# EFFICIENT SOURCING AND DEBT FINANCING IN IMPERFECT PRODUCT MARKETS

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## Abstract

Supplier relations play an important role in determining a firm's product market strategy and position, by affecting the cost and quality of the product produced by the firm. These relations are especially significant since the cost of purchased materials for an average firm is more than half its total sales. In this paper, we model the adverse incentives of a firm that sources from a competitive supplier industry. We show that a firm's propensity to behave opportunistically towards its suppliers raises the firm's input costs by decreasing the number of suppliers servicing it. This results in a suboptimal production decision compared to the firm's first best choice. We argue that an appropriate level of debt financing alters the shareholder incentives and mitigates the hold-up problem. Further, we also show that at the optimal debt level, the firm produces its first best level of output.

## 1. Introduction

Manufacturing corporations typically operate within a network of contractual relations with their suppliers and distributors. They rely on arm's-length, bid-priced transactions with a large number of competitive suppliers and subcontractors. Few, if any, are so vertically integrated as to entirely avoid sourcing their inputs externally. In fact, in the U.S., the cost of purchased materials for an average manufacturing firm accounts for more than 50% of its total sales.[1] Supplier relations, therefore, have a major impact on the operating performance and shareholder value of a firm. To a great extent, these relations determine if the firm will establish and maintain a competitive advantage in the product markets. In this paper, we analyze an opportunism problem that arises in firm-supplier relations, and determine how corporate financial policy can be used to mitigate it.

The conditions for a mutually beneficial relation between a firm and its suppliers may be violated when the firm exploits its buying power. For instance, once suppliers have incurred set-up costs, a firm could lower the offered input price. The suppliers will stay in production as long as their variable costs do not exceed this new price, even if their sunk investment is not being recovered. Equivalently, the firm can renege on its obligation to provide enough business to the suppliers. This is known as the "hold-up" problem.[2] Examples of such opportunistic behavior abound. In one case, after a supplier built a plant to make radios for Ford, the auto-maker took a large fraction of the work in-house to Philco, its acquired subsidiary. The supplier was offered substitute work by Ford, but at a level that was insufficient to cover its initial outlay (Helper, 1991a).

Some firms have found it easier and more rewarding to simply force costs of their organization onto compliant suppliers, who are eager to maintain or increase their volume of business. Recently, GM is alleged to have rebid long-term contracts, demanding and obtaining price cuts of up to 20%, from its material suppliers.[3] United Airlines Inc. also forced its suppliers to cut costs by more than 10%.[4] Opportunistic behavior also can take other forms. A recent article discusses how large retailers like Wal-Mart demand (without further compensation) extra features

in products, or extra services such as new packaging and new delivery conditions, all of which cut into suppliers' quasi-rents.[5,6] Therefore suppliers, particularly those in competitive markets, are increasingly wary of buyer power, and take measures to protect themselves. In fact, Fitzgerald (1996) documents that most suppliers are reluctant to open their books to buying firms. Suppliers have a greater fear that buyers will chip away at their profit margin, than they fear a breach of confidentiality. We demonstrate that a firm's propensity for opportunism is rationally anticipated and therefore reduces the number of suppliers servicing it. This leads either to higher input prices or to fewer sourced inputs and consequently, to a suboptimal production level.

In a simple model where the states of nature are observable and verifiable, it is possible to write perfectly enforceable contracts that solve the problem of opportunism. In reality, there are many well-known practical constraints that make it costly to write and enforce complete contracts.[7] While we do not formally model these obstacles to efficient commitment, they motivate our research. This paper develops a model that illustrates how a firm's financing choice can mitigate the hold-up problem. For large corporations that make production decisions under price uncertainty, debt financing creates a distortion in the firm's output. We show that when debt financing is used, the output level chosen by the shareholders is larger than the firm-value maximizing level.[8] In our model, since an increase in output increases the optimal quantity of input demanded, more suppliers are encouraged to service the firm. However, an increase in debt is not without cost. The use of debt and the consequent deviation in the firm's output away from the value-maximizing level (and away from the output level desired by the bondholders), exacerbates the conflict of interest between the bondholders and shareholders of the firm. The bondholders rationally anticipate this "agency cost," and incorporate it in the price of debt. In their financing decision, the shareholders select the optimal level of debt by trading-off this agency cost against the benefit of improved sourcing efficiency in the supplier market. We show that for an optimally levered firm, the equilibrium input costs are lower, the output is at its first best level, and shareholder value is higher than that of an unlevered firm. These results obtain even when the suppliers extend trade credit to the firm.

