Backward Integration and Risk Sharing in a Bilateral Monopoly

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ABSTRACT

This paper investigates the nature of the contract between a risk-neutral downstream firm (principal) and a risk-averse upstream firm (agent) within a bilateral monopoly model in which the problems of risk sharing, private information, moral hazard, and backward integration are simultaneously present. The findings of this paper indicate that (1) it is never optimal for the principal to design the cost-plus-fixed-fee (CPFF) contract for the agent and (2) it is never optimal for the principal to hold full backward integration or to hold no backward integration.

INTRODUCTION

A considerable agency-theoretic literature has developed recently that addresses procurement of goods and services as often being characterized by bargaining and contracting between the government (principal) and a single supplier (or several suppliers, i.e. agent(s)). Papers focusing on this theme (see Baron and Besanko (1987, 1988), Laffont and Tirole (1986) and McAfee and McMillan (1986)) study the purchase of a particular good within the framework in which uncertainty, asymmetric information, and moral hazard are simultaneously present. A common feature of all these models is that the optimal linear contracts are both incentive compatible and efficient. Moreover, if the supplier is risk-averse, procurement contracts must be designed to share the risk of unpredictable cost fluctuations. An exception is Laffont and Tirole (1986), who showed that under risk neutrality the most efficient firm chooses a fixed-price contract and that the less efficient firms opt for an incentive contract.

In the context of bilateral monopoly contracting practices with uncertainty and asymmetric information, Riordan (1984) established necessary and sufficient conditions for the existence of contracts that are efficient and incentive compatible. These contracts can be implemented by a truthful sequential revelation game, which means that truthfulness is an optimal Bayesian strategy for the seller and a dominant strategy for the buyer. In his later work, Riordan (1986) extended and generalized his previous work to show that ex post public information (e.g., accounting data and performance tests) can be employed in designing contracts that yield first-best specification decisions. His analysis demonstrated that price schedules depend explicitly on the realization of jointly observed ex post information. In his two papers, neither risk sharing nor moral hazard were considered.

Most recently, building on a principal and agent model and assuming that the long-term contract between principal and agent is incomplete, Riordan (1990) showed that some backward integration by the risk-neutral principal (downstream firm) is optimal if it increases the risk-neutral agent's (upstream firm) production, and that backward integration increases with the sunkness of the agent's investment. In a subsequent work, Riordan (1991) demonstrated that the agent's investment in relation-specific human assets (e.g., effort) may be either discouraged or encouraged by backward integration. Also, a heightened degree of asset specificity might either favor or disfavor backward integration.
However, neither ex post public information (e.g., the agent's reported costs), which can be employed in designing contracts, nor the effect of backward integration's risk sharing is considered by Riordan. Furthermore, the assumption that allows the quantity ordered from the downstream firm to be normalized to one ignores the effect of quantity changes upon backward integration and effort investment.

Although risk sharing, moral hazard, and private information have been studied extensively in the above models, there has been almost no investigation of the extent or precise nature of their effects on a bilateral monopoly that maintains a long-standing relationship, for instance, business partners.

This is accomplished by extending Riordan's (1984) bilateral contracts model to include moral hazard and backward integration in a framework of long-term business partner structure of stable and mutual relationships among trading partners. From this point of view, therefore, our model move toward the study of uncertainty, asymmetric information, moral hazard, and risk sharing in a procurement contracting framework by introducing backward integration into the model of vertical shareholding interlocks previously examined in the above models.

The remainder of the paper is organized as follows. Section 2 defines the basic model used to describe the contracting problem. Section 3 analyzes the problem and derives the second-best procurement contract contingent upon the agent's reported cost. Section 4 presents the comparative static results of our model. Conclusions are summarized in Section 5.

