 0$. Finally, if $s_g - \gamma > s_d$, then $r'_\sigma = g$ for $\forall\sigma$, and thus $u'_\sigma = G$ for $\forall\sigma$. Applying Lemma A.1, no loss of generality occurs in restricting our attention to schedules of wages satisfying $s_g + \gamma \geq s_d \geq s_g - \gamma$. Thus, $r'_c = g$ and $r'_n = d$, so that $u'_c = G$ and $u'_n = 0$. Furthermore, $V'_c = s_g$ and $V'_n = s_d$.

Deal

Assume the deal entails the permit being granted, that is, $r_\sigma = g$. To determine b_c , the official maximizes $s_g - \gamma + b_c$ subject to $G - b_c \geq u'_c = G$, which yields $b_c = 0$. To determine b_n , the official maximizes $s_g - \gamma + b_n$ subject to $G - b_n \geq u'_n = 0$, which yields $b_n = G$. As a result, $V(c, g, 0) = s_g$ and $V(n, g, G) = s_g - \gamma + G$.

Now assume the deal specifies $r_\sigma = d$. To determine b_c , the official chooses its highest possible value subject to $-b_c \geq u'_c = G$, which yields $b_c = -G$. To determine b_n , the official chooses its highest possible value subject to $-b_n \geq u'_n = 0$, which yields $b_n = 0$. As a result, $V(c, d, -G) = s_d - G - \gamma$ and $V(n, d, 0) = s_d$. Comparing these payoffs to $V(c, g, 0)$ and $V(n, g, G)$, and using $G > 2\gamma$, one derives that the official never chooses the deals involving $r = d$.

Finally, comparing $V(c, g, 0) = s_g$ and $V(n, g, G) = s_g - \gamma + G$ to V'_c and V'_n , we derive the official does not offer a deal when $\sigma = c$, so that $r_c = g$ and $b_c = 0$. By contrast, when $\sigma = n$, the official offers a deal if and only if $s_g - \gamma + G > s_d$. This condition holds because $s_g + \gamma \geq s_d$ and $G > 2\gamma$. As a result, $r_n = g$ and $b_n = G$.

Optimal schedule of wages

An entrepreneur intent on applying chooses $e = h$ if and only if $G - b_c - \psi \geq \rho(G - b_n) + (1 - \rho)(G - b_c)$, which simplifies to $\rho G \geq \psi$. Because $\rho(G - b_n) + (1 - \rho)(G - b_c) = (1 - \rho)G > 0$, all entrepreneurs apply for the permit. Also, a fraction $H(\rho G)$ of entrepreneurs chooses $e = h$, and the rest choose $e = l$. As argued above, the optimal incentive scheme must satisfy $s_g + \gamma \geq s_d \geq s_g - \gamma$. Therefore, the government chooses $\{s_g, s_d\}$ to maximize

$$W = \int_0^{\rho G} (G - \psi) dH(\psi) + \int_{\rho G}^{\bar{\psi}} (G - D - \rho\gamma) dH(\psi) - (\lambda - 1) s_g, \quad (9)$$

subject to $s_d \in [s_g - \gamma, s_g + \gamma]$. The solution is such that $s_g = 0$ and $s_d \in [0, \gamma]$. Moreover, expression (9), plugging in $s_g = 0$, is strictly positive if and only if $D < D_0^{NS} \equiv \frac{G - \int_0^{\rho G} \psi dH(\psi)}{1 - H(\rho G)} - \rho\gamma$. Therefore, when this inequality holds, setting $s_g = 0$ and $s_d \in [0, \gamma]$ is socially optimal. Otherwise, the government bans the activity.

Proof of Proposition 2

We structure the proof as follows. In Part I, we assume the self-reporting scheme is in place:

1. the government denies the permit to all entrepreneurs who send message m_{E1} ,
2. whether the entrepreneurs who send message m_{E2} obtain the permit is left to the discretion of their official, and
3. the government sets $s_a \equiv s_{m_{E1}}$, $s_g \equiv s_{g, m_{E2}}$, and $s_d \equiv s_{d, m_{E2}}$.

We compute the optimal self-reporting scheme. As we show below, the government can always replicate the level of welfare achieved under the policy outlined in Proposition 1. As a result, in Part I, we also compute the conditions under which communicating with the entrepreneurs *through the self-reporting scheme* improves on the level of welfare achieved under Proposition 1.

