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"Corruption with competition among hidden principals "

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Corruption with competition among hidden principals[1]

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Abstract

Generally when there is increased competition on one side of the market, the other side is better off. In this paper we study the effects of increased competition among sellers when there is a potentially corrupt agent who procures the good on behalf of a buyer. The model consists of a principal (the owner of a firm), an agent (the manager), and many "hidden principals" (suppliers of an input). Corruption occurs when an agent conspires with one of these hidden principals to appropriate gains at the principal's expense.

Suppliers have two key attributes: production cost and "dishonesty" cost (a utility penalty incurred from being corrupt). The effects of increased competition among suppliers depend crucially on whether new suppliers are heterogeneous across these characteristics. When the new suppliers vary according to their productivity levels and/or their honesty levels, there are three possible sources of inefficiency. First, no transaction may occur, although it is socially efficient to transact. Second, the most productive supplier may not be used because he is too honest. Third, the most productive supplier may not be used because the principal has (optimally) restricted the pool of potential suppliers. Importantly, we find that increased competition among sellers may in fact harm the buyer.

JEL CLASSIFICATION NUMBERS: C72, C73, D23, D61, D82.
KEYWORDS: *corruption, bribery, principal-agent, hidden principal, competition.*

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1 Introduction

In this paper we examine the effects of introducing competition among hidden principals. We analyze what happens when there are several suppliers of the input from which the agent can choose. Our goal is to determine whether competition of this sort reduces or amplifies the effects of corruption[2]. Generally when there is competition in one side of the market (buyers or sellers) the other side is better off. The question that we try to answer in this essay is what happens when there is an agent, that can be corrupt, in the middle. Corruption occurs when an agent conspires with one of these hidden principals to appropriate gains at the principal's expense. If the principal is better off with a smaller number of suppliers he can increase his utility by restricting the set of possible suppliers. This is a possible justification of having a restricted list of suppliers.

We find three possible sources of inefficiencies. 1) Socially efficient transactions may not occur[3]. 2) The most productive supplier may not be used because he is too honest. 3) The most productive supplier may not be used because the principal has (optimally) restricted the pool of potential suppliers. Another consequence of corruption is a redistribution of transaction surplus from the principal to the agent and/or the hidden principal.

The structure of the rest of the chapter is as follows. Section 2 introduces a model that is based on Weinschelbaum (1997) and presents some results of the model. Section 3 analyzes the effects of increasing the number of suppliers and Section 4 concludes.

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2 The model

There are three players: the owner of a firm (the principal), the manager (the agent) and the supplier (the hidden principal). The manager's task is to buy an input from a supplier. If the input is purchased the principal can sell his output at a price I. The hidden principal and the agent know the cost (c) of the input but the principal knows only that $c \in \{c_1, c_2, c_3\}$ and that $\Pr(c) = q_j$ if $c = c_j$; where $q_1 + q_2 + q_3 = 1$. We assume $I > c_3 > c_2 > c_1$.

[2]For a discussion about the effects of corruption you can see Ades and Di Tella (1995), Bardhan (1997), Rose-Ackerman (1978), and Weinschelbaum (1997).

[3]This inefficiency may still arise even if corruption does not occur in equilibrium.

Thus the transaction is always socially desirable.

We also assume that there are two types of agents who differ according to their level of honesty, $h_a^i \in \{0, H\}$,where $h_a^i = H$ indicates that the agent i is honest and thus will not lie. The probability that the agent is honest is $\Pr(h_a^i = H) = h$. There are only two possible values for the level of honesty of the hidden principal $h_{hp}^i \in \{0, H\}$, where $h_{hp}^i = H$ indicates that the hidden principal i is honest and thus will not lie. The probability that the hidden principal is honest is $\Pr(h_{hp}^i = H) = p$. If either one of these players is honest, neither will lie. They lie only if both are dishonest, i.e., the cost of lying is 0 for both of them.

The strategy of the principal is to choose a scheme $w_a : \widehat{C} \rightarrow \Re$. In other words, the principal offers a payment contract contingent on the announcement of cost $(\widehat{c})$ after the transaction has been completed.

We refer to the coalition between the agent and the hidden principal as the *conspiracy*. The conspiracy's strategy space is $\widehat{c}{:}C \rightarrow \Re$. Thus, they choose an announcement $(\widehat{c})$ for each possible actual cost (c). We define "corruption" as $\widehat{c} \neq c$ and "no corruption" as $\widehat{c} = c$.

We are assuming that the principal knows neither the type of the agent nor the supplier, as opposed to the agent and the supplier who have complete information.