THE MODEL

Descriptions of the market and information

A principal-agent model is developed in this section. To accomplish the objectives of analyzing the downstream firm's ownership share (δ) in upstream profits πA and the downstream firm's compensation T, a bilateral monopoly with uncertainty and asymmetric information is employed. The long-term contracting environment involves a single large downstream firm (henceforth referred to as the principal) and a single upstream firm (henceforth referred to as the agent), who contract for provision of quantity X of a good in exchange for compensation T.

The market demand function of the principal is assumed to be linear and stochastic. Specifically

\[ P_Y = a - bY + \varepsilon, \quad a, b > 0, \]  \hspace{1cm} (1)

where \( \varepsilon \) is a normally distributed random variable with zero mean and variance \( \alpha \). The variable \( Y \) is the product amount produced by the principal. For simplicity, the production function of the principal is \( Y = \lambda X \). Variable \( P_Y \) denotes the prices of product Y. We assume that the market demand of the principal is unknown to the agent.

The agent produces a single intermediate output X at monetary cost \( C = C(E, \theta)X + \eta \). Variable E denotes the agent's relation-specific cost-reducing effort level, which is chosen after the contract is determined and is unknown to the principal. Efficiency parameter \( \theta \) belongs to \([0, \theta_0] \) where \( \theta_0 > 0 \). This cost information is privately observed by the agent before the specification of the contract. Random variable \( \eta \) is assumed to be normally distributed with zero mean and variance \( \beta \), and denotes a forecast error, unknown to the agent when he chooses his output and effort levels. To keep the problem mathematically tractable, however, we shall assume that the agent's cost function is bilinear in \( E \) and \( \theta \) of the form

\[ C = (\theta - E)X + \eta. \]  \hspace{1cm} (2)
Following Baron and Besanko (1987,1988), we assume that production cost C can only be observed by the agent and is not verifiable, so the contract with the agent cannot be selected contingent upon C. It can, however, be determined contingent upon the message delivered by the agent about his production cost. We assume that the principal knows the agent's ex post reported cost given by

\[ \hat{C} = C + \xi, \] (3)

Where \( \xi \) is a normally distributed random variable with zero mean and variance \( \gamma \). It follows that \( \hat{C} \) is also a normally distributed random variable with a mean of \( \langle 0 - E \rangle X \) and a variance of \( \gamma + \beta \).

As Baron and Myerson (1982) noted, if the principal asks the agent for a cost report, we could anticipate that the agent might misreport his cost because it was to his advantage to do so. However, If the principal and the agent are business partners and hence have a long-term relationship, to impose a penalty on the agent’s misreported cost or to monitor the agent’s reported cost may not be appropriate. Consequently, in this paper, we propose a new method for the principal to induce the agent to report his true cost. Our method is to allow the principal to hold partial ownership in the agent's profits. This implies that backward integration assumes the roles of shared interdependence and stability in long-term contracting relationships. To our knowledge, no work to date has focused on these implications in procurement contracts.

In the context of the model considered here, the principal offers the agent a contract that specifies the principal's ownership share (\( \delta \)) in the agent's profits, the agent's compensation (T), and the quantity (X) to be provided by the agent. Variables \( \delta \), T, and X are all dependent on the agent's reported cost \( \hat{C} \). In Riordan's (1990) terminology, variable \( \delta \) measures the degree of backward integration. As mentioned above, this partial ownership in the agent's profits serves as a cost-revealing mechanism that can induce the agent to report his true cost. Like contracts used in actual practice, the agent's compensation T is assumed to be linear in the ex post reported cost, \( \hat{C} \). Thus:

\[ T = F + R\hat{C}, \] (4)

where F is a fixed payment and R is a cost-sharing ratio. As is well known, if R=1, (4) defines a cost-plus fixed fee contract (CPFF). If R=0, this is a firm-fixed price contract (FFP). If 0<R<1, this is a cost-plus incentive contract (CPIF).

As in Baron and Besanko (1987, 1988), we model the behavior of the principal and the agent to consist of the following stages.

(1) “Nature” chooses a type \( \theta \in [\theta_1, \theta_2] \) for the agent that is privately observable to the agent.