In this paper, we build on the literature on appropriable rents by Williamson (1975), Klein, Crawford, and Alchian (1978), Kleindorfer and Knieps (1982), and Von Ungern-Sternberg (1988). Von Ungern-Sternberg (1988), in particular, considers the hold-up problem that arises when a large firm sources from a competitive supply market. We extend this literature by incorporating the effects of the firm's financing choice and the conflict of incentives between debtholders and equityholders on the equilibrium outcome. Kleindorfer and Knieps (1982) compare arm's length sourcing (spot markets), vertical integration, and long-term contracts, and conclude that vertical integration is optimal when the difference in bargaining power between the firm and the supplier is large. In our paper, we focus only on arm's length sourcing relations and show that even when bargaining power asymmetries are large (as is the case when the suppliers have to make large investments up-front), the financing policy of the firm may be structured such that the resulting sourcing inefficiency is mitigated. Thus, even arm's length sourcing arrangements may be sustained efficiently by using an appropriate financing choice that alters the firm's incentives for opportunistic behavior.

Our paper also is related to Dasgupta and Sengupta (1993) who model the propensity of a labor union to bargain with a firm for a fraction of its final product market profits. This results in underinvestment by the firm. They show that an action that locks up cash flows with a third party (such as debtholders), shields some of the firm's wealth from the labor union and solves the underinvestment problem. In their model, debt is a protection mechanism, while in our model debt is a mechanism that commits the firm to abstaining from opportunism.

The rest of the paper is organized as follows. Section 2 describes the model and the underlying assumptions. Section 3 discusses the hold-up problem, the costs associated with hold-up, and the firm's optimal financing decision. Section 4 contains some concluding comments.

## 2. The Model and Assumptions

### *2.1 The Firm*

Consider a firm that purchases an input for its production process from a competitive supply market. This firm is assumed to be a monopoly that faces a stochastic, downward sloping

demand curve $P(Q,\omega)$, where Q is the firm's output, P is the price of the product, and $\omega$ is the random variable that represents the price risk. The probability density function of $\omega$ is $f(\omega)$. The lower bound of this random variable is normalized to zero, and the support of $f(\omega)$ is on $[0,\Omega]$. We assume that the quantity of output produced is a linear function of the quantity of inputs.[9] Without loss of generality, each unit of output requires one unit of input. $R(Q,\omega)$ represents the revenues of the monopolist net of production and other costs, but *not* net of procurement costs. The state dependent profits of the monopolist are therefore,

$$\Pi(Q,\omega) = R(Q,\omega) - rQ \qquad (1)$$

where r is the procurement cost per unit of the input. Subscripts 1 and 2 (as in $R_1$ and $R_2$) are used to represent partial derivatives w.r.t. Q and $\omega$ respectively. We assume that $R_{11} < 0$. The domain of the state variable $\omega$ is arranged such that higher realizations of $\omega$ correspond to higher revenues: $R_2 > 0$. And since the input costs are not state dependent this is equivalent to $\Pi_2 > 0$. We assume that the demand function faced by the monopolist satisfies the Principle of Increasing Uncertainty (PIU) proposed by Leland (1972). The PIU criterion ensures that the marginal profits also are increasing in $\omega$, and is satisfied in those cases where higher $\omega$ is associated with lower marginal costs or higher marginal revenues.[10]

$$R_{12} > 0 \text{ or equivalently } \Pi_{12} > 0. \qquad (2)$$

The monopolist finances its operations on date 0 and sells its output on date 1. Debt, if issued, is repaid from the profits at the end of the period on date 1. D ($\geq 0$) denotes the face value of debt of the monopolist. When $\omega = \bar{\omega}$, the firm is just able to pay off its debt obligations. In other words, for a given level of debt D,

$$\bar{\omega} \quad [0,\Omega] \text{ is such that } \Pi(Q,\bar{\omega}) = D. \qquad (3)$$

