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Partners in Crime:
Collusive Corruption and Search

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Abstract

This paper analyses corruption as a collusive act which requires the participation of two willing partners. An agent intending to engage in a corrupt act must search for a like-minded partner. When many people in the economy are corrupt, such a search is more likely to be fruitful. Thus when an agent engages in search, he raises the net benefit of searching for other similar agents in the economy, creating an externality. This introduces a non-convexity in the model, which consequently has multiple equilibria. The economy can be in stable equilibrium with a high or low level of corruption.

Starting from the high-corruption equilibrium, A sufficient increase in vigilance triggers a negative cascade, leading the economy to a new equilibrium in which no agent finds it profitable to search for corrupt partners. The no-corruption equilibrium continues to be stable if vigilance is then relaxed.

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1 Introduction

Corruption is a common problem around the world, in developed as well as in less-developed countries. In the latter it is often ubiquitous, with bribes changing hands daily over small transactions. In developed countries there are fewer instances of corruption in everyday transactions, though incidents involving large considerations frequently come to light.

Corruption is defined as the use of public office for private gain (Jain 2001, Bardhan 1997). The most common acts of corruption—such as bribery—require collaboration between at least two agents: the individual who needs a dispensation he does not deserve, and the public official who is willing to make that dispensation in return for a payment or other favour.

In poorer countries, corrupt public officials are often in large supply and it is easy for an individual to identify such an official. In turn corrupt officials foresee a steady stream of individuals willing to pay bribes, and hence find it worthwhile to facilitate such identification even if it entails some risk of being apprehended and punished.

In most developed countries, on the other hand, members of the public do not expect to find a corrupt official readily. Rather than engage in costly search for a corrupt official, they therefore go about their business in a lawful way. Correspondingly, officials do not expect that many clients will arrive bearing offers of bribes, and hence find it prudent not to advertise themselves as being open to such advances. Only in cases where large gains are to be made do the respective agents undertake the costly process of searching for potential partners in corrupt activities.

This paper analyses corruption as a collusive act which requires the participation of two willing partners. An agent intending to engage in a corrupt act must search for a like-minded partner. When many people in the economy are corrupt, such a search is more likely to be fruitful; when few are corrupt success is less likely. Search is costly, therefore agents in the economy are more willing to search when they know that many others are also searching, and less willing when others are not. Thus the same economy may end up in a high-corruption equilibrium or a low corruption one. For an economy in the high-corruption equilibrium, the policy problem is to move the economy to the low-corruption equilibrium.

1.1 The case of Hong Kong

The history of corruption in Hong Kong shows this is not a far-fetched theory.[1] In the 1960s and 70s the Hong Kong police force was riddled with corruption. Bribery was rampant, and the Anti-Corruption Branch was itself thoroughly corrupt. Despite efforts by the government, corruption was increasing steadily in Hong Kong.

In 1973, the governor of Hong Kong established a new body known as the Independent Commission Against Corruption (ICAC) under the leadership of Jack Cater. Cater instituted a major assault on corruption, which among other things incorporated two features. First, he drastically increased the degree of vigilance, including the establishment of new channels for reporting corrupt acts. Secondly, he recruited experienced police officers from Britain on short contracts to replace local officers.

Klitgaard (1988) observes that the short-term hiring of officers from abroad prevented the development of "buddy-buddy" relationships, and increased the cost of searching for corrupt partners. It thus reduces the probability of being successful in undertaking an illegal transaction. The high vigilance level increases the probability of being caught. Although these steps made the ICAC very expensive in the short run, it was successful in curbing corruption in the long run.

This paper emphasises that agents need to secure the cooperation of others to perform corrupt acts, and analyses the consequences of policy initiatives on this search process. This is discussed further in section 1.3 below.

1.2 Approaches to the analysis of corruption

Much of the literature on corruption analyses the problem using the principal-agent model. Corruption is the outcome of a moral hazard problem which arises because of an information asymmetry between the government (principal) and the public servant (agent) (e.g. Bardhan 1997, page 1321). The government cannot perfectly monitor the agent, so the latter has some discretion over his actions. He may use this discretion in a manner that promotes personal gain, e.g. by accepting a bribe to authorise an application that does not meet relevant guidelines.

Since corruption is the outcome of asymmetric information, the remedy is to reduce information asymmetry. Rose-Ackerman (1978, pp. 17-29)

[1] The following account is based on Klitgaard (1988).

shows that legislative corruption cannot survive in a world of perfect information as long as penalties are enforced effectively. Even if information is imperfect so that acts of corruption may escape detection with some probability, Becker's (1968) model indicates that a high enough penalty will deter corruption. Basu et. al. (1992) point out that, if enforcement authority is itself susceptible to corruption, then the penalty is not as efficient a deterrent. Marjit and Shi (1998) show that this problem can be alleviated by using part of the penalty to reward the agent who brings him to justice. Other work on corruption using the principal-agent problem includes Barro (1973), Becker (1983), Klitgaard (1988), Grossman and Helpman (1994), Rose-Ackerman (1999), Rasmusen and Ramsayer (1994) and Banerjee (1997).