(2) The contract specifies a compensation T to be made when quantity X is delivered, and the principal's ownership \( \delta \) in the agent's profits. Both T and \( \delta \) depend on the agent's reported cost. At this moment, the principal has a uniform distribution function \( H[\theta] \) prior on the range \([\theta_1, \theta_2] \) of \( \theta \) and an associated density function \( h(\theta) = H' \), which we assume is positive in its support \([\theta_1, \theta_2] \). Thus, the principal offers a contract \( (F(\theta), R(\theta), \delta(\theta), X(\theta)) \) for all \( \theta \in [\theta_1, \theta_2] \), where \( \theta \) is the agent's reported cost parameter.

(3) The agent selects a particular value of \( \theta \).

(4) Once a contract has been made, the agent exerts effort in the production of X and incurs a cost C.

(5) The agent submits his reported cost \( \hat{C} \) and delivers X to the principal in exchange for compensation T.

(6) The principal satisfies the demand \( Y(R_{i}(\theta)) \) during the period.
The agent’s optimization problem

In this subsection we employ the model to characterize the optimal conditions of the contracting problem.

The profit $\pi^A$ of the agent is

$$\pi^A = (1 - \delta)\left( F + R\hat{C} - C \right).$$  \hspace{1cm} (5)

Assume that the preference of the risk-averse agent is described by the negative exponential utility function in profits $\pi^A$ and effort $E$ and the agent has constant absolute risk aversion; that is

$$U(\pi^A, E) = a - b \exp\left[-\rho(\pi^A - W(E))\right].$$ \hspace{1cm} (6)

Where $a, b$ are parameters, $\rho$ denotes the agent’s risk aversion, and $W(E)$ stands for the agent’s disutility of effort. Without loss of generality, we assume that $W(E) = \frac{1}{2}E^2$ is common knowledge. Given that the stochastic rate of profits is normally distributed, it follows that for a type-0 agent

$$\max U(\pi^A, E) \text{ is equivalent to } \max \left[ \mu_{x^t} - \frac{\rho \sigma_{x^t}^2}{2} - W(E) \right].$$ \hspace{1cm} (7)

where $\mu_{x^t}$ and $\sigma_{x^t}^2$ are the mean and variance of profits.

To obtain the expressions $\mu_{x^t}$ and $\sigma_{x^t}^2$, straightforward calculation shows that

$$\mu_{x^t} = (1 - \delta(0))^2\left[ F(0) - (1 - R(0))(\theta - E(0))X(0) \right] \quad \text{and} \quad \sigma_{x^t}^2 = (1 - \delta(0))^2\left[ \gamma R^2(0) \right]$$ \hspace{1cm} (7a)

As pointed out in Kawasaki and McMillan (1987) and Asanuma and Kikutani (1992), (7a) tells us that if the value of either the cost-sharing ratio, $R$, or backward integration, $\delta$, is set high, then the principal absorbs more cost fluctuations of the agent. These are the insurance effects of the contract formula and the compensation. Concerning the effect of incentive, however, we get a different picture. That is, when $\delta$ is set high, gains from the agent’s cost-reducing efforts are largely shared by the principal. This will reduce the agent’s innovation incentives. But $R$ does not affect the level of the agent’s cost-reducing effort. We shall demonstrate this implication in the following section.

The foregoing results show that for the principal both backward integration and the cost-sharing ratio have the same insurance effect but only the former has an incentive effect. In other words, only the principal’s backward integration can influence the agent’s effort decisions. (i.e., the degree of the agent’s moral hazard).

