

Corruption And The Provision Of Public Output In A Hierarchical Asymmetric Information Relationship*

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Abstract

This paper develops a principal-agent model to explore the interaction of corruption, bribery, and political oversight of production. Under full information, an honest politician achieves the first best while a dishonest politician creates shortages and bribes. Under asymmetric information, an honest politician may create more shortages relative to a dishonest one, but the latter creates more bribes. The model identifies a tradeoff between bribery and efficiency. This helps to reconcile some conflicting results on the implications of corruption for the size of the public sector. It also provides new results on the circumstances under which an improvement in the auditing technology is beneficial. The paper identifies conditions under which corruption is welfare enhancing. However, the paper also shows that under precisely these conditions private provision, even by an unregulated monopolist, would be better than public provision.

Keywords: Corruption, Regulation, Expected information rent per unit of revenue, Tradeoff between efficiency and corruption.

JEL Classification: D82(Asymmetric and Private Information), D78 (Positive Analysis of Policy-Making and Implementation), L51 (Economics of Regulation)

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1. Introduction

Consider the following situation. A possibly corrupt politician regulates a monopolist¹ intermediary who provides some output or service to final consumers. The regulatory contract has the following features:

1. The politician chooses an official price which can be charged by the intermediary.
2. The contract specifies the volume of output to be sold by the intermediary.
3. The politician can freely audit the intermediary.

This regulatory framework characterizes at least two generic situations.

Example 1 : *The monopolist intermediary is an arm of the government, a public-agent, who supplies a ‘public output’ on behalf of the government. The public-agent could, for instance, be a civil servant or an executive branch of the government. There is no presumption that the output supplied by the public-agent has the nature of a public good.*

Example 2 : *The intermediary is a monopolist private firm that supplies some ‘private output’. In particular, the private firm is not an arm of the government.*

While the interpretations in Examples 1 and 2 are both plausible, the interpretation in Example 1 may be more natural for the following reason. Whilst regulatory conditions (1) and (2) above are often observed separately in the regulation of private firms, their simultaneous occurrence is less frequent. Furthermore, the government is constrained in several respects when it audits private firms, for instance, on account of various confidentiality clauses. On the other hand, as the notional owner on behalf of the citizens, it has much greater powers in auditing public-agents.

1.1. Scarcity rents and shortages

A corrupt monopolist agent is often cited as the reason for the existence of *scarcity rents* and *shortages* of output; for instance, Aidt (2003) and Bardhan (1997). Private individuals often require the consent of a monopolist agent to engage in some intermediate or final

¹Possible normative explanations for the conferment of such monopoly rights might include market failures, merit goods, national security, national goals, homogeneity of standards or feasibility, issues. For many public outputs such as passports, industrial licenses etc. there are strong grounds for giving control to a single provider; see Bardhan (1997). The positive explanations view the conferment of such legal rights as a device to generate political rents; for example Shleifer and Vishny (1992, 1993) and Coolidge and Rose-Ackerman (1997). The effect of competition on corruption is not considered here but see Rose-Ackerman (1999) and Laffont and Guessan (1999). There is a sense in which the competition results of Laffont and Guessan (1999) can be applied to this paper; see Section 4 below.

economic activity, the actual demand for which often exceeds its supply. The agent then charges a price in excess of the official price (scarcity rent per unit) to clear the market. Scarcity rents are extensively documented for a wide range of activities such as industrial licenses, export-import licenses, public housing, irrigation water, passports, driving licenses, public credit, exchange rates and old age pensions, in developed and developing countries².

There are two main explanations of shortages and scarcity rents. In queuing models, for example Lui (1985), waiting in a queue for an output is costly. The objective is to find the Nash equilibrium in bribing strategies for individuals who can pay bribes to jump the queue. However, the results are very sensitive to the different methods of organizing the queue and are not robust to plausible extensions; see for example Bardhan (1997).

In the other explanation, due to Shleifer and Vishny (1993), the government has *full information* on the cost/ demand conditions facing a monopolist agent who provides a *non-contractible* output. Hence, the agent sells the monopoly output and collects a scarcity rent equal to the monopoly profit. However, under full information, the monopoly profits are public information. A possibility, not explicitly considered by Shleifer and Vishny (1993), is that charging the public-agent a transfer/ franchise fee equal to the monopoly profit ensures the first best. Corruption would then be non-distortionary, a prediction rejected by the empirical evidence; for example Mauro (1995).

One of the aims of this paper is to provide an extension of the basic Shleifer-Vishny model that enables an equilibrium with shortages and scarcity rents to be supported.

1.2. Basic building blocks of the model

1.2.1. The agent is better informed about costs

The notion that the government has access to information on all relevant aspects of the operation of an agent is quite strong; see, for example, Acemoglu and Verdier (2000). Agents are likely to have superior information on, for instance, the physical and managerial technology used for producing the output or their competence in using it. Insofar as these factors impinge mainly on costs, we assume that the agent has private information on costs. The agent has two types, a low-cost type, c_L , and a high-cost type, c_H .

Costs can be interpreted either as *production* or *provision* costs. In some situations the agent engages directly in production. In other situations the agent engages in provision

²See Rose-Ackerman (1999: Chapter 2) and UNDP (1997) for examples from Russia/ E. Europe, United States, Hong-Kong, Philippines and Pakistan. Also see Bardhan (1984) for the much-maligned ‘License-Raj’ in India and Mbaku (2000) for a range of examples from the African continent, but especially Nigeria and Ghana. Levine and Satarov (2000) illustrate the experience of transition economies, especially Russia, with respect to scarcity rents. Other specific instances of this form of corruption can be found in Krueger (1974), Shleifer and Vishny (1992, 1993), Tanzi (1998) and Coolidge and Rose-Ackerman (1997).

of output. Provision costs can be high. For instance, in the provision of scarce housing, expensive ‘means testing’ is often carried out and the provision of industrial licenses is often accompanied by detailed feasibility studies and checking of compliance criteria.

Provision costs might be small relative to the costs of production which are sunk. Nevertheless, it is on the basis of the provision costs that the agent takes his decision. The marginal costs, not the fixed costs, condition the corruption decision of the agent. Hence, inefficiencies or distortions might arise on account of these ‘small’ costs of provision. Furthermore, our results do not crucially hinge on the magnitude of the costs c_L and c_H . The important condition is $c_H > c_L$.

Costs of provision among agents can differ for several reasons. The agent could be particularly inefficient in processing the available information. Or the agent might lack in experience and insist on undertaking detailed means testing, feasibility studies and checking in minute detail all compliance criteria so that the costs in terms of resources or time foregone are very high. Also, a particularly conscientious agent could have high costs for similar reasons. Since ‘competence’ and ‘conscience’ are deep personal characteristics, cost becomes private information for the agent.

1.2.2. Output is often observable and verifiable

Shleifer and Vishny (1993) assume that the government cannot contract on the quantity sold by the agent. However, the converse assumption is often more realistic. For many types of outputs supplied by agents, the transaction must be officially recorded to be of any use to the consumer. Thus, for instance, public housing is of limited use if it is not officially issued. The same also applies to a passport and several forms of industrial and export-import licenses. Once officially recorded, the output sold by the agent is fully observed by the government and can be contracted upon. Indeed, it is common practice for governments to set quantity targets for agents in both developed and developing countries³. On the other hand, although the government often mandates the price at which the agent is required to sell its output⁴, it typically does not observe the actual price charged by the agent when the latter is dishonest. Indeed, the evidence suggests that when output is scarce, agents often resort to scarcity rents in order to clear the market.

³Quantity targets can be explicit or implicit. In the latter case, fixing the budgetary allocation to an executive department implicitly defines the quantity that can be supplied.

⁴Governments routinely announce an official price (or require the agent to announce one) at which the public-agent’s output will be sold. Examples include an official price for passports/ permits/ licenses or an official interest rate for borrowing from public financial institutions etc.

1.2.3. Dynamic issues

Once the choice of contracts reveals the type of the agent, why does the politician not tear up the original contract and offer the full information contracts? There are two reasons why this does not happen. First, the ability of the government to commit not to renegotiate its contracts underpins a large literature that uses mechanism design in the presence of asymmetric information. We find this to be a fairly plausible restriction given issues of reputation etc. Second, renegotiation might actually not be possible in several kinds of static games when previous events are irreversible; see for instance Laffont and Tirole (1993). While dynamic issues and the associated problems arising from renegotiation of contracts are not discussed further in this paper, an earlier version of this paper (Dhami and al-Nowaihi (2005), section 5) explicitly models these issues.

1.3. Other features of the model

The politician reimburses the agent's cost using non-distortionary taxation, instructs the latter to sell at some official price and contracts on its output. The agent can engage in bribery by selling at a price above the official price⁵. An exogenously given auditing technology allows the politician to discover hard evidence of such bribery with some probability $\rho > 0$. However, in return for a share in the bribe, certain kinds of politicians, the *venal* ones, are willing to hide evidence of the bribe. *Decent* politicians, on the other hand, eschew such corrupt side transactions. The 'degree of venality' of the politician is a parameter of her preferences. We solve for the equilibrium and analyze the comparative static properties of contracted output and bribes under these conditions.

