CSAE WPS/2008-22

Bargaining for bribes under uncertainty*

Danila Serra†

September 2007

Abstract

A corrupt transaction is often the result of bargaining between the parties involved. This paper models bribery as a double auction where a private citizen and a public official strategically interact as the potential buyer and the potential seller of a corrupt service. Individuals differ in the internalized moral cost generated by corruption, and may have only imperfect information on others' moral cost, i.e. their "corruptibility". This paper investigates the role that imperfect information with respect to the "corruptibility" of one's potential partner in corruption plays in his or her propensity to engage in bribery, and, consequently, the equilibrium level of corruption in a society. We find that corruption is lower when potential bribers and potential bribees are uncertain regarding each other's "corruptibility". This paper provides therefore theoretical support to anti-corruption strategies, such as staff rotation in public offices, aimed at decreasing the social closeness of bribers and bribees.

JEL Classification: D72, D82, Z13

Key words: bribery, moral cost, double auction, imperfect information, multiple equilibria

*I am grateful to Chris Wallace, Klaus Abbink, Abigail Barr, Simone D'Alessandro, Mikhail Drugov, Patrick Premand and Pedro Vicente for their feedback and suggestions.

†Department of Economics and Centre for the Study of African Economies, University of Oxford. Email: danila.serra@economics.ox.ac.uk.

1 Introduction

Corruption is usually defined as an "abuse of public power for private gain". Bribery is typically referred to as an illegal provision of public services or goods in exchange for private monetary compensations. According to both definitions, the potentially corrupt people in a society are the providers of public services, *i.e.* the public servants. This might explain why economic theories of corruption have mainly focused on the supply side of the corruption market (the providers' side).

One significant portion of the theoretical literature has employed principal-agent-client models to investigate ways for a benevolent principal to monitor the moral hazard of the public servants (following Becker and Stigler, 1974, Rose-Ackerman, 1978, and Klitgaard, 1988).[1] A number of more recent studies has modelled corruption as a frequency-dependent phenomenon, subject to strategic complementarities in the public officials' economic incentives [Andvig and Moene (1990), Cadot (1987) and Lui (1986)]; these models assume that when corruption is widespread, the likelihood that a public official will act corruptly is relatively high, due to the lower cost of being caught and punished, and the higher chance of finding a corruption partner.[2]

The existing theories of corruption do not usually take into account the role that intrinsic motivations or moral costs may play on one's decision to act corruptly; when they do [Klitgaard (1988) and Andvig and Moene (1990)] they focus on the supply side of the market only. However, bribery involves not only the "sellers" of illicit public services or goods, but also the "buyers", *i.e.* private citizens (or firms), and each individual in a society is exposed, to some extent, to behavioral rules and socialization processes; therefore, intrinsic motivations are likely to affect both the supply side and the demand side of any corrupt transaction. Moreover, like economic incentives, intrinsic motivations may be subject to strategic complementarities: the more people obey a norm, the more likely it is for an individual to internalise that norm.[3] This paper focuses on the demand and the supply

[1] Note that in real life those in power, *i.e.* the principals, are usually not as benevolent as these models assume, since they are often those who can benefit the most from corruption.

[2] See Bardhan (1997) for a review of the most recent theories of corruption.

[3] For formal models see: Akerlof, G. (1980), Cavalli-Sforza, and Feldman (1981), and Boyd and Richerson (1985). Tirole (1996) also studies corruption as a "societal phenomenon" (page 2), however he adopts a multi-generational approach where one's decision to act corruptly positively depends on the level of corruption among the elder members of the same group due to inherited reputation in matters of corruption.

side of the corruption market by: 1) investigating the decision to engage in corruption of both public officials (potential bribees) *and* private citizens (potential bribers) and 2) allowing for the presence of strategic complementarities in the extrinsic incentives and the intrinsic motivations of potential bribers and bribees.

Recent empirical micro-evidence (Svensson, 2003, and Reinikka and Svensson, 2003) suggests that the amount of the bribe paid by a citizen or a firm is often the result of bargaining between the parties[4]; this would explain within-country and within-sector variations in both the frequency of corrupt transactions and the amount bribed in exchange for a certain service. Following this recent empirical literature, this paper models bribery as a double auction where a private citizen and a public official strategically interact as the potential buyer and the potential seller of a corrupt service. This setting also makes it possible to explore the micro-determinants of corruption without having to assign the role of "initiator" of the transaction to either the briber or the bribee. Instead, we can investigate the conditions under which both parties are willing to engage in or abstain from corruption.

Models of corruption with strategic complementarities typically maintain the assumption of perfect information among the parties. On the contrary, principal-agent-client models of corruption always point at imperfect information as an important cause of corruption, however they only refer to imperfect information on the part of the principal with respect to the actions and/or morality of the agent (Klitgaard, 1988). Empirically, a few recent micro-based studies of corruption have shown that imperfect information on the demand side – typically in the form of uncertainty with respect to the amount to be bribed – has a negative impact on the probability that any firm will pay a bribe (Herrera and Rodriguez, 2003[5]) and a country's overall level of corruption (Lambsdorff, 2007).

We address this issue theoretically by investigating the role that imperfect information with respect to the corruptibility (or moral cost) of one's opponent plays out in his or her willingness to engage in bribery, and, consequently, the equilibrium level of corruption in the society.We find that when agents are uncertain about the intrinsic corruptibility of their potential corruption partner, they are less likely to engage in corruption. This translates into a lower probability that society will end up in a systemic

[4] This seems to be especially true where corruption is not yet systemic, or "organized". See Shleifer and Vishny (1993).

[5] Using firm-level data from the Business Environment Survey they show that "predictable and effectual corruption regimes increase the frequency of bribery and the total monetary cost of corruption to firms".

"corruption trap"; additionally, when individuals are uncertain about each other's corruptibility, any anti-corruption policy is more effective in reducing corruption. This is especially true when the briber and bribee differ in their bargaining power over the amount to be bribed. It is reasonable to think that bribers and bribees who do not know each other are more likely to be uncertain about their opponents' intrinsic corruptibility; thus, we can draw two main policy conclusions from our findings. First, decentralizing public service provision to the local administrative level may have adverse effects on corruption, as it would reduce the social distance between potential bribers and potential bribees; second, anti-corruption strategies, such as staff rotation in public offices, may be highly effective in reducing corruption, since they would lower the likelihood that citizens and officials know each other.[6]

This paper is organized as follows. Section 2 presents our double auction model of bribery and Section 3 derives the corruption equilibria under perfect information. Section 4 introduces imperfect information with respect to one's opponent's moral cost and compares the results obtained under perfect and imperfect information. Section 5 concludes with a summary of the main findings and policy implications.

