Web Appendix for the paper "Can corruption foster regulatory compliance?"

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Abstract

This appendix complements the paper "Can corruption foster regulatory compliance?", which was accepted for publication at Public Choice. The text in the appendix makes reference to the original equation numbers in the paper, as well as the original Tables and Figures.
1 Appendix A

This appendix provides a more detailed explanation of the algebraic steps leading to equations 4, 6, 7, and 8 in the paper, to the equilibrium conditions stated, and the comparative statics exercises conducted in the text. The steps described are limited to those of the high-monitoring scenario. The corresponding steps for the low-monitoring scenario are obtained in a similar manner.

To derive the compliance equations (4, 7) one needs to go back and solve the firm’s problem. From the firm’s problem stated in (3) it follows that a firm chooses not to comply with the regulations if and only if \( v(1) = R_i - \bar{r} - r R_i < v(0) = d [d_h(R_i - \alpha) + d_c(R_i - \beta)] + (1 - d) (R_i) \). Where the overall probability of detection is given by the ratio of total cases monitored to total number of firms \( (d = \frac{J G(R*)}{J G(R*) + (1 - G(R*))}) \) and the conditional detection probabilities are given by the ratio of cases monitored by a corrupt or honest official to the total cases monitored, respectively \( (d_c = \frac{G'(R*)}{G(R*) + (1 - G(R*))}) \) and \( (d_h = \frac{(1 - G(R*))}{G(R*) + (1 - G(R*))}) \). After substituting the detection probabilities into this condition and conducting some algebraic manipulation, the condition simplifies to \( R_i - \bar{r} - r R_i < R_i - \frac{J \pi \beta G'(R*) - J \rho \alpha (1 - G(R*))}{J} \); which then leads directly to the value \( R^* \) in equation (7) and to the result stated in equation (4). The fraction \( G(R^*) \) of firms (those with \( R < R^* \)) choose to comply with the regulations; while the remaining fraction \( 1 - G(R^*) \) of firms (those with \( R > R^* \)) choose not to comply.

In turn, to derive the corruption equations (6, 8) one needs to solve the public officials problem under the assumption that \( \beta (1 - G(R^*)) = \rho > 0 \); which characterizes the high-monitoring scenario. From the public officials’ problem as stated in (5) it follows that public officials choose to act in corrupt fashion if and only if \( \frac{(w - \rho \pi)^{1-\theta}}{1-\theta} < \frac{[w - \rho \pi + \pi \beta (1 - G(R^*))]^{1-\theta} (1 - p)}{ln (w - \rho \pi + \pi \beta (1 - G(R^*)))} \). After taking logarithms for each side and solving for \( \theta \), this condition simplifies to \( \theta < 1 - \frac{\ln (1 - p)}{\ln (w - \rho \pi + \pi \beta (1 - G(R^*)))} \); which coincides with the value of \( \theta^* \) from equation (8) and generates the result stated in equation (6). The more risk-loving fraction of officials \( \bar{G}(\theta^*) \) (those with \( \theta_j < \theta^* \)) choose to be corrupt; the remaining fraction \( 1 - \bar{G}(\theta^*) \) (those officials with \( \theta_j > \theta^* \)) choose to be honest.

The equilibrium solution of the model is then given by the system of simultaneous equations for \( G(R^*) \) and \( \bar{G}(\theta^*) \) stated in (4) and (6). These functions are continuous and bounded between
zero and one. Thus, as long as the derivatives \( \frac{\partial G(R^*)}{\partial \theta} \) and \( \frac{\partial \tilde{G}(\theta^*)}{\partial G(R^*)} \) have opposite signs, the solution for the model exists and is unique. Given that both functions are monotonic, however, the simpler condition that the derivatives \( \frac{\partial R^*}{\partial \theta} \) and \( \frac{\partial \theta^*}{\partial R^*} \) have opposite signs is enough to guarantee the existence and uniqueness of the equilibria. That type of solution is illustrated by Figure 1-a and leads to our finding that it is possible for corruption to foster compliance. Alternatively, when the derivatives \( \frac{\partial R^*}{\partial \theta} \) and \( \frac{\partial \theta^*}{\partial R^*} \) take on the same sign, the existence of an internal solution for the model is not guaranteed. When an internal solution exists, the equilibrium is unique by virtue of the functions being monotonic (such cases are illustrated by Figure 1-b and 1-c). It is possible, however, that no internal solution exist for some parameter values. In such situations the solution takes the form of full compliance accompanied with no corruption, or full corruption accompanied with no compliance. We are not interested in these types of equilibriums.