1.4. Results

Under full information, shortages and corruption occur only if the politician is venal. Decent politicians, by virtue of their ability to contract on output, produce the first best outcome. This is in contrast to Shleifer and Vishny (1993) where bribery can occur even when the politician is decent because the latter cannot contract on output. Furthermore, under full information, the contracted output always exceeds that produced by a private unregulated monopolist.

Under asymmetric information, each type of politician creates shortages in order to limit information rents. Whilst limiting information rents is the sole aim of a decent politician, a venal politician creates further distortions in contracted output because of

⁵The politician is able to contract on the official price, but not the unofficial price. The latter might be considered a form of contractual incompleteness in the model. However, "incomplete contracts" are usually discussed in the context of legal activity. Of course, illegal or illicit activity could also be considered a form of contractual incompleteness. But we think it is useful, and in line with standard practice, to distinguish between legal but incomplete contracting on the one hand and illicit activity on the other.

his interest in collecting bribes. This feature of the model helps to reconcile apparently conflicting results on the effects of corruption on the size of the public sector.

An improvement in the auditing technology lowers the *private marginal cost of a unit of bribes* to the dishonest politician and increases her bargaining power. The dishonest politician then distorts output in the direction of increasing bribes. The distortion of output can be efficiency enhancing or efficiency reducing. The direction of distortions depends on the relation of the contracted output to that produced by a private unregulated monopolist. Because the direction of these distortions depends on the parameters, the asymmetric information case gives surprising new insights relative to the full information case. For example, if contracted output is below that of an unregulated private monopolist, then corruption is welfare enhancing. However, in that case, private provision, even by an unregulated monopolist would be even better.

2. The Model

An upper-tier of the government, referred to by the generic term *politician*, contracts a monopolist agent or lower-tier of the government, referred to by the generic name *agent*, to supply some good or service, on its behalf, to final consumers. Let q be the quantity of the output or service and p its price. The agent faces a publicly known invertible demand curve. Both the demand curve, $q(p)$, and the inverse demand curve, $p(q)$, are (1-1) mappings of $(0, \infty)$ onto $(0, \infty)$ and each is twice continuously differentiable. Let $\epsilon = -\frac{p}{q} \frac{dq}{dp}$ be the price elasticity of demand. We make the following standard assumptions:

$$p' < 0, 2p' + qp'' < 0, \lim_{q \rightarrow 0} p = \infty, \lim_{q \rightarrow \infty} p = 0, \lim_{q \rightarrow 0} \epsilon > 1. \quad (2.1)$$

These assumptions are sufficient to guarantee that each optimization problem considered in this paper has a unique solution and is an interior point. They are satisfied by, for example, the constant elasticity demand curve $q(p) = p^{-\epsilon}$, $\epsilon > 1$.

The cost curve of the agent is given by $C(q) = cq$, where c is the constant marginal cost. The marginal cost c is privately known to the agent and is referred to as her ‘type’. The type space is given by the discrete set $\Theta = \{c_H, c_L\}$ where subscripts ‘ H ’ and ‘ L ’ have the connotation of ‘high’ and ‘low’ cost, respectively, and $0 < c_L < c_H$. We shall denote the cost difference by $\Delta c = c_H - c_L$. The prior belief that the type is efficient, i.e. $c = c_L$, is given by the probability $\nu \in (0, 1)$.

All players, the consumers, politician and the agent, are risk neutral.

Define the first best output, q_i^{FB} , by

$$p(q_i^{FB}) = c_i; \quad i = L, H. \quad (2.2)$$

From the assumptions made so far, it follows that q_i^{FB} exists, is positive and is unique.

The profit of a private unregulated monopoly with cost $c_i, i = L, H$, is given by

$$\Pi_i(q) = q[p(q) - c_i], q > 0 \text{ and } \Pi_i(0) = 0. \quad (2.3)$$

Proposition 1 : *The private monopoly's profit $\Pi_i(q)$ satisfies $\Pi_i'(q) < 0$ and attains a maximum value at some $q = q_i^M$. This q_i^M is unique and satisfies: $0 < q_i^M < q_i^{FB}, \Pi_i(q_i^M) > 0, \Pi_i'(q_i^M) = 0$. $\Pi_i(q)$ is strictly increasing for $q < q_i^M$ and strictly decreasing for $q > q_i^M$.*

Proof. By (2.1), $\lim_{q \rightarrow 0} p = \infty$. Hence, from (2.3), $\Pi_i(q) > 0$ for all sufficiently small $q > 0$. Also from (2.3), $\Pi_i'(q) = \frac{\epsilon-1}{\epsilon}p(q) - c_i$. By (2.1), $\lim_{q \rightarrow 0} \epsilon > 1$. Hence $\Pi_i'(q) > 0$ for all sufficiently small $q > 0$. It follows that $\Pi_i(q) > 0$ and $\Pi_i'(q) > 0$ on $(0, \underline{q}_i]$ for some $\underline{q}_i > 0$. Since also $\Pi_i(0) = 0$, it follows that $\Pi_i(\underline{q}_i) > \Pi_i(q) \geq 0$ on $[0, \underline{q}_i]$. By (2.1), $\lim_{q \rightarrow \infty} p = 0$. Hence, from (2.3), $\Pi_i(q) < 0$ on $[\bar{q}_i, \infty)$ for some $\bar{q}_i > \underline{q}_i$. Since Π_i is continuous on the compact non-empty interval $[\underline{q}_i, \bar{q}_i]$, it must attain a maximum, q_i^M , on $[\underline{q}_i, \bar{q}_i]$. From the way we constructed $[\underline{q}_i, \bar{q}_i]$, it follows that q_i^M is a global maximum. Since $0 < \underline{q}_i \leq q_i^M$, it follows that $\Pi_i'(q_i^M) = 0$. From $2p' + qp'' < 0$ it follows that $\Pi_i'' < 0$. Hence, q_i^M is unique and $\Pi_i'(q) > 0$ for $0 < q < q_i^M$ and $\Pi_i'(q) < 0$ for $q > q_i^M$. Hence, since $\Pi_i'(q_i^{FB}) = q_i^{FB}p'(q_i^{FB}) < 0$, it follows that $q_i^M < q_i^{FB}$. QED.

2.1. Bribes

The politician levies non-distortionary taxes⁶ on the consumers to finance the payment of a lump sum transfer 't' and the cost of provision $C(q)$ to the agent. The politician announces the type contingent contracts $\mathbf{L} = (t_L, q_L, c_L)$, $\mathbf{H} = (t_H, q_H, c_H)$, for the low-cost and the high-cost types of the agent, respectively. Each of these contracts specifies a triple: a transfer t_i , a quantity q_i and an official per unit price $c_i; i = H, L$. Shleifer and Vishny (1993) also set the official price equal to c_i .

Whilst we assume that the official price is identical to the exogenous marginal cost c_i , we could have worked with a more complex model, where the official prices are set at some endogenous level $c_i^o \geq c_i$. We now show that our assumption is without loss of generality. The results for the model, where $c_i^o \geq c_i$, are as follows. For the regime of a 'decent' politician (one who does not accept bribes, see Definition 1, below) outputs and payoffs are unaffected⁷. On the other hand, a 'venal' politician (one who accepts bribes)

⁶Distorting taxes do not essentially change our results. This is discussed in an earlier version of this paper: Dharami and al-Nowaihi (2005, pp20-21).

⁷For example, under full information a decent politician will contract first best outputs q_i^{FB} , that satisfy $p(q_i^{FB}) = c_i$ (Proposition 5, below). If the contract specifies official prices $c_i^o > c_i$ then, to deliver the contracted outputs q_i^{FB} , the agent will have to charge the market prices, $c_i < c_i^o$, that would clear the market i.e., the agent would have to 'bribe' the consumer to take the good. Transfers, t_i , would then have to be adjusted to satisfy the individual rationality constraints. Outputs and payoffs would not be affected. But, clearly, a much simpler system would be to specify the official prices $c_i^o = c_i$.

will choose $c_i^o = c_i$. The intuition for this is that a venal politician has the incentive to create shortages to force the market price above the official price and extract the difference as a bribe. Hence, a venal politician would choose the lowest feasible official price, $c_i^o = c_i$. Thus, we have decided to set $c_i^o = c_i$ at the outset and achieve a considerable simplification of the model.

If a type c_j agent ($j = i$ or $j \neq i$) accepts the contract (t_i, q_i, c_i) , its bribe is

$$B_i(q_i) = q_i [p(q_i) - c_i], 0 < q_i < q_i^{FB} \text{ and } B_i(q_i) = 0 \text{ if } q_i = 0 \text{ or } q_i \geq q_i^{FB}; \quad i = H, L. \quad (2.4)$$

Note that the bribe received by type c_j depends on the contracted output, q_i , the consumer's willingness to pay, $p(q_i)$, and the official price, c_i . In particular, the bribe does not depend on the unit cost, c_j , of agent j . Sometimes we will simply use the abbreviated notation B_i for $B_i(q_i)$. Figure 2.1 shows a situation in which the low-cost type, type c_L , accepts the contract designed for type c_H .