In equilibrium it follows that the agent will choose his report $\theta(0)$ and his effort $E(0)$ to maximize $U(\pi^A, E)$. In addition, according to Fudenberg and Tirole (1991), the revelation principle shows that optimal mechanisms for the principal can restrict attention to mechanisms that induce the agent to reveal its type truthfully; In other words, for a mechanism to induce truthful reporting, it must be incentive compatible. i.e., $\theta(0) = 0$. So that we have

$$(\theta(0), E(0)) = \arg \max_{\theta, E} U(\theta(0), E; 0) = \left[ 1 - \delta(0) \right] F(0) - \left[ 1 - R(0) \right] \left[ (\theta - E(0))X(0) \right] \cdot \frac{1}{2} \rho \left[ 1 - \delta(0) \right] \left[ \gamma R^2(0) \right] + \frac{1}{2} E^2(0) \hspace{1cm} (8)$$

As in Baron and Besanko (1988), let $u(\theta) = U[\theta(0), E(0); 0]$ be the agent’s indirect utility. Because the agent’s utility level must be positive under an optimal mechanism, meaning that $u(\theta)$ must also satisfy the individual rationality constraint, $u(\theta)$ can be denoted the agent’s information rent.

Now the first-order condition for the agent to choose the level of effort is
\[(1 - \delta(0)(1 - R(0)))X(0) = E(0) \text{ for } \forall \theta \in [0, \theta_2].\]  

(9)

Equation (9) explains how an optimal contract should be designed to alleviate the agent’s moral hazard problem. Therefore, (9) essentially is the moral hazard constraint (see Baron and Besanko (1988)).

To ensure that the agent participates in the principal’s contract, individual rationality or participation must be satisfied. That is, the agent will accept a contract only if his utility \(u(0)\) is greater than his reservation utility, which here is assumed to be equal to 0. Therefore, the contract must satisfy

\[u(0) \geq 0 \quad \forall \theta \in [0, \theta_2].\]  

(10)

Equation (10) states that if the contract is feasible, the agent obtains nonnegative information rent because of its private information. As will be seen later, \(u(0)\) represents a state variable that gives the agent’s utility under an incentive compatible contract. The envelope theorem implies that under any incentive compatible contract

\[u'(0) = -[1 - \delta(0)][1 - R(0)]X(0).\]  

(11)

From (11) we see that \(u(0)\) is nonincreasing in \(\theta\) so as expected the higher is the cost parameter \(\theta\), the lower is the agent’s utility. This implies that (11) can be rewritten as

\[u(0) = u(\theta_2) - \int_{\theta_2}^{\theta_1} (1 - \delta(i)(1 - R(i)))X(i)di \quad \forall \theta \in [\theta_1, \theta_2].\]  

(12)

Equation (12) states how the agent chooses \(\theta\) to increase his utility. Thus, in the terminology of Baron and Besanko (1988), (12) is referred to as the self-selection constraint.

In what follows, we shall discuss the optimal contract for the principal subject to (9), (10), and (12).

The principal’s optimization problem

We assume that the principal is risk neutral. He designs a contract to maximize his expected profits subject to the agent’s individual rationality and incentive compatible constraints:

\[
(P) \max_{F(\cdot), R(\cdot), \delta(\cdot), X(\cdot), E(\cdot), u(\cdot)} \pi^* = \int_{\theta_1}^{\theta_2} \left[ \frac{\alpha X(\theta)}{\lambda} - \frac{bX(\theta)^2}{\lambda^2} \right] \left[ (1 - \delta(0))F(\theta) - \left[ (R(\theta) + \delta(0)(1 - R(\theta)))X(0) \right] \right] f(\theta)d\theta
\]

s.t: (9), (10) and (12).

