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RESUMO/ABSTRACT

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Keywords: outsourcing, cash, incentives, uncertainty
JEL classification: D81; G32; G33; L23; L24

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Abstract

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This paper investigates the effect of cash on a firm's choice between vertical integration and outsourcing. We model the production decision in a Principal-Agent framework, and show that what motivates the choice of outsourcing are the firms' cost differentials in effort and the benefit provided by the supplier's effort alone. This latter benefit is linked with greater probabilities of reaching high production values in good states of nature. Suppliers use cash as a strategic instrument to collect the surplus from outsourcing, and their wealth constraint or limited liability ensures them more attractive compensation schemes.

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1 Introduction

Since the seminal work of Sappington (1983) the Principal-Agent literature has recognized the importance of the agent's wealth constraints on the design of trade contracts. Sappington (1983) shows that in the presence of the agent's limited liability or wealth constraint, the risk neutral principal cannot afford to collect the whole surplus from trade, and therefore has to share this surplus with the risk neutral agent in order to ensure the firm's participation on trade. This is due to the fact that with the agent's wealth constraints, the principal is not entitled to use as much penalties to induce effort from the agent, and therefore the result is a contract that provides the latter with high-power incentives. Even though this limited liability effect has been documented in the economic literature, there are other related issues that remain to be explored, as the effect of the firms' cash holdings on the surplus parties derive from a contract. This study aims to fill this gap in the literature. We show that firms can strategically accumulate cash as means of increasing their bargaining power in an outsourcing relationship.

The model considers a risk neutral buyer (principal) that has to decide between two production regimes: vertical integration or outsourcing. Outsourcing involves delegation of production to a risk neutral supplier (agent) and relies on a contract that provides the incentives to ensure the supplier's participation and the adequate effort level. If the supplier has wealth constraints or limited liability, the contract has to be designed in such a way that also satisfies these constraints. Rather, vertical integration consists of internal production, which can occur with or without effort by the buyer. For each production regime, the probabilities associated with the value of production in each state of nature depend on the effort level exerted by firms. An increase in effort level influences positively the probabilities associated with the values of production in good states. Positive effort, however, implies a cost of effort.

In our model, the main advantage of the outsourcing contract stems from the lower cost of effort exerted by the supplier. If the buyer's choice is between outsourcing from a supplier that exerts effort and internal production also involving effort, then the surplus from outsourcing comes from the cost differential in effort between the buyer and the supplier. This is due to the assumption that both firms can generate the same value of production when exerting effort. If, however, the choice is between outsourcing from a supplier that exerts effort and internal production requiring no effort, the advantage of outsourcing relies entirely on the benefit associated with effort itself. This latter benefit is directly linked with a greater probability of reaching high values of production in good states.

One of the main aims of this study is to examine the link between the choice of the optimal production mode (outsourcing versus vertical integration) and the capital structure decision of both firms. We show that this decision plays an important role in the incentive scheme of the outsourcing contract. We examine under what circumstances the supplier should accumulate cash when participating in the outsourcing contract. We analyze the effect of the supplier's cash on the incentive scheme, and on the value derived by each firm under outsourcing.

We obtain the following main results. First, the major determinant of the use of cash by the supplier is the magnitude of the surplus from outsourcing and the relative value of the limited liability rent collected by the supplier.[1] As noted earlier, this surplus either comes from the difference in cost of effort between both firms (when the buyer's outside option is internal production with effort), or from the benefit associated with having the supplier exerting effort (when the buyer's outside option is internal production with no effort). For this latter case, we find that the benefit from effort is directly related with the wedge between the probabilities

[1]The surplus is measured as the extra value that can be generated by outsourcing as opposed to vertical integration.

associated with each state of nature and the volatility in the values of production. Our model predicts that the supplier accumulates cash for low levels of this surplus, in particular when it is lower than its limited liability rent. This occurs because the buyer's net gain from outsourcing is not enough to induce himself to choose outsourcing as opposed to vertical integration, and thus he requires from the supplier a cash compensation in order to participate in the outsourcing regime. Moreover, since the proportion of the surplus the supplier derives from outsourcing depends negatively on its level of cash holdings, in equilibrium the supplier accumulates the minimum cash, ensuring that the buyer is indifferent between outsourcing and vertical integration.