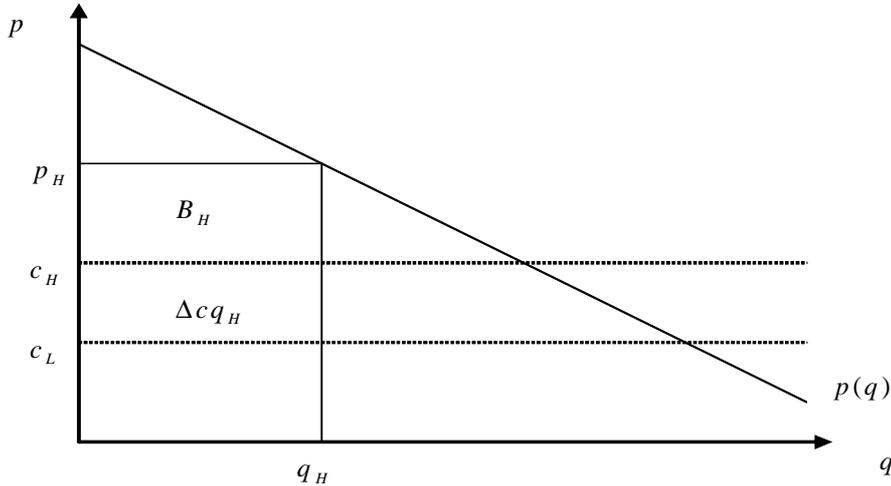


Figure 2.1: Bribes And Cheating On Costs

The low-cost type is then faced with an official price per unit, c_H , but the consumers' willingness to pay per unit is $p_H = p(q_H)$ and so type c_L receives a bribe $B_H = q_H(p_H - c_H)$ (which is independent of c_L). Furthermore, by misstating costs, type c_L derives an extra payoff equal to $\Delta c q_H$, where $\Delta c = c_H - c_L$, because her per unit costs are c_L but she is reimbursed at the rate of c_H per unit by the politician.

Also note that bribes, under contract (t_i, q_i, c_i) , are positive if, and only if, contracted output, q_i , is below the first best, so that $p(q_i) > c_i$. Hence, a dishonest politician has an incentive to generate shortages to create the scope for bribes.

The proof of Proposition 2, below, is similar to that of Proposition 1, above.

Proposition 2 : *The bribe function $B_i(q)$ satisfies $B_i''(q) < 0$ and attains a maximum value at some $q = q_i^M$. This q_i^M is unique and satisfies: $q_i^M > 0$, $B_i(q_i^M) > 0$, $B_i'(q_i^M) = 0$. $B_i(q)$ is strictly increasing for $q < q_i^M$ and strictly decreasing for $q > q_i^M$. Comparing (2.3) and (2.4), we see that this q_i^M is the same as the q_i^M of Proposition 1.*

2.2. Sequence of moves

The sequence of moves is as follows.

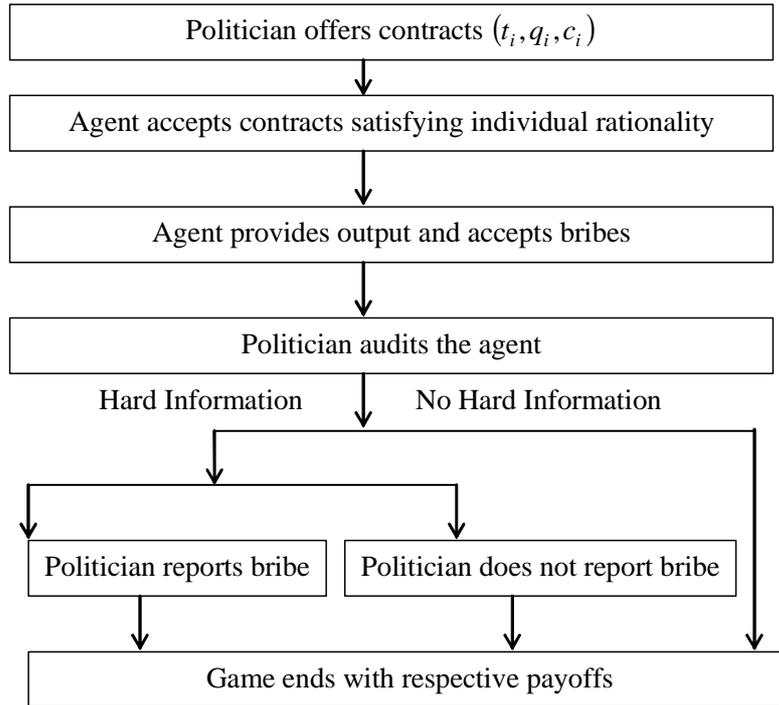


Figure 2.2: Sequence of Moves

The politician announces the type contingent contracts $\mathbf{L} = (t_L, q_L, c_L)$, $\mathbf{H} = (t_H, q_H, c_H)$. The agent accepts or rejects the contracts. If a contract is accepted, the agent decides whether to receive bribes from consumers. Then the politician discovers hard evidence of bribes with probability $\rho \in (0, 1)$. With probability $1 - \rho$, the agent gets to keep the bribe. There are no penalties over and above the confiscation of the bribe. Such penalties do not qualitatively alter the results as long as they are not prohibitive in the sense that they completely eliminate the incentive for bribery. This conforms to the experience in many countries, notably several developing countries; for instance Rose-Ackerman (1999).

If hard evidence is discovered, then the politician might (depending on the degree of venality) offer to suppress the evidence if the agent agrees to share the bribe. We assume that such sharing uses the Nash Bargaining solution. If the agent refuses to share the bribe, then the bribe is confiscated and returned back to consumers. If the agent agrees to share the bribe then the game ends with the division of the bribe and no bribes are returned back to consumers.

2.3. Audits and information revelation

In our model, a successful audit merely reveals that a bribe has been paid (and its magnitude). In particular, even a successful audit does not reveal any new information about the cost parameter c_i . From (2.4) it is immediately apparent that bribes only depend on the type of the contract accepted by the agent and not on the agent's type. We explain this more fully below.

In a fully separating equilibrium, type i (with marginal cost c_i) chooses contract (t_i, q_i, c_i) and, hence, obviously, reveals the type through her choice of contract.

At the other extreme, in a fully pooling equilibrium where, say, both types c_L and c_H choose contract **H**, auditing does not reveal any information about costs. The audit merely reveals, with probability ρ , that a bribe $q_H [p(q_H) - c_H]$ has been paid. This gives no new information about the true value of c_i .

In a hybrid equilibrium where, say, type c_H chooses contract **H** with certainty and type c_L chooses **L** with probability $\pi > 0$, the politician updates her belief, $\text{Prob}(c = c_L)$, from ν_1 to ν_2 using Bayes' law. If contract **L** is chosen, then $\nu_2 = 1$. A successful audit will reveal the bribe $q_L [p(q_L) - c_L]$ indicating that $c = c_L$. But this is already known from the fact that the agent has accepted the contract **L**. On the other hand, if contract **H** is accepted, then $\nu_2 = \frac{(1-\pi)\nu_1}{(1-\pi)\nu_1 + 1 - \nu_1}$. A successful audit would reveal a bribe of $q_H [p(q_H) - c_H]$ confirming that $\nu_2 = \frac{(1-\pi)\nu_1}{(1-\pi)\nu_1 + 1 - \nu_1}$, but adding no new information.

In an extended model we could allow 'cost auditing' as well as 'honesty auditing'. But this lies beyond the scope of this paper.

2.4. Preferences of consumers

The expected utility of a representative consumer is defined as

$$EU(t_i, q_i, c_i) = S(q_i) - (t_i + c_i q_i) - B_i + EB_i^C ; i = H, L, \quad (2.5)$$

where $S(q_i)$ is the 'gross consumer surplus' given by

$$S(q_i) = \int_0^{q_i} p(q) dq. \quad (2.6)$$

Consumers pay taxes of an amount $t_i + c_i q_i$ to finance the operation of the agent and bribes equal to B_i to gain access to the (possibly scarce) output. In the event that hard evidence of bribes is discovered by the politician *and* if the bribe is confiscated (which is an endogenous decision), it is returned back to consumers as a lump sum transfer. EB_i^C is the expected receipt of such bribes by the consumers from the politician when an agent chooses contract (t_i, q_i, c_i) .