Since $\Pi_2(Q,\omega) > 0$, the firm is bankrupt in all states $\omega$, where $\omega < \bar{\omega}$. $\rho = \Pr\{\omega: \omega \geq \omega^*\}$ is the probability that the firm is solvent. From (3), it may be seen that this probability is implicitly a function of the monopolist's level of debt and output. All agents are risk neutral and the risk-free rate is assumed to be zero without loss of generality. The managers of the monopolist are

shareholder value maximizers. Let S and B represent shareholder and bondholder value respectively.

$$S = \int_{\omega^*}^{\Omega} \{\Pi(Q,\omega) - D\} f(\omega)\, d\omega. \quad (4)$$

$$B = \int_{0}^{\omega^*} \Pi(Q,\omega) f(\omega)\, d\omega + \rho D. \quad (5)$$

The first order condition for shareholder value maximization in the production decision is

$$S_1(Q) = \int_{\omega^*}^{\Omega} \Pi_1(Q,\omega) f(\omega) d\omega = 0. \quad (6)$$

The second order condition is $S_{11}(Q) < 0$. (7)

By implicitly differentiating (3), we observe the following for future use

$$\partial\omega^* / \partial D = [\partial\Pi(Q,\omega^*) / \partial\omega]^{-1} > 0. \quad (8)$$

Let M(Q,D) denote the expected marginal revenue accruing to the shareholders from *production*. Using (6) we observe that M forms the inverse demand for the input. Hence,

$$M(Q,D) = (1/\rho)\int_{\omega^*}^{\Omega} R_1(Q,\omega) f(\omega)\, d\omega. \quad (9)$$

## *2.2 Shareholder-Bondholder Incentive Conflict*

We assume that managers maximize shareholder value. Since the shareholder objective (4), differs from the bondholder objective (5), there exists a conflict of incentives between the two parties in our model. The optimal output $Q^S$ selected by the shareholders is greater than the output level $Q^B$ desired by the bondholders of the firm.[11] This difference in the optimal output levels of the bondholders and the shareholders is due to the adverse incentives of limited liability. The shareholders have an incentive to select a riskier output level because their payoffs are unbounded when the firm is solvent, but bounded by zero when the firm is insolvent. Since, the firm faces price risk on date 1, larger output levels are inherently more risky. Thus the shareholders overproduce relative to the level desired by the bondholders. This conflict of incentives at the production stage forms the basis for the "agency cost" of debt in our model. Since the bondholders rationally anticipate the incentives of the shareholders to overproduce, the fair price of

debt on date zero (equation (5)) reflects the anticipated production level $Q^S$. In other words, for each output level Q anticipated by the bondholders if B(Q) represents the loan proceeds given to the shareholders, where the face value is fixed at some D, then $B(Q^B) - B(Q^S)$ represents the implicit agency cost of debt in our framework.

### *2.3 The Suppliers*

The supplier market consists of a large number, N, of competing input suppliers who possess identical technologies and produce a homogeneous good. We treat N as a continuous real variable throughout our analysis. These suppliers are assumed to invest \$I at the time of entry, and face a marginal cost function s(q), where q is the quantity produced. Each supplier is assumed to be a price taker. The monopolist announces the input price, and then purchases all the quantity provided by its suppliers at that price. Therefore, for each supplier, the upward sloping part of the marginal cost function s(q) that lies above its minimum average variable cost is also the supply function. We assume that s(q) is convex in q. The marginal cost (MC), average variable cost (AVC), and the average cost (AC) functions are all U-shaped. Figure 1 illustrates this.

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Insert Figure 1 about here

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Since the up-front investment I is positive, the AC function lies above the AVC function. Let $\hat{q}$ and $q^*$ be the quantities that minimize the AVC and the AC functions respectively. $s(\hat{q}) = \hat{s}$ and $s(q^*) = s^*$ are the minimum average variable cost and minimum average total cost respectively. Note that the fixed investment of I implies that, $\hat{s} < s^*$ and $\hat{q} < q^*$. If the price r announced by the monopolist is less than $s^*$ then the suppliers will not fully recover their sunk investment -- as a result, all suppliers earn negative profits.

