Economica

Economica (2022) **89**, 191–213
doi:10.1111/ecca.12396

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Bribes and Bureaucracy Size: The Strategy of Watering Down Corruption

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Final version received 30 September 2021.

We present a simple agency model with a revenue-maximizing government and many public officials (agents) in charge of collecting payments from citizens. Agents are of two types, honest and potentially dishonest, with the latter having an inherent propensity to demand bribes from citizens. This propensity may eventually turn into actual (perceived) corruption depending on the strategy pursued by the government. In equilibrium, we derive a non-linear relationship between potential and perceived corruption and, specifically, three distinct policy regimes in which the opportunistic behaviour is curbed, eradicated or tolerated. Different regimes are characterized by different bureaucracy sizes, and we conjecture that low levels of perceived corruption may, in some circumstances, be due to a dilution effect of bribery cases on large numbers of public employees. Some simple descriptive evidence on European regions appears to confirm our theoretical insights.

INTRODUCTION

Corruption is about breaking some fundamental rule of law in exchange for personal benefit. The exercise of power and the implementation of policies require delegation to bureaucrats and government officials, and this may give rise to rent-seeking behaviour or create room for bribery. Corruption can be broadly defined as the abuse or misuse of public power for private gain. On one side, there is an individual who is in a position to break the law and bestow some advantage on some other individual who, on the other side, is prepared to reward the former. If both parties engage in this activity, without any coercion, then both parties will be better off than in the case where no exchange takes place. But as argued, among others, by Rose-Ackerman (1975), Treisman (2000) and Lambsdorff (2007), a number of negative externalities can be associated with corruption, so this is why it has a bad reputation and is often severely sanctioned.[1]

Most of the works on corruption fall into two broad categories.[2] The first is the structural approach, which views corruption as institutionalized in social structures or networks. As echoed recently by Vannucci and Della Porta (2013), and Moene and Søreide (2016), the propensity to engage in bribery is essentially shaped by cultural and moral values, and this can partially explain the significant divergence across countries. For instance, this divergence is nicely documented by the experiment in Fisman and Miguel (2007), in which they examine the parking behaviour of United Nations diplomats in New York City and report that the number of violations is correlated with the extent of corruption in their native countries. Similarly, Gatti *et al.* (2003) and Pop (2012) present comparative studies in which the attitude towards corruption depends on country-specific cultural traits and institutional factors. The second category is the rational-actor approach, based on the early work of Becker and Stigler (1974), which assumes that even criminal behaviour results from a rational risk-return calculus. This is also true for corruption and, as concerns this paper, the relationship between governance and public service administration. According to this approach, the potential misconduct

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of public servants and bureaucrats can be constrained through the design of enforcement systems, using the right set of rewards and penalties.

In this paper, we present a simple model in which we incorporate both individual self-interest and social preferences. We analyse the agency problem between a government and a number of individuals who wish to hold public office. The government's objective is to maximize expected net revenues from the administration of a public service, for which citizens may be required to pay a lump sum (for instance, a fee or fine). The government needs to delegate some discretionary power to public officials, who are of two types, honest and (potentially) dishonest. Honest agents always transfer the fees collected to the government, while dishonest agents may want to extort a bribe from citizens, whenever they have the chance and no incentive to do otherwise. Appropriate incentives can be provided by the government through combinations of wage and monitoring intensity. We interpret the proportion of dishonest individuals as the share of public officials who may potentially be involved in corruption. Their tendency may or may not result in actual or visible corruption, depending on government action. Our interpretation is in line with a number of theoretical and empirical works, which assume that individuals are, to some degree, inherently honest or dishonest, and have well-defined moral tastes when it comes to criminality (Corbacho *et al*. 2016). But corruption can be regarded, at least in part, as a crime of opportunity (Rose-Ackerman 1975). A public position, in particular, may be viewed as an instrument for the acquisition of political power and control, and can offer many chances for illicit private gain. Thus the government needs to take into account not only that bureaucracies tend to generate high pecuniary returns to corruption, but also that public contracts and policies can have significant incentive effects on the willingness to bribe of its employees. As Besley and McLaren (1993) put it:

> Dishonesty is defined as an immutable characteristic of preferences—an honest person regards his integrity as priceless and thus will not take a bribe for any material reward, while a dishonest person will maximize his expected income. While dishonesty is immutable it is possible, therefore, to make a dishonest person behave honestly by making it in his or her interest to do so (Besley and McLaren 1993, p. 122).

In the model, we derive a non-linear relationship between *potential* corruption and *perceived* corruption. Specifically, we derive three distinct policy regimes. When the proportion of dishonest individuals (that is, potential corruption) is relatively high, the government will find it optimal to choose the 'all bribe' policy, where it pays the lowest possible wage, invests little in monitoring, and hires only those agents who will engage in corruption as a gamble. When the proportion of dishonest individuals is lower, the government will adopt the 'no bribe' policy, under which it hires all types of candidates, pays reservation wages, chooses the incentive-compatible monitoring, and substantially eliminates corruption. Finally, there is a third regime, which we will refer to as the 'some bribe' policy. Namely, when there is an even lower proportion of dishonest individuals, the government hires all candidates and again pays them reservation wages, but sets monitoring at a level that does not discourage bribe-taking by dishonest public officials.

Our equilibrium configuration is similar to those derived in the tax evasion games of Graetz *et al*. (1986), Erard and Feinstein (1994), and Besley and McLaren (1993). Similarly to us, the authors of the last paper identify three possible policy strategies, but in terms of the wage paid to public servants: efficiency wages, at which all agents behave honestly; reservation wages, with both honest and dishonest agents; and capitulation

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wages, which are below the reservation wage and attract only the dishonest. The difference between their model and ours is that we endogenize the investment in monitoring, in order to take account of the situations in which the government is unable to commit to strategies that are not *ex post* incentive-compatible. Hence we derive only two wage policies, capitulation wages and reservation wages, where the latter can either provide or not provide the right incentive to agents, depending on monitoring. In our case, there may exist a regime in which some public officials, who are paid the market wage, will engage in corruption and be barely monitored and detected. Unlike Besley and McLaren (1993), endogenous monitoring allows us to derive an unambiguous relation between potential dishonesty and intensity of control, and rule out equilibria in which auditing is very (or extremely) effective but some tax inspectors still decide to engage in corruption.[3] In addition, since in our model the government does not pay more than the market wage, this does not raise the potential issue of resource misallocation, for example talent, as analysed in Acemoglu and Verdier (2000).

This paper is also related to the more recent literature on governance and anticorruption measures. Gauthier and Goyette (2016) analyse a model in which tax inspectors are corruptible and can impose red-tape or harassment costs on taxpayers. In their case, raising fiscal pressure increases bribery incentives, and this forces the government to choose between two policies with different tax rates and detection levels: the no-corruption regime with low tax rate and high monitoring, and the flexible regime with high tax rate and low monitoring. They conclude that the flexible regime, with some corruption, yields higher tax revenues and lower social costs (in terms of bribe size). Strîmbu and González (2018) develop a common agency framework with an agent (a contractor) and two principals, the public and the corruptor. The principals have opposite preferences over the action chosen by the contractor, for instance the quality of materials used to produce a credence good. Their main result is that more transparency (monitoring) reduces the incidence of corruption, but can motivate the corruptor to behave more aggressively and demand larger bribes from the contractor. Wadho (2016), in a setup in part similar to ours, considers endogenous monitoring and shows that the government maximizes its revenues by either eradicating corruption with high wages or accepting corruption with low wages. Unlike us, in his analysis, the combination of high wages and partial bribery is never optimal.[4]

A corollary result of our paper is that the available policy options are characterized by different pairs of bureaucracy size and proportion of public officials who will likely engage in bribery. This proportion can be viewed as an indirect indicator of the level of public sector corruption that will eventually be perceived by society. And since perceived corruption depends on the number of public servants, the size of bureaucracy provides an opportunity for the government to choose how much of the intrinsic characteristic of dishonest individuals to be made ‘visible’ to the public eye. In other words, we conjecture that when reducing corruption is too costly, the choice is between a small and a large bureaucracy, with the same number of potential dishonest public officials, but different levels of perception about the spread of this criminal activity. Therefore we can obtain a U-shaped relation in which very low levels of potential corruption do not necessarily imply less corruption in absolute terms. In terms of the wage paid to public servants, it is possible to observe situations where high remunerations can be associated with a certain degree of perceived corruption. This is, in part, in contrast with the prevailing empirical literature, in which there is usually a negative correlation between civil-service pay and corruption, as for example in the seminal work by Van Rijckeghem and Weder (2001), although the authors recognize that the causal link may also depend on other policy

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instruments, such as more transparency and accountability. Our results are more consistent with the findings in Di Tella and Schargrodsky (2003), who find that the most effective deterrent of corruption is the simultaneous increase in audit and public wages.