2.5. Preferences of the agent

The expected utility of the agent of type c_j who accepts the contract (t_i, q_i, c_i) , $j, i = H, L$ is defined as

$$EV_j(t_i, q_i, c_i) = t_i + EB_i^A + (c_i - c_j) q_i; \quad j = i \text{ or } j \neq i, \quad (2.7)$$

where t_i is the transfer received from the politician, EB_i^A is the expected bribe received by the agent and the term $(c_i - c_j) q_i$ arises because a type j has unit cost c_j but is reimbursed c_i by accepting the contract (t_i, q_i, c_i) (see Figure 2.1). The agent's reservation utility is normalized to zero.

2.6. Preferences of the politician

The objective function of the politician is given by

$$EW(t_i, q_i, c_i) = EU(t_i, q_i, c_i) + \mu EB_i^P, \quad (2.8)$$

where U is the utility of consumers (a measure of social welfare) and EB_i^P is the expected bribe received by the politician from the agent when the latter chooses contract (t_i, q_i, c_i) . The parameter $\mu \in [0, \infty)$ is the weight placed by the politician on personal gratification relative to social welfare; it reflects the “degree of the politician's venality”. From (2.5), (2.6) and (2.8) we get

$$EW(t_i, q_i, c_i) = \int_0^{q_i} p(q) dq - (t_i + c_i q_i) - B_i + EB_i^C + \mu EB_i^P; \quad i = H, L. \quad (2.9)$$

Definition 1 : A “venal” politician cares relatively more for personal benefits i.e. $\mu > 1$ while a “decent” politician cares relatively more for social welfare i.e. $\mu \leq 1$. The “degree of venality” is given by the size of μ . We shall use the superscript $j = D, V$ to index the type of the politician: D for decent ($\mu \leq 1$) and V for venal ($\mu > 1$).

Note that a “decent” politician does not have to be absolutely honest ($\mu = 0$); see Proposition 3, below. Also note that if $\mu = 1$ then the politician is indifferent between keeping a bribe or returning it to consumers. For simplicity, we shall assume that such a politician returns the bribe to consumers.

2.7. Two measures of social welfare

For our model *total surplus*, TS , is given by

$$TS(t_i, q_i, c_i) = \int_0^{q_i} p(q) dq - c_i q_i; \quad i = H, L, \quad (2.10)$$

while *consumer surplus*, CS , is given by

$$CS(t_i, q_i, c_i) = \int_0^{q_i} p(q) dq - (t_i + c_i q_i) - B_i + EB_i^C; \quad i = H, L. \quad (2.11)$$

Total surplus consists of consumer surplus, profits and bribes. We are reluctant to count the (direct) proceeds of corruption as additions to social welfare. Furthermore, one of the results of this paper is that, under some circumstances, a degree of corruption can be welfare enhancing. We wish to ensure that this result is not merely a consequence of counting bribes as part of social welfare. Hence, consumer surplus appears to be the more correct measure of social welfare here. However, by Proposition 14, below, an output change towards the first best results in an increase in *both* consumer surplus and total surplus. Hence the two measures turn out to be equivalent to each other and equivalent to a movement in output towards the first best. The reason is that consumers ultimately pay (or receive) the transfers necessary to insure that the conditions of individual rationality and incentive compatibility hold for producers.

2.8. The Nash bargaining solution

Suppose that the politician discovers hard evidence of bribes after the agent chooses contract (t_i, q_i, c_i) . Let $x \in [0, B_i]$ be the politician's share of the bribe. If the politician and the agent reach an agreement on sharing the bribe, their respective payoffs are

$$W = S(q_i) - (t_i + c_i q_i) - B_i + \mu x,$$

$$V_j = t_i + B_i - x + (c_i - c_j) q_i; \quad j = i \text{ or } j \neq i.$$

However, should the politician and the agent not be able to reach an agreement, their respective disagreement payoffs, d^P and d^A , are

$$\begin{aligned} d^P &= S(q_i) - (t_i + c_i q_i), \\ d_j^A &= t_i + (c_i - c_j) q_i. \end{aligned}$$

The net surplus from this relationship equals $(W - d^P) + (V_j - d_j^A) = x_i (\mu - 1)$, which is positive only when the politician is venal i.e. $\mu > 1$. The Nash Bargaining solution, x_i , is found by maximizing the product $(W - d^P) (V_j - d_j^A)$, hence

$$x_i \in \arg \max (\mu x - B_i)(B_i - x).$$

It is straightforward to check that the solution, x_i , is given by

$$x_i = \frac{1 + \mu}{2\mu} B_i \equiv B_i^P, \quad (2.12)$$

and the agent's share $B_i - x_i$ equals

$$B_i - x_i = \frac{\mu - 1}{2\mu} B_i \equiv B_i^A. \quad (2.13)$$

Proposition 3 : *In the event that hard evidence of bribes is found, a decent politician ($\mu \leq 1$) returns all bribes to the consumers, so $EB_i^C = \rho B_i$, $EB_i^P = 0$. A venal politician ($\mu > 1$) conceals the evidence for a share in the bribe, so $EB_i^C = 0$, $EB_i^P = \rho \frac{1+\mu}{2\mu} B_i$. Furthermore, the politician's expected share of the bribe is decreasing in the degree of venality, μ , with $EB_i^P \rightarrow \rho B_i$ as $\mu \rightarrow 1+$ and $EB_i^P \rightarrow \rho B_i/2$ as $\mu \rightarrow \infty$.*

In Proposition 3 the decent politician's decision to eschew a corrupt deal with the agent is an endogenous one. It is harder to bribe a less venal politician, hence, the politician's share of bribes is decreasing in the degree of venality μ , for $\mu > 1$. Note the discontinuity at $\mu = 1$: $\lim_{\mu \rightarrow 1+} B_i^P = B_i$ but, for $\mu \leq 1$, $B_i^P = 0$.

2.9. The agent's bribery decision

When the politician is decent ($\mu \leq 1$), she confiscates the agent's bribe. In this case the agent's expected bribe, EB_i^A , is $\rho(0) + (1 - \rho) B_i$. Hence,

$$EB_i^A = (1 - \rho) B_i. \quad (2.14)$$

When the politician is venal ($\mu > 1$), given (2.13), the expected bribe of an agent who accepts the contract (t_i, q_i, c_i) is $EB_i^A = \frac{\mu-1}{2\mu} \rho B_i + (1 - \rho) B_i$. Hence

$$EB_i^A = \left(1 - \rho \frac{1 + \mu}{2\mu}\right) B_i. \quad (2.15)$$

From (2.14) and (2.15), we get

Proposition 4 : *When the politician is decent ($\mu \leq 1$), the agent's expected bribe, when she accepts the contract (t_i, q_i, c_i) , is $EB_i^A = (1 - \rho) B_i$. When the politician is venal ($\mu > 1$), $EB_i^A = \left(1 - \rho \frac{1+\mu}{2\mu}\right) B_i$.*

Using (2.4) and Proposition 4, if $p(q_i) \geq c_i$ holds in equilibrium (we show this to be the case below), we get that $EB_i^A \geq 0$. Hence, in the absence of any additional penalties above the confiscation of the bribe, the agent always accepts bribes⁸.

3. The Full Information Equilibrium

Under full information, the agent cannot misrepresent her type. Denote the equilibrium contract for an agent of type c_i under full information by $(t_i^{j*}, q_i^{j*}, c_i)$, where the superscript $j = D, V$ indexes the type of the politician: decent ($\mu \leq 1$) and venal ($\mu > 1$) respectively. Subscript $i = H, L$ refers to the agent's type.

3.1. The problem facing the politician

From (2.9), given c_i , the problem facing a politician of type j is to find t_i^{j*}, q_i^{j*} , so as to maximize

$$EW^j(t_i, q_i, c_i) = \int_0^{q_i} p(q) dq - (t_i + c_i q_i) - B_i + EB_i^C + \mu EB_i^P, \quad (3.1)$$

subject to :

$$EV_i = t_i + EB_i^A \geq 0 \quad (\text{Individual Rationality Constraint}),$$

$$p(q_i) \geq c_i \quad (\text{Feasibility Constraint}).$$

The feasibility constraint ensures that the agent does not make any losses. It is omitted for the time being but the solution is subsequently checked against it. The individual rationality constraint, which ensures that the agent receives at least the reservation utility, binds under full information because rents to the agent must be given by sacrificing valuable consumer welfare. Hence,

$$t_i = -EB_i^A. \quad (3.2)$$

Notice that the term $(c_i - c_j) q_i$ does not appear in the individual rationality constraint because types cannot be misrepresented under full information.

⁸If fines are high enough then the decent (and perhaps some forms of venal politicians) can also stamp out corruption. We are sceptical about raising fines for corruption to an appreciable degree, for the following reasons. First, it is a legal requirement that comparable offences for fraud be punished in a comparable manner. Indeed, for comparable cases of fraud, for instance, tax evasion, the fine is only about 0.5 of the evaded tax payment. Second, high fines might make legal mistakes unacceptably expensive. Third, high fines are more difficult to collect and involve complex complementary legal positions on bankruptcy law. Fourth, if the politician is venal then high fines will raise his bargaining power. Hence, we are reluctant to push the case for high fines.