2 A double auction model of bribery

We model bribery as a transaction between a private citizen and a public official for the illegal provision of a public service or good, such as, for instance, the cancellation of a fine or the provision of a license undercutting some of the legal requirements. A corrupt agreement involves the payment of a bribe by the private citizen and the provision of the illicit service by the public official.[7] We focus on collusive corruption, *i.e.* a transaction which

[6] Staff rotation has been recently presented as an effective anti-corruption measure. See Ali (2000) for a successful example of reduction in corruption following the introduction of staff-rotation in Singapore. Staff-rotation is usually thought of as a way to break long-term corruption relationships between regular bribers and bribees and introduce uncertainty about the trustworthiness of one's potential corruption partner. Using data from a bribery experiment, Abbink (2004) shows that staff rotation could indeed be an effective way to control corruption in situations where briber and bribee repeatedly interact. Our approach is partially different, as we focus on one-shot bribery transactions. Here, the potential relevance of staff rotation in public officices relies on the possibility to introduce uncertainty regarding the intrinsic corruptibility of one's potential corruption partner, keeping the assumption that if a bribe is paid the corrupt service is delivered.

[7] Note that this setting excludes the possibility for the official to take the bribe and not provide the corrupt service. In this way we exclude the level of trust between the

benefits both the briber and the bribee, rather than extortionary corruption.

We assume that citizen and official have independent private valuations of the corrupt transaction, based on the costs and benefits generated by the exchange. The total cost generated by corruption comprises both the intrinsic moral cost that an individual may suffer from acting corruptly and the expected cost of receiving formal and/or informal sanctions. We assume that the probability that a corrupt individual will be caught and sanctioned is subject to strategic complementarities: the more people are corrupt the less likely it is for a corrupt individual both to be detected and to receive formal and informal sanctions. Therefore, we define the total cost of corruption suffered by an agent i, c_i, as:

$$c_i(x) = a_i - x,$$

where: a_i represents an internalized moral cost and we assume it is uniformly distributed over the interval $[1, \overline{a}]$, and x is the proportion of corrupt people in the population, *i.e.* the people who actually paid or received a bribe in exchange for a corrupt service, with $0 \leq x \leq 1$. Expected punishment enters the cost function through the endogenous variable x, due to our assumption of strategic complementarities. It follows that corruption has a cost for any individual unless he or she is intrinsically corrupt and the whole society is corrupt, *i.e.,* $a_i = 1$ and $x = 1$.

The citizen's private valuation of the corrupt transaction, which we call v_b, where the suffix b stands for "buyer" of the corrupt service, is equal to the monetary benefit she would gain from the illicit service, y, minus the cost generated by corruption, c_b:

$$v_b = y - a_b + x,$$

with $y \geq 1$. Note that v_b also represents the citizen's "reservation bribe" for the corrupt service, *i.e.* the highest bribe that she is willing to pay in exchange for the illicit service.

The official's private valuation, which also corresponds to his "reservation bribe", v_s, where the suffix s stands for "seller" of the corrupt service, is equal to the cost he would have to sustain in order to provide the illicit service (for example the administrative cost and the cost of hiding or falsifying documents), q, plus the total cost generated by corruption,[8] c_s:

briber and the bribee from the analysis. Trust is an important issue especially for grand corruption, where corrupt agreements are more likely to have a long-term nature and tend to repeatedly take place among the same corruption partners.

[8] The bribe is simply a transfer of money from the citizen to the official.

$$v_s = q + a_s - x.$$

Note that the cost of providing the corrupt service, q, is lower the higher the discretionary power of the official, and the more vague or complex the rules and the regulations associated with the service.

Citizen and official simultaneously decide the amount of the bribe, if any, that they would be willing respectively to pay and take in order for the corrupt transaction to occur. These bribes correspond to sealed bids in a traditional double auction, where the private citizen is the buyer and the public official is the seller of the service.

A corrupt transaction occurs if and only if the bribe "submitted" by the private citizen, b_b, is higher than or equal to the bribe "submitted" by the public official, b_s. If the conditions for a transaction to take place are met, the citizen and the public official negotiate the final amount of the bribe in the range of mutually agreeable bribes. The final bribe is equal to $b = kb_b + (1 - k)b_s$, with $0 \leq k \leq 1$ (see Chatterjee and Samuelson, 1983). The parameter k represents the bargaining power of the private citizen relative to the bargaining power of the public official. When $k = 1$ we can think of a situation where the private citizen "submits" a bribe equal to b_b, which the public official will accept without the possibility to negotiate; when $k = 0$ we can think of a situation where the public official "submits" a bribe equal to b_s which the private citizen will pay without the possibility to negotiate. It is reasonable to assume that k depends negatively on the total number of citizens demanding the service relative to the total number of public officials supplying the service. In other words, the bargaining power of each private citizen is likely to be smaller the higher the competition for the service among the citizens and the lower the competition for the service delivery among the public officials.

Next, we investigate the equilibrium levels of corruption when citizens and officials have perfect information with respect to each other's corruptibility, i.e., their intrinsic moral cost. Subsequently, we introduce imperfect information in the corruptibility of one's potential corruption partner (Section 4).

3 Bribery under perfect information

Consider a society where citizens and officials can perfectly observe their opponent's private valuation of a corrupt transaction. In other words, each citizen knows the minimum bribe that the official would be willing to take in exchange for the corrupt service, and each official knows the maximum bribe that the citizen would be willing to pay in exchange for the corrupt service. Therefore, a corrupt transaction takes place if and only if the private citizen's valuation for the corrupt service is larger than (or equal to) the public official's valuation:

$$v_b = y - a_b + x \geq q + a_s - x = v_s.$$

If the condition above is met, the citizen and the public official will each submit a bribe, b_b and b_s, which represent the maximum and minimum bribe that they are willing to pay and take, where $b_b \leq v_b$ and $b_s \leq v_s$. In this game, any bribe between v_s and v_b can be sustained as an equilibrium; the final bribe will depend on the citizen's and official's bids and their relative bargaining powers. Since here we worry about the existence of corruption only (and not about the size of the bribe), we can restrict attention to following condition for corruption to take place, which, rearranging from above, becomes:

$$a_s + a_b \leq y - q + 2x. \quad (1)$$

Those private citizens and public officials whose combined moral costs are lower than the total gains from corruption agree on a corrupt transaction. This is more likely to happen the larger the monetary benefit that the private citizen receives from the transaction, the lower the administrative cost the public official needs to sustain to provide the corrupt service (higher discretionary power) and the higher the proportion of corrupt people in the population, as the probability of being detected and formally or informally punished is relatively low.

Define A as the sum of the citizen's and the official's moral costs: $A = (a_s + a_b)$. As the intrinsic moral costs of citizen and official are independently distributed according to a uniform distribution over the interval $[1, \overline{a}]$, it follows that A is distributed according to a triangular distribution over the interval $[\underline{A}, \overline{A}]$ where $\underline{A} = 2\underline{a} = 2$ and $\overline{A} = 2\overline{a}$. Then the proportion of corrupt people, or corrupt transactions, in the population, x, is implicitly defined as:

$$x = F[y - q + 2x] \quad (2)$$

where F is the cumulative distribution of a triangular distribution defined over the interval $[2, 2\overline{a}]$, and with median equal to $(\overline{a} + 1)$.

3.1 Possible equilibria under perfect information

The proportion of corrupt transactions or corrupt people that we observe in equilibrium depends on: the distribution of the internalized moral cost a_i over the population of citizens and officials, the lowest and highest values that a_i can assume, the benefit that corruption generates to the citizen, y, and the administrative cost that the official needs to sustain to provide the corrupt service, q. We can distinguish four cases.