In Part II, we compute an upper bound on the the level of welfare any mechanism within the class of mechanisms we consider can achieve. We show the self-reporting scheme achieves this upper bound whenever communicating with the entrepreneurs is valuable.

Part I

We first describe the outcome of the subgame that takes place if an entrepreneur and an official do not strike a deal. Next, we describe the conditions under which the two parties enter a deal, and the resulting outcome. Finally, we characterize the optimal schedule of wages. Throughout, we suppose the government makes a transfer $G > t \geq 0$ to the entrepreneurs who self-report, and treat t as a choice variable. We allow for this possibility to show that our results are robust to this modification. In this slightly modified setup, the government will be able to make entrepreneurs strictly better off by self-reporting. To obtain the results stated in Proposition 2, simply set $t = 0$. In what follows, we let m denote a given message sent by an entrepreneur, and set $m_1 = m_{E1}$ and $m_2 = m_{E2}$.

No deal

Consider a given pair and suppose no deal was struck. We compute the official and entrepreneur's payoffs when the latter has chosen *not* to self-report. The official obtains $s_g - l(\sigma, g)\gamma$ if $r = g$ and $s_d - l(\sigma, d)\gamma$ if $r = d$, where $l(\sigma, g) = 1$ (resp. $l(\sigma, d) = 1$) if $\sigma = n$ (resp. $\sigma = c$), and zero otherwise. It follows that if $s_g > s_d + \gamma$, then $r_\sigma = g$ and $u_{m_2, \sigma} = G$ for $\forall \sigma$, where $u_{m_2, \sigma}$ denotes the entrepreneur's payoff when choosing not to self-report, for a given σ . Similarly, if $s_d + \gamma \geq s_g \geq s_d - \gamma$, then $r_c = g$, $u_{m_2, c} = G$, $r_n = d$, and $u_{m_2, n} = 0$. Finally, if $s_d - \gamma > s_g$, then $r_\sigma = d$ and $u_{m_2, \sigma} = 0$, $\forall \sigma$.

We now analyze the entrepreneur's choice whether to self-report (and forgo the permit). This choice is rational for the entrepreneur if and only if her payoff in the ensuing subgame exceeds $u_{m_2, \sigma}$. We consider the three cases highlighted in the previous paragraph in turn. The first is such that $s_g > s_d + \gamma$. Because $u_{m_2, \sigma} = G$ for $\forall \sigma$, the entrepreneur is better off not self-reporting. As a result, $r'_\sigma = g$, $m'_\sigma = m_2$, and $u'_\sigma = G$ for $\forall \sigma$. Now suppose $s_d - \gamma > s_g$. Because $u_{m_2, \sigma} = 0 \leq t$, the entrepreneur is better off self-reporting, $\forall \sigma$. As a result, $m'_\sigma = m_1$, and $u'_\sigma = t$, $\forall \sigma$. Finally, suppose $s_d + \gamma \geq s_g \geq s_d - \gamma$. Because $u_{m_2, c} = G$, the entrepreneur does not self-report when $\sigma = c$. As a result, $r'_c = g$, $m'_c = m_2$, $V'_c = s_g$, and $u'_c = G$. By contrast, because $u_{m_2, n} = 0 \leq t$, the entrepreneur is better off self-reporting when $\sigma = n$. As a result, $m'_n = m_1$, $V'_n = s_a$, and $u'_n = t$.

Therefore, if the official-entrepreneur pair does not strike a deal, the outcome of the ensuing subgame is such that $u'_c = u'_n$, except when $s_d + \gamma \geq s_g \geq s_d - \gamma$. By Lemma A.1, we know no loss of generality occurs in restricting attention to $s_d + \gamma \geq s_g \geq s_d - \gamma$.

Deal

Consider a given pair. Assume the deal specifies $r = d$ and $m = m_2$. Because, conditional on $r = d$, the entrepreneur receives t when $m = m_1$ and 0 when $m = m_2$, deviating is profitable for her. Thus, the deal is not implementable. Assume the deal specifies $m = m_1$. Because (i) the official cannot commit to a ruling r , which here only occurs out-of-equilibrium (i.e., if the entrepreneur sends $m = m_2$), (ii) $G > t$, and (iii) the bribe b is sunk, the entrepreneur deviates if choosing $r = g$ is then in the official's interest. Faced with a deviation, the official chooses $r = g$ if and only if $\sigma = c$, because $s_d + \gamma \geq s_g \geq s_d - \gamma$. As a result, a deal specifying $m = m_1$ is viable only if $\sigma = n$. However, given that $m'_n = m_1$ and $u'_n = t$, note the official's payoff cannot be strictly larger than $V'_n = s_a$ when implementing this deal. The official is thus better off not offering this deal when $\sigma = n$.