Note that \((P)\) is known as the second-best problem and the solution of \((P)\) as the second-best mechanism (see Baron and Besanko, 1987, 1988). To further simplify \((P)\), we rewrite (8) as

\[(1 - \delta)F = u + (1 - \delta)(1 - R)(\theta - E)X + \frac{1}{2} \rho (1 - \delta)^2 \left[ (1 - \gamma)^2 + \gamma R^2 \right] + \frac{1}{2} E^2.\]  

(14)

Substituting (12) and (14) into (13) yields

\[
\pi^* = \int_{\theta_1}^{\theta_2} \left[ \frac{\alpha X(\theta)}{\lambda} - \frac{bX(\theta)^2}{\lambda^2} \right] \left[ (1 - \delta(0))F(\theta) - \left[ (R(\theta) + \delta(0)(1 - R(\theta)))X(0) \right] \right] f(\theta)d\theta - G(\theta) \left[ (1 - \delta(0))\left[ (1 - R(\theta))X(0) \right] \right] f(\theta)d\theta-u(\theta_2),
\]

where \(G(\theta) = \frac{H(\theta)}{h(\theta)}\), which is assumed to be nondecreasing in \(\theta\). In the literature on incentive contracts, \(G(\theta)\) is referred to as the marginal information costs associated with the agent’s incentive to overstate his costs under procurement contracting (see Baron (1988)). In this model, however, \(G(\theta)\) is interpreted as the shadow price of the self-selection constraint (12).
Note that incentive compatibility implies that from (11), \( u(0) \) is nonincreasing in \( \theta \), so \( u(0_2) \geq 0 \) is necessary and sufficient for individual rationality. Therefore, we can replace (10) by \( u(0_2) \geq 0 \). Now the principal's optimization problem can be restated as follows:

\[
\max_{R(\delta(\cdot), \lambda(\cdot), \xi(\cdot), u(\theta_2))} \pi^p = \int_0^1 \left( \frac{\alpha X(0)}{\lambda} - \frac{bX(0)^2}{2\lambda^2} - (0 - E(0))X(0) \right) + \frac{E(0)^2}{2} - \frac{\rho(1 - \delta(0))^2(\beta(1 - R(0))^2 + \gamma R(0)^2)}{2} \\
- G(0)[1 - \delta(0)][1 - R(0)]X(0) f(0) d\theta - u(0_2)
\]

s.t.: (9) and \( u(0_2) \geq 0 \)

We have reduced Problem \( (P) \) to an optimal control Problem \( (P^*) \) with control variables \( R(\cdot) \), \( \delta(\cdot) \), \( E(\cdot) \), and \( X(\cdot) \) and state variable \( u(0_2) \).

In the next section, we shall characterize and also represent analytic expressions for the agent's optimal effort and the principal's effort subsidy, backward integration, and ordered quantity.

**PROPERTIES OF THE SECOND-BEST SOLUTION**

**Determination of the optimal cost-sharing ratio**

To analyze the optimal solution of Problem \( (P^*) \), let the multiplier for the constraint (9) be \( \eta \); the Lagrangean associated with this problem can be expressed as

\[
L(R, \delta, E, X, \eta) = \left[ \frac{\alpha X^2}{\lambda^2} - \frac{(0 - E)X}{2} - \frac{\rho(1 - \delta)^2(\beta(1 - R)^2 + \gamma R^2)}{2} - G(0)[1 - \delta(0)][1 - R(0)]X + \mu[1 - R(0)]X - E \right] f(0)
\]

It is worth noting that either with or without backward integration \( G(0) \) is nonnegative, which implies that the agent with a lower cost parameter always has an incentive to misreport its cost to obtain higher profits. The multiplier \( \mu(0)/f(0) \) reflects the principal's preferences for backward integration and can be interpreted as the shadow price of the moral hazard constraint (9). More specifically, we think of the sign of \( \mu(0) \) as representing the preference of the principal to subsidize or to tax the agent's relation-specific cost-reducing effort activity. In what follows, we call \( \mu \) an effort subsidy if it is positive, and \( \mu \) an effort tax if it is negative.

The first-order conditions are both necessary and sufficient because the Lagrangian is a strictly concave function of \( X \), \( E \), \( \delta \), and \( R \) and is independent of \( u \).