Case 1. *Systemic corruption*: The situation where everybody is corrupt, $x = 1$, can be sustained as an equilibrium if:

$$\overline{A} \leq y - q + 2, \tag{3}$$

that is, even the moral costs of the "most intrinsically honest" citizen-official pair in the society are not large enough to oppose the incentives associated with corruption when the whole population is behaving corruptly. The condition above suggests that we are more likely to observe $x = 1$ in equilibrium when the net benefit generated by corruption $(y-q)$ is relatively large, *i.e.* when the administrative cost to provide the service is relatively small (the discretionary power of the public official is relatively high) and/or the benefit to the private citizen is relatively large. Society is also more likely to be trapped in a systemic corruption equilibrium when the highest possible moral cost generated by corruption in the society is relatively small.

Case 2. *Honesty*: The situation where everybody is honest, *i.e.* $x = 0$, can be sustained as an equilibrium if:

$$\underline{A} = 2 \geq y - q. \tag{4}$$

that is, even the moral costs of the "most intrinsically corrupt" citizen-official pair, those with the moral cost equal to $\underline{a} = 1$, are larger than or equal to the net benefit associated with corruption when everybody in the population is behaving honestly. The condition for honesty suggests that we are more likely to observe $x = 0$ in equilibrium when the net benefit generated by corruption $(y - q)$ is relatively small, *i.e.* when the administrative cost to provide the service is relatively large (the discretionary power on the public official is relatively small) and/or the benefit to the private citizen is relatively small. Society is also more likely to permanently stay in a honesty equilibrium when the lowest possible moral cost associated with corruption is relatively large.

Case 3. *Honesty, systemic corruption and interior equilibria*: Both a corruption and a honesty equilibrium exist iff:

$$\overline{A} - 2 \leq y - q \leq 2. \tag{5}$$

Moreover, if (5) is satisfied we also have *at least one* interior corruption equilibrium x^* which satisfies:

$$x^* = F[y - q + 2x^*]. \tag{6}$$

Condition (5) suggests that we are more likely to observe multiple equilibria when the highest possible moral cost generated by corruption, $\overline{a}$, is relatively small and when the net benefit from corruption $(y - q)$ is also relatively small. Figure 1 illustrates the three corruption equilibria, $x = 0$, $x = 1$, and $x = x^*$, keeping our assumption of $f(\cdot)$ being a triangular distribution.[9] It is straightforward to see that the interior equilibrium is unstable, as follows: if the proportion of corrupt people is larger than x^*, the process converges to the systemic corruption equilibrium, whereas if the proportion of corrupt people is smaller than x^* the process converges to the honesty equilibrium. To see why, assume that $x = x^* + \theta$, for small positive θ. Since due to strategic complementarities a higher proportion of corrupt people in the population lowers the total cost associated with corruption, the probability that a corrupt transaction will take place, $F(y - q + 2x)$, is now greater than the actual proportion of corrupt people, x. This causes the proportion of corrupt people to increase. The process continues until x reaches the systemic corruption equilibrium. A similar process, in the opposite direction, holds if $x = x^* - \theta$.

[9] Note that our results hold for any bell-shaped distribution function on the support $[\underline{A}, \overline{A}]$.

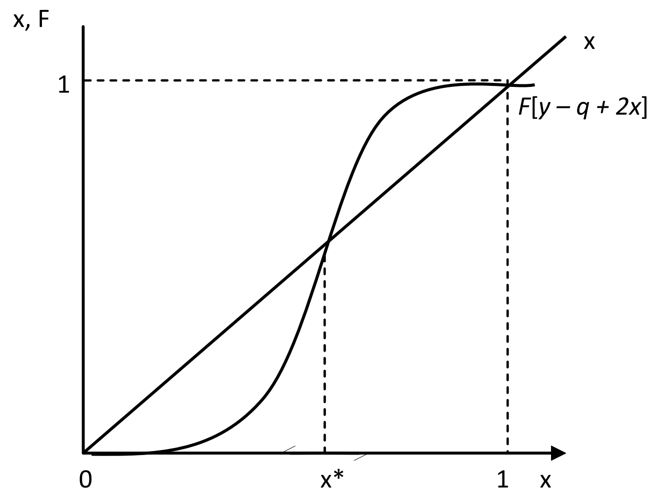

Figure 1

Case 4. *Interior corruption equilibria*: Neither “full honesty” nor “systemic corruption” can be sustained in equilibrium iff:

$$\overline{A} - 2 > y - q > 2, \tag{7}$$

If the above condition is satisfied we have at least one interior corruption equilibrium x^* which satisfies:

$$x^* = F[y - q + 2x^*]$$

Figure 2 shows that when $x = 1$ the $F[y - q + 2x]$ curve is now below the 45 degree line. This is because $\overline{A} > y - q + 2$, which means that at least the most intrinsically honest citizens and public officials now abstain from corruption even when $x = 1$. On the other hand, when $x = 0$, the $F[y - q + 2x]$ is now above the 45 degree line. This is because $2 < y - q$, which means that at least the most intrinsically corrupt citizens and public officials now engage in corruption even when $x = 0$. We could still have multiple equilibria, as shown in Figure 2, however the equilibria would all be interior. Moreover, as in *Case 3*, only the highest and lowest corruption equilibria (x_1 and x_3 in the figure) would be stable. To see why, let's look at x_1 and assume that $x = x_1 + \theta$, for small positive θ. Now, the probability that a corrupt transaction will take place, $F(y - q + 2x)$, is lower than the actual proportion of corrupt people, x. This causes the proportion of corrupt people to decrease. The process continues until the proportion of corrupt people reaches x_1. A similar process, in the opposite direction, holds if $x = x_1 - \theta$.

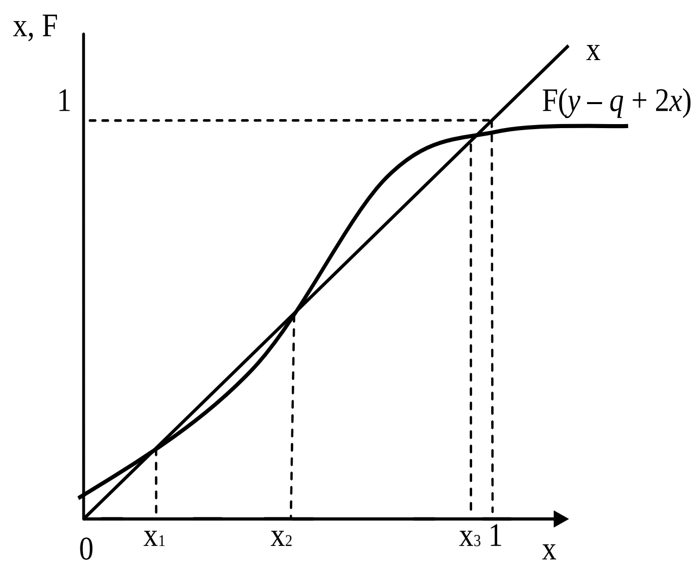

Figure 2

3.2 Comparative statics

As seen in equations (1) to (7) the values of y, q, a_s and a_b, as well as the initial level of corruption, determine the corruption equilibrium to which society will converge. From equation (1) we saw that the greater the monetary benefit to the briber, y, the smaller the administrative cost required to provide the corrupt service, q, the smaller the moral costs of briber and bribee, a_s and a_b, the larger the proportion of corrupt people in the population, x (as this affects the total cost associated with corruption), the more likely it is that a corrupt transaction will take place. We can now investigate which policies could be effective in reducing corruption.