It follows that, given σ , if a deal is struck, it must entail $r_\sigma = g$ and $m_\sigma = m_2$. To determine b_c , the official maximizes $s_g - \gamma + b_c$ subject to $G - b_c \geq u'_c = G$, which yields $b_c = 0$. To determine b_n , the official maximizes $s_g - \gamma + b_n$ subject to $G - b_n \geq u'_n = t$, which yields $b_n = G - t$. As a result, $V(c, g, m_2, 0) = s_g$ and $V(n, g, m_2, G - t) = s_g - \gamma + G - t$. Comparing these payoffs to $V'_c = s_g$ and $V'_n = s_a$, we find the official is payoff-indifferent regarding whether to offer a deal when $\sigma = c$. Thus, no deal is struck and $r_c = g$ and $b_c = 0$. Further, when $\sigma = n$, the official offers a deal if and only if $s_g - \gamma + G - t > s_a$. As a result, $r_n = g$, $m_n = m_2$, and $b_n = G - t$ if $s_g - \gamma + G - t > s_a$, whereas $m_n = m_1$ and $b_n = 0$ otherwise.

Officials' Optimal Schedule of Wages

We now determine the optimal schedule $\{s_g, s_a, s_d, t\}$. We know the optimal schedule of wages is such that $s_d + \gamma \geq s_g \geq s_d - \gamma$. Moreover, we must distinguish between two cases, depending on whether $s_g - \gamma + G - t > s_a$ holds. For each of these two cases, we characterize the associated expression

for social welfare, and the (locally) optimal schedule of wages. We then compare welfare levels to determine the globally optimal scheme.

Assume $s_g - \gamma + G - t > s_a$. An entrepreneur intent on applying chooses $e = h$ if and only if $G - b_c - \psi \geq \rho(G - b_n) + (1 - \rho)(G - b_c)$, which simplifies to $\rho(G - t) \geq \psi$. Because $\rho(G - b_n) + (1 - \rho)(G - b_c) = \rho t + (1 - \rho)G > 0$, all entrepreneurs apply for the permit. Also, a fraction $H(\rho(G - t))$ of entrepreneurs chooses $e = h$, and the rest choose $e = l$. Therefore, the government chooses $\{s_g, s_a, s_d, t\}$ to maximize

$$W = \int_0^{\rho(G-t)} (G - \psi) dH(\psi) + \int_{\rho(G-t)}^{\bar{\psi}} (G - D - \rho\gamma) dH(\psi) - (\lambda - 1) s_g \text{ s. t.} \quad (10)$$

$$s_g \in [s_d - \gamma, s_d + \gamma],$$

$$s_g - \gamma \leq s_a,$$

$$s_g - \gamma + G - t > s_a.$$

Setting $s_g = 0$, $s_a \in [0, G - \gamma - t)$, and $s_d \in [0, \gamma]$ is optimal because doing so achieves the highest possible value of (10) while satisfying all constraints. Observe also that (10) is decreasing in t . In particular, (10) goes to

$$W = \int_0^{\rho G} (G - \psi) dH(\psi) + \int_{\rho G}^{\bar{\psi}} (G - D - \rho\gamma) dH(\psi), \quad (11)$$

as t goes to 0. Therefore, a government concerned about whether entrepreneurs who are payoff-indifferent whether to self-report indeed prefer to self-report can ensure self-reporting is strictly optimal and achieve a level of welfare arbitrarily close to (11) by setting t arbitrarily close to 0.

Assume now $s_g - \gamma + G - t \leq s_a$. An entrepreneur intent on applying chooses $e = h$ if and only if $G - b_c - \psi \geq \rho t + (1 - \rho)(G - b_c)$, which simplifies to $\rho(G - t) \geq \psi$. Because $\rho(G - b_n) + (1 - \rho)(G - b_c) = \rho t + (1 - \rho)G > 0$, all entrepreneurs apply for the permit. Also, a fraction $H(\rho(G - t))$ of entrepreneurs chooses $e = h$, and the rest choose $e = l$. Note, however, that unlike when $s_g - \gamma + G - t > s_a$, the entrepreneurs for which $\sigma = n$ is realized do not obtain the