The specific algebraic terms for the derivatives \( \frac{\partial R^*}{\partial \theta} \) and \( \frac{\partial \theta^*}{\partial R^*} \) are provided in the text. Given that \( \tilde{G}'(\theta^*) > 0 \) (which must be true since \( \tilde{G} \) is a cumulative density function), it is easy to verify that the term \( \frac{\partial R^*}{\partial \theta} = \frac{J_0}{T_0} [\pi \gamma - w] \tilde{G}'(\theta^*) \) is positive as long as \( \pi \gamma > n \). In turn, in order to show that \( \frac{\partial \theta^*}{\partial R^*} \) is positive simply by expressing it as \( \frac{\pi \beta \ln(1-p)G'(R^*)}{[w-\pi \rho + \pi \beta(1-G(R^*))][\ln \frac{w-\pi \rho + \pi \beta(1-G(R^*))}{\ln \frac{w-\pi \rho + \pi \beta(1-G(R^*))}{\ln \frac{w-\pi \rho + \pi \beta(1-G(R^*))}}]} < 0 \) one must notice that the numerator is negative because \( \ln(1-p) < 0 \) for all values of \( p \in (0, 1) \) and that the denominator is positive because it is the product of two positive terms. One can show that the term \( w-\pi \rho + \pi \beta(1-G(R^*)) \) is positive in the high monitoring scenario, by definition. With the signs of these derivatives established, three possible types of equilibrium emerge. These are the types of equilibriums portrayed in Figure 1.

Finally, in order to conduct the comparative statics exercises illustrated in Figure 2, we need to show the effects of changes in either \( p \) or \( w \) on the main system of equations (7, 8). Compliance decisions are not directly affected by changes in either \( p \) or \( w \). They are only indirectly affected via the effects that these variables might have on the value \( \theta^* \) and the consequent change in \( R^* \) \( \frac{\partial R^*}{\partial \theta} \). Thus, as \( p \) or \( w \) change, the dashed lines in Figure 2 do not shift. In contrast, changes in either \( p \) or \( w \) have a direct impact on the value of \( \theta^* \) and are thus capable of shifting
the solid lines in Figure 2. The specific terms for the corresponding derivatives are obtained from equation (8) and take the form \( \frac{\partial \theta^*}{\partial p} = \left[ (1 - p) \left[ \ln \frac{w - \rho n}{w - \rho n + \pi \beta (1 - G(R^*))} \right] \right]^{-1} \) and \( \frac{\partial \theta^*}{\partial w} = \ln(1 - p) \left[ \ln \frac{w - \rho n}{w - \rho n + \pi \beta (1 - G(R^*))} \right]^{-2} \left[ \frac{1}{w - \rho n} - \frac{1}{w - \rho n + \pi \beta (1 - G(R^*))} \right] \). Both terms are negative; so when either \( p \) or \( w \) decrease, the solid lines in Figure 2 shift right.

2 Appendix B

In this appendix we extend the basic model presented in the text in order to incorporate extortion. Extortion arises when public officials unjustifiably threaten law-abiding firms with the fine (\( \alpha \)) and use that threat in order to extract bribes. Thus, in this extended version of the model, corrupt officials demand extortive bribes \( \beta \) in addition to the non-extortive bribes \( \beta \) contemplated before. The underlying question is whether the presence of extortion by itself precludes our theoretical result that corruption can potentially foster compliance.

We continue to assume that bribes are resolved via Nash-bargaining. Both types of bribes are naturally bounded by 0 and \( \alpha \); since the corrupt official is not willing to accept a non-positive bribe and the firm is not willing to pay more than it would have to pay if the fine was imposed.

As pointed out by Hindriks, Keen and Muthoo (1999), however, as long as there are appeals procedures designed to overturn unjustified fines, the expected cost of fines that ultimately do not hold in court should be smaller than their face value and the upper bound for an extortory bribe should amount to only a fraction of \( \alpha \). We adopt this argument in a simple way by assuming that the expected cost of an unjustified fine amounts to \( q \alpha \); where \( q \in (0, 1) \) is determined by exogenous conditions related to the costs of a legal appeal and its probability of success\(^1\). The Nash-bargaining solutions for the resulting bribes are then \( \tilde{\beta} = \gamma q \alpha \) and \( \beta = \gamma \alpha \).