Before proceeding, we further contrast our analysis of the principal-agent model of outsourcing with related work in the literature.[2] As in Sappington (1983), Lewis and Sappington (2000) and Laffont and Martimort (2002), we derive a contract with limited liability constraints, and show how these constraints create a limited liability rent that accrues to the agent. More recently, Grossman and Helpman (2004) take an incentive scheme approach to explore the production decision in a model with limited liability constraints. They focus on the trade-off between greater monitoring under vertical integration and high-powered incentives for effort under outsourcing. We extend this literature by examining the link between the firms' capital structure and the production decision. Moreover, contrary to Grossman and Helpman (2004), we focus on costs differential as the main motivation for firms to outsource.

There is both empirical and anecdotal evidence that firms outsource to take advantage of cost differentials. Fixler and Siegel (1999) show that the propensity of a firm to outsource is a function of the difference between the price or marginal cost of the product or service and the marginal cost of in house production. Among

[2]Bolton and Dewatripont (2005), Laffont and Martimort (2002), Salanie (1999) and Hart (1995) provide extensive analysis of the main models on the theory of incentives.

the determinants for these cost differentials are differences in wages, the use of superior technology, economies of scale, or monitoring and transaction cost savings. Domberger (1999) and Greaver (1999) refer the existence of anecdotal evidence where one of the main reasons for outsourcing is "functional specialization", allowing the supplier to produce at a lower cost. Theoretical models that examine the choice between outsourcing and vertical integration have also incorporated cost differentials as a motive for outsourcing. The main contributions in this field include Grossman and Helpman (2002), McLaren (2000) and Antras and Helpman (2004) in the incomplete contracting or transaction economics literature, and Buehler and Haucap (2006), Chen (2001) and Shy and Stenbacka (2003) in the literature that has highlighted the role of strategic competition for a firm's decision to outsource.

The remainder of the paper is organized as follows. In section 2 we describe the basic assumptions of the model and derive the first best equilibrium. Section 3 develops the model when the supplier has to accumulate cash in order to induce the buyer to participate in the outsourcing regime. Section 4 concludes. Proofs of all propositions are given in the Appendix.

2 Model setup and first best

Consider a firm that has two alternatives regimes of production: vertical integration (I) or outsourcing (O). The vertical integration regime is equivalent to internal production, whereas outsourcing implies acquiring the good from a supplier. We denote the vertically integrated firm and the buyer of the outsourcing regime by B, and the supplier of the outsourcing regime by S. The value of production in each regime is stochastic and is denoted by $\widetilde{S}$, with $\widetilde{S} = \overline{S}$ in the good state of nature, or $\widetilde{S} = \underline{S}$ in the bad state of nature, with $\overline{S} > \underline{S}$. Define ΔS as the difference between these two values of production, i.e. $\Delta S \equiv \overline{S} - \underline{S}$. Moreover, the value of

production depends on the costly effort e exerted by each firm $i \in \{B, S\}$ (firm B for the vertical integration regime or supplier S for the outsourcing regime). We assume a binary effort level, which we normalize as a zero effort level and a positive effort of one: $e \in \{0, 1\}$. Exerting effort implies a cost of effort for the producer that is equal to $\psi_i(e)$ with the normalizations of $\psi_i(0) = 0$ and $\psi_i(1) = \psi_i$.

We assume that the supplier is more efficient in producing the good in the sense that its cost of effort is lower than the buyer's, i.e. $\psi_B \geq \psi_S$. The stochastic influence of effort on production is characterized by the probabilities $Pr\left(\widetilde{S} = \overline{S} \mid e = 0\right) = \pi_0$, and $Pr\left(\widetilde{S} = \overline{S} \mid e = 1\right) = \pi_1$, with $\pi_1 > \pi_0$. We denote the difference between these two probabilities by $\Delta\pi \equiv \pi_1 - \pi_0$. Thus, π_1 can be interpreted as the probability of the value of production being high when effort is exerted and π_0 as the probability of it being high when effort is not exerted. With this characterization, the supplier prefers the stochastic distribution of the value of production induced by the positive effort level $e = 1$ to that induced by the null effort level $e = 0$. For simplification purposes, we assume risk neutrality and a zero discount rate.