3.2. Decent politician ($\mu \leq 1$)

From Proposition 3 $EB_i^C = \rho B_i$, $EB_i^P = 0$. From Proposition 4 and (3.2) we get $t_i = -(1 - \rho) B_i$. Substituting in (3.1) we get that the politician's problem in subsection 3.1 reduces to the following unconstrained problem

$$q_i^{D*} \in \arg \max EW_i^D(q_i) = \int_0^{q_i} p(q) dq - c_i q_i.$$

It follows from (2.1) that this problem has a unique solution, q_i^{D*} , $q_i^{D*} > 0$, and is given by

$$p(q_i^{D*}) = c_i. \quad (3.3)$$

It is obvious that the solution is first best, $q_i^{D*} = q_i^{FB}$, and the feasibility constraint is satisfied. From (2.4) we see that bribes are zero. The intuition is that under full information, a decent politician will contract the market clearing output, leaving no room for bribes. This contrasts with Shleifer and Vishny (1993) where bribery can occur even when the politician is decent, because output is not contractible. This result is recorded in Proposition 5.

Proposition 5 : *Under full information and a decent politician, the outcome is first best with no bribes. The corruptibility of the agent is irrelevant.*

3.3. Venal politician ($\mu > 1$)

From Proposition 3, $EB_i^C = 0$, $EB_i^P = \rho \frac{1+\mu}{2\mu} B_i$. From Proposition 4 and (3.2), $t_i = -EB_i^A = -\left(1 - \rho \frac{1+\mu}{2\mu}\right) B_i$. Substituting in (3.1) we get that the politician's problem in section 3.1 can be written as the following unconstrained problem:

$$q_i^{V*} \in \arg \max EW_i^V(q_i) = \int_0^{q_i} p(q) dq - c_i q_i + \xi B_i(q_i), \quad (3.4)$$

where

$$\xi = \rho \frac{\mu^2 - 1}{2\mu} > 0. \quad (3.5)$$

The first order condition to this problem leads to

$$p(q_i^{V*}) = c_i - \xi B_i'(q_i^{V*}). \quad (3.6)$$

The second order condition is

$$p'(q) + \xi B_i''(q) < 0,$$

which is satisfied everywhere since $p'(q) < 0$, $B_i''(q) < 0$, $\xi > 0$ (from (2.1), Proposition 2 and (3.5), respectively). Using (2.4), (3.6) becomes

$$p_i^{V^*} = p(q_i^{V^*}) = c_i - \frac{\xi}{1+\xi} q_i^{V^*} p'(q_i^{V^*}) ; i = H, L. \quad (3.7)$$

It follows that $p(q_i^{V^*}) > c_i$ and, hence, $q_i^{V^*} < q_i^{FB}$. From (3.6), $B_i'(q_i^{V^*}) = -[p(q_i^{V^*}) - c_i]/\xi$. Hence, $B_i'(q_i^{V^*}) < 0$. From Proposition 2, it follows that $q_i^{V^*} > q_i^M$. Thus, $q_i^M < q_i^{V^*} < q_i^{FB}$, $i = H, L$. Differentiating (3.6) implicitly with respect to ρ and μ give

$$\frac{\partial q_i^{V^*}}{\partial \rho} = -\frac{B_i'(q_i^{V^*}) \frac{\partial \xi}{\partial \rho}}{p'(q_i^{V^*}) + \xi B_i''(q_i^{V^*})} < 0, \quad \frac{\partial q_i^{V^*}}{\partial \mu} = -\frac{B_i'(q_i^{V^*}) \frac{\partial \xi}{\partial \mu}}{p'(q_i^{V^*}) + \xi B_i''(q_i^{V^*})} < 0.$$

These results are summarized by the following proposition.

Proposition 6 : *Under full information and a venal politician, the contracted output is intermediate between the monopoly level and the first best, i.e., $q_i^M < q_i^{V^*} < q_i^{FB}$ $i = H, L$. There are positive bribes in equilibrium, $B_i(q_i^{V^*}) > 0$. The contracted output is decreasing and bribes are increasing in: (1) the politician's degree of venality, μ , and (2) the efficiency of the monitoring technology, ρ .*

Proposition 6 shows that corruption takes the form of shortages of public output relative to the first best, however, the contracted output exceeds that produced by a private unregulated monopolist. Some well known examples of shortage environments include the former Soviet Union (Shleifer and Vishny (1992)), the recent experience of transition economies (Levine and Satarov (2000), UNDP (1997)), and the ‘License Raj’ in India (Bardhan (1984)).

More venal politicians (higher μ) contract lower output. Hence, shortages worsen under their regime. This result can change under asymmetric information, as will be shown in section 4 below. A more efficient auditing technology (higher ρ) increases shortages and bribes.

Under full information, transfers are negative in the regime of a venal politician, $t_i < 0$. This could take the form of sale of public offices, for instance ‘tax farming’. Competition for government jobs by paying up-front bribes (negative transfers) is pervasive in several countries; see for instance Krueger (1974) and Shleifer and Vishny (1993).

4. Equilibrium Under Asymmetric Information

The full information allocation is not incentive compatible under asymmetric information. To see this, recall that, from (2.7) and (3.2), an agent's expected utility is $EV_j(t_i, q_i, c_i) =$

$(c_i - c_j) q_i$. The low-cost type's expected payoff from accepting her full information contract is thus $EV_L(\mathbf{L}) = 0$. On the other hand, by accepting the high-cost type's full information contract, the low-cost type's expected payoff is $EV_L(\mathbf{H}) = (c_H - c_L) q_H > 0$. Hence, the low-cost type has an incentive to misrepresent her type under asymmetric information.

4.1. The problem facing the politician

The politician chooses type contingent contracts to maximize his expected utility (recall, ν is the probability that $c = c_L$):

$$EW = \nu EW(\mathbf{L}) + (1 - \nu) EW(\mathbf{H}), \quad (4.1)$$

subject to the following four constraints

$$EV_H(\mathbf{H}) \geq 0, \text{ i.e., } t_H + EB_H^A \geq 0, \quad (IR_H)$$

$$EV_L(\mathbf{L}) \geq 0, \text{ i.e., } t_L + EB_L^A \geq 0, \quad (IR_L)$$

$$EV_H(\mathbf{H}) \geq EV_H(\mathbf{L}), \text{ i.e., } t_H + EB_H^A \geq t_L + EB_L^A - \Delta c q_L, \quad (IC_H)$$

$$EV_L(\mathbf{L}) \geq EV_L(\mathbf{H}), \text{ i.e., } t_L + EB_L^A \geq t_H + EB_H^A + \Delta c q_H, \quad (IC_L)$$

where $EW(t_i, q_i, c_i)$ is defined in (2.9), $EV_j(t_i, q_i, c_i)$ is defined in (2.7), $\mathbf{L} = (t_L, q_L, c_L)$, $\mathbf{H} = (t_H, q_H, c_H)$ and $\Delta c = c_H - c_L$. The 'individual rationality' constraints IR_H and IR_L ensure that each of the types gets at least its reservation utility, while the 'incentive compatibility constraints' IC_H and IC_L ensure that none of the types chooses the contract intended for the other type. The solution to this problem is well known⁹. Essentially, IC_L and IR_H bind and their satisfaction ensures satisfaction of IR_L . From the binding IR_H constraint, one obtains

$$t_H = -EB_H^A. \quad (4.2)$$

Substituting t_H into the binding IC_L constraint, the latter can be rewritten as

$$t_L = -EB_L^A + q_H \Delta c. \quad (4.3)$$

Definition 2 : *The information rent of the low-cost agent (type c_L) equals $q_H \Delta c > 0$.*

⁹See Fudenberg and Tirole (1990) or Laffont and Tirole (1993).

Furthermore, by adding the two *IC* constraints one gets $\Delta c (q_L - q_H) \geq 0$ which implies that $q_L \geq q_H$ i.e. incentive compatibility requires that the contracted output of the efficient type is higher. Substituting t_H and t_L from (4.2) and (4.3) into the objective function (4.1), and using (2.9), one derives the unconstrained optimization problem of the politician, written below.

$$EW = \nu \left[\int_0^{q_L} p(q) dq - c_L q_L - B_L + EB_L^A - \Delta c q_H + EB_L^C + \mu EB_L^P \right] + (1 - \nu) \left[\int_0^{q_H} p(q) dq - c_H q_H - B_H + EB_H^A + EB_H^C + \mu EB_H^P \right]. \quad (4.4)$$

As in section 3, we distinguish between a decent ($\mu \leq 1$) and a venal ($\mu > 1$) politician by a superscript j , where $j = D, V$ refers to decent and venal, respectively. Denote the optimal solution under asymmetric information as (t_L^j, q_L^j) , (t_H^j, q_H^j) . Since t_L^j and t_H^j can be found as residuals from (4.2) and (4.3), attention will be focussed on finding q_L^j and q_H^j .