A second approach to corruption analyses it as a rent-seeking problem (Krueger 1974, Shleifer and Vishny 1993). In its purest form, successful rent-seeking realises potential surplus by appropriately reallocating resources to high-surplus uses. Thus when many individuals are waiting in a queue, one of them who has a high opportunity cost for waiting may be willing to "buy" the place in front of the queue from another individual who has a lower cost of waiting. Alternatively, the clerk at the window may effectively "auction" the place in front of the queue, by serving first the client who is willing to pay the highest bribe (see, e.g., Lui 1985, Beck and Maher 1986). Thus this kind of corruption increases efficiency by suitably reallocating resources to their best uses. However, Shleifer and Vishny (1993) distinguish between corruption "without theft" and corruption "with theft", and show that the efficiency argument does not hold uniformly.

Murphy, Shleifer and Vishny (1993, page 409) argue that there are at least two major reasons that makes rent seeking behaviour costly to growth. First, rent seeking activities exhibit increasing returns, i.e., a general increase in rent seeking activity may make it more attractive relative to productive activity. Secondly, public rent seeking by government officials is likely to hurt innovative activities more than everyday production. The first of these characteristics has a reflection in our model described below, where an additional individual engaging in corruption increases the payoff to other corrupt agents.

One of the limitations of the above approaches is that they fail to explain why the incidence of corruption is so different across countries. A third approach, which addresses this shortcoming, explores the possibility that different countries have different norms, and therefore what is regarded in one culture as a corrupt act may in another be considered a routine transaction (Bardhan, 1997, page 1330). Multiple equilibria arise from an externality which originates in agents' perceptions of the prevalence and acceptability of corruption in the economy (see e.g. Cadot 1987, Sah 1988, Andvig and Moene 1990, Tirole 1996).

1.3 This paper

The present paper differs from work in the principal-agent and rent-seeking approaches in that it focuses on the way agents come together to perform corrupt acts, rather than specifically modelling an individual corrupt act. A successful corrupt act in our model yields a positive benefit to the agent who cooperate in performing it, and simultaneously generates a larger cost for the society at large. Thus we do not engage the question whether corruption reduces overall economic efficiency; we assume that it does. In this paper, as in the norm-based approach, individuals who engage in corruption generate an externality for others contemplating it. However, the present model is not a norm-based model of coordination—multiple equilibria in this model arise from complementarities in search rather than changes in popular attitudes towards corrupt activities. The externality is a consequence of the structure of the economy, not of a change in the subjective perceptions of agents.

The specific externality that we address is one found in models of search, to which this paper is technically closely related. The classic example is Diamond (1982), which uses search and coordination failure to explain the simultaneous possibility of high- and low-employment equilibria. Here we use it to explain the emergence of high- and low-corruption equilibria in economies with the same fundamental characteristics.

In order to reap the private benefit from corruption, agents must act in pairs. Thus an agent who wishes to engage in corruption must find a like-minded partner. This calls for search, which is costly. When there are many such agents searching, finding a partner is relatively easy, and the expected benefit of search is positive. In other words, when an agent engages in search, he raises the net benefit of searching for other similar agents in the economy, creating an externality. This introduces a non-convexity in the model, which consequently has multiple equilibria. The economy can be in stable equilibrium with a high or low level of corruption.

The government in our economy engages in vigilance against corruption. Vigilance results in some corrupt agents being apprehended, and these agents incur a penalty which outweighs the benefit of the corrupt act. An increase in vigilance increases the probability of being apprehended, and hence reduces the expected payoff of engaging in corruption.

If the government does increase the level of vigilance, then, some erstwhile corrupt individuals find that the net benefit of such behaviour becomes negative, and refrain from looking for partners. In turn, this reduces the payoff for the remaining corrupt agents. A sufficient increase in vigilance can trigger a negative cascade, leading the economy to a new equilibrium in which no agent finds it profitable to search for corrupt partners. Once this equilibrium is reached, however, vigilance can be relaxed again—the no-corruption equilibrium continues to be stable.

The next section sets out the model. Section 3 identifies the equilibria and establishes their characteristics. Section 4 then analyses the consequence of different anti-corruption policies.

2 Model

The economy consists of a large number of identical agents with mass normalized to unity, and a government. Time is divided into periods.

In each period, each agent can potentially undertake a productive transaction. The transaction may be made in an *honest* manner or in a *corrupt* manner. The number (proportion) of agents who are corrupt is denoted e, subscripted by the period if necessary.

2.1 Honest and corrupt transactions

The agent can undertake an honest transaction on his own in the normal course of activities. An honest transaction generates a private income of y to the agent.

In order to undertake a corrupt transaction, an agent needs a partner who is also corrupt. An agent must conduct search to find a partner. If he fails to find a partner, he must content himself with an honest transaction.