From an observational point of view, it is difficult to conduct a thorough empirical investigation of something that, by its very nature, is illegal and secretive. Besides, the available indices of perceived corruption are based on subjective evaluations and opinions, which might happen to be correlated with the same factors that are believed to cause corruption. Despite these methodological difficulties, we present some suggestive evidence in an attempt to validate our theoretical predictions. A first quick visual inspection of the data in Figure 1 suggests that low (high) levels of perceived corruption can coexist with large (small) numbers of public employees. In the figure, we report the corruption perception index published by Transparency International and the number of public employees per 1000 inhabitants for a selection of European countries, in the year 2015. These simple descriptive data appear to contradict the common belief that large bureaucracies inevitably increase the scale and incidence of corruption. In addition, using a fixed effects model and data on the intensity of perceived corruption at the regional level in the European Union, as measured by the European Quality of Government, we report in Figure 2(a) the predicted values of perceived corruption for different degrees of potential corruption, proxied by the levels of trust or social capital (a more detailed description is provided in Appendix B). As shown, an increase in potential corruption leads to first a decrease and then an increase in the perceived measure, yielding a U-shaped relationship.[5] Finally, considering as dependent variable the share of employees in the public administration, we show in Figure 2(b) that potential corruption is negatively correlated with the size of the public sector.

The corruption perception index and other similar indices are based on surveys of local country analysts and experts who are asked to give their *subjective* assessment of the likelihood of encountering or dealing with corrupt officials in the public sector. There is therefore some reason to argue that the very low perception of corruption in some countries may be in part the result of a watering down effect. Namely, larger public

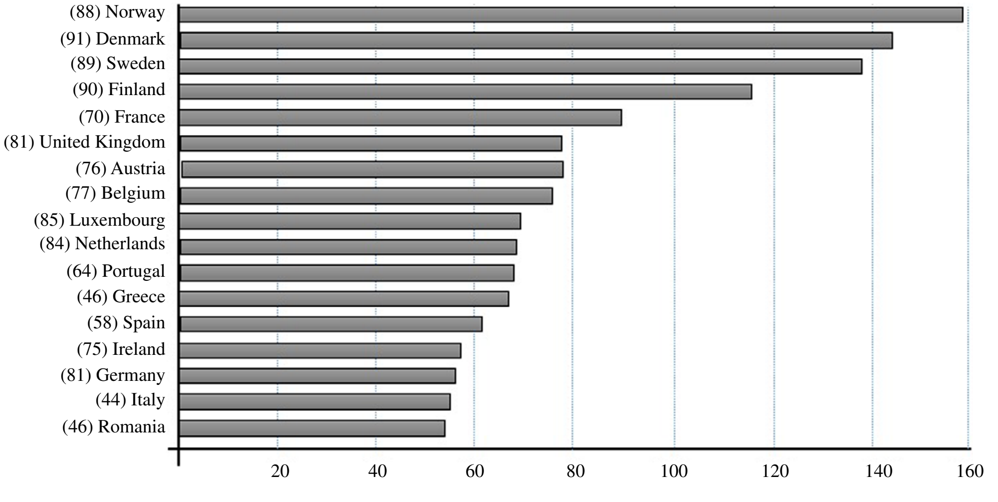

FIGURE 1. Employees in public sector per 1000 inhabitants (2015). *Notes*: The number in parentheses is the Corruption Perception Index (2015). (Sources: OCDE and Transparency International.)

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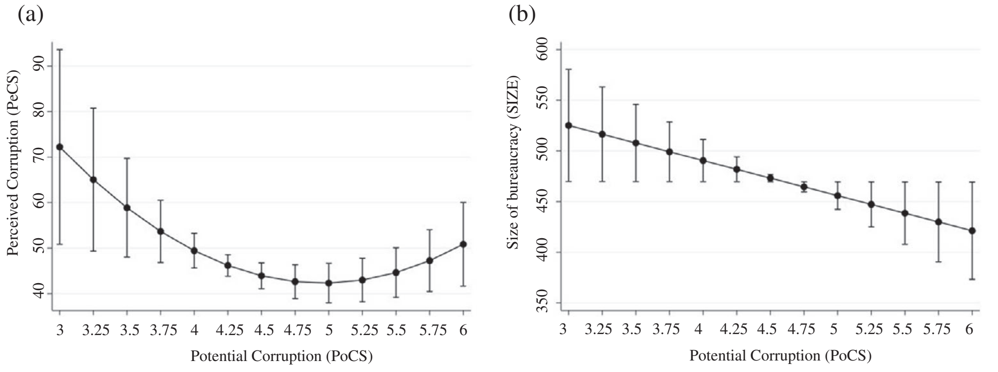

FIGURE 2. Predicted values for *PeCS* and *SIZE* with 95% confidence intervals.

sectors can create more opportunities for bribery but, at the same time, reduce the relative number and first-hand observations of corrupt transactions. Conversely, smaller public sectors may increase the chances that the subjective assessment on the conduct of public servants is something along the lines of 'they are all the same!'.

In what follows, Section I builds up the model. Section II derives the equilibrium configurations. Section III discusses the policy implications. Section IV concludes.

I. THE SETUP

Consider a one-period, risk-neutral economy with a government (principal), N individuals (agents) who wish to hold public office or positions, and a large number of citizens who may be required to pay a fee or fine, ϕ, to the authority. Agents are of two types, honest (H) and (potentially) dishonest (D), with the following characteristics: H agents always transfer ϕ to the government; D agents have an innate propensity to misinform the government and demand a bribe from citizens, asking them to pay less than ϕ, and keeping the difference. For example, we can consider some citizens who go to a public office to pay ϕ, and are received by agents in charge of collecting the payments, where the agents of type D are those soliciting and receiving the bribe (which thus takes the form of a harassment bribe or extortion). To simplify, we assume that each agent exerts costless effort to fine at most one citizen,[6] and that D agents have complete bargaining power over citizens, so the bribe size is equal to ϕ.

The government's objective is to maximize expected net revenues, and to this end, it will design the most effective policy to curb or eradicate corruption, but only if it is not too costly to implement.[7] The government is endowed with a monitoring technology that generates a corruption detection probability m at a cost given by the function $C(m)$, with $C(0) = 0$, $C_m(m) > 0$ and $C_{mm}(m) > 0$. To make the analysis tractable, especially in the comparison of policy regimes, we will make use of a simple quadratic monitoring cost function, $c \cdot m^2/2$, with $c > 0$. We assume that the monitoring investment is observable by pubic officials, in particular by D types, when they decide whether or not to accept the job.[8] This, however, does not mean that *ex post* (after public officials are hired), the government cannot decide to increase the amount of resources allocated to supervision activities. (It is less likely, though not impossible, that monitoring can be decreased if, for example, the government has already hired public inspection personnel or installed surveillance equipment.) If corruption is detected, then no penalty is imposed on citizens,

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whereas public officials are forced to transfer the fine extorted and bear a non-pecuniary sanction σ. In much of the literature, the risk of engaging in corruption is represented by the loss of job positions and thus of future earnings, but no other (pecuniary or non-pecuniary) penalties are imposed on bribers. Two exceptions are Mookherjee and Png (1995) and Fan (2006), in which public officials are subject to a penalty if caught for corruption, and argue that this is both realistic and relevant for incentive design. In our setup, public officials are paid at the beginning of the period, and if caught for bribery, they are subject to a non-pecuniary sanction, but do not pay back or lose their wages. Thus our focus here is to investigate whether public officials can increase their job utility by engaging in bribery. The justification for this modelling choice is that given the one-period nature of our setup and the one-to-one relationship between briber and bribed, the public job task can be considered 'completed' as soon as D bureaucrats extort a bribe from citizens, so the threat of job loss would lose its motivational effect.[9]

Unlike Acemoglu and Verdier (2000), we assume that agents know whether they are potential bribers before they become bureaucrats. This means that other than hidden action on the part of D agents, there is hidden information. The government knows only the probability, π_H or π_D, with $\pi_H + \pi_D = 1$, that a candidate is of type H or D. We indicate by $p \in (0, 1)$ the probability that a citizen is required to pay the fee. The introduction of stochastic fee payments is a key assumption for our analysis: if p were equal to 0, then citizens would never be in a position to pay the fee; if p were equal to 1, then the information asymmetry between the government and agents would play no role. Corruption is thus modelled as a gamble both in the probability of being detected (and punished) and in the likelihood that the exchange of bribes can take place. Finally, candidates for public office have a positive reservation wage ω_R.