The sequence of decisions by the monopolist and the suppliers may be viewed in the following stages. First, the firm decides on a debt level; then the suppliers make their decision to enter the market and service the firm; once the suppliers have entered the market, the firm

announces an input price and sources from the suppliers. The equilibrium developed here is restricted to be subgame perfect (Selten, 1975) i.e., at each stage, the decision maker's choice is not only optimal in that stage, but also reflects the rational anticipation of the optimal actions of the other player in the subsequent stages. In our model, this equilibrium is also sequentially rational. We use backward induction to arrive at the equilibrium debt level and at the equilibrium number of suppliers servicing the firm. If N is the number of suppliers already present in the market and if the input price announced by the monopolist is r, then the monopolist's output is

$$Q(N,r) = Ns^{-1}(r) \quad \text{if} \quad r \geq \hat{s} \tag{10}$$
$$= 0 \quad \text{if} \quad r < \hat{s}$$

We note for future use that $\frac{\partial Q(N,r)}{\partial r} = \frac{N}{s'(s^{-1}(r))}$ when $r \geq \hat{s}$ (11)

where $s'(\,)$ is the first derivative of $s(\,)$.

## 3. Capital Structure and the Mitigation of the Hold-up Problem

### *3.1 The Hold-up Problem in an Unlevered Firm*

The suppliers' decision to enter the market, incur the set-up costs, and service the monopolist is sequentially rational if and only if r, the price expected by them is greater than or equal to $s^*$, their minimum average cost (since $r < s^*$ would imply that all suppliers make negative profits). Hence, if an unlevered monopolist could convince the suppliers, say, through perfectly enforceable long-term contracts, that they will be paid $s^*$ per unit, the production decision that maximizes shareholder value of the monopolist is that quantity $Q^*$ which equates the marginal gains from production accruing to the shareholders to the marginal cost of procurement, $s^*$, i.e.,

$$M(Q^*, D=0) = \int_0^{\Omega} R_1(Q^*,\omega)\, f(\omega)\, d\omega = s^*. \tag{12}$$

*This production level $Q^*$, is our efficient contract benchmark.* However, absent any binding contracts, once the suppliers enter the market and incur the fixed investment of \$I, then it is optimal for the monopolist to announce a price that is below $s^*$ but above $\hat{s}$. Since this strategy will ensure that the suppliers are compensated for their variable costs but not for their total costs, they will stay

in production in order to minimize their losses. This is formally established in the following proposition:

***Proposition 1****: Let $Q^*$ be the quantity of output that maximizes shareholder value of an unlevered monopolist, and let $q^*$ be the output produced by each supplier in the absence of any firm-supplier interactions. If $N^*$ $(= Q^*/q^*)$ input suppliers are already present in the input market, then in the presence of firm-supplier interactions, the quantity that maximizes shareholder value of the monopolist is $Q^{**}$ where $Q^{**} < Q^*$.*

***Proof*****:** See Appendix.

The intuition behind the proposition is straight forward. By decreasing its output, the monopolist loses some revenues that accrue to it from the output market. However, the monopolist needs to source fewer inputs, and demands less from each supplier at a price below $s^*$. Since this price is too low to compensate suppliers for their total costs, and since investment costs are sunk, each supplier incurs a loss. This loss represents a wealth transfer from the suppliers to the monopolist. Given that $Q^*$ is the optimal production level, the marginal loss due to a decrease in output from that point is zero, but the marginal gains from expropriating the suppliers is strictly positive. Therefore, opportunistic behavior after the suppliers have entered the market is optimal. Unfortunately, this incentive hurts the monopolist since the suppliers *anticipate it* and do not service the firm in the first place.

***Corollary 1:*** *If there are no perfectly enforceable long-term contracts between the monopolist and the suppliers, the number of suppliers servicing the monopolist will be $N^{**} = Q^{**}/q^* < N^*$. Hence, the monopolist will operate inefficiently $(Q^{**})$ relative to the efficient contract benchmark $(Q^*)$.*

***Proof*****:** See Appendix.

Observe first that the marginal loss to the monopolist from decreasing its output is zero only at the optimum (benchmark) output. Further, this marginal loss increases as the quantity moves below the optimal level because the monopolist firm's value is concave in output. On the

other hand, the marginal gains from expropriation are decreasing at output levels below the optimal level. At the equilibrium number of suppliers, the lost marginal profits to the monopolist from reducing output exceed the marginal gains from expropriation.[12]