We gives

\[
X - E = \mu(0)
\]

\[
\rho(1 - \delta)[\beta(1 - R)^2 + \gamma R^2] = (1 - R)X - E - G(0))
\]

\[
\rho(1 - \delta)[\beta(1 - R)^2 - \gamma R^2] = X(X - E - G(0))
\]

Given (18) and (19) we have the following.

**Proposition 1.** The optimal cost-sharing ratio \( R^* \) is given by \( R^*(0) = 0 \) if \( \gamma > 0 \), and \( R^*(0) \in [0, 1] \) if \( \gamma = 0 \).

Note that the optimal cost-sharing ratio is independent of the principal’s beliefs about the agent’s cost parameter \( 0 \) and the quantity demanded from the principal. Furthermore, it is not determined by the interaction of risk-sharing, private information and moral hazard effects. Rather, the optimal cost-sharing ratio can be implemented by using information about the variance of the agent’s reported costs. In other words, the noisiness of the reported costs
determines whether the agent will be “subsidized” but not what the value of the optimal cost share ratio will be.

Furthermore, the striking feature of Proposition 1 is that it contains the property of double separation. This means that both the optimal policies of the agent's effort and the principal's effort subsidy, backward integration, and ordered quantity are independent of the agent's cost-reporting policy. More specifically, for the agent, cost-reducing effort policy is separate from cost-submitting policy. In practice, this is an important phenomenon of division of labor because a production commission decides how to exert cost-reducing effort and a cost-submitting commission determines how to report production cost truthfully. Moreover, the decisions of the cost-submitting commission are not affected by the policies of the principal's effort subsidy, backward integration and demanded quantity. This indicates that the agent has the authority to determine how it wants to submit its costs.

For the principal, auditing policy and the policies of effort subsidy, backward integration, and ordered quantity are separate. This indicates that once the auditing commission finds that the agent has misreported its costs, the decisions of the commission do not affect or interrupt the agent's cost-reducing effort activity. This means that the interdependent relationships of production between both parties continue without interruption because of the auditing policy.

The above discussion suggests that the principal's auditing policy and production-related policies are not dependent upon each other. Therefore, two policies can be performed by the different commissions. This is crucial in the view of administrative management.

Proposition 1 also provides the implications that show how the principal uses his cost-sharing strategy. Two special cases of the Proposition warrant emphasis. First, when $\gamma > 0$, this means that the principal has found that the agent is likely to misreport its cost parameter. Then, the principal will set $R^* = 0$. In this case, the FFP (firm-fixed price) contract is optimal. Second, when $\gamma = 0$, this means that the principal has found that the agent will report his true cost parameter. The compensation will be based on the cost incurred by the agent. In this circumstance, both FFP and CPIF (cost-plus incentive fee) contracts are optimal.

Furthermore, Proposition 1 also indicates that it is never optimal for the principal to design the cost-plus-fixed-fee (CPFF) contract for the agent, even if the latter has submitted his true cost parameter.

**Determination of the optimal effort, effort subsidy, and backward integration**

For simplicity, we make the following assumptions,

Assumption 1. There exists a second-best quantity $X^*(0)$.

Assumption 2. The average shadow price of the self-selection is less than 1, that is, $X^*(0) > G(0)$.

It is easy to see that Assumption 1 is satisfied as long as we choose the proper specification of parameters. Stated another way, the problem concerning determination of what quantities to be produced can be solved. Although this is an essential problem for the principal, most previous studies have ignored this aspect. As indicated in Footnote 16, an important property of the second-best quantity is that it is not dependent on the value of $\gamma$, i.e., the noisiness of the agent's reported cost. Consequently, neither control variables $E$ and $\delta$ nor multiplier $\mu$ is dependent on $\gamma$. This ensures what we have discussed above regarding the property of double separation. Furthermore, we do not assume that the quantity ordered from the principal is normalized to one (i.e., $X^*(0) = 1$). This allows us to investigate if the amount of cost risk the principal is willing to absorb increases with increases in output by the agent (or equivalently the quantity ordered from the principal). And it also allows us to analyze the effect of fluctuations of quantity ordered from the principal on the principal's backward integration and effort subsidy and on the agent's cost-reducing effort. Assumption 2 simply puts a positive upper bound on the agent's marginal information cost (or hazard rate). This also
indicates that the marginal information cost for the agent to overstate its true cost cannot be too large. Now, solving the system of equations by a simple algebraic calculation yields