The timing of the game is: (1) nature determines ω_R, p and π_H or π_D; (2) the government chooses the wage ω of public officials, and monitoring m; (3) H and D agents decide whether or not to accept the position; (4) if D agents are hired and fine a citizen, then they decide whether to bribe or not.

II. Policy Regimes

There are three different possible strategies to deal with corruption. In the first subsection below, we discuss the 'all bribe' (AB) policy, in which the government pays to public officials a wage lower than the reservation level, hires only D individuals who engage in corruption, and tries to detect them through random auditing. In the second subsection, we discuss the 'some bribe' (SB) policy, where the government hires all candidates and pays them reservation wages, but sets monitoring at the lowest level, so that D public officials will be incentivized to demand bribes. In the third subsection, we discuss the 'no bribe' (NB) policy, where again the government hires all types of candidates at the reservation wage, but chooses the incentive-compatible auditing level, so it eliminates corruption.

A policy is defined by the pair (ω, m). We denote the expected utilities of H and D agents by u_H and u_D, where the latter is additive in wage and payoff from bribery β. As specified in the model description, the government maximizes expected net revenues, but in the analysis we will also determine and compare aggregate welfare (government's revenue and agents' utilities) under the three policy regimes. To this end, we will assume that society attaches a lower value, discounted by $\delta \in (0, 1]$, to the surplus earned by bribers. The reason is that in the model, we do not consider the supply and demand sides of public spending, so we need a rationale for why the fees transferred by citizens are

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worth more in the hands of the government rather than in those of bribers. The fraction $1-\delta$ can be interpreted as an indirect measure of institutional quality in the economy/society.

The 'all bribe' policy

If the government pays a wage $\omega < \omega_R$, then the only candidates for public office are of type D, and they will demand a bribe if they have no incentive to do otherwise. As in the model of criminal behaviour by Becker (1968), the decision to engage in misconduct depends on the potential gains from illegal activity, the probability of conviction and the severity of punishment. Since D agents can make their bribe demand only when a citizen is fined—that is, if the opportunity arises—the incentive compatibility (no-bribe) constraint requires that

$$\beta = (1-m)\phi - m\sigma \leq 0,$$

where the left-hand side of the inequality is the agent's expected payoff from corruption. With probability $1-m$, the agent is not detected and retains the bribe, whereas with probability m, the agent is detected and sanctioned (the fee is confiscated and transferred to the government). The wage is paid at the beginning of the period and consumed. The no-bribe constraint holds if

$$m \geq \frac{\phi}{\phi+\sigma} \equiv m_{NB}, \tag{1}$$

which means that a large detection probability would be sufficient to prevent corruption in this simple setup. However, the individual rationality (participation) constraint must also be satisfied, otherwise D types would not accept the job. In the design of the participation constraint, the government must take into account that when $\omega < \omega_R$, monitoring cannot be set at a level such that the participation and incentive constraints can be satisfied simultaneously. Hence the participation constraint of D types must require that before accepting the job, the expected payoff from bribery is equal to or larger than the reservation wage, that is,

$$u_D = \omega + p\beta = \omega + p[(1-m)\phi - m\sigma] \geq \omega_R.$$

The public office therefore allows participation in a lottery where, with probability $p(1-m)$, a citizen is fined and D agents are not detected and keep ϕ, and with probability pm, they are detected and punished. The participation constraint (PC) holds if

$$m \leq \frac{p\phi + \omega - \omega_R}{p(\phi+\sigma)} = m_{PC}(w), \tag{2}$$

which depends on the wage chosen by the government, and is below 1 when $\omega < \omega_R$, and above 0 if $p\phi + \omega \geq \omega_R$, that is, if the potential earnings in the public sector are higher than the opportunity cost of labour.

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From equations (1) and (2), for all $\omega < \omega_R$, it follows that

$$m_{NB} - m_{PC}(w) = \frac{\omega_R - \omega}{p(\phi + \sigma)} > 0, \tag{3}$$

and this means that if D agents accept the job, then they will always demand a bribe whenever citizens are required to pay their fees.

Under the AB policy, the expression for the government's expected revenue is

$$\rho(\omega,\ m) = \pi_D\left[pm\phi - \omega - C(m)\right]N,$$

which consists of the fee transferred by the agent if caught (which happens with probability pm), the wage paid, and the monitoring cost. Note that the only source of revenue for the government is through successful auditing.

To maximize expected revenues, the government will choose the lowest wage and monitoring level satisfying the participation constraint in equation (2). From the first-order condition, the optimal monitoring implicitly derives from the equality between marginal revenue and marginal cost:

$$p\phi = C_m(m) \quad \Longrightarrow \quad m = C_m^{-1}(p\phi) \equiv m_{AB}.$$

With the quadratic cost function $C(m) = c \cdot m^2/2$, we have $m_{AB} = p\phi/c$, which is lower than 1 if the cost parameter is relatively high. Since m_{AB} can be either higher or lower than $m_{PC}(w)$, this raises the issue of *ex post* commitment on the use of monitoring. Specifically, the government may decide to change the monitoring intensity soon after agents take office and, anticipating this, D individuals may not apply for the job. (On the topic of *ex post* monitoring incentives, see Khalil 1997.) Thus we need to distinguish between the following two cases.

Case 1. $m_{AB} \le m_{PC}(0)$ In this case, m_{AB} is *ex post* incentive-compatible even at a wage of 0. So if there are no minimum wage requirements, then the government chooses $\omega = 0$ and $m = m_{AB}$, and has no incentive to adjust, *ex post*, the intensity of monitoring.

The government's equilibrium revenue is

$$\rho(0,\ m_{AB}) = \pi_D\left[p\, m_{AB}\,\phi - C(m_{AB})\right]N. \tag{4}$$

Each D agent receives

$$u_D = p[(1 - m_{AB})\phi - m_{AB}\,\sigma] \ge \omega_R.$$

If $m_{AB} < m_{PC}(0)$, then $u_D > \omega_R$, so public officials obtain a strict positive surplus when the participation constraint is not binding at the revenue-maximizing m_{AB}.

Aggregate welfare is

$$W(0,\ m_{AB}) = \left[\pi_D\,\rho(0,\ m_{AB}) + \pi_H\,\omega_R + \pi_D\,\delta\,u_D\right]N, \tag{5}$$

where H individuals earn their reservation wage elsewhere, and D public officials generate the social deadweight loss $(1 - \delta)u_D$.

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Case 2. $m_{AB} > m_{PC}(0)$ In this case, the government is forced to increase the wage above 0, because it cannot commit to the monitoring level satisfying the individual rationality constraint. Namely, if initially the government were to choose $m_{PC}(0)$, it then would have the *ex post* incentive to set $m_{AB} > m_{PC}(0)$, and D individuals would not apply for the position. This means that the wage must be increased to the level, denoted by $\omega_{\min}$, such that $m_{PC}(\omega_{\min}) = m_{AB}$, so the participation constraint is satisfied. The expressions of the government's expected revenues and social welfare are essentially equivalent to equations (4) and (5), except for the positive wage $\omega_{\min}$ paid to public officials.