The above analysis assumes that the monopolist sources its inputs from *several* suppliers. This may not be representative of all industries. The sourcing literature documents that many firms are now aggressively cutting the number of suppliers, and the average firm buys from 20.5% fewer suppliers today than it did just five years ago.[13] In fact, larger firms such as Allied-Signal, Ford, General Electric, Lear, and Whirlpool have reduced (or have specific plans to reduce) their supplier base by an even larger proportion -- about 50% to 70%.[14] Sourcing from fewer suppliers lowers the administrative costs associated with the logistical requirements of just-in-time (JIT) manufacturing, provides the firm with a higher level of control over its inventories, and reduces the dispersion in the quality of the input. Therefore, for a given set of suppliers it may be more natural to focus on their desire to control their level of sunk-investment in response to the fear of opportunism, rather than focus on their entry and exit. We model such a scenario in a framework where the suppliers make an up-front investment that determines the *quality* of the input. We show that in this case, opportunism manifests in the form of the firm announcing a price that is not high enough to compensate the supplier for the quality level. Correct anticipation of such behavior leads the supplier to decrease the investment in quality below the first best level.[15] This is consistent with the findings of Helper (1991b). In a survey of over 400 manufacturing firms and their suppliers, she finds that nearly 40% of the suppliers believe that the buying firms would not hesitate to switch suppliers if their demands were not met. Further, these suppliers react to this fear by cutting back on investment in innovation, automation, and capacity.

Before we move to the next section we note that the standard monopsony result that the input price is lower when the buyer is a price maker than if he were a price taker obtains in the shareholder value maximization setting. Since the marginal cost of purchasing an extra input exceeds the input price (due to the upward sloping supply curve), the marginal gains from

production accruing to the shareholders will exceed the input price paid by them. The equilibrium price expected by the suppliers reflects this fact.

***Lemma 1****: The input price announced by the monopolist firm will be*

$$r = M(Q,D) - Qs'/N. \tag{13}$$

*For each input the shareholders of the firm will pay out less than their benefits from that input.*

***Proof*****:** See Appendix.

## *3.2 Suppliers' Entry Decision*

While it is true that a supplier will not enter the market if the expected demand is below its break-even level, a monopolist can alter the supplier's perception through certain commitment mechanisms. Such a mechanism constitutes an indirect but credible promise to provide at least the break-even level of business to the supplier. We describe below how the monopolist's financing choice is one such mechanism.[16] For any level of debt chosen by the monopolist in the first stage, the suppliers enter the market and service the monopolist only if they expect to make non-negative profits. Further, the free entry condition in the input market imposes the restriction that suppliers earn zero profits, i.e., the input price expected by the suppliers be equal to their long run average cost. Once in the market, suppliers produce until the price they receive equals their short run marginal cost. The only point where all these conditions are simultaneously satisfied is where the input price is equal to the minimum average total cost $s^*$. (See Figure 1). The total supply by each input producer at price $s^*$ is $q^*$. Hence, if N(D) is the equilibrium number of suppliers entering the market when the monopolist takes on debt with face value of D, the optimal total output Q of the monopolist is $N(D)q^*$. These two equivalent constraints are stated below in (14).

$$r = s^*; \quad \text{or equivalently} \quad Q = N(D)q^*. \tag{14}$$

Substituting these in the condition (13) for the input price offered, we have

$$s^* = M(Q,D) - s'q^* \quad \text{from (13 and 14)} \tag{15}$$

and from (9) it implies that $s^* = (1/\rho)\int_{\omega^*}^{\Omega} R_1(Nq^*,\omega)\, f(\omega)d\omega - s'q^*$. (16)

***Proposition 2:*** *For small levels of the face value of debt, D, the number of suppliers servicing the monopolist increases with D, i.e.,*

$$\partial N(D)/\partial D > 0. \tag{17}$$

***Proof*:** See Appendix.

The proposition may be understood as follows. As the monopolist adds debt, the number of states $\omega$ where the monopolist is bankrupt increases. Therefore, as debt increases limited liability has an increased impact on the shareholders' decisions. In particular, once the monopolist receives the loan proceeds, it has an incentive to overproduce relative to the value maximizing level. With over-production, if the state of nature is "good" (price is high) the shareholders receive large payoffs. If not, their payoffs are still non-negative due to limited liability. Therefore, the optimal output of the monopolist is now larger. Since more input is needed to support larger output levels, more suppliers are willing to invest in the set-up costs. Taking on a small level of debt is thus equivalent to a commitment to abstain from opportunism.[17]