permit. The government chooses $\{s_g, s_a, s_d, t\}$ to maximize

$$\int_0^{\rho(G-t)} (G - \psi) dH(\psi) + \int_{\rho(G-t)}^{\bar{\psi}} (G - D) dH(\psi) \quad (12)$$

$$- [1 - \rho(1 - H(\rho(G-t)))](\lambda - 1)s_g - (1 - H(\rho(G-t)))\rho(\lambda - 1)(s_a + t) \quad \text{s.t.}$$

$$s_g \in [s_d - \gamma, s_d + \gamma],$$

$$s_g - \gamma + G - t \leq s_a, \quad (13)$$

$$s_g - \gamma \leq s_a. \quad (14)$$

Notice (12) is decreasing in s_g and s_a . Also, from (13) and (14), s_a is bounded from below by $s_g + G - \gamma - t$ and $s_g - \gamma$. Substituting $s_a = s_g + G - \gamma - t$ into (12), one immediately derives that setting $s_g = 0$ is optimal. Moreover, setting $s_d \in [0, \gamma]$ ensures the other constraints are indeed satisfied. Also, (12) goes to

$$W = \int_0^{\rho G} (G - \psi) dH(\psi) + (1 - \rho) \int_{\rho G}^{\bar{\psi}} (G - D) dH(\psi) \quad (15)$$

$$- (1 - H(\rho G))\rho(\lambda - 1)(G - \gamma),$$

as t goes to 0. Therefore, a government concerned about whether entrepreneurs who self-report indeed prefer to self-report can ensure self-reporting is strictly optimal and achieve a level of welfare arbitrarily close to (15) by setting t arbitrarily close to 0.³⁶ Observe that (15) is positive if and only if $D \leq D_0^S \equiv \frac{1}{1-\rho}(D_0^{NS} - \lambda\rho(G - \gamma))$.

Social welfare

The last step involves comparing welfare levels. Welfare level (15) is strictly higher than (11) if and only if $D > D^S \equiv \lambda(G - \gamma)$. Therefore, this condition must hold for the scheme to be desirable. Further, welfare level (15) is nonnegative if and only if $D \leq D_0^S$. Thus, this condition must also hold

³⁶This finding establishes the robustness of the self-reporting scheme because it shows that the government can ensure—at an arbitrarily small cost—that entrepreneurs who have not entered a deal are strictly better off self-reporting when $\sigma = n$.

for the scheme to be preferred over banning the activity. Finally, $D_0^S \geq D^S$ if and only if $\lambda \leq \frac{D_0^{NS}}{G-\gamma}$. Thus, exploiting entrepreneur self-reporting is optimal whenever $\lambda \leq \frac{D_0^{NS}}{G-\gamma}$ and $D^S < D \leq D_0^S$. If $\lambda \leq \frac{D_0^{NS}}{G-\gamma}$ and $D \leq D^S$, the incentive scheme associated with (11) is optimal: the government does not exploit entrepreneur self-reporting but allows the activity. The same conclusion applies if $\lambda > \frac{D_0^{NS}}{G-\gamma}$ and $D \leq D_0^{NS}$. Finally, when $\lambda > \frac{D_0^{NS}}{G-\gamma}$ and $D > D_0^{NS}$, the government bans the activity.

Part II

We now compute an upper bound on the level of welfare any mechanism within the class of mechanisms we consider can achieve. We show that the level of welfare achieved under the self-reporting scheme (when $t = 0$) is equal to this upper bound whenever communicating with the entrepreneurs is valuable. The proof proceeds as follows. We first establish that it is without loss of generality for the government to retain authority over permits. We then compute the upper bound. As a corollary result, this proof also establishes that restricting message spaces to contain only two messages is without loss of generality. Indeed, in what follows consider arbitrary message spaces M_O and M_E , where $\{m_{O1}, m_{O2}\} \subseteq M_O$ and $\{m_{E1}, m_{E2}\} \subseteq M_E$.

Proof that Retaining Authority is Weakly Optimal

Recall our maintained assumption whereby m_E is chosen prior to the ruling r and publicly observable. Consider a given mechanism, with some delegation-rule $x^*(m_E) : M_E \rightarrow \{0, 1\}$. Suppose, moreover, that $x^*(m_E) = 0$ for some (possibly all) message(s) m_E . Let $\tilde{M}_E \equiv \{m_E : x^*(m_E) = 0\}$, and denote by s_{g, m_E}^* and s_{d, m_E}^* the wages specified in the mechanism.