The sequence of the game is as follows:

1. Nature selects the honesty levels of the agent and the hidden principal.
2. The agent and the hidden principal observe both honesty parameters.
3. The principal decides the payment system w_a.
4. Nature selects the acquisition cost c: c_1 (with probability q_1), c_2 (with probability q_2) and c_3 (with probability q_3).
5. The agent and the hidden principal observe the acquisition cost.
6. The agent and the hidden principal jointly announce the value $\widehat{C}$. They have the option of refusing the transaction, leading to one "participation " constraint for each state.

2.1 Some results:

Lemma 1 : *Without loss of generality we can restrict our analysis to the following three schemes*

$$w_a^1 : w_a(c_1) = w_a(c_2) = w_a(c_3) = c_1$$
$$w_a^2 : w_a(c_1) = c_1, \quad w_a(c_2) = w_a(c_3) = c_2$$
$$w_a^3 : w_a(c_1) = c_1, \quad w_a(c_2) = c_2, \quad w_a(c_3) = c_3$$

Proof. See Appendix 1.

Note that when the coalition does not lie it gets no surplus. When the scheme is w_a^1, the utility of the principal is:

$$U_p\left(w_a^1\right) = q_1(I - c_1) \tag{1}$$

Under w_a^1, the principal does not allow the agent to exercise discretion. However, this restriction is costly the transaction will only take place when the cost is c_1, independently of the level of honesty. Since the agent has no discretion under this scheme, there cannot be corruption. There is, however, an inefficiency that arises since the transaction does not always occur. Since there is no transaction when the cost is medium or high, the magnitude of the inefficiency is given by

$$q_3\left(I - c_3\right) + q_2\left(I - c_2\right)$$

When the scheme is w_a^2, the utility of the principal is:

$$\begin{aligned} U_p\left(w_a^2\right) &= q_1\left(h + (1-h)\,p\right)\left(I - c_1\right) + \\ &\quad \left(q_2 + q_1\left(1-h\right)\left(1-p\right)\right)\left(I - c_2\right) \end{aligned} \tag{2}$$

The payment will be c_1 when the actual cost is c_1 and at least one of the conspiracy members is honest. The payment will be c_2 when a) the actual cost is c_1 and both the agent and the hidden principal are dishonest and b) when the actual cost is c_2. In this scheme the agent has some discretion. When the real cost is c_3 there will be no transaction. Thus when the principal uses scheme w_a^2 there is an inefficiency equal to $q_3\left(I - c_3\right)$ because, when the cost is high, there is no transaction.

When the principal uses scheme w_a^2, there is corruption with probability

$$q_1(1-h)(1-p)$$

When the cost is low and both the agent and the supplier are dishonest, they announce that the cost is medium.

When the scheme is w_a^3 the utility of the principal is:

$$\begin{aligned} U_p\left(w_a^3\right) &= q_1(h+(1-h)p)(I-c_1)+q_2(h+(1-h)p)(I-c_2)+ \\ &\quad ((q_1+q_2)(1-h)(1-p)+q_3)(I-c_3) \end{aligned} \tag{3}$$

This yields corruption with probability

$$(q_1+q_2)(1-h)(1-p)$$

2.1.1 Some comparative statics

We assume the principal chooses the utility maximizing scheme. As the parameters of the problem change, we can ask how his utility under each scheme changes and how, as a consequence, the "probability" of choosing each scheme varies. As we move from w_a^1 to w_a^3, the level of discretion of the agent increases. This has two effects, increasing the probability of corruption and increasing the probability there is a transaction.

Proposition 1 : *The probability of corruption is increasing both in I and c_1 but decreasing in c_3.*

Proof. See Appendix 2.

The intuition is as follows, the probability of corruption under each scheme is independent of (I, c_1, c_3), but the probability of using each scheme is not. There are at least three possible reasons why the principal might choose a scheme in which corruption is more likely to occur: 1) The higher the level of income, the more expensive it is to forego the transaction in any state. As a consequence, the principal will more often use schemes that lead to corruption with higher probability. 2) The higher c_1 the smaller the loss from corruption. Thus, the principal will more often use schemes where corruption occurs more often. 3) The lower c_3 the smaller the loss from corruption. Thus, the principal will more often use schemes where corruption occurs more often.

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3 Increasing the number of hidden principals

Generally increased competition on one side of the market is better for the other side. An important question is whether this will hold true when corruption is possible. The answer is that it will depend on how we introduce competition.

We determine the level of competition by the quantity of hidden principals in the market. But the number of hidden principals is not the only issue. A hidden principal's type is defined by two characteristics, cost and level of honesty $\left(HP_i = [c_i, h^i_{hp}]\right)$. We can increase the number of hidden principals in four different ways, according to the possible combinations of characteristics.