The AB policy exists when H individuals do not participate and all public officials are of type D—that is, when $\omega_{\min} < \omega_R$ or $m_{AB} < m_{NB}$. Since $m_{AB} = C_m^{-1}(p\phi)$, and $C(m)$ is strictly convex, the condition $m_{AB} < m_{NB}$ holds when monitoring is relatively costly. For example, using the quadratic cost function, it follows that $\omega_{\min} = \omega_R + p(\phi + \sigma)m_{AB} - p\phi$, and the inequality $\omega_{\min} < \omega_R$ can be rewritten as $c > p(\phi + \sigma)$. Hence when $c \leq p(\phi + \sigma)$, we obtain $\omega_{\min} \geq \omega_R$, and the AB policy does not exist.[10] The intuition is that this regime, in which the government barely receives the fee payments from public officials, is attractive because the wage is low and, in particular, because the number of inspections is relatively small. (If monitoring is relatively cheap, then the government may find it more profitable to choose one of the policies analysed in the following subsections.)

Proposition 1. In the 'all bribe' policy, the government hires $\pi_D N$ public officials of type D, who receive the lowest possible wage, demand a bribe whenever they have the chance, and are detected with probability $m_{AB} < m_{NB}$.

The argument on the mismatch between m_{PC} and m_{NB} can also be made for the sanction, which cannot be set at a level such that the no-bribe constraint holds. This may occur when there are institutional or legal constraints on the adoption of large and repressive penalties, an argument discussed by Becker and Stigler (1974), and Laffont and N'Guessan (1999). In addition, it is important to remark that the situation in which $\delta > 0$ and $\delta u_D < \omega_R$ may call into question the existence of a public office where the social value of what bureaucrats earn is lower than what they could obtain elsewhere.[11]

The 'some bribe' policy

If the government pays a wage equal to or above the reservation level, then all N individuals apply for the position, of both types H and D. In contrast to the analysis of the previous subsection, the government can elicit the 'right' behaviour from D individuals and, at the same time, encourage them to participate. Indeed, if $\omega \geq \omega_R$, then the inequality in equation (3) can be rewritten as

$$m_{NB} - m_{PC}(\omega) = \frac{\omega_R - \omega}{p(\phi + \sigma)} \leq 0.$$

This means that when the no-bribe constraint holds, the participation constraint is automatically satisfied and the revenue-maximizing wage is $\omega = \omega_R$, so that all N agents are hired. However, another option for the government, explored in this subsection, is to save on monitoring costs and drive the 'wrong' behaviour from D agents by setting

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$m < m_{NB}$. In this case, some public officials will bribe and some will not, and the expression for the government's expected revenue is

$$\rho(\omega_R,\ m) = [\pi_H p\phi + \pi_D pm\phi - \omega_R - C(m)]\, N,$$

where with probability π_H, the agent is of type H and the government receives ϕ when a citizen is fined, whereas with probability π_D, the agent is of type D and the government obtains ϕ if he is detected with a bribe in hand. The costs for wage payments and monitoring are incurred in any case.

The revenue-maximizing monitoring derives from

$$\pi_D\, p\phi = C_m(m) \quad \Longrightarrow \quad m = C_m^{-1}(\pi_D\, p\phi) \equiv m_{SB}.$$

For the assumption of strictly convex monitoring cost, we always obtain that m_{SB} is lower than m_{AB} of the previous subsection. The revenue-maximizing monitoring is *ex post* incentive-compatible whenever $m_{SB} < m_{NB}$, otherwise the SB strategy does not exist. For example, with the quadratic cost function, $m_{SB} = \pi_D\, p\phi/c < \phi/(\phi + \sigma) = m_{NB}$ if $\pi_D\, p\phi < c\, m_{NB}$, which means that the marginal revenue from the fees collected by D types is less than the marginal monitoring cost necessary to induce truth-telling (also $m_{SB} < p\phi/c = m_{AB}$). The condition $\pi_D\, p\phi < c\, m_{NB}$ can be written as $\pi_D < c/p(\phi + \sigma) \equiv \widetilde{\pi}_D$. Thus if $\pi_D \geq \widetilde{\pi}_D$ ($\pi_D < \widetilde{\pi}_D$), then marginal revenue is higher (lower) than marginal cost and it is more profitable for the government to (not to) incentivize D types to transfer the fees collected. (In the former case, we would end up with the NB policy analysed in the next subsection.)

Under the SB policy, the government's revenue is

$$\rho(\omega_R,\ m_{SB}) = [\pi_H\, p\phi + \pi_D\, p\, m_{SB}\, \phi - \omega_R - C(m_{SB})]\, N,$$

and aggregate welfare is

$$W(\omega_R,\ m_{SB}) = [\rho(\omega_R,\ m_{SB}) + \pi_H\, \omega_R + \pi_D\, \delta\, u_D]\, N,$$

where each D agent has a positive expected surplus of

$$u_D = \omega_R + p\beta = \omega_R + p[(1 - m_{SB})\, \phi - m_{SB}\, \sigma] > \omega_R,$$

leading to a welfare loss of $(1 - \delta)\, u_D$.

Proposition 2. In the 'some bribe' policy, the government pays the reservation wage and hires N public officials, who are monitored with probability $m_{SB} < m_{AB}$, and among them, D types will demand bribes if the opportunity arises.

The 'no bribe' policy

The third strategy available to the government is to pay $\omega = \omega_R$ and set $m = m_{NB}$, thus essentially eliminating corruption in this simple setup. ('No bribe' should be interpreted

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as relatively very low levels of corruption since, in reality, some noise or unknown individual characteristics will prevent the design of a perfect incentive mechanism.)

Under the NB policy, the government's expected revenue is

$$\rho(\omega_R,\ m_{NB}) = [p\phi - \omega_R - C(m_{NB})]\,N,$$

equal to the expected fee payment minus wage and monitoring costs.

It is important to stress that under this regime, the government pre-commits to an audit activity that is *ex post* not optimal. Since all public officials behave honestly, the *ex post* optimal monitoring would be $m = 0$. However, under the assumption that public officials can observe the monitoring investment (and thus know the detection probability) when the decision to accept the job or not is made, it is necessary to distinguish between two possibilities. If the government can freely choose to decrease the *ex ante* investment (for example, by firing newly hired supervisors and uninstalling surveillance equipment), then the NB policy does not exist. Conversely, if investment, once made, cannot be reduced, then the NB policy is feasible.

Aggregate welfare is

$$W(\omega_R,\ m_{NB}) = [p\phi - C(m_{NB})]\,N,$$

in which there is no deadweight social loss, as the two types of public officials obtain $u_H = u_D = \omega_R$.

Proposition 3. In the 'no bribe' policy, the government hires all N public officials, who receive $\omega = \omega_R$, are monitored with the incentive-compatible m_{NB}, and never demand bribes.

III. Policy Comparison

In this section, we compare the government's expected revenues under the three regimes to derive the equilibrium configuration. We present the results in terms of the proportion of D types in the population, and to simplify the analysis, we will use the quadratic cost function $C(m) = c \cdot m^2/2$, and assume that $m_{AB} \leq m_{PC}(0)$, so the wage under the AB policy is 0.

AB policy versus SB policy The government's expected net revenue under the AB policy is

$$\rho(0,\ m_{AB}) = \frac{\pi_D\, p^2 \phi^2}{2c}\, N,$$

which is increasing in π_D (since, as already noted, bribers are the only source of revenue).

Net revenues under the SB policy are

$$\rho(\omega_R,\ m_{SB}) = \left[\frac{2(1-\pi_D)\, pc\phi + \pi_D^2 p^2 \phi^2}{2c} - \omega_R\right] N,$$

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which are first decreasing and then increasing in π_D, with a minimum at $\pi_D = c/p\phi$. (Since $c/p\phi > \widetilde{\pi}_D$, as derived in the second subsection of Section II, we have that $\rho(\omega_R,\ m_{SB})$ is always decreasing in the relevant range where the SB policy exists.)

The proportion π_D for which the government is indifferent between the SB and AB policies (namely, between hiring all N agents at $\omega = \omega_R$ and $\pi_D N$ agents of type D at $\omega = 0$) derives from

$$\rho(0,\ m_{AB}) = \rho(\omega_R,\ m_{SB}),$$

yielding

$$\pi_D = \frac{2c + p\phi - \sqrt{(2c - p\phi)^2 + 8c\,\omega_R}}{2p\phi} \equiv \pi_D^{AB=SB}.$$

It can be shown that, when $\pi_D > \pi_D^{AB=SB}$ ($\pi_D \le \pi_D^{AB=SB}$), it follows that $\rho(0,\ m_{AB}) > \rho(\omega_R,\ m_{SB})$ ($\rho(0,\ m_{AB}) \le \rho(\omega_R,\ m_{SB})$). Thus the AB policy is more profitable when the proportion of D types is relatively high.