As a benchmark, let us first assume that a global optimizer can produce the good exerting the lowest cost of effort ψ_S. Under the assumptions given above, the first best firm value, $V_{e=1}^{FB}$, is:

$$V_{e=1}^{FB} = \pi_1 \overline{S} + (1 - \pi_1)\,\underline{S} - \psi_S \tag{1}$$

Had the firm decided not to exert effort, it would realize the value of production in the good state $\overline{S}$ with a lower probability π_0, avoiding the cost of effort ψ_S. In this scenario, the firm value, $V_{e=0}$, would be:

$$V_{e=0} = \pi_0 \overline{S} + (1 - \pi_0)\,\underline{S} \tag{2}$$

Positive effort is exerted only if the firm value with effort is higher than the firm value with no effort ($V_{e=1}^{FB} \geq V_{e=0}$). We show that this condition for effort to be

exerted simplifies to:[3]

$$\Delta\pi\Delta S \geq \psi_S \tag{3}$$

This inequality states the benefit versus the cost of exerting effort under first best. By exerting effort the firm incurs the cost of effort ψ_S (RHS of (3)) and collects the value $\Delta\pi\Delta S$ (LHS of (3)). This benefit from effort comes from the fact that the value of production $\overline{S}$, which is greater than $\underline{S}$, arises more frequently when a positive effort is exerted. Greater effort value is directly linked with the wedge between the probabilities associated with each state of nature ($\Delta\pi$) and the volatility in the values of production (ΔS). From now on, it is assumed that it is efficient for the supplier to exert effort ($\Delta\pi\Delta S \geq \psi_S$) and that the first best is given by the RHS of (1).

We now examine the buyer's production decision (i.e. outsourcing versus vertical integration) assuming that cash will be accumulated by both firms prior to the outsourcing contract. We derive the conditions for which the outsourcing regime dominates, as well as the set of parameters for which firms find it optimal to accumulate cash. We assume in the equilibrium that cash will be accumulated by the supplier (section 3).

3 The model with cash holdings

In what follows we study the buyer's production decision assuming that the supplier can hold cash prior to the acceptance of the outsourcing contract. We examine under what circumstances the supplier is required to accumulate cash in order to induce the buyer's participation in the outsourcing contract. In particular, we investigate whether the use of cash by the supplier is linked with the magnitude of the surplus

[3]See proof in the Appendix.

from outsourcing, and analyze the effect of cash on the value collected by each firm. We start off with the derivation of the equilibrium for exogenous cash holdings, and subsequently consider the equilibrium with endogenous cash.

The contracting variable of the outsourcing regime consists in the transfer payments $\left(\overline{t}, \underline{t}\right)$ made by the buyer to the supplier. Since the supplier's effort is not directly observed by the buyer, the buyer can only offer a contract based on the observable and verifiable value of production, i.e. the transfer payments $t(\widetilde{S})$ are a function of the stochastic value of production. Transfer $\overline{t}$ ($\underline{t}$) is the payment received by the supplier if the value of production $\overline{S}$ ($\underline{S}$) is realized. The timing of the model is as follows. A time $t = 0$ the buyer offers a contract $\left\{\left(\overline{t}, \underline{t}\right)\right\}$ and the supplier invests in cash holdings in the amount C_S, with $C_S \geq 0$. At time $t = 1$ the supplier accepts or refuses the contract and, in case of acceptance, at time $t = 2$ exerts effort or not. Then, at time $t = 3$ the stochastic value of production $\widetilde{S}$ is realized and at time $t = 4$ delivery is executed.

The buyer's firm value under outsourcing, $B^O_{e=1}$, is given by:[4]

$$B^O_{e=1} = \pi_1 \left(\overline{S} - \overline{t}\right) + (1 - \pi_1)\left(\underline{S} - \underline{t}\right) \tag{4}$$

The problem of the buyer is to decide whether to induce the supplier to exert effort, and if he chooses to do so, which incentive contract $\left(\overline{t}, \underline{t}\right)$ should be used. The contract has to induce the supplier to exert positive effort and ensure participation, i.e. has to satisfy both the supplier's incentive and participation constraints. Furthermore, since we assume that the supplier has limited liability, the contract also has to satisfy its limited liability constraints. The optimal contract will depend on which constraints are binding. Let us first define those constraints and subsequently discuss the optimal contract of the outsourcing regime. If the supplier exerts positive

[4]We ignore the level of the buyer's cash holdings as they have no impact on the total firm value expression, and consequently on the decision to outsource. See proof in Appendix

effort, its value, $S^O_{e=1}$, is given by:

$$S^O_{e=1} = \pi_1 \max\left[\bar{t} + C_S, 0\right] + (1-\pi_1)\max\left[\underline{t} + C_S, 0\right] - \psi_S - C_S \tag{5}$$

Conversely, with no effort, the value, $S^O_{e=o}$, is:

$$S^O_{e=o} = \pi_0 \max\left[\bar{t} + C_S, 0\right] + (1-\pi_0)\max\left[\underline{t} + C_S, 0\right] - C_S \tag{6}$$