For an individual agent the probability of finding a partner, $k(e)$, is an increasing function of e, the number of corrupt agents in the economy. For simplicity of exposition we assume that $k(e)$ is linear and increasing in e, and the probability of finding a partner is 0 when no one is corrupt. The results are robust to much weaker restrictions (see remark 2.1 below).

$$k(e) \;=\; ke, \qquad k \leq 1 \tag{1}$$

If e agents are corrupt (i.e., attempt corrupt transactions) then each agent finds a partner with probability ke. By the law of large numbers ke^2 agents will actually succeed in executing a corrupt transaction.

A corrupt transaction generates a private income of $y + \phi$ to the agent (where $\phi > 0$), but also imposes an external cost of B on the economy. The cost B is shared equally by all agents. Since the number of agents is large, the individual ignores the externality generated by his own corrupt act. However, the net social benefit of a corrupt act is negative:

$$B > \phi.$$

Thus when an agent undertakes a corrupt act instead of an honest one, the total income generated in the economy decreases.

2.2 Vigilance

The government undertakes vigilance to prevent corruption. The quantity of vigilance is determined by expenditure allocated to it, denoted v. Vigilance is financed by a tax levied equally on all agents in the economy.

Vigilance results in some corrupt agents being apprehended. The probability that a corrupt agent will be apprehended depends positively on v, and negatively on e, the number of agents who are corrupt. In what follows, we ignore e as a determinant of the probability since this simplifies the algebra and does not make a qualitative difference to the analysis. We denote the probability of a corrupt agent being caught by $p(v)$. We assume $p(.)$ is continuous, increasing and concave in v. Further, if the level of vigilance is high enough, then a corrupt agent will almost surely be apprehended, i.e.

$$p'(v) > 0, \quad p''(v) < 0, \quad p(v) \to 1 \text{ as } v \to \infty \tag{2}$$

If an agent is apprehended, he is fined an amount β. The consequences of varying the penalty on crime is well known, as are the limitations placed by limited liability and finite wealth, and we do not investigate those in this paper. For our purposes, the quantity β is exogenous and constant throughout the analysis. We assume $\beta > \phi$; so the punishment is potentially a deterrent against corruption.

2.3 Incomes from transactions

We can now calculate the expected income of an agent conditional on the type of transaction he chooses, the proportion of agents in the economy that are corrupt, and the vigilance expenditure allocated by the government. Let superscripts h and n denote honest and corrupt agents respectively. The expected incomes of an agent on choosing the two kinds of transactions are, respectively:

$$\begin{aligned} Y^h &= y - Bke^2 - v \\ Y^n &= y + ke[\phi - p(v)\beta] - Bke^2 - v \end{aligned}$$

An honest agent obtains income y, pays a tax of v and suffers negative externality of B per corrupt transaction undertaken in the economy. Since ke^2 of the agents succeed in undertaking such acts, the total externality generated is Bke^2. A corrupt agent in addition succeeds in undertaking a corrupt transaction with probability ke, which generates a gain of ϕ but attracts a penalty β with probability $p(v)$.

The incremental expected benefit of attempting a corrupt transaction rather than an honest one is therefore the difference between Y^n and Y^h, which is denoted

$$Z(e, v) = ke[\phi - p(v)\beta] \tag{3}$$

For given v, $Z(e, v)$ is a straight line from the origin with slope $k[\phi - p(v)\beta]$ when plotted against e. Since $\beta > \phi$, and $p(v)$ tends to unity as v becomes large, Z becomes flatter, then horizontal, and ultimately negative as v increases.

When e agents are corrupt, the total income or surplus produced in the economy is

$$S = y - (B - \phi)ke^2 \tag{4}$$

2.4 Cost of corrupt action

There is a cost to undertake a corrupt transaction, and this cost varies across agents.[2] For each agent, this cost is given and constant throughout the analysis, and does not vary in response to the agent's perception of the prevalence of corruption in the economy.

Let the i-th agent's cost of being corrupt be denoted c_i. c is distributed in an interval $[c_0, c_1]$ with $c_0 > 0$. Without loss of generality, we arrange the agents in the economy so that

$$i > j \;\Leftrightarrow\; c_i \geq c_j \tag{5}$$

[2]We leave the exact details of the cost unspecified. It may be a cost of undertaking search—some agents know better than others where to look for a corrupt partner. Alternatively, it may be a psychological cost of being dishonest, arising from a prejudice towards honesty, which is a consequence of the agents' socialization and upbringing.

The costs are distributed with density function $f(c)$ and distribution function $F(c)$. Since the population has been normalized to unity, we have $F(c_0) = 0$ and $F(c_1) = 1$.