Suppose the government designs an alternative mechanism identical to the previous one in every respect, except that now $x(m_E) = 1, \forall m_E$, and, moreover, that, $\forall m_E \in \tilde{M}_E, r_{m_{O1}, m_E} = g, r_{m_{O2}, m_E} = d, s_{m_{O1}, m_E} = s_{g, m_E}^*$, and $s_{m_{O2}, m_E} = s_{d, m_E}^*$. The equilibrium induced by this alternative mechanism is identical to that induced under the original mechanism, because officials, when $m_E \in \tilde{M}_E$, enjoy just as much discretionary power over permits. It follows there exists no loss of generality in restricting attention to mechanisms such that the government retains authority.

Computing an Upper Bounder on the Level of Welfare

Suppose the government retains authority over permits and communicates with both officials and entrepreneurs. In what follows, let $m \equiv (m_O, m_E)$ denote a given pair of messages. We maintain the assumption whereby m_E is chosen prior to m_O . The government chooses the officials' schedule of wages $s(m_E, m_O) : M_O \times M_E \rightarrow \mathbb{R}^+$ and the decision-rule $r(m_E, m_O) : M_O \times M_E \rightarrow \{g, d\}$ to maximize expected welfare, where s_m and r_m denote, respectively, a wage and a decision under a given pair of messages m . In case a mechanism induces multiple equilibria, we suppose players coordinate on the government's preferred equilibrium. This assumption is conservative insofar as it can only raise the upper bound on the level of welfare that we characterize.

Setting $r_m = g, \forall m$, cannot be optimal. Systematically granting permits would lead to all entrepreneurs applying for the permit, but none of them choosing $e = h$. As a result, welfare would be negative, and the government would be better off, for instance, by forbidding the activity. Further, setting $r_m = d, \forall m$, cannot be strictly optimal. Systematically denying permits would deter all entrepreneurs from applying and welfare would be equal to zero. It follows that, at the optimum, there must exist at least 2 pairs of messages m and m' , where $m, m' \in M_O \times M_E$, such that $r_m \neq r_{m'}$.

In what follows, let m_σ , where $\sigma \in \{c, n\}$, denote the equilibrium pair of messages sent by the pairs whose associated signal realization is σ . It is unimportant for our purposes whether these messages are the outcomes of deals that entrepreneurs and officials enter.

A mechanism $\{s(m_E, m_O), r(m_E, m_O)\}$ that would induce $r_{m_c} = r_{m_n} = d$ (with possibly $m_c = m_n$) cannot be strictly optimal. Indeed, entrepreneurs would anticipate such an outcome when deciding whether to apply, and choose not to apply (leading to a level of welfare equal to zero).³⁷ Similarly, a mechanism $\{s(m_E, m_O), r(m_E, m_O)\}$ that induces $r_{m_c} = d$ and $r_{m_n} = g$ cannot be optimal because it either leads to no entrepreneur applying for the permit (and a welfare level equal to zero), or all entrepreneurs applying for the permit and choosing $e = l$ (and a negative level of welfare).³⁸ It follows the government must design $\{s(m_E, m_O), r(m_E, m_O)\}$ so as to induce either $r_{m_c} = r_{m_n} = g$ (with possibly $m_c = m_n$) or $r_{m_c} = g$ and $r_{m_n} = d$. Notice that, under either outcome,

³⁷Notice that, in this putative equilibrium, messages are never actually sent to the government because no entrepreneur chooses to apply for the permit. However, for a strategy profile to constitute a subgame perfect equilibrium, one must specify the Nash equilibrium of every subgame.

³⁸Which of the two scenarios arises depends on what messages officials and entrepreneurs send when not entering deals.

all entrepreneurs whose associated signal realization is c obtain the permit.

We now proceed under the unrealistic assumption that entrepreneurs and officials, when observing $\sigma = c$, are perfectly “obedient”: they send whatever messages the government recommends them to send when observing $\sigma = c$, and never enter deals (i.e., do not exchange bribes). However, we maintain the assumption whereby officials and entrepreneurs can enter deals and behave opportunistically when $\sigma = n$. Intuitively, the optimal mechanism under this assumption can only yield a weakly higher level of welfare than the optimal mechanism when corruption and framing are an issue for both $\sigma = n$ and $\sigma = c$. This assumption can only raise the upper bound on the level of welfare that we characterize.