4.2. Decent politician ($\mu \leq 1$)

From Proposition 3, $EB_i^C = \rho B_i$, $EB_i^P = 0$. From Proposition 4, $EB_i^A = (1 - \rho)B_i \geq 0$. Substituting in (4.4), the politician's unconstrained problem becomes

$$(q_L^D, q_H^D) \in \arg \max EW^D = \nu \left[\int_0^{q_L} p(q) dq - c_L q_L \right] + (1 - \nu) \left[\int_0^{q_H} p(q) dq - c_H q_H \right] - \nu q_H \Delta c.$$

The Hessian matrix of EW^D is

$$H(q_L, q_H) = \begin{bmatrix} \nu p'(q_L) & 0 \\ 0 & (1 - \nu) p'(q_H) \end{bmatrix},$$

which is negative definite everywhere.

From the first order conditions for an interior maximum, the optimal contracted output for types c_L and c_H , respectively, is given by

$$p_L^D = p(q_L^D) = c_L, \quad (4.5)$$

$$p_H^D = p(q_H^D) = c_H + \frac{\nu}{1 - \nu} \Delta c. \quad (4.6)$$

Since (4.5) is identical to (3.3) so $q_L^D = q_L^{D*} = q_L^{FB}$, thus, the decent politician always requires the low-cost type to produce the first best output. However, from (4.6) and (3.3) we see that $p(q_H^{D*}) = c_H < c_H + \frac{\nu}{1 - \nu} \Delta c = p(q_H^D)$. Hence $q_H^D < q_H^{D*}$, since $p'(q) < 0$. To compare q_H^D with q_H^M , the output produced by a private unregulated monopolist, recall,

from Proposition 1, that q_H^M satisfies $\Pi'_H(q_H^M) = 0$ where $\Pi_H(q)$ is given by (2.3). This implies that $p(q_H^M) = c_H - q_H^M p'(q_H^M)$. Comparing with (4.6), we get

$$q_H^D < q_H^M \Leftrightarrow -\frac{q_H^M}{p(q_H^M)} p'(q_H^M) < \frac{\nu}{1-\nu} \frac{\Delta c q_H^M}{q_H^M p(q_H^M)}. \quad (4.7)$$

Definition 3 We define the ‘expected information rent per unit of revenue’ as $EIRUR(q) = \frac{\nu}{1-\nu} \frac{q \Delta c}{qp(q)}$.

Recall that $\epsilon(q) = -\frac{p}{q} \frac{dq}{dp}$ is the price elasticity of demand for the output. Then (4.7) can be written as

$$q_H^D < q_H^M \Leftrightarrow \epsilon^{-1}(q_H^M) < EIRUR(q_H^M).$$

From Proposition 2, we get that bribes are increasing in q_H^D , if $q_H^D < q_H^M$; while bribes are decreasing in q_H^D , if $q_H^D > q_H^M$.

These results are summarized by the following proposition.

Proposition 7 : Under asymmetric information, the decent politician contracts $q_L^D = q_L^{D*} = q_L^{FB}$ with the low-cost producer. Output is first best and there are no bribes. He contracts q_H^D , $q_H^D < q_H^{D*} = q_H^{FB}$, with the high-cost producer. Output is below first best and bribes are positive. Furthermore, q_H^D is lower (greater) than q_H^M as the ‘expected information rent per unit of revenue’ is greater (lower) than the inverse of the price elasticity of demand. If $q_H^D < q_H^M$ bribes are increasing in q_H^D while if $q_H^D > q_H^M$ bribes are decreasing in q_H^D .

Although there is no distortion of output for the low-cost agent in equilibrium, nevertheless, the low-cost type is paid “information rent” in return for her choosing contract \mathbf{L} ((3.2), (4.3) and Definition 2). Bardhan (1997) provides several examples of the empirical relevance of this result. Historically, imperial China used the policy of paying an extra allowance called the “yang-lien yin” (money to nourish honesty) to district magistrates. Robert Clive used a similar policy to reduce corruption in the East India Company. Hong-Kong and Singapore have successfully used incentive payments to reduce corruption; see for instance Klitgaard (1988) and Rose-Ackerman (1999). Although, incentive payments accord more naturally with an agency theoretic explanation, for instance Rose-Ackerman (1999), Mookherji (1997), Mookherji and Png (1995), Besley and McLaren (1993) and Klitgaard (1988), the essence of the result is unchanged in an adverse selection model.

The following result is a consequence of (4.6) and Proposition 2.

Proposition 8 : Under asymmetric information and a decent politician contracting with a high-cost producer, shortages in contracted output worsen as (1) Δc increases, and (2) ν increases. However, the effect on the magnitude of bribes in equilibrium depends on whether $q_H^D \gtrless q_H^M$; increasing when $q_H^D > q_H^M$ and decreasing when $q_H^D < q_H^M$.

An increase in Δc or in ν increases expected information rents, $\frac{\nu}{1-\nu} \Delta c q_H^D$, which the politician attempts to reduce by creating shortages (by reducing q_H^D). Since the effect on the magnitude of bribes depends on whether the contracted output $q_H^D \geq q_H^M$, these results illustrate an important trade-off faced by anti-corruption programmes, namely, a possible conflict between moving output towards the first best and bribery when $q_H^D < q_H^M$.

4.3. Venal politician ($\mu > 1$)

From Proposition 3, $EB_i^C = 0$, $EB_i^P = \rho^{\frac{1+\mu}{2\mu}} B_i$. From Proposition 4, $EB_i^A = \left(1 - \rho^{\frac{1+\mu}{2\mu}}\right) B_i$. Substituting in (4.4), the venal politician's unconstrained problem is to choose (q_L, q_H) to maximize the following expression

$$EW^V = \nu \left[\int_0^{q_L} p(q) dq - c_L q_L + \xi B_L \right] + (1 - \nu) \left[\int_0^{q_H} p(q) dq - c_H q_H + \xi B_H \right] - \nu q_H \Delta c, \quad (4.8)$$

where $\xi = \rho^{\frac{\mu^2-1}{2\mu}} > 0$ is defined in (3.5).

The Hessian matrix of EW^V is

$$H(q_L, q_H) = \begin{bmatrix} \nu [p'(q_L) + \xi B_L''(q_L)] & 0 \\ 0 & (1 - \nu) [p'(q_H) + \xi B_H''(q_H)] \end{bmatrix},$$

which is negative definite everywhere.

The first order conditions for an interior maximum give

$$p(q_L^V) = c_L - \xi B_L'(q_L^V), \quad (4.9)$$

$$p(q_H^V) = c_H - \xi B_H'(q_H^V) + \frac{\nu}{1-\nu} \Delta c, \quad (4.10)$$

Comparing (3.6), for $i = L$, with (4.9) it follows that $q_L^V = q_L^{V*}$. The comparative static properties for a venal politician under full information, stated in Proposition 6, continue to hold for q_L^V . This is formalized by Proposition 9, below.

Proposition 9 *Under asymmetric information and a venal politician, the contracted output specified by the contract \mathbf{L} for the low-cost type is intermediate between the monopoly level and the first best, i.e., $q_L^M < q_L^V < q_L^{FB}$. There are positive bribes in equilibrium, $B_L(q_L^V) > 0$. The contracted output is decreasing, and bribes are increasing, in (1) the politician's degree of venality, μ , and (2) efficiency of the monitoring technology, ρ .*

Comparing (3.6) with (4.10) we see that the contracted output levels and the comparative statics will in general differ under full information and asymmetric information. Subtracting (4.10) from (3.6), then using the mean value theorem, gives

$$q_H^{V*} - q_H^V = \frac{\nu}{1-\nu} \left(\frac{-1}{p'(x) + \xi B_H''(y)} \right) \Delta c, \quad (4.11)$$

where x and y are outputs intermediate between q_H^V and q_H^{V*} . Since the right hand side of (4.11) is positive, it follows that

$$q_H^V < q_H^{V*} < q_H^{FB}, \quad (4.12)$$

where the second inequality follows from Proposition 6.