2.5 Some assumptions

An agent i will choose to undertake a corrupt transaction if the expected gain from doing so exceeds the cost, in other words if $Z(e, v) \geq c_i$. In order to ensure that corruption occurs under some circumstances, we make the following assumption:

Assumption 1 $Z(e, v) \; > \; c_1 \;\; \textit{at} \;\; e = 1, \; v = 0.$

This ensures that if there is no vigilance and if the entire population is corrupt, then even the agent with the highest cost will find it profitable to be corrupt. For ease of exposition we also impose the following restriction on the density/distribution function:

Assumption 2 *There is* $m \in]0, 1[$ *such that* $f(.)$ *is strictly increasing in* $[0, m[$*, reaches a maximum at* m*, and is strictly decreasing in* $]m, 1]$*.*

It follows that F is strictly convex over $[c_0, m]$ and strictly concave over $[m, c_1]$, i.e. $F(.)$ is S-shaped. Further since f is non-zero everywhere, F is strictly increasing over its domain. In the analysis below it will be convenient to use the inverse of F. Define

$$G(e) \;\equiv\; F^{-1}(e), \qquad e \in [0, 1]$$

$G(e)$ is the cost such that the proportion of the population with costs $c \leq G(e)$ is exactly e. It follows from assumption 2 that G has the following properties:

Observation 1 *G is well-defined and strictly increasing.* $\exists \mu \in]0, 1[$ *such that* $G(e)$ *is concave in the region* $[0, \mu[$ *and convex in the region* $]\mu, 1]$*.*

2.5.1 Expectations

To link periods in the dynamic analysis we will assume that, in period t, agents expect the degree of corruption that obtained in period $t - 1$ to prevail, that is

Assumption 3 $\mathrm{E}e_t \; = \; e_{t-1}.$

Where E is the expectations operator. The simple adaptive expectations assumption provides a degree of inertia that keeps the analysis intuitive.[3]

Remark 2.1 *In what follows, the general results we obtain would hold true as long as*

(i) $k(.)$ *and* $p(.)$ *are increasing in their arguments, which implies that* $Z(e,v)$ *is increasing in* e *and decreasing in* v*,*

(ii) $Z(e,0) < c_0$ *at* $e = 0$*, and*

(iii) $Z(e,0) > G(e)$ *for some* $0 < e < 1$*.*

Assumption 1 is a strong version of the last requirement, which ensures that there are some circumstances under which corruption will occur. The remaining properties are part of the model. The specific shapes assumed for $F(.)$ in assumption 2 and Z (via k) limit the multiplicity of equilibria and facilitate the diagrammatic exposition which accompanies the analysis.

The next section establishes the equilibria for this economy. The following section investigates the dynamics of changing vigilance.

3 Equilibria: existence and stability

Given the number of corrupt agents e and the level of vigilance v, the i-th agent will be corrupt (attempt to undertake a corrupt transaction) if

$$Z(e,v) \geq c_i \tag{6}$$

By the ordering of agents described in (5), if the i-th agent chooses to be corrupt, then so will all agents with indexes smaller than i. When e agents are corrupt, an agent will choose to be corrupt if his expected gain from corruption, $Z(e,v)$ exceeds his cost. If the economy is in equilibrium with e agents being corrupt, then the corrupt agents will be precisely the ones with costs between 0 and $Z(e,v)$, while those agents with a higher cost will choose not to be corrupt. Thus the fraction of the population with costs not exceeding $Z(e,v)$ must be exactly e.

[3]In the present model, fully rational expectations would unnecessarily multiply the multiplicity of equilibria. Adaptive expectations eliminates the possibility that the existing equilibrium might become disrupted purely as a result of the coordinated *expectation* that all agents may behave differently tomorrow.

Definition 3.1 (equilibrium) *Given the vigilance level v, an equilibrium is a fraction of the population e such that*

$$F(Z(e,v)) = e.$$

For $Z(e,v) \in]c_0, c_1[$, an interior equilibrium corresponds to an intersection of the curves Z and G plotted against e as in figure 1. At the corners, $e = 0$ is an equilibrium if $Z(0,v) \leq c_0$, and $e = 1$ is one if $Z(1,v) \geq c_1$.

An equilibrium e^* is stable if a small deviation of e from e^* is self-correcting. We need that when e exceeds e^* by an infinitesimal amount, the marginal corrupt agent prefers not to be corrupt, while when e falls below e^* the marginal corrupt agent strictly prefers to be corrupt. At $e = 0$ only the first condition is relevant, and at $e = 1$ only the second condition is relevant.

Definition 3.2 (Stability) *An equilibrium e^* is stable if there is $h > 0$ such that $G(e) < Z(e,v)$ for $e \in]e^* - h, e^*[\bigcap [0,1]$, and $G(e) > Z(e,v)$ for $e \in]e^*, e^* + h[\bigcap [0,1]$.*

In terms of the diagram, an interior equilibrium e^* is unstable if Z intersects G from below, and stable if the reverse is true. Corner equilibria, if they exist, are stable.

3.1 Corner Equilibria

Propositions 3.1 and 3.2 follow straightforwardly from the assumptions.

Proposition 3.1 *$e = 0$ is a stable equilibrium for all values of v.*

proof: $Z(0,v) = 0$ for all values of v, since $k(0) = 0$. Since all agents have strictly positive costs ($c_0 > 0$), no agent will choose to be corrupt when $Z = 0$. In other words, $F(Z(e,v))\big|_{e=0} = 0$. By continuity of Z and G in e, the gain remains less than the cost for small e, so the equilibrium is stable. ■

Proposition 3.2 *$e = 1$ is a stable equilibrium for $v = 0$.*

proof: By assumption 1, the gain from corruption exceeds the cost for all agents, so $e = 1$ is an equilibrium. By continuity of Z and G, this remains true when e falls below unity by a small amount, so the equilibrium is stable. ■

3.2 Interior Equilibria

Next we trace the equilibria that obtain for different values of the vigilance parameter v.