The corresponding supplier's incentive constraint is thus written as $S^O_{e=1} \geq S^O_{e=o}$, which simplifies to:

$$\begin{aligned} & \pi_1 \max\left[\bar{t} + C_S, 0\right] + (1-\pi_1)\max\left[\underline{t} + C_S, 0\right] - \psi_S \\ \geq \; & \pi_0 \max\left[\bar{t} + C_S, 0\right] + (1-\pi_0)\max\left[\underline{t} + C_S, 0\right] \end{aligned} \tag{7}$$

This constraint imposes the supplier to prefer to exert effort in the sense that he expects to receive the transfer payments with higher probability when effort is exerted, by comparison to the case when effort is not exerted. However, with no effort the supplier avoids the cost of effort ψ_S.

The supplier's participation constraint ensures that if effort is exerted, the supplier obtains at least its opportunity utility level, which we assume as zero. Therefore, it is written as $S^O_{e=1} \geq 0$, and simplifies to:

$$\pi_1 \max\left[\bar{t} + C_S, 0\right] + (1-\pi_1)\max\left[\underline{t} + C_S, 0\right] - \psi_S \geq C_S \tag{8}$$

We model the assumption of the supplier wealth constraint or limited liability by imposing that the incentive transfer payment must be greater than $-C_S$. Hence, the limited liability constraints are given by:

$$\bar{t} \geq -C_S \tag{9}$$

$$\underline{t} \geq -C_S \tag{10}$$

We show that depending on the exogenous amount of cash accumulated by the supplier, two contracts can be put in place. One ensuring that only the incentive constraint (7) and participation constraint (8) are binding, and another ensuring that only the incentive constraint (7) and limited liability constraint (10) are binding.[5] Proposition 1 summarizes these contracts.

Proposition 1 *Assume that the supplier holds an exogenous cash level C_S prior to the outsourcing contract. If $C_S > \frac{\pi_0}{\Delta\pi}\psi_S$ such that only the supplier's incentive constraint (7) and participation constraint (8) are binding, the equilibrium transfer payments of the outsourcing contract are:*

$$\overline{t}^* = \frac{1-\pi_0}{\Delta\pi}\psi_S \tag{11}$$

$$\underline{t}^* = -\frac{\pi_0}{\Delta\pi}\psi_S \tag{12}$$

If, however, $0 \leq C_S \leq \frac{\pi_0}{\Delta\pi}\psi_S$ such that only the supplier's incentive constraint (7) and limited liability constraint (10) are binding, the equilibrium transfer payments of the outsourcing contract are:

$$\overline{t}^* = \frac{1}{\Delta\pi}\psi_S - C_S \tag{13}$$

$$\underline{t}^* = -C_S \tag{14}$$

The results show that if the supplier is endowed with high levels of cash such that only the incentive and participation constraints are binding, it is rewarded if the value of production is high and punished if the value of production is low. The net utility if the value of production is high $\overline{U}^* = \overline{t}^* - \psi_S$ is $\overline{U}^* = \frac{1-\pi_1}{\Delta\pi}\psi_S > 0$ and the net utility if the value of production is low $\underline{U}^* = \underline{t}^* - \psi_S$ is $\underline{U}^* = -\frac{\pi_1}{\Delta\pi}\psi_S < 0$. Rather, for low levels of cash that bind both the incentive and limited liability constraints, the

[5]We also show that in equilibrium the transfer payment in the good state is higher than the transfer payment in the bad state, i.e $\overline{t} > \underline{t}$. This means that the constraint (9) is implied by (10).

supplier is entitled with a more attractive compensation scheme since the RHS of (11) is strictly higher than the RHS of (13), and the RHS of (12) is strictly higher than the RHS of (14). This result is in line with the well known limited liability effect of the incentive schemes literature, as discussed by Sappington (1983), Lewis and Sappington (2000) and Grossman and Helpman (2004). When the limited liability constraint is binding, the buyer is limited in his punishments to induce effort. The supplier does not have enough cash to cover the punishment requested by the principal, and therefore needs to be compensated with more rewards when $\overline{S}$ is realized. A limited liability constraint on the supplier somehow induces the firm to become a risk lover, and implies high-power incentives (Laffont and Martimort (2002)).