First of all, acting on the severity of the penalty or the probability that a corrupt pair will be discovered would not be necessarily effective in this framework. Recall that the expected cost of formal and informal punishment enters the cost function through the proportion of corrupt people, x, due to the presence of strategic complementarities in both the extrinsic incentives and the intrinsic motivations associated with corruption. Our setting implies that the effectiveness of anti-corruption policies aimed at increasing the probability that a corrupt citizen (briber) or a corrupt official (bribee) will be discovered and severely punished depends on how corrupt society already is. If the level of corruption is high, increasing the penalty associated with corruption is likely to be ineffective. This is due to the fact that potential bribers and bribees would still believe that the likelihood for them to be discovered is very low and that, even in the unlikely case of detection they could still escape the severe sanction through bribery. Similarly, increasing the probability that corrupt people will be detected, for example by increasing the number of officials in charge of vertical and horizontal controls in public offices, may also prove ineffective when the level of corruption is high, since potential bribers and bribees would expect the inspecting officials to be willing to accept bribes themselves, in exchange for turning a blind eye.

Our setting suggests that an effective anti-corruption measure would be to increase the administrative cost of providing the corrupt service, by lowering the discretionary power of the public officer, for example by clarifying or simplifying the rules and the regulations associated with public service delivery. Indeed, equation (1) suggests that an increase in q would reduce the likelihood for a corrupt agreement to take place. The increase in q could make at least the most intrinsically honest citizens and officials in the population turn from corruption to honesty.

Figure 3 shows how, in a situation of multiple corruption equilibria, an increase in q would shift the $F[y - q + 2x]$ curve to the right, causing the unstable interior equilibrium to increase, that is reducing the "jump" needed in order for society to move from the systemic corruption to the honesty equilibrium. A large enough increase in q could ultimately eliminate both the systemic corruption equilibrium and the interior unstable equilibrium, by making it optimal for all the citizen-official pairs in the society to behave honestly.

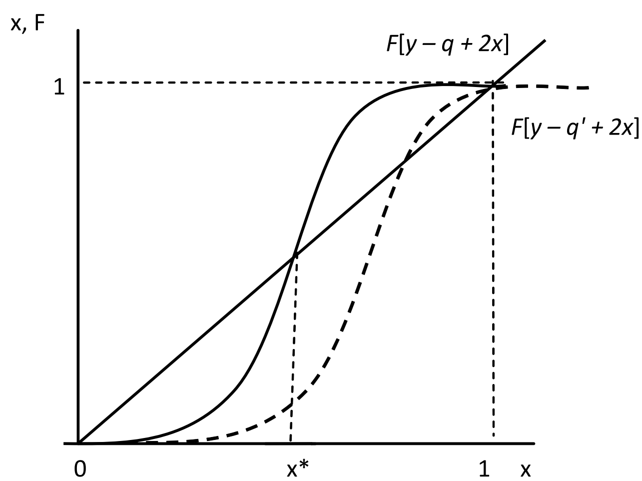

Figure 3

Figure 4 shows the effect of an increase in the administrative cost of providing the corrupt service in the presence of multiple interior corruption equilibria. The shift of the $F[y-q+2x]$ curve to the right would in this case move the highest corruption equilibrium further from $x = 1$ and the lowest corruption equilibrium closer to $x = 0$, and could ultimately eliminate the high corruption equilibrium. An alternative or complementary way of escaping a high corruption trap would be to modify the distribution of the moral cost associated with corruption in the society, such that for any given level of y, q and x, the monetary incentives of fewer briber-bribee pairs will be high enough to compensate for the higher intrinsic costs generated by corruption. For instance, public awareness campaigns and educational programs able to increase the moral cost a_i of any individual i in the population by a positive fraction z, would shift the cumulative distribution function of $(a_s + a_b)$, in a similar way as depicted in Figure 3 and Figure 4, for any given y, q and x. This would result in either a higher unstable interior corruption equilibrium, *i.e.* a smaller "jump" required to move from the high corruption to the low corruption equilibrium, or, if z is large enough, in the elimination of the high corruption equilibrium.

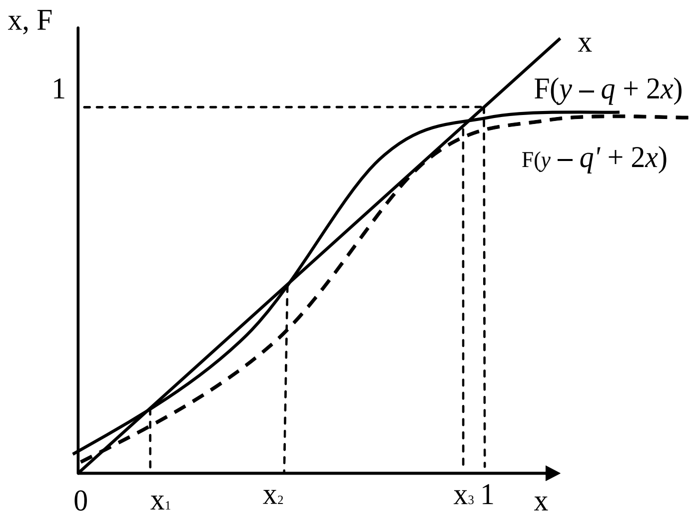

Figure 4

4 Bribery under uncertainty

Consider a society where, while each individual is aware of how costly it would be for him or her to be involved in corruption, there is imperfect information with respect to the intrinsic moral cost that his or her opponent would suffer if they engage in corruption; in other words, individuals are uncertain about the corruptibility of their opponent.

Formally, we now assume that individuals know their own total and intrinsic costs associated with corruption, yet they only know the distribution of their opponent's intrinsic moral cost over the interval $[1, \overline{a}]$. This implies that each agent is aware that his or her opponent's total cost associated with corruption is uniformly distributed over the interval $[1-x, \overline{a}-x]$, for any given x. We set $1-x=\underline{c}$ and $\overline{a}-x=\overline{c}$ for convenience.

We assume that citizen and official simultaneously decide the amounts of the bribe, b_b and b_s, that they will use as their reservation bribes when bargaining over the corrupt transaction.[10] A corrupt transaction occurs if and only if the bribe "submitted" by the private citizen, b_b, is higher than

[10] This assumption allows us to look at both the citizen's and the official's willingness to engage in corruption independently from their active (i.e. first-mover) or passive (i.e. second-mover) role in the transaction.

or equal to the bribe "submitted" by the public official, b_s. Therefore, the citizen and the official face a trade-off between acting aggressively on the one hand – *i.e.* "submitting" a low bribe for the citizen and "submitting" a high bribe for the official in order to make higher profits in case of agreement – and, on the other hand, lowering the risk of disagreement – *i.e.* "submitting" a bribe close to the reservation bribe.