The two central relations of the model, Z and G are sketched in figure 1. The horizontal axis measures e, and the vertical axis measures incomes, costs, etc.

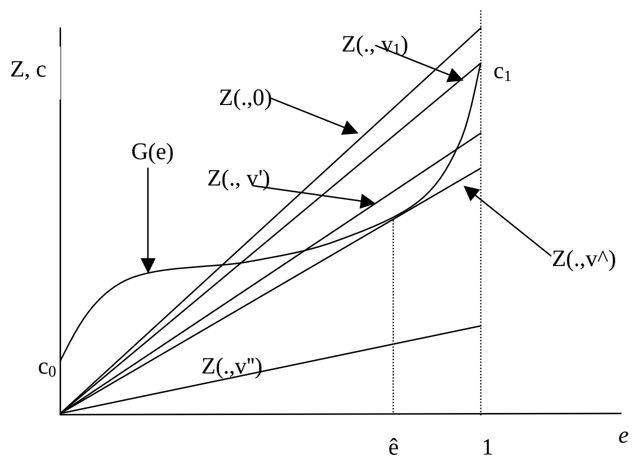

Figure 1: Cost of corrupt action compared with expected gain given different levels of vigilance

$G(e)$ has the shape discussed in observation 1 and takes values c_0 at $e = 0$ and c_1 at $e = 1$. $Z(e, v)$ has a value of 0 at $e = 0$ independent of v, and is linear by equations (1) and (3) for any given v. In the figure, $v'' > \hat{v} > v' > 0$.

Lemma 3.3 *: There is $\hat{v} > 0$ such that for $v < \hat{v}$, $Z(e, v) > G(e)$ for some $e \in]0, 1[$, and for $v > \hat{v}$, $Z(e, v) < G(e)$ for all $e > 0$.*

Proof: When there is no vigilance, the gain function Z lies below the cost function G at $e = 0$, and above it at $e = 1$. By the continuity of both functions, Z must intersect G at least once between 0 and 1. As v increases, Z decreases for all $e > 0$, and falls below the horizontal axis. Thus, for large enough v, Z must lie entirely below G. By the continuity of both functions, the assertion must be true. ■

Corollary 3.4 *: It follows that there is some* $\hat{e} \in]0,1]$ *such that when* $v = \hat{v}$*,*

$$Z(e,\hat{v}) \begin{cases} = G(e) & \text{for} \quad e = \hat{e} \\ < G(e) & \text{for} \quad e \neq \hat{e} \end{cases}$$

i.e. Z *lies below* G *everywhere except at* $\hat{e}$*.*[4]

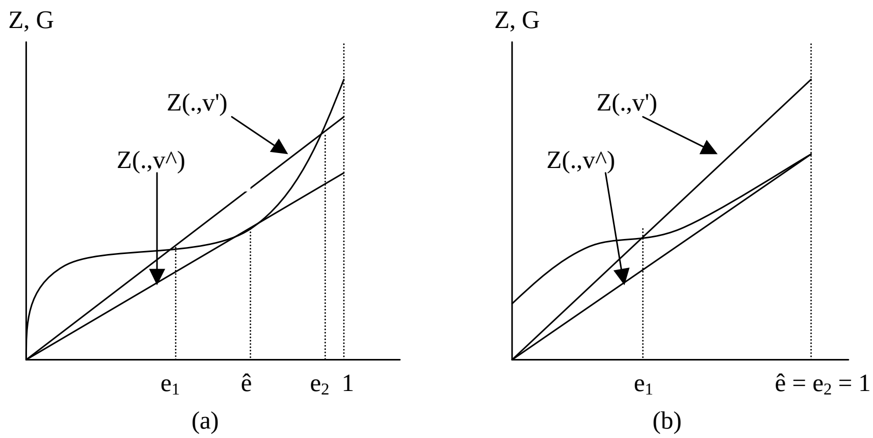

Figure 2: Two possible configurations of costs and expected gains($v' < \hat{v}$)

The two possible configurations of the functions Z and G are shown in figure 2. The pattern of equilibria for different values of v now follows naturally. Define v_1 to be the level of vigilance such that $Z(1, v_1) = G(1)$ (i.e., if $v = v_1$ and all agents are corrupt, then the individual with the highest cost of corruption is just indifferent between corruption and honesty). Let $\hat{v}$ be as defined in lemma 3.3.

Proposition 3.5 (Equilibria for different levels of vigilance)

(i) When $v \leq v_1$*, there are three equilibria, at* $e = 0$*,* $e_1 \in]0, \hat{e}[$ *and* $e = 1$*. Of these,* 0 *and* 1 *are stable and* e_1 *is unstable.*

[4]If $G(e)$ does not become sufficiently steep as e approaches unity, then $\hat{e} = 1$. Note that, by assumption 2, G is strictly convex and then strictly concave, which ensures that $\hat{e}$ is a point and not a segment.