Up to now, we have characterized the terms of the outsourcing regime. Next, we derive the firm value expressions under vertical integration in order to define the buyer's gain from outsourcing, and ultimately the condition for the outsourcing equilibrium. We assume that if the buyer produces internally he can either exert effort and incur the cost of effort ψ_B or do not exert effort and avoid this cost. If we denote the buyer's value under vertical integration with positive and zero effort by $B^I_{e=1}$ and $B^I_{e=0}$, respectively, it follows that the corresponding firm value expressions are given by:[6]

$$B^I_{e=1} = \pi_1 \overline{S} + (1 - \pi_1)\, \underline{S} - \psi_B \tag{15}$$

$$B^I_{e=0} = \pi_0 \overline{S} + (1 - \pi_0)\, \underline{S} \tag{16}$$

Therefore, if the buyer chooses outsourcing as opposed to any form of vertical integration, his gain from outsourcing, $GainB^O_{e=1}$, can be defined as the difference between his value under outsourcing and the maximum of his value under vertical

[6]We also assume that both the buyer and the supplier can generate the same value of production when exerting effort.

integration, i.e.:

$$GainB^{O}_{e=1} = B^{O}_{e=1} - \max\left(B^{I}_{e=1}, B^{I}_{e=0}\right) \tag{17}$$

We are now in a position to derive the firms' equilibrium values under each compensation scheme of the outsourcing contract, and the corresponding gain to the buyer. Substituting the appropriate equilibrium transfer payments $\overline{t}^{*}$ and $\underline{t}^{*}$ from proposition 1 into the expressions for $B^{O}_{e=1}$, $S^{O}_{e=1}$ and $GainB^{O}_{e=1}$, gives us the results of proposition 2 below. To simplify our exposition of the equilibrium, define M as:

$$\begin{aligned} M &\equiv \psi_B \text{ if the buyer's outside option is integration with effort} \\ M &\equiv \Delta\pi\Delta S \text{ if the buyer's outside option is integration with no effort.} \end{aligned} \tag{18}$$

Proposition 2 *Assume that the supplier holds an exogenous cash level C_S prior to the outsourcing contract. 1) If $C_S > \frac{\pi_0}{\Delta\pi}\psi_S$ such that only the supplier's incentive constraint (7) and participation constraint (8) are binding, the equilibrium values of the buyer and the supplier are given by:*

$$B^{O}_{e=1} = \pi_1\overline{S} + (1-\pi_1)\,\underline{S} - \psi_S \qquad\qquad S^{O}_{e=1} = 0$$

The net gain to the buyer from the outsourcing regime is positive and is given by:

$$GainB^{O}_{e=1} = M - \psi_S \tag{19}$$

where M is as stated in (18). 2) If, however, $0 \leq C_S \leq \frac{\pi_0}{\Delta\pi}\psi_S$ such that only the supplier's incentive constraint (7) and limited liability constraint (10) are binding, the equilibrium values of the buyer and the supplier are given by:

$$B^{O}_{e=1} = \pi_1\overline{S} + (1-\pi_1)\,\underline{S} - \psi_S\left(1 + \frac{\pi_0}{\Delta\pi}\right) + C_S \qquad\qquad S^{O}_{e=1} = \frac{\pi_0}{\Delta\pi}\psi_S - C_S$$

The net gain to the buyer from the outsourcing regime is:

$$GainB^{O}_{e=1} = M - \psi_S\left(1 + \frac{\pi_0}{\Delta\pi}\right) + C_S \tag{20}$$

The supplier's optimal reaction with positive cash occurs if $\frac{\pi_0}{\Delta\pi}\psi_S \geq M - \psi_S$.

Proposition 2 shows very intuitive results concerning the effect of the supplier's limited liability and cash on the surplus generated by the outsourcing contract, and on how this surplus is shared between the buyer and the supplier. First, it is important to discuss what determines the surplus generated by the outsourcing contract $(M - \psi_S)$.[7] As noted earlier, it depends on which outside option is considered for the outsourcing regime. If the buyer's decision is between outsourcing from the supplier that exerts effort and internal production also involving effort, then the surplus from outsourcing derives from the difference in cost of effort between the buyer and the supplier: $\psi_B - \psi_S > 0$. If, however, the choice is between outsourcing from a supplier that exerts effort and internal production requiring no effort, the advantage from the outsourcing regime relies entirely on the net value associated with having the supplier exerting effort: $\Delta\pi\Delta S - \psi_S > 0$. For this last case, the results show that a greater wedge between the probabilities associated with each state of nature $(\Delta\pi)$ and a higher volatility in the values of production (ΔS) increase the value associated with the supplier's effort, and consequently increase the chances of having outsourcing.