AB policy versus NB policy The expected net revenues under the AB policy are

$$\rho(\omega_R,\ m_{NB}) = \left[p\phi - \omega_R - \frac{\phi^2 c}{(\phi+\sigma)^2}\right]N,$$

which are independent of π_D.

If the choice is between the AB and NB policies, then we obtain

$$\rho(0,\ m_{AB}) = \rho(\omega_R,\ m_{NB})$$

when

$$\pi_D = \frac{2(p\phi - \omega_R)c}{p^2\phi^2} - \frac{c^2}{p^2(\phi+\sigma)^2} \equiv \pi_D^{AB=NB}.$$

If $\pi_D > \pi_D^{AB=NB}$ ($\pi_D \le \pi_D^{AB=NB}$), then $\rho(0,\ m_{AB}) > \rho(\omega_R,\ m_{NB})$ ($\rho(0,\ m_{AB}) \le \rho(\omega_R,\ m_{NB})$). Again, the AB policy is preferred if there is a high number of D types.

SB policy versus NB policy In this case,

$$\rho(0,\ m_{SB}) = \rho(\omega_R,\ m_{NB})$$

when

$$\pi_D = \frac{2c + p\phi - \sqrt{(2\phi+\sigma)\sigma}}{2p\phi} \equiv \pi_D^{SB=NB}.$$

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If $\pi_D > \pi_D^{AB=NB}$ ($\pi_D \le \pi_D^{AB=NB}$), then $\rho(0,\ m_{SB}) < \rho(\omega_R,\ m_{NB})$ ($\rho(0,\ m_{AB}) \ge \rho(\omega_R,\ m_{NB})$). This means that the SB policy is more profitable when π_D is relatively low.

Equilibrium policy

From the analysis of this subsection, we can derive two distinct scenarios, depending on whether the cost parameter c is lower or higher than a certain threshold.

It can be shown that when

$$c = \frac{p(\phi+\sigma)\left[\sqrt{(2\phi+\sigma)\sigma}+\phi+\sigma\right]}{\phi} - \frac{2(\phi+\sigma)^2\omega_R}{\phi^2} \equiv \widetilde{c},$$

we have $\pi_D^{AB=SB} = \pi_D^{AB=NB} = \pi_D^{SB=NB}$, that is, the three policies generate the same expected net revenue. When $c < \widetilde{c}$, we obtain that $\pi_D^{SB=NB} < \pi_D^{AB=SB} < \pi_D^{AB=NB}$. In words, in terms of the proportion π_D, the most profitable policy is: the SB policy for relatively very low values; the NB policy for intermediate values; the AB policy for relatively high values. Conversely, when $c \ge \widetilde{c}$, we have $\pi_D^{AB=NB} < \pi_D^{AB=SB} < \pi_D^{SB=NB}$, and the NB policy is never the most profitable.

Therefore these two scenarios ($c < \widetilde{c}$ and $c \ge \widetilde{c}$) will correspond to either two or three equilibrium regimes. In Figure 3, we show two numerical examples of equilibrium configurations. In panel (a), $c < \widetilde{c}$ and $\pi_D^{SB=NB} < \pi_D^{AB=SB} < \pi_D^{AB=NB}$. In the interval $(0,\ \pi_D^{SB=NB}]$, there is a low proportion of D types, and monitoring is not very cost-effective, so the government chooses the SB policy. In the interval $(\pi_D^{SB=NB},\ \pi_D^{AB=NB}]$, the proportion of D types is higher and it is more profitable to adopt the NB policy, in which monitoring is at the incentive-compatible level m_{NB}, and the government raises the highest revenues from fee payments. In the interval $(\pi_D^{AB=NB},\ 1]$—that is, for even higher levels of π_D—the government adopts the AB policy, in which the wage is the lowest and revenues are generated from bribers who are successfully audited. (In the example of Figure 3(b), $c \ge \widetilde{c}$ and $\pi_D^{AB=NB} < \pi_D^{AB=SB} < \pi_D^{SB=NB}$, so it is never optimal to implement the NB policy.)

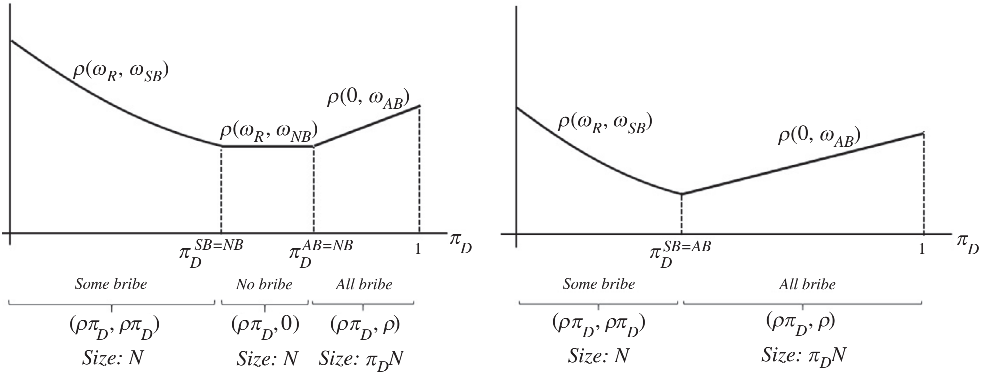

FIGURE 3. Policy scenarios.*Notes*: (a) Case $c < \tilde{c}$, parameters $\phi = 0.4$, $\sigma = 0.3$, $c = 0.1$, $p = 0.2$, $\omega_R = 0.1$. (b) Case $c > \tilde{c}$, parameters $\phi = 0.4$, $\sigma = 0.3$, $c = 0.1$, $p = 0.2$, $\omega_R = 0.3$.

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Proposition 4. When $c < \widetilde{c}$, the equilibrium policy is

$$\begin{aligned} &\text{'some bribe'} \quad \text{if } \pi_D \in (0,\ \pi_D^{SB=NB}], \\ &\text{'no bribe'} \quad \text{if } \pi_D \in (\pi_D^{SB=NB},\ \pi_D^{AB=NB}], \\ &\text{'all bribe'} \quad \text{if } \pi_D \in (\pi_D^{AB=NB},\ 1). \end{aligned}$$

From the analysis of this subsection, the higher c, the more likely that the government will choose a policy where corruption is tolerated (SB or AB). This conclusion can be related to the topic on new audit technologies and on whether the nature and extent of their use differ between developed and less-developed countries. New technologies have greatly reduced the costs for surveillance and led to major improvements in the efficiency and accuracy of monitoring systems. But it is known that such technologies are more widespread in developed economies, whereas poorer countries may be constrained to adopt less cost-effective monitoring technologies and thus be stuck in a corruption trap.

For other comparative statics, it can be shown that a higher ω_R reduces both $\pi_D^{AB=SB}$ and $\pi_D^{AB=NB}$ ($\pi_D^{SB=NB}$ is independent of ω_R). So a large reservation wage makes the combination of high wages of public bureaucrats and high monitoring more costly. (If ω_R is too high, then the NB policy becomes too costly and is never an option for the government.) In contrast, an increase in the penalty σ would increase $\pi_D^{AB=NB}$ and lower $\pi_D^{SB=NB}$, leaving more room for the NB policy.

Size of bureaucracy and perceived corruption

From Proposition 4, we can derive different policy regimes with different bureaucracy size and proportion of public officials who will likely be involved in bribe-taking. We will refer to this proportion as *perceived* corruption share (*PeCS*), and this gives a measure of the actual or visible level of corruption in this context. According to the common indicators of perceived corruption, *PeCS* may be interpreted as the likelihood that external observers or 'experts' can encounter or deal with corrupt officials in the public sector. *PeCS* will be contrasted with the *potential* corruption share (*PoCS*), which is based on the initial proportion of D types, and thus can be interpreted as the intrinsic level of dishonesty in the population.