If the conditions for a transaction to take place are met, citizen and official negotiate the final amount of the bribe in the range of mutually agreeable bribes. The final bribe is equal to $b = kb_b + (1 - k)b_s$, with $0 \leq k \leq 1$, where k represents the bargaining power of the private citizen relative to the bargaining power of the public official. We are ultimately interested in the extreme scenarios corresponding to symmetric bargaining powers, i.e. $k = 1/2$, and perfectly asymmetric bargaining powers, i.e. $k = 0$ or $k = 1$.[11]

Citizen and official choose b_b and b_s to maximize their expected gains from corruption; b_b and b_s represent their Bayesian strategy. An individual i's Bayesian strategy b_i is defined as $b_i = B_i(c_i)$, indicating that for any given y and q the bribe that an agent declares to be willing to pay or take depends on his own intrinsic moral cost, *i.e.* his "type", as c_i determines the reservation price v_i. An agent i's strategy b_i constitutes a *best response strategy* if for any c_i the "submitted" bribe b_i is a best response to his corruption partner's Bayesian strategy. Any pair of best response strategies constitutes a Bayesian Nash Equilibrium.

The citizen-official game has many Bayesian Nash equilibria. However, we are ultimately interested in the equilibrium level of corruption in the society as a whole. Therefore a "corruption equilibrium", x^*, in our model is defined as the fraction of corrupt citizen-official pairs/transactions which satisfies the following two conditions:

1) In the citizen-official Bayesian game, given x^*:

(i) the citizen plays a *best response strategy* to the official's Bayesian strategy;

(ii) the official plays a *best response strategy* to the citizen's Bayesian strategy;

2) The induced proportion of corrupt citizen-official pairs in the population, is consistent with x^*, $x = Prob[(\text{citizen bribes}|x^*) \cap (\text{official takes a bribe}|x^*)]$.

We investigate the corruption equilibria when the private citizen and the

[11] All the intermediate bargaining power cases are not as interesting, as the results in terms of corruption are "in between" the extreme cases results.

public official "submit" their bribes, b_b and b_s, by adopting linear strategies in their private valuations of the corrupt service,[12] as follows:

1) $b_b = \alpha + \beta(v_b) = \alpha + \beta(y - c_b)$

2) $b_s = \gamma + \delta(v_s) = \gamma + \delta(q + c_s)$

The private citizen chooses b_b to maximize his expected gain from corruption, U_b, which is equal to the monetary gain he would get from corruption minus the (expected) final bribe that he would have to pay in case of agreement with the official, times the probability that an agreement will be reached:

$$U_b(b, c_b, y) = Pr(b_b \geq b_s)[y - c_b - kb_b - (1-k)E(b_s|b_s \leq b_b)].$$

Note that $E(b_s|b_s \leq b_b)$ represents the bribe that the citizen expects the official to ask, conditional on this asked bribe being lower than what the citizen would be willing to pay, *i.e.* the condition for a transaction to occur needs to be met. Recall that c_s is uniformly distributed over the interval $[\underline{c}, \overline{c}]$. It follows that b_s is uniformly distributed over the interval $[\gamma + \delta(q + \underline{c}), \gamma + \delta(q + \overline{c})]$, which gives:

$$U_b(b, c_b, y, q) = \tfrac{b_b - \gamma - \delta(q + \underline{c})}{\delta(\overline{c} - \underline{c})}[y - c_b - kb_b - (1-k)\tfrac{\gamma + \delta(q + \underline{c}) + b_b}{2}].$$

By setting $\frac{\partial U_b}{\partial b_b} = 0$ and solving for b_b, we obtain the best response strategy of the private citizen:

$$b_b = \frac{k}{k+1}[\gamma + \delta(q + \underline{c})] + \frac{1}{k+1}(y - c_b). \tag{8}$$

We now turn to the public official. He chooses b_s to maximize his expected gain from corruption, U_s, which is equal to the (expected) final bribe that he/she would receive in case of agreement minus the administrative cost he would have to sustain to provide the service, times the probability that an agreement will be reached:

$$U_s(b, c_s, y, q) = Pr(b_b \geq b_s)[(1-k)b_s + kE(b_b|b_b \geq b_s) - c_s - q].$$

[12] Myerson and Satterthwaite (1983) show that adopting linear strategies in a standard double auction generates the highest probability for trade to occur under imperfect information. By assuming linear strategies in our double auction model of bribery we are therefore considering the worst case scenario with respect to the resulting level of corruption.

As before, $E(b_b|b_b \geq b_s)$ represents the bribe that the official expects the citizen to offer in exchange for the corrupt service, conditional on this offer being larger than the bribe the official would be willing to take. Since c_b is uniformly distributed over the interval $[\underline{c}, \overline{c}]$, then b_b is uniformly distributed over the interval $[\alpha + \beta(y - \overline{c}), \alpha + \beta(y - \underline{c})]$, which gives:

$$U_s(b, c_s, q) = \tfrac{\alpha+\beta(y-\underline{c})-b_s}{\beta(\overline{c}-\underline{c})}[(1-k)b_s + k\tfrac{\alpha+\beta(y-\underline{c})+b_s}{2} - c_s - q].$$

Setting $\frac{\partial U_s}{\partial b_s} = 0$ and solving for b_s, we obtain the best response strategy of the public official:

$$b_s = \frac{1-k}{2-k}[\alpha + \beta(y - \underline{c})] + \frac{1}{2-k}(q + c_s). \tag{9}$$

From (8) and (9), solving for α and γ, we derive the equilibrium linear strategies of the citizen and the public official:

1) $b_b = \alpha + \beta(v_b) = \frac{k(1-k)}{2(k+1)}(y - 1 + x) + \frac{k}{2}(q + 1 - x) + \frac{1}{k+1}(y - c_b),$

2) $b_s = \gamma + \delta(v_s) = \frac{k(1-k)}{2(2-k)}(q + 1 - x) + \frac{1-k}{2}(y - 1 + x) + \frac{1}{2-k}(q + c_s),$

and the condition for a bribery agreement to take place:

$$a_b + \frac{k+1}{2-k}a_s \leq \frac{1+k}{2}(y - q) + (1+k)x + \frac{k^2 - k + 1}{2-k}. \tag{10}$$

We focus on the levels of corruption corresponding to the bargaining power "lower" and "upper bounds": 1) equal bargaining power of citizen and official with respect to the bribery transaction, *i.e.* $k = 1/2$, and 2) asymmetric bargaining power with $k = 0$. Results for the case $k = 1$ are symmetric to the results obtained for case 2. The intermediate cases, *i.e.* those corresponding to $0 < k < 1/2$, and $1/2 < k < 0$ do not provide additional information, as they generate results which are "in between" those corresponding to the lower and the upper bounds.