The increase in competition in the supplier market brought on by an increased use of debt is not without cost. Observe that the managers are free to decide the output level once they have received the loan. So, for each level of debt, bondholders correctly anticipate the equilibrium in the output and input markets along with the associated cash flows, and price the debt correctly. Thus, the cost of increasing the output level beyond what is desired by the bondholders is imposed on the shareholders through the price of debt. Further, since the optimal output level for the shareholders is increasing in the amount D owed to the bondholders, the cost of debt is increasing in the face value of debt. We show below that for small levels of debt the sourcing benefit to the shareholders unambiguously outweighs this agency cost of debt.

## *3.3 The Financing Decision*

In the preceding sections, decisions regarding supplier entry and the monopolist's demand for input were made for a given level of debt. In this section we analyze the final stage of the backward induction process and determine the optimum debt level. Since the funds received from

the bondholders belong to the shareholders of the monopolist, a manager acting in the interests of the shareholders will select a level of debt that maximizes the sum of their receipts today from bondholders and the residual payoffs from the revenues received next period.

***Proposition 3:*** *If the managers of the monopolist maximize the sum of the loan proceeds and the residual payoffs to the shareholders from the revenues received next period, the optimal debt level of the monopolist is strictly positive.*

***Proof:*** See Appendix.

When the manager selects a level of debt that maximizes the loan proceeds plus the residual revenues to the shareholders next period, there are two opposing effects. The first effect is that with each additional dollar of debt, the number of bankruptcy states increases, which in-turn increases the output chosen by the shareholders to a level higher than that desired by the bondholders. This distortion due to the conflict of incentives between bondholders and shareholders, when viewed in isolation, reduces the value of the firm's debt, and therefore, reduces the loan proceeds received by the shareholders. The second effect is the benefit associated with convincing more suppliers to service the firm, and the consequent increase in production to a level that is closer to the efficient contract benchmark. This latter effect, when viewed in isolation, increases shareholder value. The net effect is that the monopolist holds a positive level of debt. This may be seen from the fact that by selecting an appropriately small level of debt, the incentive conflict costs associated with debt may be made arbitrarily small, while the benefit due to debt remains a positive constant. Thus zero debt is strictly *sub-optimal*, and the monopolist will use a positive level of debt to exploit the sourcing benefits. In fact, as we establish below, when the firm selects the optimal level of debt the first best production level is achieved.

***Corollary 2****: At the optimal level of debt the efficient contract benchmark output* $Q^*$ *described in (12) is produced.*

*Proof:* See Appendix.

There are other well-known ways of mitigating the hold-up problem. A long-term contract with the suppliers is a simple method to eliminate this problem in a world with *verifiable* states of nature. In reality however, contracting costs are high because the states of nature may not be easily verifiable by a court *ex post*. In this context, the escape clause associated with "quality" of the input supplied, a common feature in most contracts, is one example of a contracting problem. Here, the monopolist can cite inferior quality of the input supplied as an excuse for reneging on a contract to buy a pre-specified quantity of the input. Long-term relations also have other hazards. Tirole (1990) shows that a long-run relationship promotes value-dissipating collusion between the two parties' *personnel*, and for instance, may lead to supplier entrenchment as documented in Pettigrew (1972). Further, Helper and Levine (1992) also show that long-term contracts in the firm-supplier context sometimes result in a distortment in the monopolist-firm's investment choice, resulting in a dead weight loss. A contract also requires the parties involved to give up any profitable outside opportunities -- the longer the duration of the contract, the higher the implicit cost. Finally, if the gains from trade are stochastic, a rigid contract may also force parties to trade even when there are no gains from trade. So a contract must be designed such that there is an optimal trade-off between flexibility and prevention of opportunism. Milgrom and Roberts (1992) discuss in greater detail the common problems associated with the design of contracts.