Under the AB policy, the size of bureaucracy is $\pi_D N$, and all public officials demand bribes if they encounter a citizen who must pay the fee. This happens with probability p, so the perceived corruption share in the public sector is $PeCS = p$. The other fraction, $1 - p$, of public officials will be unintentionally honest, simply because the opportunity for bribery does not arise. This means that *PeCS* is different from the initial criminal propensity, $PoCS = p\pi_D$, so this policy choice results in a divergence between potential and perceived corruption and in a deterioration of the average quality of public servants. In contrast, under the NB policy, the size of the public sector is N, with both H and D types, but no bribers. Hence $PeCS = 0$ and $PoCS = p\pi_D$, and the policy leads to an improvement in the inherent average propensity to bribe. Finally, under the SB policy, $PeCS = PoCS = p\pi_D$, and there is no difference between potential and visible corruption.

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Proposition 5. When $c < \widetilde{c}$, the bureaucracy size and pair ($PoCS$, $PeCS$) are

$$\begin{array}{ll} N \text{ and } (p\pi_D,\ p\pi_D) & \text{if } \pi_D \in (0,\ \pi_D^{SB=NB}], \\ N \text{ and } (p\pi_D,\ 0) & \text{if } \pi_D \in (\pi_D^{SB=NB},\ \pi_D^{AB=NB}], \\ \pi_D N \text{ and } (p\pi_D,\ p) & \text{if } \pi_D \in (\pi_D^{AB=NB},\ 1). \end{array}$$

In the examples of Figure 3, we also report the pair ($PoCS$, $PeCS$) and the size of bureaucracy for each regime. From Proposition 5, an increase in π_D, namely an increase in potential corruption, has a U-shaped effect on the level of perceived corruption (or V-shaped if $c \geq \widetilde{c}$). One of the key points of this analysis is that under the AB and SB policies, there are the same numbers of public officials potentially involved in bribe-taking, but different proportions of perceived corruption.

IV. Concluding Remarks

The paper addresses a much-debated question concerning corruption, its detrimental effects, people's predisposition towards it, and the importance of bureaucracy size. Depending on the parameters, in particular the proportion of public officials who may contemplate bribing, the government will select the revenue-maximizing regime. It turns out that as that proportion of potential dishonest public officials rises, the dimension of the public sector is reduced, as fewer public officials are hired, whereas actual or perceived corruption can follow a U-shaped pattern. We identify three different policy regimes. In the 'all bribe' regime, the government prefers a small bureaucracy with only potential dishonest public officials, who will demand bribes as long as they have the chance. Alternatively, the government may choose to pay reservation wages and hire both honest and potential dishonest agents, and thus have a large bureaucracy size. Depending on the extent of monitoring, corruption can be either eliminated or tolerated. In the latter case, perceived corruption would be lower than in a small bureaucracy made by only dishonest agents, and this may explain why a certain level of corruption is observed in more developed countries. If society stops giving a bad name to corruption, then a regime with some corruption can be just as welfare-enhancing as one with no corruption, or even more. This is a somewhat thought-provoking argument, which is more widely explored in the literature incorporating the psychological role of social norms to the corruption problem (as for example, in Chang and Lai 2002).

In the model, we have considered monitoring as an impersonal and mechanical procedure that provides a reliable probability of detecting bribery. However, in actuality, this activity may require a considerable degree of human input (though much of the equipment can be automated), and as such this raises two potential issues. First, controllers themselves may be subject to the same incentive problems as bureaucrats, that is, to the problem of who monitors the monitor. This topic is explored in many works that propose multi-level hierarchy models for monitoring, and the final results depend on the number of control tiers and on the differences in the propensity to bribe across the pools of auditors. For example, Besley and McLaren (1993), in the Appendix of their paper, extend their setup to a two-tier hierarchy in which tax collectors can be inspected by super-auditors. Since these auditors are drawn from the same pool as tax collectors, the decision problem of the dishonest is subject to the same incentive and bribe-taking behaviour. Since there is no monitoring of super-auditors, the government has no choice

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but to offer reservation wages to upper-tier controllers and rely on the reports of the honest. The second issue is that more monitoring can lead to an increase in the bureaucracy itself, to the point where it may become too complex, inefficient or even Kafkaesque. In terms of our model, when there is a relatively high prior probability of dishonesty in the pool of public officials, the government sets a heavy control bureaucracy (NB or AB policy). But if there is a risk that bureaucracy will become inefficiently Kafkaesque, a rational revenue-maximizing government would rather choose a smaller control apparatus and increase penalties for those who are detected. Only when the prior probability of dishonesty is relatively low is there no need to enlarge the control bureaucracy (SB policy), even if this means tolerating some degree of corruption.

As we have said, testing the cause and effect relationship between potential and perceived corruption in the regimes identified by the theoretical framework is not straightforward. The evidence shown in the Introduction, in fact, provides some motivating stylized facts but suffers from causal ambiguity. Given such a limitation, in the literature, it is common to resort to experimental techniques to try to identify the causal link as well as the impact of external incentives on deviant behaviour. For example, Cameron *et al*. (2009) argue that there is a systematic difference between people's self-reported preferences and actual choices. In their experimental game, carried out in Australia, India, Indonesia and Singapore, they show that the propensity to engage in bribe-taking among participants from different countries does not necessarily match the corruption rankings of indices such as that of Transparency International. Similarly, Barr and Serra (2010), in an experimental setting in which 'public servants' receive a sum of money and must choose how much to transfer to the 'community', find that corruption is in part a cultural phenomenon, depending on the country of origin and the social context. Gächter and Schulz (2016), using an anonymous die-rolling game, conduct a cross-societal experiment with students from 23 countries, and find a close relationship between rule violation (proxied by democratic quality, shadow economy and corruption) and the level of individual intrinsic honesty. Their argument is that cheating can be costly even in the absence of control, and that institutions and cultural values can affect the degree of inherent compliance.

In line with the literature, it would be possible to test the empirical predictions of this paper by means of a specific experimental setup. For example, the public service and corruption game can be simulated in a controlled laboratory setting with homogeneous groups of people of different territorial contexts (for example, international or interstate). The experiment could consist of the following two-round game. In the first round, participants decide whether to accept a job, in which they are offered no wage and have to collect a 'fee' with a certain probability, or refuse the job, receiving a small amount of money. The presence of an outside option is relevant to allow a separation between honest and dishonest, and determine the proportion of potential (intrinsic) dishonest individuals in each group. Participants know that they will face the possibility of being discovered and punished if they do not transfer the fee to the 'government', based on a series of control levels.[12] The monitoring control can range from a very low or zero probability of being caught to a maximum threshold such that all participants have no incentive to misbehave. Accordingly, since the wage is zero, jobs will be accepted only by potentially dishonest individuals, who will earn by keeping the stochastic fee for themselves, if not detected. In the second round, participants will be given a larger sum of money (to approximate the reservation utility), and asked to perform the task and whether to transfer the fee or not to the government, taking into

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account the probability of being caught. The two rounds will reproduce the hypothetical cases of small and large 'public sectors'. By altering the parameter on the monitoring cost, what we would expect from the experiment is that in groups or contexts with relatively high levels of potential dishonesty, the government maximizes its revenues by offering zero entrance salaries and earning from the fees collected by corrupt public officials detected by monitoring. In this scenario, we also expect that only those individuals with a high propensity to cheat will agree to participate, so the 'bureaucracy' will comprise a relatively low number of public officials, all of whom engage in bribery. As a result, the degree of *perceived* corruption will be high (AB policy). On the other hand, in groups with relatively low potential corruption, the revenue-maximizing strategy should be to offer a high entrance salary, so that all types of subjects, honest and dishonest, participate, and set a relatively low monitoring level. (Higher monitoring would be less cost-effective if most participants are intrinsically honest.) Given the high number of public officials, the degree of perceived corruption will be low (SB policy). Finally, at intermediate levels of potential corruption, the government would maximize by setting the highest level of control, so as to elicit compliant behaviour from all public officials, and the degree of perceived corruption will be the lowest possible (NB policy). If properly designed and conducted, the experiment should yield a U-shaped relationship between potential and perceived corruption. The ranking of potential corruption in the different territorial contexts can be compared with those of perceived corruption, as measured by the available corruption indices, so as to show that they may not perfectly overlap. In our case, perceived corruption is influenced by the government's maximization strategy.[13]