(ii) *When* $v_1 < v < \hat{v}$, *there are three equilibria, at* $e = 0$, $e_1 \in]0, \hat{e}[$ *and* $e_2 \in]\hat{e}, 1[$. *Of these,* 0 *and* e_2 *are stable and* e_1 *is unstable.*

(iii) *When* $v = \hat{v}$ *there are two equilibria, one at* $e = 0$ *which is stable and the other at* $e = \hat{e}$ *which is unstable.*

(iv) *When* $v > \hat{v}$ *there is only one stable equilibrium at* $e = 0$.

Proof: (iii) follows from lemma 3.3 and observation 3.4. *(i)* and *(iv)* are obvious. The proof of *(ii)* follows from the shape of G. Since $v < \hat{v}$, Z is greater than G at $\hat{e}$. Thus it must intersect G from below at $e_1 < \hat{e}$ causing an unstable equilibrium. To the right of $\hat{e}$, Z intersects G at $e_2 \in]\hat{e}, 1[$ causing a stable equilibrium at $e_2 < 1$. G becomes progressively steeper as e increases beyond e_2, so Z remains below G. ■

When $v = 0$, there is the stable equilibrium at $e = 0$. Z intersects G from below at e_1 which is an unstable equilibrium. A slight displacement from e_1 to the left will send the proportion of corrupt agents cascading down to zero, a slight displacement to the right will send that proportion to unity. To the right of e_1, Z remains above G, and forms another stable equilibrium at $e = 1$.

As v increases from zero, the line Z pivots downwards, remaining rooted at the origin. Thus e_1 moves to the right. The point at which Z intersects the vertical at $e = 1$ moves down until it reaches c_1 when $v = v_1$. For higher values of v, Z cuts G from above at $e_2 < 1$, which forms a stable equilibrium (see the line $Z(., v')$ in figure 2). For such values of v, the economy will gravitate to an equilibrium at 0 if the starting point is at some $e \in [0, e_1[$, and to e_2 starting from any $e \in]e_1, 1]$.

As v increases further, e_1 and e_2 move closer to each other, and coincide at $\hat{e}$ when $v = \hat{v}$. The equilibrium at $\hat{e}$ is stable for deviations to the right, but unstable for deviations to the left.

Once the level of vigilance exceeds $\hat{v}$, there is only one equilibrium at $e = 0$, and this equilibrium is stable.

4 Policy Considerations

When the extent of vigilance is low, then, the economy may find itself in a stable equilibrium with a high degree of corruption, or at equilibrium with no corruption. The latter is not a problem and calls for no solution, but in the former case the government may want to take action. In this section we concern ourselves with the costs and benefits of changes in vigilance, and the process by which such changes affect the level of corruption.

4.1 Returns to increasing vigilance

We know from proposition 3.5 that high and stable levels of corruption can only occur when the level of vigilance is less than $\hat{v}$. For $v \in [0, v_1]$ the equilibrium is at $e = 1$, and the level of corruption is not sensitive to small changes in v. For $v > \hat{v}$, the only equilibrium is at $e = 0$. For levels of vigilance between v_1 and $\hat{v}$, there is a stable equilibrium at $e_2 < 1$. A small increase in v causes Z to rotate down and e_2 to move to the left.

For interior equilibria, the equilibrium value of e is implicitly defined by equality between the costs $G(e)$ and benefits $Z(e, v)$ of corruption. Using (3), this can be written as

$$G(e) = ke[\phi - p(v)\beta] \tag{7}$$

Note that this is satisfied at two values of e, e_1 and e_2. The rate at which e changes with v is found by implicitly differentiating the equilibrium condition (7). Rearranging and substituting from (7) we obtain

$$\frac{de}{dv} = -\frac{\beta k e^2 p'(v)}{eG'(e) - G(e)} \tag{8}$$

β, k and p' are positive, so the sign of the derivative depends on the sign of $eG'(e) - G(e)$. A simple geometrical interpretation assures us that this is positive for e to the right of $\hat{e}$, and negative for e to the left of $\hat{e}$. Thus e_2, the stable equilibrium to the right of $\hat{e}$ moves to the left—i.e. corruption falls—as v increases.

When $v = \hat{v}$ the denominator of (8) vanishes. We know that the equilibrium e is discontinuous in v at this point, falling abruptly to zero.

When e agents are corrupt, the number of corrupt acts in the economy is ke^2, each of which generates a (negative) social surplus $(\phi - B)$. The rate at which social surplus increases when e falls is therefore given by

$$\frac{dS}{de} = 2ke(\phi - B) \tag{9}$$

As long as v remains less than $\hat{v}$, the rate at which social surplus increases with a marginal increase in vigilance can be obtained from (8) and (9). However, an increase in vigilance from less than $\hat{v}$ to a value greater than $\hat{v}$ causes corruption to fall discontinuously to zero, restoring the entire amount of social surplus that was previously lost owing to corruption.