$\overline{C}\,\overline{H}$: All the hidden principals are of the same type: We take a single draw of cost and honesty level and replicate this type.

$C\,\overline{H}$: All the hidden principals have the same level of honesty, but they can have different costs: We take a draw of the cost for each hidden principal but just one draw for the level of honesty.

$\overline{C}\,H$: All the hidden principals have the same level of cost, but they can have different levels of honesty: We take a draw of the level of honesty for each hidden principal but just one for the cost.

$C\,H$: The hidden principals can have different levels of honesty and different costs: We take a draw of the level of honesty and a draw of the cost for each hidden principal.

We assume that the principal knows how many suppliers are in the market so the optimal scheme may depend on this number. If we do not allow the principal to learn the number of hidden principals, he cannot condition the scheme on this number so he will not be able to capture some gains associated with having more suppliers. However, this is mainly a problem of information, not one of competition.

There are n suppliers independently of the kinds of heterogeneity that we allow. The sequence of the game is as follows:

1. Nature selects the honesty level of the agent and of the hidden principals. Notice that under cases $\overline{C}\,H$ and $C\,H$ different hidden principals can have different levels of honesty.

2. The agent observes all honesty parameters and each hidden principal observes his own honesty parameter.

3. The principal decides the payment system w_a.
4. Nature selects the acquisition cost c: c_1 (with probability q_1), c_2 (with probability q_2) and c_3 (with probability q_3).
5. The agent observes every acquisition cost and each hidden principal observes his own acquisition cost.
6. The agent chooses a hidden principal.
7. The agent and the hidden principal (chosen by the agent) jointly announce the value $\widehat{c}$. They have the option of refusing the transaction, leading to one "participation constraint" for each state.

As we will see the results vary dramatically depending on how we replicate the hidden principals.

3.1 Homogeneous honesty levels and costs ($\overline{C}\,\overline{H}$)

With completely homogeneous hidden principals most of the results are independent of the number of hidden principals. The principal always uses the same scheme and the level of inefficiency and the utility of the principal are independent of the number of hidden principals. All that changes is the distribution of surplus inside the conspiracy. In all cases with multiple hidden principals the agent has a better "bargaining" position. For many structures of the "bargaining game" with at least two hidden principals, the agent gets the whole surplus.

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3.2 Homogenous honesty levels and heterogenous costs ($C\,\overline{H}$)

The utility of the principal when there are n hidden principals and the principal uses scheme w_a^1 is:

$$U_p\left(w_a^1\right) = \left(1 - (1 - q_1)^n\right)(I - c_1)$$

That is, there is a transaction when there is at least one supplier with low cost. Under this scheme there is an inefficiency

$$\left((1 - q_1)^n - (q_3)^n\right)(I - c_2) + (q_3)^n (I - c_3)$$

reflecting the fact that, when there is no supplier with low cost, there is no transaction. When there is at least one supplier with medium cost which occurs with probability $((1-q_1)^n - (q_3)^n)$, the loss is $(I - c_2)$, and when all have high cost, which occurs with probability $(q_3)^n$, the loss is $(I - c_3)$.

When the scheme is w_a^2 the utility of the principal is:

$$\begin{aligned} U_p\left(w_a^2\right) &= (1-(1-q_1)^n)(h+(1-h)p)(I-c_1) + \\ &\quad (1-q_3{}^n-(1-(1-q_1)^n)(h+(1-h)p))(I-c_2) \end{aligned}$$

The payment will be c_1 when there is at least one supplier with low cost and the conspiracy is honest. The payment will be c_2 when a) there is no supplier with low cost and at least one with cost c_2 or b) the actual cost is c_1 and the conspiracy is dishonest.

When the principal uses this scheme, there is an inefficiency

$$q_3{}^n (I-c_3)$$

reflecting the fact that, when all the hidden principals are high cost, there is no transaction. Under this scheme, there is corruption with probability

$$(1-(1-q_1)^n)(1-h)(1-p)$$

occurring when there is at least one hidden principal with low cost and the agent and the hidden principals are dishonest.

When the scheme is w_a^3 the utility of the principal is:

$$\begin{aligned} U_p\left(w_a^3\right) &= (1-(1-q_1)^n)(h+(1-h)p)(I-c_1) + \\ &\quad ((1-q_1)^n - q_3{}^n)(h+(1-h)p)(I-c_2) + \\ &\quad ((1-h)(1-p)+(h+(1-h)p)q_3{}^n)(I-c_3) \end{aligned}$$

If either the agent or the suppliers are honest, the payment will be the true minimum cost available, but when everyone is dishonest the payment will be c_3, regardless of the actual minimum cost. Under this scheme there is corruption with probability

$$(1-h)(1-p)(1-q_3{}^n)$$

which occurs whenever the agent and the hidden principals are dishonest and not all the hidden principals are high cost.