On social efficiency, although the equilibrium in which public officials are barely monitored can be more cost-effective, this does not mean that corruption is welfare-enhancing. In the model, there may be a wedge between equilibrium and socially optimal welfare—that is, corruption can be 'in equilibrium' but not necessarily 'optimal'. Social welfare depends on deadweight loss associated with bribery. For example, a relatively low deadweight loss can make either partial or total corruption socially desirable, that is, welfare-superior to the NB policy. This may fit the case of less-developed countries, where the share of potential bribers appears to be high, and corruption can be viewed as part of the optimal allocation as long as it is not strongly stigmatized by society. It can be shown that a relatively low proportion of dishonest bureaucrats makes the SB policy socially efficient only when the deadweight loss of bribery is small, as the gap between equilibrium and optimal welfare is low. The same happens for the AB policy for relatively very high proportions of dishonest bureaucrats. When, instead, the deadweight loss is large, this simply gives rise to a wider range for which the NB policy is optimal. (At the extreme, when the deadweight loss is 1—the maximum—the AB policy is never socially efficient, and the NB policy is welfare-superior for very high proportion of dishonest types when the monitoring cost is small or the fee particularly high.) These conclusions are, in part, in contrast to Acemoglu and Verdier (2000), in which the equilibrium with bribery can be socially optimal, but only when market failures are important and the share of dishonest bureaucrats is low.

ACKNOWLEDGMENTS

We thank Ali Khan, Sezer Yasar, two anonymous referees and the editor Maitreesh Ghatak.

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FUNDING

Open Access Funding provided by Universita degli Studi di Catania within the CRUICARE Agreement. [Correction added on 03 June 2022, after first online publication: CRUI funding statement has been added.]

NOTES

1. In some circumstances, corruption can also have efficiency-improving allocative effects, as in the 'grease-the-wheels' hypothesis. On this topic, see Shleifer and Vishny (1994), Andvig and Moene (1990), and Kofman and Lawarrée (1996).
2. For two reviews on the determinants of corruption, see Aidt (2003) and Hunady (2017).
3. See Appendix A for an elaboration on the model by Besley and Maclaren (1993) in which an equilibrium with the three regimes is not possible when monitoring is exogenous.
4. The key difference with Wadho (2016) is that in his model there is a strategic complementarity in the corruption activities of bureaucrats (tax inspectors). In particular, the higher the number of tax inspectors who engage in bribery, the lower the probability of being detected. This may give rise to multiple equilibria, but to obtain non-negative radicands and real solutions, it is required that the fraction of corruptible agents is higher than the parameter of institutional quality in the population. This assumption leads to the conclusion that the government's expected revenue with reservation wages and low audit is always lower than with capitulation or efficiency wages.
5. Although our results cannot address the question of causality in a satisfactory way, mainly due to data limitations, this suggestive evidence can provide some useful insights and is in line with the previous empirical literature. For example, La Porta *et al.* (1996) use data from the World Values Survey, and show that an increase in trust lowers the corruption score in a cross-section of countries. In Adsera *et al.* (2003), the authors attempt to explain the variations in corruption scores through the political control of well-informed electorate in a panel analysis of US states. They report that interpersonal trust and free circulation of newspapers are negatively correlated with corruption. Charron *et al.* (2014) use the Quality of Government Index in a cross-section of 73 European regions, and find a positive correlation with social trust. The use of measures of trust and social capital as proxies for the inherent propensity for criminal activity is quite widespread, as in the papers by Bj⊘rnskov and Paldam (2004), and Uslaner (2004). The arguments reported in this strand of the literature are in favour of a causal correlation with corruption, and not vice versa.
6. As in Acemoglu and Verdier (2000), the assumption of a one-to-one relationship is used to simplify the analysis. A framework in which each public official can fine more or less (probabilistically) than one citizen would give substantially the same qualitative conclusions. With a many-to-one relationship between citizens and public officials, a very low monitoring activity might be self-defeating when it leads to high quantities of bribes extorted (see Mookherjee and Png 1995). Similarly, an endogenous determination of the bribe size (for example through a Nash bargaining process between public officials and citizens) would not change the analysis substantively.
7. The assumption of revenue maximization is quite standard in the literature. See, for example, Besley and McLaren (1993), Druk-Gal and Yaari (2006), Wadho (2016) and Strîmbu and González (2018). In our case, from a technical point of view, a welfare-maximizing government would introduce the complication that the wage of public officials in the 'no bribe' policy could assume any (sustainable) value equal to or above the reservation level.
8. As in Basu *et al.* (2016), m is the probability that bribery will be both detected and penalized.
9. If we assumed contingent wage payments, then this would make the analysis slightly more cumbersome but would not change the qualitative conclusions. For a corruption model that leads to no-bribery in one-shot interactions and an equilibrium with bribery in an infinitely repeated game, see Dechenaux and Samuel (2012).
10. As will be clear in the analysis below, the inequality $c > p(\phi + \sigma)$ does not necessarily imply that the revenue-maximizing strategy is the AB policy.
11. The combination of $\delta > 0$ and $\delta u_D < \omega_R$ may be one of the reasons why, as far as politics is concerned, the (anecdotal) opinion of many people in Italy, after yet another corruption scandal, is something like: 'Why do we have to pay for these crooked politicians? Why don't they get a job?'
12. In a laboratory experiment, the sanction can take the form of a short period of 'imprisonment'. For example, participants should agree to be prevented from using their cell phones for a certain period of time, and forced to attend a boring (from their standpoint) lecture or documentary.
13. Things are more complicated when the experiment is moved out of a laboratory, especially because corruption involves informal and illegal transactions. In this case, as in the parking-ticket experiment of Fisman and Miguel (2007), a possible approach is to link the level of potential corruption to some form of behaviour not conforming to the rules of law.

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APPENDIX

In this Appendix, we present a simple variation of the model in which monitoring is set at the exogenous level m, with linear cost $c{\cdot}m$. The aim is to show that in a setup similar to that of Besley and McLaren (1993), it is not possible to obtain the three corruption regimes in terms of the proportion of potential corruption π_D. To make the setups comparable, we will assume that for public officials who are caught engaging in corruption, there are no penalties other than losing the wage.

The no-bribe constraint becomes

$$\beta = (1-m)(\phi+\omega) \le \omega, \tag{A1}$$

which, in terms of wage, holds if $\omega \ge (1/m - 1)\phi \equiv \omega_{NB}$.

The participation constraint of C types is $u_C = \omega \ge \omega_R$, whereas for D types it is

$$u_D = \omega + p[(1-m)\phi - m\cdot\omega] \ge \omega_R, \tag{A2}$$

which can be rewritten as $\omega \ge [\omega_R - p(1-m)\phi]/(1-pm) \equiv \omega_{PC}$.

From inspection of equations (A1) and (A2), it follows that $\omega_{NB} = \omega_{PC} = \omega_R$ when monitoring is at the threshold

$$m = \frac{\phi}{\phi+\omega_R} \equiv \widetilde{m}.$$

So, depending on the exogenous monitoring level (comparative statics), we have two possible scenarios: (1) if $m < \widetilde{m}$, then $\omega_{NB} > \omega_R > \omega_{PC}$; (2) if $m \ge \widetilde{m}$, then $\omega_{NB} \le \omega_R \le \omega_{PC}$. While in the former case the government can choose one of three wages, based on its revenue maximization, in the latter the choice is restricted to paying the reservation wage ω_R. The reason is that when $\omega_{NB} \le \omega_R \le \omega_{PC}$, D bureaucrats (who are not inherently corrupt in that they can respond to incentives) will accept the job and not bribe if offered the reservation wage.

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SCENARIO (1): $m<\widetilde{m}$

The revenue-maximizing wage under the NB policy is $\omega = \omega_{NB}$. If $m < \widetilde{m}$, then ω_{NB} is an efficiency wage, higher than ω_R. Hence D bureaucrats will not demand bribes, and the government obtains

(A3) $$\rho(\omega_{NB},\ m) = [p\phi - \omega_{NB} - c\cdot m]\,N = \left[\left(\frac{1}{m} - 1 + p\right)\phi - c\cdot m\right]N.$$

The wage under the SB policy is $\omega = \omega_R$. As $\omega_{NB} > \omega_R > \omega_{PC}$, the wage leads to bribe demands from D types, and the government's expected revenue is

(A4) $$\begin{aligned}\rho(\omega_R,\ m) &= \{\pi_H(p\phi - \omega_R) + \pi_D[pm\phi - (1-pm)\omega_R] - c\cdot m\}N\\ &= \{[1-\pi_D(1-m)]p\phi - (1-\pi_D pm)\omega_R - c\cdot m\}N,\end{aligned}$$

which is decreasing in π_D.