\[
E^* = \frac{X^* - GX^*}{X^* + \rho \beta}, \quad \delta^* = 1 - \frac{X^* - GX}{X^* + \rho \beta}, \quad \mu^* = X^* \left(1 - \frac{X^* - GX}{X^* + \rho \beta}\right).
\] (20)

It is easy to see that \(E^*\), \(\delta^*\), and \(\mu^*\) are all positive. Since \(\mu^* > 0\) for expositional ease, we shall refer it as an effort subsidy. This result says that, in the presence of moral hazard and private information, the principal always prefers the agent's cost-reducing effort be subsidized. It is not surprising because the principal would use backward integration to reduce the agent's information rent and obtain some benefits from the agent's cost-saving effort. Therefore, to subsidize the agent's effort may in fact raise the principal's expected profits. This is exactly the meaning of backward integration-helping one another, shared interdependence and stability. Without loss of generality, we may also call backward integration a “profit-sharing ratio” because of the property of double separation above. Consequently, the role of backward integration in this paper serves two functions, cost risk-sharing and profit-sharing. This means that increasing the principal's backward integration raises its intentions both to share its agent's cost risk and to share its agent's expected profits. Now, because \(0 < \delta^* < 1\), we have the following.

**Proposition 2.** Suppose assumptions 1 and 2 hold. Then it is never optimal for the principal to hold full backward integration or to hold no backward integration.

To see why Proposition 2 is true, consider the case of \(\delta^* = 1\), which implies that the agent will not exert any effort in its cost-reducing activity because its principal takes away all of its returns from that activity. The case of \(\delta^* = 0\) illustrates that the principal is not concerned with the problem of moral hazard of his agent and allows his agent to report his production cost arbitrarily. In addition, the principal has subsidized his agent's effort activity even if \(\delta^* = 0\). Therefore, it is not profitable for the principal to set \(\delta^* = 0\).

Moreover, an important observation of Proposition 2 is that the principal prefers to produce his parts or manufacturing services from an outside firm (i.e., the agent) and to rely less on his in-house plant. Accordingly, backward integration supports the partner relationship between both parties.

Furthermore, \(E^* > 0\) implies that it is always best for the agent to exert cost-reducing effort activity. This is consistent with the implications of individual rationality and incentive compatibility.

In summary, (20) suggests that regardless of whether the agent has truthfully reported its production cost, the principal should choose profit-sharing and effort subsidy strategies to enforce its contracting mechanism, although the agent will be better off if it uses a truthful reporting strategy because of the property of double separation.

**CONCLUSION**

In this paper, we have examined the bilateral contracts model to include risk sharing, private information, moral hazard, backward integration in a long-term business structure of stable and mutual relationships among trading partners. Backward integration is used as an instrument to influence the agent's incentives to lie about his private cost information. We find that if the principal expects that the agent is likely to lie about his cost information, then an FFP(firm-fixed price) contract is optimal. On the other hand, if the principal expects the agent to truthfully report his cost information, then both FFP and CPIF(cost-plus incentive fee) contracts are optimal. Moreover, for the agent, cost-reducing effort policy is separate from cost-submitting policy; for the principal, auditing policy and the policies of effort subsidy, backward integration, and ordered quantity are separate. Our result shows that backward integration
supports the partner relationship between both parties, this implies that the principal prefers to produce his parts or manufacturing services from an outside firm (the agent) and to depend less upon his in-house plant. One extension is worth exploring. It would be interesting to include the interaction between the time paths of effort and monitoring in the model.

REFERENCES