Differentiate (4.10), implicitly, with respect to each of $\Delta c, \nu$, then use Proposition 2, to get

$$\frac{\partial q_H^V}{\partial \Delta c} < 0, \quad (4.13)$$

$$\frac{\partial q_H^V}{\partial \nu} < 0. \quad (4.14)$$

From (4.12), (4.13) and (4.14) we get

Proposition 10 : *Under asymmetric information and a venal politician the contracted output for the high-cost producer is less than that under full information and, hence, less than first best. Shortages worsen with increasing Δc and with increasing ν .*

Subtracting (4.10) from (4.6) gives

$$p(q_H^D) - p(q_H^V) = \xi B'_H(q_H^V). \quad (4.15)$$

Recall that $p' < 0$ and $\xi > 0$. Proposition 2 and (4.15) then give

$$q_H^V \leq q_H^D \text{ as } q_H^V \geq q_H^M. \quad (4.16)$$

Differentiate (4.10), implicitly, with respect to each of μ, ρ , then use Proposition 2, to get

$$\frac{\partial q_H^V}{\partial \mu} \leq 0 \text{ as } q_H^V \geq q_H^M, \quad (4.17)$$

$$\frac{\partial q_H^V}{\partial \rho} \leq 0 \text{ as } q_H^V \geq q_H^M. \quad (4.18)$$

From (4.16), (4.17) and (4.18) we get

Proposition 11 : *For the high cost producer, under asymmetric information, the venal politician creates less (greater) shortages relative to a decent politician if q_H^V is less (greater) than q_H^M . Furthermore, output shortages worsen in the regime of a venal politician with increasing (decreasing) μ and ρ as q_H^V is greater (less) than q_H^M .*

The effect on equilibrium bribes from changes in the contracted output that arise from changes in the parameters (see Proposition 11) can be found by using Proposition 2. We formalize this in Proposition 12 below.

Proposition 12 : Under asymmetric information and a venal politician, bribes are positive. If the contracted output for the high-cost producer is less (greater) than that under a private unregulated monopolist, then any parameter change that causes this contracted output to increase (decrease) will cause bribes to increase.

The relative performance of the venal and the decent politician in terms of contracted output and equilibrium bribes hinges on the relative magnitudes of q_H^V and q_H^M (see Propositions 11, 12). We now turn to the determinants of these relative magnitudes.

Definition 4 : The ‘Lerner index’ is $LI(q) = \frac{p(q)-c}{p(q)}$.

Rewrite (4.10) as $-\xi B'_H(q_H^V) = p(q_H^V) - c_H - \frac{\nu \Delta c}{1-\nu}$. From (3.5) $\xi > 0$, hence,

$$\begin{aligned} B'_H(q_H^V) \geq 0 \text{ as } p(q_H^V) - c_H &\leq \frac{\nu \Delta c}{1-\nu} \Leftrightarrow \text{as } \frac{p(q_H^V) - c_H}{p(q_H^V)} \leq \frac{\nu}{1-\nu} \frac{q_H^V \Delta c}{q_H^V p(q_H^V)} \\ \Rightarrow B'_H(q_H^V) \geq 0 \text{ as } LI(q_H^V) &\leq EIRUR(q_H^V) \text{ (using definitions 3 and 4).} \end{aligned}$$

It follows, from Proposition 2, that

$$q_H^V \leq q_H^M \text{ as } LI(q_H^V) \leq EIRUR(q_H^V). \quad (4.19)$$

From (4.19), and Definitions 1-4, we get

Proposition 13 : Under asymmetric information and a venal politician the contracted output for the high-cost producer is less (greater) than that under a private unregulated monopolist if the Lerner index is less (greater) than the expected information rent per unit of revenue.

4.4. Welfare analysis

Proposition 14 : A movement in output towards the first best increases both total surplus and consumer surplus.

Proof. By (2.10) the total surplus is given by

$$TS(t_i, q_i, c_i) = \int_0^{q_i} p(q) dq - c_i q_i; \quad i = H, L. \quad (4.20)$$

Differentiating TS with respect to q_i gives

$$\frac{\partial TS}{\partial q_i} = p(q_i) - c_i. \quad (4.21)$$

Hence, $\frac{\partial TS}{\partial q_i} > 0 \Leftrightarrow p(q_i) > c_i \Leftrightarrow p(q_i) > p(q_i^{FB}) \Leftrightarrow q_i < q_i^{FB}$. Similarly, $\frac{\partial TS}{\partial q_i} < 0 \Leftrightarrow q_i > q_i^{FB}$. Hence, a movement in output towards the first best increases total surplus. To show a similar result for consumer surplus, we have to consider each regime separately.

Recall, from (2.11), that consumer surplus is given by

$$CS(t_i, q_i, c_i) = \int_0^{q_i} p(q) dq - t_i - c_i q_i - B_i + EB_i^C; \quad i = H, L. \quad (4.22)$$

4.4.1. Full information

For the regime of a decent politician under full information, (3.2) and Propositions 3 and 4 give $EB_i^C = \rho B_i$ and $t_i = -(1 - \rho) B_i$. Substitute in (4.22) to get

$$CS(t_i, q_i, c_i) = \int_0^{q_i} p(q) dq - c_i q_i; \quad i = H, L. \quad (4.23)$$

Comparing (4.20) with (4.23) we see that, for this regime, consumer surplus is identical to total surplus. Hence, a movement in output towards the first best increases consumer surplus as well as total surplus.

For the regime of a venal politician under full information, (3.2) and Propositions 3 and 4 give $EB_i^C = 0$ and $t_i = -\left(1 - \rho \frac{1+\mu}{2\mu}\right) B_i$. Substitute in (4.22) to get

$$CS(t_i, q_i, c_i) = \int_0^{q_i} p(q) dq - c_i q_i - \rho \frac{1+\mu}{2\mu} B_i; \quad i = H, L. \quad (4.24)$$

For $q_i \geq q_i^{FB}$ bribes are identically zero. Hence, from (4.24), consumer surplus is identical to total surplus in this range. It follows that a movement in output towards the first best, from above, increases consumer surplus. For $0 < q_i < q_i^{FB}$, (4.24) and (2.4) give

$$\frac{\partial CS}{\partial q_i} = \left[1 - \rho \frac{1+\mu}{2\mu}\right] [p(q_i) - c_i] - \rho \frac{1+\mu}{2\mu} q_i p'(q_i); \quad 0 < q_i < q_i^{FB}; \quad i = H, L. \quad (4.25)$$

Let $q_i < q_i^{FB}$. Then $p(q_i) - c_i > 0$. Since $\mu > 1$ and $0 < \rho < 1$, it follows that $1 - \rho \frac{1+\mu}{2\mu} > 0$. Since $p'(q_i) < 0$, it follows that $\frac{\partial CS}{\partial q_i} > 0$. Hence, a movement in output towards the first best, from below, increases consumer surplus in this case.

4.4.2. Asymmetric information

For the regime of a decent politician under asymmetric information, (4.2), (4.3) and Propositions 3 and 4 give $EB_i^C = \rho B_i$, $t_H = -(1 - \rho) B_H$ and $t_L = -(1 - \rho) B_L + q_H \Delta c$. Substitute in (4.22) to get

$$CS(\mathbf{H}) = \int_0^{q_H} p(q) dq - c_H q_H, \quad (4.26)$$

$$CS(\mathbf{L}) = \int_0^{q_L} p(q) dq - c_L q_L - q_H \Delta c. \quad (4.27)$$

From (4.26) it is clear that, when a decent politician contracts with the high cost producer, a movement in output towards the first best increases consumer surplus. From (4.27) we get

$$\frac{\partial CS}{\partial q_L} = p(q_L) - c_L. \quad (4.28)$$

From (4.28) we get that, when a decent politician contracts with the low cost producer, a movement in output towards the first best increases consumer surplus.

For the regime of a venal politician under asymmetric information, (4.2), (4.3) and Propositions 3 and 4 give $EB_i^C = 0_i$, $t_H = -\left(1 - \rho\frac{1+\mu}{2\mu}\right)B_H$ and $t_L = -\left(1 - \rho\frac{1+\mu}{2\mu}\right)B_L + q_H\Delta c$. Substitute in (4.22) to get

$$CS(\mathbf{H}) = \int_0^{q_H} p(q) dq - c_H q_H - \rho\frac{1+\mu}{2\mu}B_H, \quad (4.29)$$

$$CS(\mathbf{L}) = \int_0^{q_L} p(q) dq - c_L q_L - q_H\Delta c - \rho\frac{1+\mu}{2\mu}B_L. \quad (4.30)$$

For $q_i \geq q_i^{FB}$ bribes are identically zero. Hence, from (4.29) and (4.30), we see that consumer surplus in this case is identical to consumer surplus under the regime of a decent politician under asymmetric information ((4.26) and (4.27)). It follows from what we proved earlier that a movement in output towards the first best, from above, increases consumer surplus. For $0 < q_i < q_i^{FB}$, (4.29), (4.30) and (2.4), give

$$\frac{\partial CS}{\partial q_i} = \left[1 - \rho\frac{1+\mu}{2\mu}\right] [p(q_i) - c_i] - \rho\frac{1+\mu}{2\mu}q_i p'(q_i); 0 < q_i < q_i^{FB}; i = H, L. \quad (4.31)$$

Comparing (4.31) with (4.25) we see that they are identical. Hence, from what we have proved earlier, a movement in output towards the first best, from below, increases consumer surplus in this case too. QED.