4.1 Imperfect information with $\mathbf{k = 1/2}$

When $k = 1/2$ the private citizen and the public official have equal bargaining power in negotiating the amount of the bribe, which implies that the final bribe paid by a corrupt citizen and received by a corrupt official is equal to $b = \frac{1}{2}b_b + \frac{1}{2}b_s$. From (10) a corruption agreement takes place if and only if:

$$a_b + a_s \leq \frac{3}{4}(y - q) + \frac{3}{2}x + \frac{1}{2}, \tag{11}$$

which implicitly defines the proportion of corrupt citizen-official pairs in the population as:

$$x = F[\frac{3}{4}(y - q) + \frac{3}{2}x + \frac{1}{2}]. \tag{12}$$

Recall that F is the cumulative distribution function of $A = (a_b + a_s)$, and A is distributed according to a triangular distribution over the interval $[2, 2\overline{a}]$.

A comparison of the equilibrium levels of corruption under perfect and imperfect information, *i.e.* equations (2) and (12), suggests that the proportion of corrupt citizen-official pairs in the society is **lower under imperfect information** as long as $2 < y - q + 2x$, *i.e.* the most intrinsically corrupt citizen and official in the population (those with $a_b = a_s = 1$) find it optimal to agree on a corrupt exchange, for any given x.

We now look at the possible corruption equilibria under imperfect information.

Case 1. *Systemic corruption*, $x = 1$, can now be sustained as an equilibrium if:

$$\overline{A} \leq \frac{3}{4}(y - q) + 2. \tag{13}$$

The comparison between conditions (13) and (3) suggests that the likelihood for society to be trapped in a systemic corruption equilibrium is relatively lower when the agents do not have perfect information about each other's "intrinsic corruptibility" (and have equal bargaining power).

Case 2. *Honesty*, $x = 0$ can be sustained as an equilibrium if:

$$2 \geq \frac{3}{4}(y-q)+\frac{1}{2},$$

or, equivalently,

$$2 \geq (y-q),$$

which is the same as condition (4). It follows that the likelihood for honesty to be an equilibrium does not depend on the agents' information about their opponent's corruptibility.

Case 3. *Honesty, systemic corruption and interior equilibria.* Honesty and systemic corruption can now be observed in equilibrium iff:

$$\frac{4}{3}(\overline{A}-2) \leq y-q \leq 2. \tag{14}$$

Comparing conditions (14) and (5) suggests that when individuals are uncertain about their opponent's intrinsic corruptibility (and have equal bargaining power), society is less likely to be characterized by multiple corruption equilibria. Note that the interior unstable equilibrium x^* now satisfies:

$$x^{*}= F[\tfrac{3}{4}(y-q)+\tfrac{3}{2}x^{*}+\tfrac{1}{2}]$$

Figure 5 shows the three corruption equilibria under perfect and imperfect information, given that $\frac{4}{3}(\overline{A}-2) \leq y-q \leq 2$. Although the $F[\frac{3}{4}(y-q)+\frac{3}{2}x+\frac{1}{2}]$ and the $F[y-q+2x]$ curves both intersect the 45 degree line at $x=0$ and $x=1$, the $F[\frac{3}{4}(y-q)+\frac{3}{2}x+\frac{1}{2}]$ is weakly below the $F[y-q+2x]$ curve when it crosses the 45 degree line.[13] It follows that the interior unstable equilibrium under imperfect information, x_{imp} in the figure, corresponds to a larger proportion of corrupt people compared to the interior equilibrium under perfect information, x_p in the figure. However, as the interior equilibria are unstable, x_{imp} greater than x_p implies that when society is trapped in the systemic corruption equilibrium, a relatively smaller "jump" is required in order for the process to converge toward the honesty equilibrium. Equivalently, a relatively smaller increase in the administrative

[13] In fact the $F[y-q+2x]$ curve can be above the $F[\frac{3}{4}(y-q)+\frac{3}{2}x+\frac{1}{2}]$ curve for small values of x and large values of $(y-q)$.

cost q and a smaller positive shift of the distribution of the moral costs of citizens and/or public officials is required in order to eliminate the systemic corruption equilibrium and ultimately the interior corruption equilibrium.

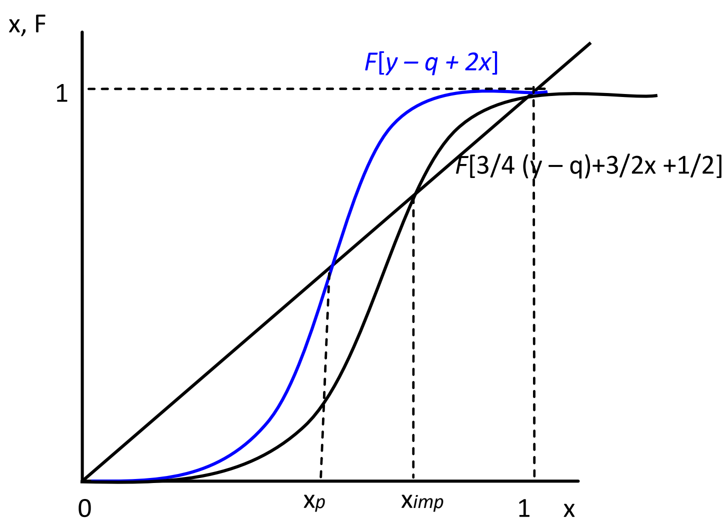

Figure 5

Case 4. *Interior corruption equilibria.* At least one interior equilibrium can now be observed if:

$$2 < y - q < \frac{4}{3}(\overline{A} - 2), \tag{15}$$

whereas under perfect information the condition for interior equilibria was $2 < y - q < \overline{A} - 2$, which suggests that imperfect information about one's opponent intrinsic moral cost associated with corruption increases the likelihood for society to be characterized by multiple interior corruption equilibria. Interior equilibria, x^*, now satisfy:

$$x^{*}= F[\tfrac{3}{4}(y-q) + \tfrac{3}{2}x^{*}+\tfrac{1}{2}]$$

Figure 6 shows multiple interior equilibria under perfect and imperfect information, given that $2 < y - q < \overline{A} - 2$ is satisfied.

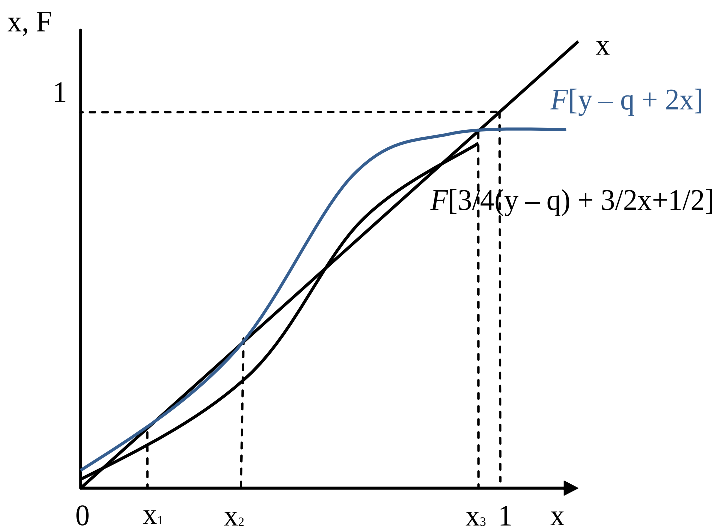

Figure 6

Three results clearly emerge from Figure 6. First of all, the high corruption equilibrium society could be trapped in is always lower under imperfect information than under perfect information. Secondly, the low corruption equilibrium which society could be driven to is always lower under imperfect information than under perfect information. Finally, the unstable corruption equilibrium, *i.e.* the critical proportion of corrupt people below which the process would converge to the low corruption equilibrium, is larger under imperfect information, suggesting that it is relatively easier/less costly for society to escape the high corruption equilibrium when agents are uncertain about each other's moral costs generated by corruption. Additionally, any policy aimed at reducing corruption, for instance by decreasing the discretionary power of the public official or shifting the distribution of the moral costs of citizens and/or officials, would be relatively more effective under imperfect information than under perfect information.