Looking at the three payment schemes, when n increases the utility of the principal increases no matter which scheme he is using, so the principal is better off.

Proposition 2 *: For every value of the parameters, when n is large enough the principal will use w_a^1 and, therefore, the probability of corruption goes to zero.*

Proof. It follows directly from the following inequality
$\lim_{n\to\infty} U_p\left(w_a^1\right) > \lim_{n\to\infty} U_p\left(w_a^2\right) > \lim_{n\to\infty} U_p\left(w_a^3\right)$. ■

This proposition implies that when we have enough hidden principals there is no corruption. This is because the probability of having at least one supplier with cost c_1 goes to one so the principal will always use w_a^1. In this case the principal is better off with more suppliers and the probability of corruption goes to zero as n increases. The economy is also more productive in a technological sense as the quantity of suppliers increases, because the probability of having at least one supplier with low cost and not all with high cost increases.

3.3 Homogenous costs and heterogenous honesty levels $(\overline{C}\,H)$

The utility of the principal when there are n hidden principals and the principal uses scheme w_a^1 is:

$$U_p\left(w_a^1\right) = q_1\left(I - c_1\right)$$

Under this scheme there is an inefficiency given by

$$q_3\left(I - c_3\right) + q_2\left(I - c_2\right)$$

reflecting the fact that, when the cost is either high or medium, there is no transaction.

When the scheme is w_a^2 the utility of the principal is:

$$\begin{aligned} U_p\left(w_a^2\right) &= q_1\left(h + (1-h)\,p^n\right)\left(I - c_1\right) + \\ &\quad \left(q_2 + q_1\left(1-h\right)\left(1-p^n\right)\right)\left(I - c_2\right) \end{aligned}$$

The payment will be c_1 when the cost is c_1 and either the agent is honest or all the hidden principals are honest. The payment will be c_2 when the real cost is c_2 and when the following conditions hold a) the real cost is c_1, b) the agent is dishonest and c) at least one hidden principal is dishonest.

Under scheme w_a^2 there is an inefficiency given by $q_3(I - c_3)$ since when the cost is high there is no transaction. Under this scheme, there is corruption with probability

$$q_1(1-h)(1-p^n)$$

When the scheme is w_a^3 the utility of the principal is:

$$\begin{aligned} U_p\left(w_a^3\right) &= q_1\left(h+(1-h)p^n\right)(I-c_1)+ \\ &\quad q_2\left(h+(1-h)p^n\right)(I-c_2)+ \\ &\quad \left((q_1+q_2)\left((1-h)(1-p^n)\right)+q_3\right)(I-c_3) \end{aligned}$$

In this case the transaction always occurs. The payment will be c_1 (c_2) when the cost is c_1 (c_2) and the agent is honest or all the hidden principals are honest. The payment will be c_3 when the cost is c_3 or when the cost is either c_1 or c_2 and the agent is dishonest and at least one hidden principal is dishonest. Under this scheme, there is corruption with probability

$$(q_1+q_2)(1-h)(1-p^n)$$

Examining how the utility under each scheme changes when the number of hidden principals changes we get the following:

Proposition 3 : *The utility of the principal is non-increasing in the number of hidden principals. It is decreasing when the optimal scheme is either w_a^2 or w_a^3.*

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Proof: It follows directly from the following inequality

$$d\left(U_p\left(w_a^3\right)\right)/dn < d\left(U_p\left(w_a^2\right)\right)/dn < d\left(U_p\left(w_a^1\right)\right)/dn = 0 \ \blacksquare \tag{4}$$

The explanation is as follows. If the agent is honest, increasing the number of hidden principals does not affect the utility of the principal. But when the agent is dishonest, if the principal uses scheme w_a^2 or w_a^3, more hidden principals, increases the chance that the agent will find a dishonest one when the cost is low (for w_a^2) or when the cost is medium or low (for w_a^1), leading to a corrupt conspiracy.

It is interesting that in this case the principal has an incentive to choice a hidden principal and restrict the agent to trade with him only. This is a possible explanation for the common business practice of keeping closed suppliers' lists.