Second, let us discuss the equilibrium for each outsourcing contract. We find that if the supplier is endowed with high level of cash such that the firm's limited liability constraint is not binding (for $C_S > \frac{\pi_0}{\Delta\pi}\psi_S$), the buyer only has to offer a contract that ensures the supplier's positive effort and matches the supplier's outside option, which is zero. The buyer collects the whole surplus from the outsourcing contract and realizes the first best firm value $(\pi_1\overline{S} + (1 - \pi_1)\underline{S} - \psi_S)$.[8] Rather, if the supplier's limited liability constraint is binding (for $0 \leq C_S \leq \frac{\pi_0}{\Delta\pi}\psi_S$), the buyer is limited in his punishments to induce effort from the supplier. This limited liability effect allows the supplier to capture a positive rent $\frac{\pi_0}{\Delta\pi}\psi_S - C_S$, which means that

[7] This surplus equals the buyer's gain under outsourcing when the supplier's limited liability constraint is not binding, i.e, it is given by the RHS of equation (19)

[8] This is equivalent to a scenario where the supplier has unlimited liability.

the surplus from outsourcing is no longer fully collected by the buyer.

Inequality $\frac{\pi_0}{\Delta\pi}\psi_S \geq M - \psi_S$ is very important as it defines the set of parameters necessary to prevail the outsourcing equilibrium where the supplier accumulates positive cash. It states that the supplier only reacts with positive cash when the buyer's gain with the outsourcing contract, $M-\psi_S$, is not enough to cover the limited liability rent captured by the supplier, $\frac{\pi_0}{\Delta\pi}\psi_S$. In that case, in order to induce the buyer to participate in the outsourcing regime, the supplier has to compensate the buyer with a cash transfer payment. This suggests that the supplier's equilibrium level of cash holdings is such that it minimizes C_S, subject to the constraint that the buyer chooses the outsourcing contract as opposed to vertical integration. This would imply the supplier to choose C_S making the buyer to break even or to have a net gain from the outsourcing contract of zero. Hence, the equilibrium level of cash accumulated by the supplier, C_S^*, is determined by solving the buyer's gain equation $M - \psi_S\left(1 + \frac{\pi_0}{\Delta\pi}\right) + C_S = 0$ for C_S. Proposition 3 summarizes the outsourcing equilibrium with endogenous cash.

Proposition 3 *Assume that prior to the acceptance of the outsourcing contract, the supplier decides which amount of cash C_S^* to hold. The supplier sets a cash level that allows the firm to collect the whole surplus from the outsourcing contract, $M - \psi_S$, and ensures to the buyer a net gain of zero. The equilibrium level of cash accumulated by the supplier is:*

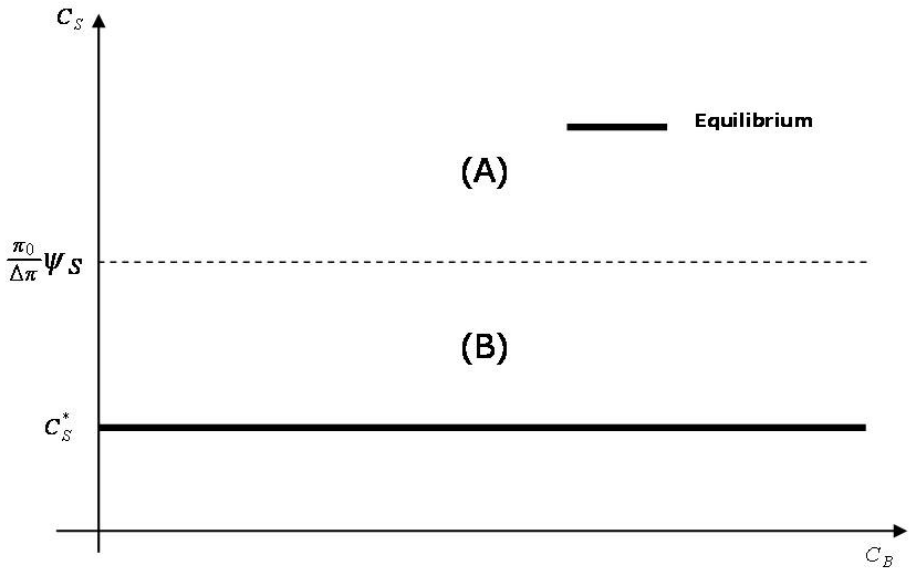
$$C_S^* = \psi_S\left(1 + \frac{\pi_0}{\Delta\pi}\right) - M \tag{21}$$

where the expressions for M are as previously stated.