4.2 Imperfect information with $\mathbf{k = 0}$

We now investigate the decision of citizens and officials to engage in bribery when the private citizen has no bargaining power with respect to the amount of the bribe. In this setting, if corruption takes place, i.e. $b_b \geq b_s$, the citizen will pay the bribe demanded by the official:

$$b = b_s = \frac{1}{2}(y + q + a_s - 1)$$

From (10), a corruption agreement takes place if and only if:

$$2a_b + a_s \leq y - q + 2x + 1 \tag{16}$$

which implicitly defines the proportion of corrupt citizen-official pairs in the population as:[14]

$$x = \Psi[y - q + 2x + 1] \tag{17}$$

where $\Psi(\cdot)$ is the cumulative distribution function of $E = (2a_s + a_b)$, *i.e.* the cumulative distribution of a triangular distribution over the interval $[3, 3\overline{a}]$, with median $\frac{3(\overline{a}+1)}{2}$.

Recall condition (3) for a corruption agreement to take place under perfect information:

$$a_b + a_s < y - q + 2x$$

Comparing conditions (3) and (16) suggests that a bribery agreement is less likely to take place under imperfect information (and all the bargaining power on the official's side) than under perfect information if and only if the private citizen's intrinsic moral cost is larger than the lowest possible moral cost in the society, *i.e.* $a_b > \underline{a} = 1$, which is always true. A comparison of the conditions for corruption to take place under imperfect information with equal bargaining powers, $a_b + a_s \leq \frac{3}{4}(y - q) + \frac{3}{2}x + \frac{1}{2}$, and under imperfect information with asymmetric bargaining powers, $2a_b + a_s \leq y - q + 2x + 1$,

[14] Note that under imperfect information and no bargaining power on the citizen's side, the intrinsic moral cost of the private citizen plays a relatively larger role in the bribe-agreement process.

does not provide us with straightforward insights, and requires a deeper look at the specific distribution functions.

We now look at the possible corruption equilibria under imperfect information and $k = 0$.

Case 1. *Systemic corruption*, $x = 1$, can now be sustained as an equilibrium if:

$$3\overline{a} \leq y - q + 3 \tag{18}$$

Under perfect information the condition for systemic corruption to be an equilibrium was $2\overline{a} \leq y - q + 2$, whereas under imperfect information and equal bargaining power between the parts the condition for systemic corruption was $2\overline{a} \leq \frac{3}{4}(y - q) + 2$. This suggests that society is least likely to be trapped in a systemic corruption equilibrium when the agents have imperfect information about each other's intrinsic willingness to act corruptly and the bargaining power is placed on one side of the market only.

Case 2. *Honesty*, $x = 0$ can be sustained as an equilibrium if:

$$3 \geq y - q + 1$$

or, equivalently,

$$2 \geq y - q$$

which is the same condition for a honesty equilibrium to be sustained under both perfect information and imperfect information with $k = 1/2$.

Case 3. *Multiple equilibria.* Honesty and systemic corruption can now be both observed in equilibrium iff:

$$3\overline{a} - 3 \leq y - q \leq 2. \tag{19}$$

A comparison with conditions (5) and (14) suggests that society is least likely to be characterised by multiple corruption equilibria when individuals have imperfect information about each other's corruptibility and the bargaining power over the amount to be bribed is perfectly asymmetric. Note that the interior unstable equilibrium x^* now satisfies:

$$x^{*}= \Psi(y - q + 2x^{*}+1)$$

Figure 7 illustrates three corruption equilibria under perfect information, imperfect information with $k = 1/2$ and imperfect information with $k = 0$, assuming that $3\overline{a} - 3 \leq y - q \leq 2$. Although honesty and systemic corruption are both sustained as equilibria in the three cases, the interior unstable corruption equilibria significantly differ. As we already pointed out in Section 4.1, when potential bribers and bribees are uncertain about each other's corruptibility, society is characterized by a higher interior corruption equilibrium than under perfect information. Moreover, Figure 7 shows that the interior equilibrium under imperfect information is higher the more asymmetric the bargaining power between the briber and the bribee, which implies that escaping from a systemic corruption trap is relatively easier or less costly when individuals are uncertain about each other's intrinsic corruptibility and all the bargaining power is placed on one side of the market only.

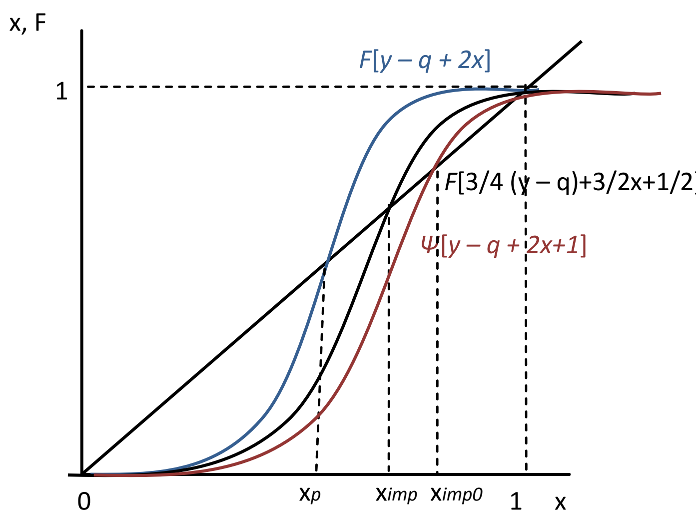

Figure 7

Case 4. *Interior corruption equilibria.* At least one stable interior corruption equilibrium can now be observed iff:

$$2 < y - q < 3\bar{a} - 3. \tag{20}$$

Comparing condition (20) with conditions (7) and (15) suggests that society is most likely to end up in an interior corruption equilibrium under imperfect information and perfectly asymmetric bargaining power. The interior equilibria, x^*, satisfy.

$$x^* = \Psi[y - q + 2x^* + 1] \tag{21}$$

Figure 8 shows the interior corruption equilibria in the three cases. Once again, the figure suggests that it is relatively easier or less costly for society to move from a high corruption to a low corruption interior equilibrium in the presence of imperfect information, and even more so when the bribee (or the briber) has full bargaining power over the amount to be bribed.[15]