With the solutions for these bribes at hand, one can proceed to study the changes introduced by the presence of extortion to the main equations of the model. For the case of the public official, the expected utility of an official with honest behavior takes again the form

\(^1\)There is very little empirical evidence available regarding the relative size of extortive and non-extortive bribes. In a rare contribution using actual data from actual corruption cases in New York, Graycar and Villa (2011) report that the dollar amounts received from extortive bribes were "generally small".
This expected utility is not affected by extortion because allowing for extortive bribes generates an additional source of revenue only for those that behave corruptly. In contrast, the expected utility of an official with corrupt behavior is now expressed as

\[ U_{ij}^c(w, n, \beta) = \frac{[w - \rho m_j + n_j \beta(1 - G(R^*)) + n_j \beta G(R^*)]^{1 - \theta_j}}{1 - \theta_j} \cdot (1 - p) + 0 p; \]

where the term \( n_j \beta G(R^*) \) constitutes the expected amount of extortive bribes collected and the term \( n_j(1 - G(R^*)) \) constitutes the expected amount of non-extortive bribes collected. The corrupt official charges an extortive bribe \( \hat{\beta} \) to those who comply with the regulations (the fraction \( G(R^*) \) of the total \( n_j \) firms he monitors) and a non-extortionary bribe \( \beta \) to those who do not comply with the regulations (the remaining \( (1 - G(R^*)) \) fraction of firms monitored).

The corresponding payoffs for the firm can be described as follows:

\[
\begin{align*}
v(1) &= d(d_h(R_i - \bar{r} - rR_i) + d_c(R_i - \bar{r} - rR_i - \hat{\beta})] + (1 - d)[R_i - \bar{r} - rR_i] \\
v(0) &= d(d_h(R_i - \alpha) + d_c(R_i - \beta)] + (1 - d)(R_i).
\end{align*}
\]

They are similar to those studied in the simpler model presented in the text, except that the payoff \( v(1) \) now includes the expected costs of extortion. That is to say, that firms who comply with the regulations now expect a lower payoff due to the likelihood of encountering a corrupt official who demands an extortionary bribe \( \hat{\beta} \).

The equilibrium solution for the model can then be obtained as it was done previously. An official of honest behavior always exerts the minimum amount of effort possible \( (n_j = \underline{n}) \) because monitoring is costly in terms of utility \( (\rho > 0) \) and the wage is fixed. In contrast, an official of corrupt behavior chooses minimum effort \( (n_j = \underline{n}) \) only when the expected bribe income falls short of the associated monitoring costs \( \beta((1 - G(R^*)) + q(G(R^*))) - \rho < 0) \). Otherwise, he chooses \( n_j = \overline{n} \). These mutually exclusive cases again lead to what we labeled "low-monitoring" and "high-monitoring" scenarios. In here, we study the "high-monitoring" case only; since it was shown before that it is possible for corruption to foster compliance only in this type of scenario.
The system of simultaneous equations that results, takes the form

\[ R^*(\theta^*) = \frac{Jn\alpha(1 - \tilde{G}(\theta^*)) + J\pi\beta(1 - q)\tilde{G}(\theta^*)}{I \cdot r} - \frac{\bar{r}}{r}; \quad \theta^*(R^*) = 1 - \frac{\ln(1 - p)}{\ln\frac{w - \rho w}{w - \rho w + \pi(1 - G(R^*) + q(G(R^*))}}. \]

Also as before, it can be verified that \( \frac{\partial \theta^*}{\partial R^*} < 0 \) for all parameter values and that \( \frac{\partial R^*}{\partial \theta^*} = \frac{Jn\beta}{\bar{r}[\pi\gamma(1 - q) - \bar{r}]\tilde{G}'(\theta^*)} \) is positive as long as \( \pi\gamma(1 - q) > \bar{r} \). Therefore, the results of the model show that the type of equilibrium illustrated in Figure 1-a is also possible in an economy with extortion. It must be noticed, however, that this conclusion no longer holds when \( q = 1 \). That is to say, that when the value of the extortive bribe \( \tilde{\beta} \) equals the value of the non-extortive bribe \( \beta \), it is no longer possible for corruption to foster compliance. The reason why this is the case is that when the two bribes equal \( \tilde{\beta} = \beta \), those firms that confront a corrupt official face the same expected payoffs regardless of whether they comply with the regulations or not. And thus, a surge in corruption provides no incentive for compliance at all. The results of the model then reveal that corruption may foster regulation compliance even in the presence of extortion as long as \( \tilde{\beta} < \beta \).

2.1 References