The equilibrium level of cash is such that it ensures the buyer's participation and allows the supplier to collect the whole surplus from the contract. This result is very important as it shows how cash can be used as a strategic instrument to

Figure 2.1: Equilibrium with Cash

Level of cash holdings accumulated by the supplier, C_S, as a function of the level of cash holding of the buyer, C_B. In region (A) $(C_S > \frac{\pi_0}{\Delta\pi}\psi_S)$ the supplier's limited liability constraint is not binding, whereas in region (B) $(C_S^* \leq C_S < \frac{\pi_0}{\Delta\pi}\psi_S)$ it is binding. The equilibrium cash level accumulated by the supplier is given by $C_S^* = \psi_S\left(1 + \frac{\pi_0}{\Delta\pi}\right) - M$, such that it minimizes C_S and the buyer breaks even (i.e. has a zero surplus from outsourcing).



grasp the surplus from a trade relationship. Figure 2.1 illustrates the equilibrium under outsourcing assuming that the supplier can accumulate positive cash in the amount C_S. In region (A) the level of cash holding is such that the supplier's limited liability constraint is not binding, and as a consequence the buyer fully collects the outsourcing surplus. For intermediate levels of cash holdings in region (B) the limited liability constraint is binding, and the rents of the outsourcing contract are shared between the parties. In equilibrium, the supplier sets C_S at C_S^*, collecting the whole surplus from outsourcing.

Next, we consider the supplier's optimal reaction assuming that the condition for positive cash is violated. This happens when the surplus from the outsourcing regime, $M - \psi_S$, is high enough to compensate the limited liability rent captured by the supplier., i.e. when $\frac{\pi_0}{\Delta\pi}\psi_S \leq M - \psi_S$. As we discussed earlier, the magnitude of this surplus depends on the buyer's outside option. It will increase either when there

is an increase in the difference of cost of effort between the buyer and the supplier (higher $\psi_B - \psi_S$), or when the net benefit from having the supplier exerting effort, as opposed to vertical integration with no effort, also increases (higher $\Delta\pi\Delta S - \psi_S$).

4 Conclusions

This paper examines the effect of capital structure on the production decision of firms in a principal-agent framework. We develop a model that explicitly considers the role of cash holdings in a firm's choice between vertical integration and outsourcing. Outsourcing involves delegation of production to a risk neutral supplier, whereas vertical integration implies internal production. We assume that for each production regime, the probabilities associated with the value of production in each state of nature depend on the effort level exerted by firms, and that production can occur with or without effort. Exerting effort is costly but it influences positively the probabilities of realizing high values of production. Furthermore, the model assumes that the supplier has wealth constraints or limited liability.

We identify two reasons why a buyer may benefit from engaging in an outsourcing contract in a setting like this. First, the firm can benefit from a lower cost of effort exerted by the supplier. We find that the surplus from the outsourcing contract, measured as the extra value that can be generated by having the outsourcing regime as opposed to vertical integration, is given by the cost differentials in effort between both firms. This occurs when the buyer's decision is between having internal production exerting effort, at a higher cost, and outsourcing from a supplier that also exerts effort but at a lower cost. Second, if the buyer's production decision is between outsourcing from the supplier and having internal production without exerting effort, then the surplus from outsourcing relies on the benefit associated with the supplier's effort itself. This benefit is directly linked with the wedge between

the probabilities associated with each state of nature and the volatility in the values of production.

We recognize in our model that the supplier can use cash holdings as a strategic instrument to collect the surplus from the outsourcing contract. We derive the conditions for which the supplier accumulates cash in order to induce the buyer to participate in the outsourcing regime. We show that what determines the use of cash by the supplier is the magnitude of the surplus from the outsourcing contract, and how it compares with the supplier's limited liability rent. The supplier accumulates cash when the surplus from the outsourcing contract is not enough to cover this limited liability rent. For this case, the buyer only chooses the outsourcing production regime if he receives a cash compensation from the supplier in the bad state of nature. Moreover, in equilibrium the supplier minimizes the amount of cash holding while still ensuring the buyer's participation (the buyer breaks even). This minimum level of cash provides the supplier the whole surplus from outsourcing.