Williamson (1975) argues that a vertically integrated monopolist does not have the mis-incentive of announcing too low a price once the suppliers have entered the market. Although vertical integration may be desirable to economize on the transaction costs associated with arms-length sourcing, it leads to several other costs. For instance, integration may not be feasible in many cases due to lack of managerial and technical expertise in the upstream product, and may in itself involve costs that could exceed the agency costs of debt (Berger and Ofek, 1995; Krishnaswami and Subramaniam, 1997). Also, expansion in operations may result in the managerial incentives not being aligned with the maximization of the aggregate surplus across divisions of the firm (Aron, 1991). In this sense, independent organizations preserve market based incentives that are lost in vertical integration. Further, if there is information asymmetry

about the supplier's assets, valuing those assets may be a risky venture for the firm. As Ravenscraft and Scherer (1987) illustrate, the valuation process is further complicated by *ex post* litigation, if the supplier has any hidden liabilities that elude the buyer's pre-merger inspections.[18] In such cases the solution we propose would be more efficient.

Williamson also suggests that a monopolist by publicly posting a price and holding it a constant may be able to convince its suppliers that it will not behave opportunistically. However, as shown in Von Ungern-Sternberg (1988), the incentives to maintain a good reputation are greatest when the market is growing but it is not very strong when the market is either declining or is stagnating. Such behavior to trade-off reputation during recessionary times in exchange for passing costs on to upstream suppliers is documented in Wiesmann (1994).[19] Von Ungern-Sternberg offers carrying excess capacity as an alternative method to solve the problem, when the marginal cost schedule of the monopolist is convex. He considers an environment without demand uncertainty and ignores the role of the firm's financing choice. The debt solution we offer in this paper is robust to the above features, and it exploits the limited liability of shareholders' obligations. Moreover, in industries that do not have a convex cost schedule, building excess capacity may not be worthwhile in that it does not go towards lowering the marginal cost of the firm. Further, our solution also works in industries where capacity additions are lumpy or are very expensive.

### *3.4 Suppliers and Trade Credit*

If the suppliers offer trade credit to the firm this could potentially change much of our analysis. For instance, the result that for small levels of debt the number of suppliers servicing a firm increases with debt is driven in part by the fact that suppliers do not face any default risk. The assumption that suppliers face no default risk when the firm faces demand uncertainty seems controversial. It is reasonable only if suppliers are paid up-front. However, since many suppliers offer trade credit to their buyers, they have a claim on the end-of-period cash flows along with the bondholders of the firm. So leverage can be of potential concern to these suppliers. So long as the suppliers offer trade credit that is priced correctly (to reflect the probability of default arising from

financial distress), we can show that a small level of debt is still optimal. This result flows from an analysis similar to the one in section 3.3, and may be seen by extending (A7) to include the price of trade credit.[20]

## 4. Conclusion

In the absence of complete contracts, inefficiencies arise in a monopolist's relations with its suppliers. An essential message of this paper is that a small level of debt financing may be used to mimic an optimal contract and thus mitigate these inefficiencies. In a setting where there is a propensity for opportunistic behavior by the monopolist, the shareholders of the monopolist lose value unless they can credibly commit to abstaining from opportunism. Debt is such a commitment mechanism. It conveys to the suppliers that the demand for the inputs will be larger at the minimum average cost. This results in a larger number of suppliers servicing the monopolist, pushing it towards the efficient production level. The resulting equilibrium is pareto optimal. With a positive level of debt the monopolist increases its value, the shareholders increase their value, there are more suppliers in the input market each earning non-negative profits, and finally the monopolist's customers are better off since the output is now higher and the price of the product lower.

Firms can confront the problem of opportunism through strategies that do not involve a specific financing choice. The merits and costs of partial solutions such as long-term contracts, and maintaining excess capacity are discussed in the paper. A possible solution set forth more recently may be in strategic alliances. Observe that in this paper the propensity for opportunism arises due to the up-front investment made by the suppliers. Also, being in a competitive supply market severely undermines the suppliers' bargaining position. However, these characteristics are not representative of all firm-supplier relations. Strategic alliances between firms and suppliers are increasingly becoming a popular means of achieving closer, and flexible contractual relations with suppliers who offer some specialized services. In such partnerships, suppliers play an important role in solving joint problems and in generating fresh ideas about products and processes. These alliances are characterized by up-front investment by the firm, and not by its suppliers, followed by

a joint choice of the quality, quantity, and price of the inputs sourced. A study of such alliances in this context is an avenue for future research.