Proposition 4 :*The expected value of the inefficiency is increasing in the number of hidden principals.*

Proof: From (5) we know that the greater is n the greater the probability that the principal uses scheme w_a^1 and the smaller the probability that he uses w_a^3. Further, the expected size of the inefficiency under w_a^1 is greater than that under w_a^2 which is greater than under w_a^3.■

For certain parameters values, there are schemes that they will never be used. For example we know that

- if $\lim_{n\to\infty} \mathrm{U}_p(w_a^3) > \lim_{n\to\infty} \mathrm{U}_p(w_a^2)$, w_a^2 will never be optimal
- if $\lim_{n\to\infty} \mathrm{U}_p(w_a^3) > \lim_{n\to\infty} \mathrm{U}_p(w_a^1)$, w_a^1 will never be optimal
- if $\lim_{n\to\infty} \mathrm{U}_p(w_a^2) > \lim_{n\to\infty} \mathrm{U}_p(w_a^1)$, w_a^1 will never be optimal

3.4 Heterogeneous costs and honesty levels (CH)

Allowing heterogeneity among hidden principals modifies principal's utility. When heterogeneity in costs is allowed $(C\,\overline{H})$, the principal is better off the larger the number of hidden principals because it is easier to find low cost hidden principals, we will call this effect "cost reducing". When heterogeneity in honesty level is allowed $(\overline{C}\,H)$, the principal is worse off the larger the number of hidden principals because for a dishonest agent it is easier to find a dishonest hidden principal, we will call this effect "easier to cheat". In case $(C\,H)$ since heterogeneity in both, costs and honesty level is allowed, both effects will be present.

The utility of the principal under w_a^1 when there are n hidden principals is:

$$U_p\left(w_a^1\right) = \left(1 - \left(1 - q_1\right)^n\right)\left(I - c_1\right)$$

There will be a transaction whenever there is at least one supplier with cost c_1. The payment will be c_1, the maximum amount that the principal will pay. Under this scheme, there is an inefficiency given by

$$\left(\left(1 - q_1\right)^n - q_3{}^n\right)\left(I - c_2\right) + q_3{}^n\left(I - c_3\right)$$

If at least one has medium cost, the inefficiency is $(I - c_2)$ while if all have high costs it is $(I - c_3)$.

When the scheme is w_a^2, the utility of the principal is:

$$\begin{aligned} U_p\left(w_a^2\right) &= \left(1-(1-q_1)^n\right)h\left(I-c_1\right)+\left(I-c_2\right)\left((1-q_1)^n-{q_3}^n\right)+ \\ &\quad \left(1-(1-q_1)^n\right)\left(I-c_2\right)(1-h)+ \\ &\quad (1-h)\sum_{i=1}^{n}\binom{n}{i}(q_1)^i(1-q_1)^{n-i}p^i\left(c_2-c_1\right) \end{aligned}$$

The first term corresponds to the case where at least one hidden principal has low cost and the agent is honest. The second term corresponds to the case where there is no hidden principal with low cost but there is at least one with cost c_2. The third term corresponds to the case where there is at least one hidden principal with low cost and the agent is dishonest. The fourth term corresponds to the case where a) there is at least one hidden principal with low cost and b) the agent is dishonest but c) there are no dishonest hidden principals.

The above expression can be rewritten as follows

$$\begin{aligned} U_p\left(w_a^2\right) &= \left(1-(1-q_1)^n\right)h\left(I-c_1\right)+\left(I-c_2\right)\left((1-q_1)^n-{q_3}^n\right)+ \\ &\quad \left(1-(1-q_1)^n\right)\left(I-c_2\right)(1-h)+ \\ &\quad (1-h)\left(c_2-c_1\right)\left((1-q_1+q_1p)^n-(1-q_1)^n\right) \end{aligned}$$

Under this scheme, there is an inefficiency given by ${q_3}^n\left(I-c_3\right)$ since, when all suppliers have high costs, the transaction does not take place

There is corruption with probability

$$\left(\left(1-(1-q_1)^n\right)-\sum_{i=1}^{n}\binom{n}{i}(q_1)^i(1-q_1)^{n-i}p^i\right)(1-h)$$

This occurs when both the agent and at least one low cost hidden principal are dishonest.