This study could be extended in various ways. One could, for instance, allow for competition among several suppliers and analyze the terms of the outsourcing contract when they have different effort costs. The existence of more than one supplier with different effort costs would change the buyer's outside option, and ultimately could have an effect on the firm's capital structure and production decisions.

5 Appendix

Derivation of effort condition (3)

Exerting effort requires the first best firm value when effort is exerted, $V_{e=1}^{FB}$, to be higher than the firm value when effort is not exerted, $V_{e=0}$, i.e. $V_{e=1}^{FB} \geq V_{e=0}$ or the RHS of (1) to be higher than the RHS of (2). Condition (3) is derived by denoting $\Delta\pi = \pi_1 - \pi_0$ and $\Delta S = \overline{S} - \underline{S}$ and solving this inequality for $\Delta\pi\Delta S$.

Proof that the buyer's firm value expression does not depends on his cash holdings

Denote the level of the buyer's cash holdings by C_B. We show that this level of cash is not relevant for the outsourcing decision as the buyer's firm value expression do not depends on it. The buyer's firm value expression with cash under outsourcing is given by:

$$B_{e=1}^{O} = \pi_1 \max\left[\overline{S} - \overline{t} + C_B, 0\right] + (1-\pi_1)\max\left[\underline{S} - \underline{t} + C_B, 0\right] - C_B \qquad (22)$$

Assuming that $\overline{S} - \overline{t} + C_B > 0$ and that $\underline{S} - \underline{t} + C_B > 0$, this expression simplifies to $B_{e=1}^{O} = \pi_1\left(\overline{S} - \overline{t}\right) + (1-\pi_1)\left(\underline{S} - \underline{t}\right)$, which is not a function of C_B.

Proof of proposition 1

The proof involves two steps. First, suppose that $0 \leq C_S \leq \frac{\pi_0}{\Delta\pi}\psi_S$. We conjecture that (7) and (10) are the only relevant constraints. Both constraints are binding since the buyer is willing to minimize the payments made to the supplier. Hence, solving (7) and (10) with equalities we obtain the transfer payments $\overline{t}^* = \frac{1}{\Delta\pi}\psi_S - C_S$ and $\underline{t}^* = -C_S$. Condition (9) is satisfied since $\overline{t}^* = \frac{1}{\Delta\pi}\psi_S - C_S > -C_S$. Condition (8) is also satisfied since $S_{e=1}^{O} = \pi_1 \max\left[\overline{t} + C_S, 0\right] + (1-\pi_1)\max\left[\underline{t} + C_S, 0\right] - \psi_S - C_S = \frac{\pi_0}{\Delta\pi}\psi_S - C_S \geq 0$.

Second, for $C_S > \frac{\pi_0}{\Delta\pi}\psi_S$, the transfer payments $\overline{t}^* = \frac{1-\pi_0}{\Delta\pi}\psi_S$ and $\underline{t}^* = -\frac{\pi_0}{\Delta\pi}\psi_S$ are obtained by solving (7) and (8) with equalities since these two conditions are binding. Both limited liability constraints (9) and (10) are strictly satisfied.

Proof of proposition 2

The equilibrium values of the buyer and the supplier under outsourcing are obtained by substituting the appropriate equilibrium transfer payments derived in proposition 1 into the firm value expressions (4) and (5), respectively. This procedure is repeated for the buyer's net gain expressions (19) and (20).

In order to obtain the condition for the supplier's equilibrium reaction with positive cash $\frac{\pi_0}{\Delta\pi}\psi_S \geq M - \psi_S$, we first determine the level of cash holdings that ensure to the buyer a net gain of zero. We solve $M - \psi_S\left(1 + \frac{\pi_0}{\Delta\pi}\right) + C_S = 0$ for C_S and it gives that C_S equals $\psi_S\left(1 + \frac{\pi_0}{\Delta\pi}\right) - M$. Second, we know that in order for this to be the optimal reaction with positive cash, condition $C_S \geq 0$ has to hold, i.e. $\psi_S\left(1 + \frac{\pi_0}{\Delta\pi}\right) - M \geq 0$. After rearranging this inequality we obtain: $\frac{\pi_0}{\Delta\pi}\psi_S \geq M - \psi_S$

Proof of proposition 3

The equilibrium cash holding C_S^* solves the net gain expression of the buyer (20) for C_S making him to break even. The firm value expression in equilibrium are obtained by substituting the equilibrium cash holding into the firm value expressions derived in propositions 1 and 2 for the relevant case where $0 \leq C_S \leq \frac{\pi_0}{\Delta\pi}\psi_S$.

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