Proposition 4.1 *Suppose the economy is at equilibrium with $v^* < \hat{v}$ and $e^* > \hat{e}$. Then a marginal increase in v will raise social surplus at the rate*

$$\frac{dS}{dv} = \begin{cases} 0 & if \quad v < v_1 \\ \dfrac{2\beta k^2 (e^*)^3 p'(v)(B-\phi)}{eG'(e) - G(e)} & if \quad v \in [v_1, \hat{v}[\end{cases} \tag{10}$$

However, if the increase in vigilance is large enough to raise v above v^*, then corruption falls to zero and social surplus increases by $(ke^*)^2[B - \phi]$.

The non-zero expression for $\frac{dS}{dv}$ in (10) is obtained from (8) and (9). The behaviour of $\frac{dS}{dv}$ is not immediately obvious. As v increases, $p'(v)$ in the numerator falls (see 2). But at the same time e decreases, so given the shape of $G(e)$, the denominator also falls. Since both numerator and denominator decline with an increase in v, it is not possible to predict the direction of change in the overall quantity without further assumptions. We do know, however, that as $v \to \hat{v}+$, $\frac{dS}{dv}$ increases without bound.

4.2 Local vs. global anti-corruption measures

If there is a high level of corruption in the economy, is it socially desirable for the government to reduce corruption by increasing vigilance? In light of proposition 4.1, the answer to this question may depend on the size of the proposed anti-corruption campaign. It is possible that a small increase in vigilance does not pay for itself in terms of increased social surplus, but a large onslaught on the problem yields more than proportionate benefits. This is a common property of coordination models.

For the purpose of this discussion, let us assume that, consequent on a change in vigilance, full adjustment to equilibrium occurs with a one-period lag.[5] Thus an increase in vigilance in this period is rewarded by a corresponding decline in corruption in the next period. The level of corruption in period $t + 1$, e_{t+1}, solves the equilibrium condition (7) with $v = v_t$.

Suppose that initially $v < \hat{v}$, and the economy is in stable equilibrium at a high level of corruption $e > \hat{e}$. Now consider two different policy proposals.

In the first proposal—which we will call the "small" proposal, the government increases vigilance marginally to $v^{'}$, where $v < v^{'} < \hat{v}$. In the second "big" proposal, vigilance is increased drastically to $v^{''} > \hat{v}$.

[5]The lag is introduced only to accomodate a discount factor. The dynamics of adjustment is discussed in more detail in section 4.3. Incorporating the full adjustment process here would complicate the analysis without qualitatively affecting the results.

If the small proposal is implemented, then the government incurs a cost of $\Delta v = v^{'} - v$ in the current period, and obtains an increase in social surplus of $\Delta S = \frac{2\beta k^2(e)^3 p'(v)(B-\phi)}{eG'(e)-G(e)}\Delta v$ in the next period. Thus the net gain is:

$$\Delta\pi^{\text{small}} = [\delta\frac{2\beta k^2(e)^3 p'(v)(B-\phi)}{eG'(e)-G(e)} - 1]\Delta v \tag{11}$$

This net gain may be positive or negative. Note that in this case the increase in surplus is obtained in subsequent periods only if vigilance is maintained at the elevated level.

If the large proposal is implemented, however, vigilance rises above $\hat{v}$ leading to a decrease in corruption to zero in the following period. Once this is attained, the level of corruption will remain at zero in subsequent periods even if vigilance is eliminated altogether, since $e = 0$ is a stable equilibrium for all values of v (proposition 3.1). Thus the net benefit from implementing the large proposal is

$$\Delta\pi^{\text{large}} = \frac{\delta}{1-\delta}k\hat{e^*}^2[B-\phi] - [v^{''} - v] \tag{12}$$

The following assertion is intuitive and easily validated by numerical simulations:

Observation 2 *There are large ranges of parameter values and initial conditions such that small porposals are not economically viable (i.e., yield negative net benefit), but large proposals are economically viable.*

Intuitively, with a large proposal the government spends a significant amount on vigilance for a short period, and then enjoys substantially lower corruption forever. With a small proposal, the reduced level of corruption endures only as long as vigilance remains high. Clearly the former is economically more beneficial when the planning horizon is long and the future is not heavily discounted.

4.3 Adjustment to equilibrium with change in vigilance

The process of adjustment to a new equilibrium after a change in vigilance in fact takes more than a single period. This section provides a brief exposition of the adjustment process.

In assumption 3 we have posited the adaptive expectation rule that agents in a given period expect the proportion of corrupt agents to be the same as the proportion they have witnessed in the previous period. They do, however, perceive the level of vigilance correctly, and hence calculate their expected gain based on these two variables:

$$\begin{aligned} \mathrm{E_t} Z_t &= k\mathrm{E_t} e_t[\phi - p(v_t)\beta] \;=\; k e_{t-1}[\phi - p(v_t)\beta] \\ &= Z(e_{t-1}, v_t) \end{aligned} \tag{13}$$

where subscripts indicate time-periods. Note that expectations are formed at the beginning of the period, before the values of the variables are realised. Actions for that period are taken based on these expectations, which then generate the realised values. The sequence of events within each period is as follows: the government announces a level of vigilance, individuals decide whether to pursue honest or corrupt transactions based on this level and on the previous period's corrupt proportion, and these decisions then determines the corrupt proportion in the present period.