The wage under the AB policy is $\omega = \omega_{PC}$, and the government's revenue is

(A5) $$\begin{aligned}\rho(\omega_{PC},\ m) &= \pi_D\,\{p[m\phi - (1-m)\,\omega_{PC} - (1-p)\,\omega_{PC} - c\cdot m\}\,N\\ &= \pi_D\,(p\phi - \omega_R - c\cdot m)N,\end{aligned}$$

which is increasing in π_D.

SCENARIO (2): $m \geq \widetilde{m}$

In this case, the revenue-maximizing wage is ω_R, and given that $\omega_{NB} \leq \omega_R \leq \omega_{PC}$, D types do not demand bribes. The government obtains

$$\rho(\omega_R,\ m) = (p\phi - \omega_R - c\cdot m)\,N.$$

We now prove that it is not possible to obtain three corruption regimes. The SB revenue is decreasing in π_D and the AB revenue is increasing, and they are equal for

$$\pi_D = \frac{p\phi - \omega_R - c\cdot m}{p(2-m)\phi - (1+pm)\,\omega_R - c\cdot m} \equiv \widetilde{\pi}_D,$$

where $\widetilde{\pi}_D$ is increasing in m and equal to 1 when $m = \widetilde{m}$.

Substituting $\widetilde{\pi}_D$ in equation (A4) or (A5), we obtain

$$\rho(\omega_R,\ m) = \rho(\omega_{PC},\ m) = \frac{(p\phi - \omega_R - c\cdot m)^2}{p(2-m)\phi - (1+pm)\,\omega_R - c\cdot m},$$

which can be shown to be larger than the NB revenue in equation (A3) for all $m < \widetilde{m}$. This means that when $m < \widetilde{m}$, the government has two policy options, either the SB or the AB policy, whereas when $m \geq \widetilde{m}$, the only policy option for the government is the NB policy with $\omega = \omega_R$. Therefore if monitoring is exogenously set at a low level, then the government finds it advantageous to implement either the SB policy when the number of potential dishonest officials is low (paying a reservation wage to all public officials and letting D types bribe), or the AB policy when the number is high (paying a capitulation wage and earning revenue from the fees transferred by corrupt public officials being caught). If, instead, monitoring is exogenously set at a high level, then D bureaucrats have no incentive to bribe, so it is optimal for the government to pay ω_R and choose the NB policy.

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TABLE A1
DESCRIPTIVE STATISTICS

Variables	Obs.	Mean	SD	Min	Max	Source	Description
PeCS	429	47.19	20.22	0	100	QoG EQI data	EQI Index
SIZE	429	469.52	129.29	168.74	1071.56	QoG EU Regional data	Employees in public administration per 10,000 inhabitants
PoCS	429	4.61	0.71	2.78	5.98	European Social Survey	Distrust index
RW	429	24.3	8.22	8.3	48.1	QoG EU Regional data	Share of population (25–64 years old) with tertiary education
GDP	429	4.44	0.38	3.33	5.23	QoG EU Regional data	GDP per capita at current price in PPP and percentage of the EU average
POP	429	14.25	0.81	11.74	16.3	QoG EU Regional data	Resident population

Notes
Regions belong to the following EU countries: Austria, Bulgaria, Croatia, Czech Republic, Denmark, Finland, France, Germany, Hungary, Ireland, Italy, The Netherlands, Poland, Portugal, Slovakia, Spain.

APPENDIX

In this Appendix, our objective is to present some descriptive evidence on the relationship between potential and perceived corruption, and the resulting effect on the size of bureaucracy. To measure the intensity of perceived corruption, we use data from the European Quality of Government Index (EQI), published by the Quality of Government Institute (QoG) of the University of Gothenburg. The EQI is based on a survey about the institutional quality and the perception and level of corruption in the public sector, and is conducted at the regional level in the European Union. In contrast to the CPI, the EQI aggregates the concepts of quality, impartiality and corruption of public servants at regional NUTS 2 level. The EQI has been collected in three periods (2010, 2013 and 2017), and allows us to compare different regions in different times (Charron *et al*. 2019). In the analysis below, we use the normalized EQI as a proxy for our *PeCS*. (We have reversed the index, so higher (lower) index values indicate higher (lower) levels of *PeCS*.) As a proxy for our *PoCS*, we use the semi-annual data of the European Social Survey (ESS), and specifically the item 'most people try to take advantage of you, or try to be fair', which can provide a standardized measure of the level of trust or social capital at regional level in Europe. We create the index by averaging the score of individuals' responses in the closest available ESS round, for each period of analysis. Thus the (reversed) distrust index can be interpreted as our proportion of dishonest individuals in the population. For the reservation wage, we use the share of population (25–64 years old) with tertiary education (variable *RW*). Moreover, we use the GDP (variable *GDP*) at current market prices in purchasing power standards per inhabitant as a percentage of the EU average, and the resident population (variable *POP*, expressed in natural logs) to control, respectively, for the differences in income and size among regions. Finally, we use the share of employees in the public administration for the size of bureaucracy (variable *SIZE*). Due to data availability, our dataset is composed of 429 observations on 143 regions (see Table A1 for descriptive statistics).

We estimate the following regressions using a fixed effects model with robust standard errors at regional level, to take account of the different idiosyncratic institutional characteristics of regions:

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Table A2
Estimation Results: Fixed Effects Model

Variables	*PeCS* (1)	*SIZE* (2)
PoCS	−77.6016**	−34.6375*
	(32.1448)	(17.58)
$PoCS^2$	7.8305**	
	(3.2711)	
RW	1.4436***	0.538
	(0.2047)	(1.2491)
GDP	−38.9795***	289.373***
	(11.3629)	(58.269)
POP	79.6053**	−921.35***
	(34.3835)	(272.231)
Observations	429	429
Number of regions	143	143
R-squared	0.371	0.1552

Notes
Robust standard errors clustered at the regional level in parentheses.
***, **, * denote significance at the 1%, 5%, 10% level, respectively.

$$PeCS_{i,t} = \alpha_i + \beta\, PoCS_{i,t-1} + \gamma\, PoCS^2_{i,t-1} + \theta\, RW_{i,t-1} + \mu\, GDP_{i,t-1} + \nu\, POP_{i,t-1} + \varepsilon_{i,t}, \quad \text{(A6)}$$

$$SIZE_{i,t} = \alpha_i + \beta\, PoCS_{i,t-1} + \theta\, RW_{i,t-1} + \mu\, GDP_{i,t-1} + \nu\, POP_{i,t-1} + \varepsilon_{i,t}. \quad \text{(A7)}$$

A Breush–Pagan Lagrange multiplier test confirms our choice for both specifications, showing the presence of significant differences across regions (p-value < 0.001), whereas the Hausman test supports the appropriateness of fixed than random effects in any specification at the 1% level of significance.

The results are shown in Table A2. The coefficients of the explanatory variables have the signs predicted by the theoretical model, and are statistically significant, at least at the 5% level (the only exception is the coefficient of *RW* in equation (A7). An increase in the variable *PoCS* leads first to a decrease and then to an increase in perceived corruption (regression (A6)). Thus potential corruption has a U-shaped effect on perceived corruption. Our findings are also robust to the use of the normalized corruption index of the GoQ EU regional dataset as the dependent variable. In addition, we also show that *PoCS* is linearly and negatively correlated with the size of the public sector (regression (A7)). The levels of visible corruption and bureaucracy size are also negatively correlated (the Spearman correlation coefficient between *SIZE* and *PeCS* is −0.2877, with p-value < 0.001). The data also confirm our theoretical comparative statics. For example, an increase in the reservation wage reduces the profitability of the NB policy (interpreted as the situation with relatively very low corruption), in favour of either the AB policy with small bureaucracies and higher perceived corruption, or the SB policy with large bureaucracies and lower perceived corruption.

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