Without loss of generality, suppose that the government recommends officials (resp. entrepreneurs) to send message m_{OI} (resp. m_{EI}) when observing $\sigma = c$, and let $m_1 \equiv (m_{OI}, m_{EI})$. It follows $r_{m_c} = r_{m_1} = g$.

Before computing the optimal mechanism, notice that, because $r_{m_c} = g$ by assumption, all entrepreneurs apply for the permit.³⁹ Further, let m'_n denote the pair of messages sent in the absence of a deal when $\sigma = n$. The optimal mechanism must necessarily be such that $r_{m'_n} = d$. To see this, suppose instead $r_{m'_n} = g$. Under such a scenario, all entrepreneurs would choose $e = l$ (anticipating that they would obtain the permit $\forall \sigma$) and welfare would be negative. To summarize, in this modified environment, the optimal mechanism is necessarily such that (i) all entrepreneurs apply for the permit and (ii) $r_{m'_n} = d$.

Suppose first the government designs $\{s(m_E, m_O), r(m_E, m_O)\}$ in a way that induces $r_{m_n} = g$ (where therefore $m_n \neq m'_n$ necessarily). In other words, suppose the government lets bribery occur. Setting all transfers to equal to 0, recommending officials to send message m_{O2} when observing $\sigma = n$, and setting $r_{m_{O2}, m_E} = d, \forall m_E$, and $r_{m_O, m_E} = d, \forall m \neq m_1$, is optimal: the expected wage bill is equal to zero, the highest possible fraction of entrepreneurs chooses $e = l$, and $r_{m'_n} = d$ indeed holds.^{40,41}

The associated level of welfare is equal to

³⁹For instance, an applicant’s expected payoff when choosing $e = l$ is weakly higher than $(1 - \rho)G > 0$.

⁴⁰Entrepreneurs’ incentives to choose $e = h$ are the highest possible because (i) their payoff when $\sigma = c$ is (by assumption) the highest possible (i.e., equal to G) and (ii) their payoff when $\sigma = n$ is the lowest possible (i.e., equal to 0). To see the latter statement, note that bribery occurs when $\sigma = n$, and that officials are able to extract $b = G$ because $r_{m'_n} = d$.

⁴¹To see why $r_{m'_n} = d$, note that, when all wages are equal to 0 and $\sigma = n$, officials are better off sending message m_{O2} to avoid the sanction γ .

$$W = \int_0^{\rho G} (G - \psi) dH(\psi) + \int_{\rho G}^{\bar{\psi}} (G - D - \rho\gamma) dH(\psi), \quad (16)$$

that is, the level of welfare achieved by the government when it cannot communicate with entrepreneurs (see (5)). Expression (16) is nonnegative if and only if $D \leq D_0^{NS}$.

Suppose now the government designs $\{s(m_E, m_O), r(m_E, m_O)\}$ in a way that induces $r_{m_n} = d$ (and recall $r_{m'_n} = d$). To achieve this outcome, the government must ensure officials weakly prefer not to enter deals when $\sigma = n$. Because $r_{m'_n} = d$, the payoff to an official who engages in bribery, ignoring wages, is equal to $G - \gamma$.⁴² Therefore, officials must necessarily receive a wage higher than $G - \gamma$ not to engage in bribery when $\sigma = n$. Setting all transfers to 0, except for $s_{m_{O2}, m_{E1}} = s_{m_{O2}, m_{E2}} = G - \gamma$, and setting $r_m = d, \forall m \neq m_1$, is optimal: it is the cheapest way for the government to deter bribery and it ensures that the highest possible fraction of entrepreneurs choose $e = h$.⁴³ Also, $r_{m'_n} = d$ indeed holds. The associated level of welfare is equal to:

$$W = \int_0^{\rho G} (G - \psi) dH(\psi) - (1 - \rho) \int_{\rho G}^{\bar{\psi}} (D - G) dH(\psi) - \rho(1 - H(\rho G))(\lambda - 1)(G - \gamma), \quad (17)$$

that is, the same expression as (8).

Because (i) (16) is the level of welfare the government achieves when not communicating with entrepreneurs and (ii) (17) is the level of welfare achieved under the self-reporting scheme, we conclude that, whenever communicating with the entrepreneurs is valuable, the self-reporting scheme is optimal.

⁴²One can show entrepreneurs and officials can always agree on a feasible deal that involves granting the permit in exchange for a bribe equal to G .

⁴³Entrepreneurs have the highest possible incentives to choose $e = h$ because their payoff is equal to G when $\sigma = c$ and equal to 0 when $\sigma = n$.

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