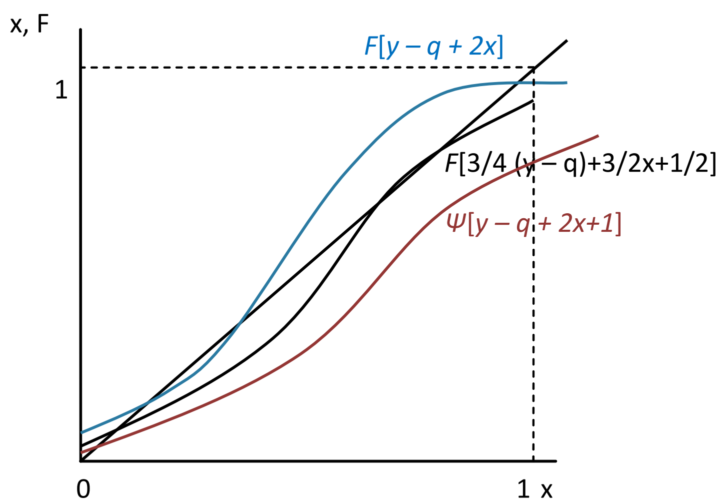

Figure 8

[15] For any level of bargaining power in between the upper bound of $k = 1/2$ and the lower bound of $k = 0$, we would have a cumulative distribution function lying in between the $F(.)$ and the $\Psi(.)$ distribution functions depicted in Figure 5.8. In other words, for any level of corruption x, the probability that a citizen-official pair will engage in corruption when $0 < k < 1/2$ would be lower than the probability corresponding to $k = 1/2$ and higher than the probability corresponding to $k = 0$.

5 Concluding remarks

This paper uses a simple double auction model to study the strategic interaction between potential bribers and potential bribees and the resulting corruption equilibria. We assume that the decision to engage in bribery is subject to strategic complementarities and that individuals are heterogeneous with respect to the intrinsic moral cost associated with corruption. The double auction framework allows us to look at the corruption decision making of both the briber and the bribee rather than focusing only on one side of the market, as has been traditionally done in the literature. We investigate how uncertainty regarding the intrinsic corruptibility of one's potential corruption partner affects the decision to engage in bribery and the resulting overall level of corruption.

We found that when individuals are uncertain with respect to their opponent's intrinsic corruptibility, they are less likely to engage in corruption. Imperfect information reduces the likelihood for society to end up in a systemic corruption trap and increases the likelihood for society to be characterized by multiple interior equilibria. Moreover, when society is characterized by multiple equilibria, imperfect information makes it relatively easier for society to "jump" from a high corruption to a low corruption or honesty equilibrium. This implies that any reduction in the equilibrium proportion of corrupt people can be achieved at a lower cost. This is especially true when the briber and bribee differ in their bargaining power over the amount to be bribed. Indeed, the lowest probability that society will end up in a "corruption trap" corresponds to a situation where citizens and officials have imperfect information about each other's corruptibility and all the bargaining power is placed on either the official's or the citizen's side, since, while monopoly power places either the citizen or the official in the position of extracting higher gains from corruption, at the same time it increases the chance for a transaction not to occur.

Our findings have interesting policy implications. It is reasonable to believe that uncertainty is lower in environments where the social distance among bribers and bribees is relatively small, *i.e.* where bribers and bribees are more likely to personally know each other or have indirect information about each other's corruptibility (see Tanzi, 2005). Our results therefore suggest that corruption can be lowered by increasing the social distance between briber and bribee, and therefore provide theoretical support against efforts to decentralize public service provision, and in favour of anti-corruption measures, such as staff-rotation in public offices, aimed at inducing as much uncertainty as possible with respect to the corruptibility of both buyers and sellers of public services.

References

[1] Abbink K. (2004). "Staff rotation: A powerful weapon against corruption?", European Journal of Political Economy 20(4), 887-906.

[2] Akerlof, G. (1980) "A Theory of Social Custom, of Which Unemployment May Be One Consequence", Quarterly Journal of Economics 94(4): 749-775.

[3] Ali, M (2000) "Eradicating corruption-The Singapore experience", Unpublished Manuscript, Corrupt Practices Investigation Bureau, Singapore.

[4] Andvig, Jens C. and Karl O. Moene (1990), "How Corruption May Corrupt," Journal of Economic Behaviour and Organization, 13, 63-76.

[5] Bardhan, P. (1997) "Corruption and Development: A Review of Issues," Journal of Economic Literature, 35: 1320-46.

[6] Benedict, R. (1934) Patterns of culture. Boston, MA: Houghton Miffin

[7] Becker, G.S. and G.J. and Stigler (1974) "Crime and punishment: An economic approach", The Journal of Political Economy, 76(2): 169-217.

[8] Bisin, A. and T. Verdier (2001). "The economics of cultural transmission and the dynamics of preferences." Journal of Economic Theory 97: 298-319

[9] Boyd , R. and P. J Richerson (1985) Culture and Evolutionary process. Chicago, IL: University of Chicago Press.

[10] Cadot, O. (1987) "Corruption as a gamble", Journal of Public Economics 33(2), 223-44.

[11] Cavalli-Sforza, L L. and M.W. Feldman (1981) Cultural transmission and evolution. Princeton, NJ: Princeton University Press

[12] Chatterjee, K. and W. Samuelson (1983) "Bargaining under imperfect information" Operations Research, 31(5):835-851.

[13] Fisman R. and R. Gatti (2007) "Bargaining for Bribes: The role of institutions", *Handbook on the Economics of Corruption*, Susan Rose-Ackerman, ed.

[14] Grusec, J.E. and L. Kuczynski (1997). Parenting and children's internalisation of values: A handbook of contemporary theory. New York: John Wiley & Sons.

[15] Herrera, A.M. and P. Rodriguez (2003). "Bribery and the Nature of Corruption". Michigan. State University, Department of Economics.

[16] Lambsdorff J. G. (2007) The Institutional Economics of Corruption and Reform: Theory, Evidence and Policy. Forthcoming.

[17] Lui, F.T. (1986) "A dynamic model of corruption deterrence" Journal of Public Economics 31(2): 215-236.

[18] Klitgaard, R. (1988) Controlling Corruption. Berkeley and Los Angeles: University of California Press.

[19] Myerson, R. B. and M. A. Satterwaite (1983), "Efficient Mechanisms for Bilatteral Trading," Journal of Economic Theory, 29: 265–281.

[20] Parsons, T. (1967) Sociological theory and modern society. New York: Free Press.

[21] Rose-Ackerman, S. (1978) Corruption: A Study in Political Economy. NY: Academic Press.

[22] Rose-Ackerman, S. (1999) Corruption and Government: Causes, Consequences and Reform. Cambridge, UK: Cambridge University Press.

[23] Reinikka R. and J. Svensson (2003) "Local capture: Evidence from a central government transfer program in uganda", The Quarterly Journal of Economics 119(2):679-705.

[24] Shleifer, R and R. W. Vishny (1993) "Corruption." Quarterly Journal of Economics 108 (3): 599–617.

[25] Svensson J. (2003) "Who Must Pay Bribes and How Much? Evidence from a cross-section of firms", Quarterly Journal of Economics.

[26] Tanzi, V. (1995) "Corruption: Arm's-lenght relationships and markets" in The economics of organized crime, ed. by G. Fiorentini and S. Peltzman, Cambridge University Press.

[27] Tirole, J. (1996), “A Theory of Collective Reputations (with Applications to the Persistence of Corruption and to Firm Quality)”, The Review of Economic Studies, 63(1), 1- 22.