Example 3 : Consider the constant elasticity demand function

$$q(p) = p^{-\epsilon}, \quad p(q) = q^{-\frac{1}{\epsilon}}, \quad \epsilon > 1, \quad p, q \in (0, \infty). \quad (4.32)$$

It can be checked that in this case

$$q_H^D \leq q_H^M \Leftrightarrow \frac{\nu}{1-\nu}(\epsilon-1)\left(1 - \frac{c_L}{c_H}\right) \geq 1, \quad (4.33)$$

$$q_H^V \leq q_H^M \Leftrightarrow \frac{\nu}{1-\nu}(\epsilon-1)\left(1 - \frac{c_L}{c_H}\right) \geq 1, \quad (4.34)$$

$$q_H^D \leq q_H^V \Leftrightarrow \frac{\nu}{1-\nu}(\epsilon-1)\left(1 - \frac{c_L}{c_H}\right) \geq 1. \quad (4.35)$$

From (4.33) to (4.35) we see that under some conditions, namely, (1) the probability, ν , of the low cost type, c_L , is sufficiently high or (2) the price elasticity of demand, ϵ , is sufficiently high or (3) the ratio, $\frac{c_H}{c_L}$ is sufficiently high, the venal politician will contract a higher output than the decent politician. Hence in these cases corruption is welfare enhancing. However, in all these cases, output is lower than under an unregulated private monopoly. Thus in these cases private provision (even by an unregulated monopoly) would be better than public provision.

5. Discussion of the Results

5.1. Shortages and bribes

Under full information, a decent politician will always contract the first best output and there are no bribes (Proposition 5). Under asymmetric information, a decent politician will contract the first best output with the low-cost producer. However, he will contract an output less than first best with the high-cost producer in an attempt to reduce informational rents of the low-cost producer. This creates the scope for bribes (Proposition 7). On the other hand, a venal politician will always create scope for bribes (Propositions 6 and 12).

Under asymmetric information, an increase in either ν or in Δc increases expected information rents. A politician (whether decent or venal) responds by contracting the high-cost type to supply an even lower quantity (Propositions 8 and 10). The effect on bribes, however, depends on whether the contracted output is below (in which case bribes decrease) or above (in which case bribes increase) the monopoly level. If $q_H^V > q_H^M$ then an increase in contracted output towards the first best is also accompanied by a reduction in bribes. However, when $q_H^V < q_H^M$ an increase in bribery is accompanied by a movement in output towards the first best; clearly in this case corruption is welfare enhancing.

The trade-off between bribery and shortages raises interesting welfare issues. For instance, it is possible, depending on the parameter values, that an increase in welfare arising from a reduction in bribes is outweighed by the decrease in welfare arising from increased shortages. Some positive level of corruption can then be welfare enhancing. The existing literature typically ignores the trade-off between efficiency and bribery.

Under full information, the venal politician creates greater scarcities and bribes relative to the decent politician and the contracted output, q_H^* , always exceeds that produced by a private unregulated monopolist, q_H^M (Proposition 6). However, under asymmetric information $q_H^j \leq q_H^M$, $j = D, H$ (Propositions 7 and 13). Furthermore, bribes are increasing in contracted output up to q_H^M and decreasing in contracted output thereafter (Proposition 12). Since, the venal politician cares about bribes, in addition to limiting information rents, while the decent politician only cares about the latter, the relative contracted output under each of these types of politicians depends on which side of q_H^M the originally contracted output lies on (Proposition 11).

Proposition 11 shows that, unlike the full information case, the venal politician does not necessarily create greater shortages relative to the decent politician. Many forms of public output, where scarcity rents have been documented, form an important prerequisite for private investment activity in the economy. These include, for instance, industrial licenses, export-import licenses and public credit. Thus, it is plausible to conjecture that scarcities, relative to the first best output, can potentially reduce private investment; see for instance

Mauro (1995, 1997). The implication of Proposition 11 in this context is that investment might be greater under the regime of a decent politician when output is high ($q_H^M < q_H$), however, at low levels of output ($q_H^M > q_H$), it might be greater in the regime of a venal politician.

5.2. Auditing technology

Several widely advocated anti-corruption measures, documented for instance in Rose-Ackerman (1999), recommend an improvement in the auditing technology in order to reduce the incidence of corruption. However, when the politician is venal, our model predicts that this policy recommendation will be unsuccessful in reducing bribes. Furthermore, there are important, and hitherto unrecognized, implications for efficiency; these issues are formalized in Proposition 11 above.

An increase in ρ enables the venal politician to detect hard information about bribes more often. Hence, if the venal politician were to distort output to increase bribes, her expected bribes would increase. This increase in the marginal benefit of creating bribes (by distorting the contracted output) over the marginal cost (the distortion in consumer surplus) results in greater output distortions and bribes in equilibrium. Using Proposition 2, it is obvious that the equilibrium contracted output moves towards the unregulated monopoly output, q_H^M , from both directions; this essentially is the intuition behind the comparative static result with respect to ρ reported in Proposition 11.

Although an improvement in the monitoring technology always leads to an increase in bribes (see Propositions 11, 12), however, when $q_H^V < q_H^M$ (through an increase in contracted output) it enhances efficiency, while if $q_H^V > q_H^M$ (through a decrease in contracted output) it reduces efficiency. Hence, at high output levels an improvement in monitoring technology is bad if the politician is venal, while at lower output levels ($q_H^V < q_H^M$) it is welfare enhancing.

What is the relation of our results to the existing literature? The bribe increasing aspect of better auditing technology is similar to Proposition 1 in Laffont and Guesan (1999) who interpret an increase in ρ as an increase in “competitiveness”. The interpretation of ρ as competitiveness is best seen by imagining that the responsibility for monitoring the agent rests with some auditing supervisors and a proportion ρ are honest. However, unlike Laffont and Guesan (1999), the intuition here is that when the politician is corrupt, then an increase in ρ reduces the private marginal cost of bribes to the venal politician.

Tanzi and Davoodi (1997) show empirically that greater distortions, relative to the first best, are associated with weaker auditing technologies (low ρ). However, in Acemoglu and Verdier (2000) the number of agents employed by the government (which corresponds to the contracted output) increases following a decrease in ρ . Propositions 11, 12 are able to

reconcile these conflicting results. At low levels of output ($q_H < q_H^M$) one gets the Tanzi-Davoodi result while at higher levels of output ($q_H > q_H^M$) one gets the Acemoglu-Verdier result. The trade-off between efficiency and bribery is again central to this explanation.

5.3. Degree of politician's venality

Under full information, if the politician is venal, the contracted output is decreasing and bribes are increasing in the degree of venality (or corruptibility) of the politician, μ (Proposition 6). Propositions 9, 11 and 12 draw the implications of a change in μ under asymmetric information. We find that the full information result survives if $q_H^M < q_H^V$. In the complementary case ($q_H^V < q_H^M$), bribes (and contracted output) are increasing in μ . The trade-off between efficiency and bribes, however, creates important welfare issues that have not been given prominence in the literature yet.

5.4. Can corruption enhance welfare?

According to Proposition 14, a movement of output towards the first best is welfare improving in the sense that it increases both consumer surplus and producer surplus. By Proposition 2, an increase in output is associated with an increase in bribes if, and only if, output is below that of an unregulated private monopoly. Hence, corruption is welfare enhancing in this case; but then private provision, even by an unregulated monopoly, would be better.

6. Conclusions

This paper considers a hierarchical relation between a possibly venal politician and a privately informed agent contracted to supply output/ services on behalf of the former to final consumers. The politician contracts the agent to supply a certain output at an official price. But the latter can choose to receive a bribe to clear the market, i.e., charge a price in excess of the official price. The politician uses a monitoring technology that unearths the incidence of bribery with some positive probability. In the event that the bribe is discovered, a venal politician is willing to hide evidence of the bribe if the agent shares the bribes with her. The paper provides information-theoretic microfoundations to this classical problem of scarcity rents. Furthermore, it generates a set of plausible and potentially testable theoretical predictions.

In general, the equilibrium is characterized by shortages and bribes. The contracted output can be smaller or greater relative to that produced by a private unregulated monopolist. The paper reconciles apparently conflicting results on the affect of an improvement in the auditing technology on the size of the public sector. An important insight of the

paper is that anti-corruption reforms, such as an improvement in the auditing technology, face a trade-off in enhancing efficiency on the one hand and changes in equilibrium bribes on the other. The size of the public sector can be symptomatic of alternative degrees of corruption.

A movement of output towards the first best is welfare improving in the sense that it increases both consumer surplus and producer surplus. An increase in output is associated with an increase in corruption if, and only if, output is below that of an unregulated private monopoly. Hence corruption is welfare enhancing in this case; but then private provision, even by an unregulated monopoly, would be better.

Future research can incorporate political institutions and electoral procedures. Political competition among parties could possibly offset some of the output distortion that arises on account of corruption. For instance, a party might contest the election on the platform that its candidates have a relatively lower degree of venality, μ , as compared to the opposition. A plausible model along these lines would have to consider contractibility, credibility and coordination issues. Other interesting extensions of the model would be to examine the relationship between corruption and growth, to consider a judicial system that could possibly punish corrupt politicians, and lobbying by consumer groups to influence the contracted output by directly engaging in side transactions with the politician.

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