When the scheme is w_a^3 the utility of the principal is:

$$\begin{aligned} U_p\left(w_a^3\right) &= \left(1-(1-q_1)^n\right)h\left(I-c_1\right)+\left((1-q_1)^n-{q_3}^n\right)h\left(I-c_2\right)+ \\ &\quad {q_3}^n\left(I-c_3\right)+(1-h)\left(1-{q_3}^n\right)\left(I-c_3\right)+ \\ &\quad (1-h)(1-q_1)^n\textstyle\sum_{i=1}^{n}\binom{n}{i}\left(q_2/(1-q_1)\right)^i \end{aligned}$$

$$\begin{aligned} &\left(q_3/\left(1-q_1\right)\right)^{n-i} p^i \left(c_3-c_2\right)+\\ &(1-h)\sum\nolimits_{i=1}^{n}\binom{n}{i}\left(q_1\right)^i\left(1-q_1\right)^{n-i}p^i\\ &\sum\nolimits_{j=0}^{n-i}\binom{n-i}{j}\left(\frac{q_2}{1-q_1}\right)^j\left(\frac{q_3}{1-q_1}\right)^{n-j-i}p^j\left(c_3-c_1\right)\end{aligned}$$

The transaction will always take place. The payment will be c_1 when there is at least one hidden principal with low cost and either the agent is honest or all the hidden principals with cost c_1 or c_2 are honest. The payment will be c_2 when a) there is no hidden principal with low cost, b) there is at least one with cost c_2 and c) either the agent is honest or all the hidden principals with cost c_2 are honest. The payment will be c_3 when 1) all the hidden principals are high cost, or 2) when the agent is dishonest and there is at least one hidden principal with cost c_1 or c_2 that is also dishonest.

The above expression can be rewritten as follows

$$\begin{aligned} U_p\left(w_a^3\right) &= \left(1-\left(1-q_1\right)^n\right)h\left(I-c_1\right)+\left(\left(1-q_1\right)^n-q_3{}^n\right)h\left(I-c_2\right)+\\ &\left(I-c_3\right)\left(1-h+hp_3{}^n\right)+\\ &\left(c_3-c_2\right)(1-h)\left(\left(q_3+q_2p\right)^n-q_3{}^n\right)+\\ &(1-h)\left(c_3-c_1\right)\left(\left(q_3+qp_2+q_1p\right)^n-\left(q_3+qp_2\right)^n\right)\end{aligned}$$

Under this scheme, there will be an inefficiency given by

$$(1-h)\left(c_2-c_1\right)\left(\begin{array}{c}\sum_{i=1}^{n}\binom{n}{i}\left(q_1\right)^i\left(1-q_1\right)^{n-i}p^i\\ \sum_{j=0}^{n-i}\binom{n-i}{j}\left(\frac{q_2}{1-q_1}\right)^j\left(\frac{q_3}{1-q_1}\right)^{n-j}\left(1-p^j\right)\end{array}\right)$$

It is worth noting that, while in prior cases under scheme w_a^3 there were no inefficiencies, in this case we have a new source of inefficiency. When the agent is dishonest and there is no dishonest supplier with low cost but there is at least one dishonest supplier with medium cost, the agent will buy from that supplier even though he is not the most efficient. This occurs because the conspiracy can obtain a surplus equal to (c_3-c_2).

There is corruption with probability

$$(1-h)\left(1-q_3{}^n-\sum\nolimits_{i=1}^{n}\binom{n}{i}q_3{}^{n-i}\left(1-q_3\right)^ip^i\right)$$

corresponding to the case where the agent is dishonest, not all the suppliers have high cost and not all the suppliers with low or medium cost are honest.

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Proposition 5 : *For every value of the parameters, when n is large enough the principal will use w_a^1 and, therefore, the probability of corruption goes to zero.*

Proof. It follows directly from the following inequality

$$\begin{aligned}\lim_{n\to\infty} U_p\left(w_a^1\right) &= (I-c_1) > \\ \lim_{n\to\infty} U_p\left(w_a^2\right) &= h\,(I-c_1)+(1-h)\,(I-c_2) > \\ \lim_{n\to\infty} U_p\left(w_a^3\right) &= h\,(I-c_1)+(1-h)\,(I-c_3) \blacksquare\end{aligned}$$

This means that when n is large enough the effect of having different draws for the costs "costs reducing" dominates the effect of having different draws for honesty level "easier to cheat". This is because as the number of suppliers increases the probability of not having any low cost supplier goes to zero. The principal will use scheme w_a^1 and the probability that the transaction occurs goes to one.

However, the utility of the principal is not necessarily a monotone increasing function of n. There are cases where for some regions it is decreasing i.e., "easier to cheat" dominates "cost reducing". In such cases the principal have incentives to restrict the possible suppliers, by creating a supplier list. If such a restriction occurs, it creates a new source of inefficiency. If the efficient suppliers are not on the list, the input will be purchased from an inefficient supplier. By restricting the number of possible draws, the expected value of the minimum cost will be greater. The objective of restricting the number of suppliers is to reduce the possibility that the agent finds a dishonest hidden principal.

Summarizing this analysis of the different specifications of hidden principal heterogeneity, the results of Proposition 1 holds for every quantity of hidden principals regardless the type of heterogeneity we allow.