Suppose that, in some initial period t, the economy is in a position of equilibrium with a high level of corruption $e_0 > \hat{e}$. Let the vigilance level at this equilibrium be v_0. In period $t+1$, the government increases the level of vigilance to a higher value v_1. Corruption will fall to a new lower equilibrium level e_1. However, this adjustment will occur in steps over a sequence of periods.

In period $t+1$, agents calculate the gain from corruption as $Z(e_0, v_1)$. Accordingly, the number of agents who decide to seek a corrupt partner is e_{t+1}, given by the solution to

$$G(e_{t+1}) \;=\; Z(e_0, v_1) \tag{14}$$

Since e_0 is the equilibrium corresponding to v_0, which is smaller than v_1, It follows that $e_{t+1} \;<\; e_0$. In successive periods, the levels of corruption e_{t+n} are given by the iterative formula:

$$G(e_{t+n}) \;=\; Z(e_{t+n-1}, v_1) \qquad\qquad n \geq 1 \tag{15}$$

Note that e_{t+n} is a decreasing sequence which converges to e_1, the equilibrium level corresponding to v_1. Convergence takes an infinite number of steps if e_1 is to the right of $\hat{e}$ (i.e. $v_1 < \hat{v}$), as is usual in equilibrium dynamics.

However, it is noteworthy that, if $e_1 = 0$ (i.e. $v_1 > \hat{v}$) full convergence occurs in a finite number of steps. Figure 3 illustrates the two processes. The reader can readily convince herself that, the larger is v_1, the smaller is the number of steps or periods it takes for corruption to fall to zero.

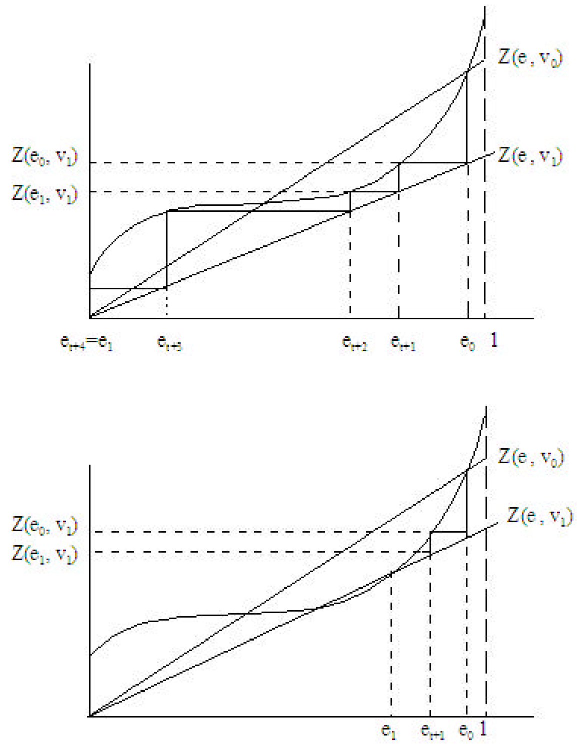

Figure 3: Adjustment to equilibrium

4.4 Dynamics and democracy

The preceding section emphasises that eliminating corruption may take some time. A government pursuing the goal of zero corruption may have to incur substantial costs of vigilance for a significant period of time before corruption actually declines, and the full benefits of the anti-corruption campaign become apparent.

In a democratic system with periodic elections, this may well be a certain way for the party in government to vote itself out of power. If the electorate is impatient and has less than full foresight, then the initial high cost of vigilance unaccompanied by the benefits of reduced corruption may turn the electorate against the incumbent, voting in an opposition party. If further the benefits of reduced corruption become apparent during the turn of the new government, it would serve to strengthen its hold on power.

Thus if the term of an elected government is not long enough for the benefits of reduced corruption to appear, then political expediency will dictate that the government does not mount a campaign to eliminate corruption, even though such a campaign is desirable from the perspective of the society.

5 Conclusion

In this paper we analysed corruption which requires collaboration between agents. In order to undertake a corrupt act, an agent must find a willing partner. This description includes some of the most common categories of corruption, such as obtaining an undeserved building permit by bribing an officer in the municipality, or obtaining information on tender bids made by rival firms by bribing the appropriate government official.

Undertaking search is costly for agents, and search is more likely to yield results when there are more agents in the economy who are willing to cooperate in corruption. Thus when many agents are corrupt, the expected benefit of corruption is high, and even agents with high costs of search find it profitable to search. Similarly, when few agents are corrupt the potential benefits low and even low cost agents find that search is not worthwhile. Thus the economy has multiple equilibria, some with high levels of corruption and some with low levels of corruption.

We have shown that, if a high-corruption equilibrium initially obtains in such an economy, then an effective policy consists of a very high intensity (and possibly high-cost) vigilance program. If such a program is pursued for a sufficient length of time, the economy will converge to the low-corruption equilibrium, where it will then stay even if the vigilance program is subsequently eliminated.

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