Proposition 6 : *For any quantity of hidden principals and any kind of heterogeneity among them, the probability of corruption is increasing both in I and c_1 but decreasing in c_3.*

Proof. See Appendix 3.

4 Conclusion

In this paper we investigate the effects of having competition among suppliers when the buyers are represented by a corruptible agent. First, we consider homogeneous suppliers only. We find that when all the hidden principals are identical, the results are basically independent of the quantity of suppliers, except for the distribution of the gains from lying between the agent and the supplier .

When we allow heterogeneous suppliers. When the suppliers differ only in the cost level, the economy becomes more productive as the number of suppliers increases, since the expected value of the minimum cost is lower. The utility of the principal is increasing in the quantity of hidden principals under any payment scheme.

When only the honesty level varies among hidden principals the probability of finding a dishonest one increases as the quantity increases. This does not affect the principal's utility when the agent is honest, but it does when the agent is dishonest. In the latter case, the principal's utility is decreasing in the number of suppliers for any scheme where there exists a possibility of corruption. If the principal has the option to restrict the possible suppliers to only one, it will be optimal to do so.

Finally, when suppliers may vary over both cost and level of honesty, we have the combination of the two effects observed before. The total effect is not defined. When the number of suppliers is large enough, the "cost reducing" effect dominates the "easier to cheat" effect, making the principal's utility increasing in n. But when n is small, the sign of the total effect is not determined. So, if the quantity of suppliers is at a point where the principal's utility is decreasing then the use of a restriction of possible suppliers, when available, is profitable for the principal. Nevertheless, such restrictions will generate an inefficiency since the expected cost is greater the smaller is the number of hidden principals.

A new source of inefficiency arises when a) the principal pays the announced cost, b) the agent is dishonest, c) there is at least one supplier with low cost but none dishonest with low cost and d) there is at least one dishonest with medium cost. A dishonest agent makes the transaction with a dishonest medium cost supplier instead of with an honest low cost supplier because this is the way in which he captures a surplus.

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Appendix 1

Proof of Lemma 1: The principal faces two possibilities:

a) A dishonest conspiracy: both agent and hidden principal are dishonest, $(h_a, h_{hp}) = (0, 0)$

or

b) An honest conspiracy: either the agent or the supplier (or both) is honest, $(h_a, h_{hp}) = (H, 0)$ or $(0, H)$ or (H, H).

If the conspiracy is dishonest,

$$\widehat{c} \in \arg\max \{\max \{w_a(\widehat{c})\}\}$$

independent of the actual cost (c). Because their joint cost of lying is zero, there is no way to make them announce something different. All that matters for the principal's utility is the value of $\max\{w_a(\widehat{c})\}$ since this is the unique value that will be paid. There will be a transaction in state i whenever $\max\{w_a(\widehat{c})\} \geq c_i$, where $i \in \{1, 2, 3\}$.

If at least one of the conspiracy members is honest, they will never lie. The principal must consider whether the transaction takes place and the size of the payment. Since a transaction occurs in state i if and only if $w_a(c_i) \geq c_i$, the principal will always choose $w_a(c_i) = c_i$ over $w_a(c_i) > c_i$. Therefore, when the conspiracy is honest the only relevant distinction is whether $w_a(c_i) = c_i$ or $w_a(c_i) < c_i$ at each possible state.

Since each coalition type occurs with positive probability, the principal must consider:

1. the value of $\max\{w_a(\widehat{c})\}$
2. whether $w_a(c_i) = c_i$ or $w_a(c_i) < c_i$ at each possible state.

Depending on the value of the parameters the optimal scheme will be one of the three given.■

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Appendix 2

Proof of Proposition 1: The probability of corruption is as follows.
$P(corruption) = \sum_{i\in\{1,2,3\}} P(w_a^i = w_a^*)P(\text{corruption}/w_a^i)$

Note that

$P(\text{corruption}/w_a^1) = 0$
$P(\text{corruption}/w_a^2) = q_1\,(1-h)\,(1-p) > 0$
$P(\text{corruption}/w_a^3) = (q_1+q_2)\,(1-h)\,(1-p) > P(corruption/w_a^2) > 0$

Thus $\frac{\partial P(corruption/w_a^i)}{\partial I} = \frac{\partial P(corruption/w_a^i)}{\partial c_1} = \frac{\partial P(corruption/w_a^i)}{\partial c_3} = 0$ for $i \in \{1,2,3\}$.

Using these facts, the derivative of the probability of having corruption with respect to I can be written as follows:

$$\frac{dP(corruption)}{dI} = \frac{\partial P(w_a^2 = w_a^*)}{\partial I} q_1\,(1-h)\,(1-p) + \frac{\partial P(w_a^3 = w_a^*)}{\partial I}(q_1+q_2)\,(1-h)\,(1-p)$$

But since

$$\frac{\partial U_p(w_a^1)}{\partial I} = q_1 < \frac{\partial U_p(w_a^2)}{\partial I} = (q_1+q_2) < \frac{\partial U_p(w_a^3)}{\partial I} = 1$$

we know that for some economies where $U_p(w_a^1) > U_p(w_a^2)$ this inequality reverses as I increases; this also happens in some economies where $U_p(w_a^2) > U_p(w_a^3)$. So $\frac{\partial P(w_a^3=w_a^*)}{\partial I} > 0$ and $\frac{\partial P(w_a^1=w_a^*)}{\partial I} < 0$. Therefore $\frac{dP(corruption)}{dI} > 0$.

The derivative with respect to c_1 can be written as follows

$$\frac{dP(corruption)}{dc_1} = \frac{\partial P(w_a^2 = w_a^*)}{\partial c_1} q_1\,(1-h)\,(1-p) + \frac{\partial P(w_a^3 = w_a^*)}{\partial c_1}(q_1+q_2)\,(1-h)\,(1-p)$$

But since

$$\frac{\partial U_p(w_a^1)}{\partial c_1} = -q_1 < \frac{\partial U_p(w_a^2)}{\partial c_1} - q_1\,(h+(1-h)\,p) = \frac{\partial U_p(w_a^3)}{\partial c_1}$$

we know that

$$\frac{\partial P(w_a^2 = w_a^*)}{\partial c_1}, \frac{\partial P(w_a^3 = w_a^*)}{\partial c_1} > 0$$

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and $\frac{\partial P(w_a^1=w_a^*)}{\partial c_1} < 0$. Therefore $\frac{dP(corruption)}{dc_1} > 0$.

The derivative with respect to c_3 can be written as follows:

$$\begin{aligned}\frac{dP(corruption)}{dc_3} &= \frac{\partial P(w_a^2 = w_a^*)}{\partial c_3} q_1 (1-h)(1-p) + \\ &\quad \frac{\partial P(w_a^3 = w_a^*)}{\partial c_3} (q_1 + q_2)(1-h)(1-p)\end{aligned}$$

But since

$$\frac{\partial U_p(w_a^1)}{\partial c_3} = 0 = \frac{\partial U_p(w_a^2)}{\partial c_3} > \frac{\partial U_p(w_a^3)}{\partial c_3} = -\left(q_3 (q_2 + q_1)((1-p)(1-h))\right)$$

we know that

$$\frac{\partial P(w_a^1 = w_a^*)}{\partial c_3}, \frac{\partial P(w_a^2 = w_a^*)}{\partial c_3} > 0, \text{ and } \frac{\partial P(w_a^3 = w_a^*)}{\partial c_3} < 0$$

Therefore $\frac{dP(corruption)}{dc_3} < 0$.■

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Appendix 3

Proof of Proposition 6: The proof is similar to that of Proposition 1 using the following facts.

A) For the four cases we have

1. $P(\text{corruption}/w_a^1) = 0$

2. $P(\text{corruption}/w_a^2) > 0$

3. $P(\text{corruption}/w_a^3) > P(corruption/w_a^2) > 0$

4. $\frac{\partial P(corruption/w_a^i)}{\partial I} = \frac{\partial P(corruption/w_a^i)}{\partial c_1} = \frac{\partial P(corruption/w_a^i)}{\partial c_3} = 0$ for $i \in \{1, 2, 3\}$

5. $\frac{\partial U_p(w_a^1)}{\partial I} < \frac{\partial U_p(w_a^2)}{\partial I} < \frac{\partial U_p(w_a^3)}{\partial I} = 1$

6. $\frac{\partial U_p(w_a^1)}{\partial c_3} = 0 = \frac{\partial U_p(w_a^2)}{\partial c_3} > \frac{\partial U_p(w_a^3)}{\partial c_3}$

B) For the cases of $\overline{C}\,\overline{H}$, $C\,\overline{H}$,and $\overline{C}\,H$ we have

$$\frac{\partial U_p(w_a^1)}{\partial c_1} < \frac{\partial U_p(w_a^2)}{\partial c_1} = \frac{\partial U_p(w_a^3)}{\partial c_1}$$

while for the case $C\,H$ we have

$$\frac{\partial U_p(w_a^1)}{\partial c_1} < \frac{\partial U_p(w_a^2)}{\partial c_1} < \frac{\partial U_p(w_a^3)}{\partial c_1}. \blacksquare$$

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