# Appendix

Proof of Proposition 1: $Q^* = N^*q^*$. If $N^*$ suppliers already exist in the market then it is optimal for the firm to announce a lower price. To show this, let the firm announce a price s(q) where $\hat{s} < s(q) < s^*$. Since the price is less than $s^*$, each supplier will only supply $q < q^*$. Also since the firm sources less, it produces less output and loses some revenue in the product market. The net gain to the shareholders if they behave opportunistically = {Cost savings in procurement - Lost revenues in the product market}.

Shareholders will therefore select q to maximize their net gain. i.e.,

$$\max_q \; [N^*q^*s^* - N^*qs(q)] \; - \; E[R(N^*q^*, \omega) - R(N^*q, \omega)]$$

where the expectation is taken over $[0, \Omega]$. The first derivative of the above objective is,

$$- N^*s(q) \; - \; N^*qs'(q) \; + N^*E[R_1(N^*q, \omega)]. \qquad \text{(A1)}$$

The second order condition holds since $R_{11} < 0$ and since s is increasing and convex.

At $q = q^*$ the FOC is: $= - N^*s^* \; - \; N^*q^*s'(q^*) \; + N^*E[R_1(N^*q^*, \omega)]$ (A2)

$$= - \; N^*q^*s'(q^*) \; < \; 0 \text{ using (12)} \qquad \text{(A3)}$$

Hence, the firm will find it profitable to demand fewer than $q^*$ inputs from each supplier. ♦

Proof of Corollary 1: For all quantities below $q^*$ each supplier makes negative profits. Therefore, the equilibrium number of suppliers in the market will be such that it is no longer optimal for the firm to demand a quantity below $q^*$. Further, due to the free entry condition in the input market the number of suppliers will be exactly such that each supplier will receive a demand of $q^*$, and no more. So, if $N^{**}$ is that number then, from (A1)

$$N^{**}\{- s(q^*) - q^*s'(q^*) + E[R_1(N^{**}q^*, \omega)]\} \; = \; 0$$

and from (A2) and (A3) $N^*\{- s(q^*) - q^*s'(q^*) + E[R_1(N^*q^*, \omega)]\} < 0.$

Since $R_1(\cdot, \omega)$ is decreasing in its first argument, $N^{**} < N^*$. ♦

Proof of Lemma 1: The first order condition of the shareholders' objective is

$$\partial S/\partial r = \int_{\omega^*}^{\Omega} \{R_1(Q,\omega)(\partial Q/\partial r) - Q(N,r) - r(\partial Q/\partial r)\} f(\omega)\, d\omega = 0.$$

$$r = (1/\rho)\int_{\omega^*}^{\Omega} R_1(Q,\omega) f(\omega)\, d\omega - Q(s'/N) \qquad \text{[Using (11)].}$$

$$r = M(Q,D) - Q(s'/N). \quad \blacklozenge$$

Proof of Proposition 2: (16) defines the implicit relationship between N and D. Rewriting it we have

$$\rho(s^* + s'q^*) = \int_{\omega^*}^{\Omega} R_1(Nq^*,\omega)\, f(\omega)d\omega$$

$$0 = \int_{\omega^*}^{\Omega} [R_1(Nq^*,\omega) - (s^* + s'q^*)]\, f(\omega)d\omega \qquad \text{(A4)}$$

Differentiating the above equation w.r.t D we have

$$0 = (\partial N/\partial D)q^* \int_{\omega^*}^{\Omega} R_{11}(Nq^*,\omega)\, f(\omega)\, d\omega - (\partial\omega^*/\partial D)[R_1(Nq^*,\omega^*) - (s^* + s'q^*)]f(\omega^*)$$

$$\frac{\partial N}{\partial D} = \frac{(\partial\omega^*/\partial D)[R_1(Nq^*,\omega^*) - (s^* + s'q^*)]f(\omega^*)}{q^*\int_{\omega^*}^{\Omega} R_{11}(Nq^*,\omega^*)f(\omega)\, d\omega} > 0 \text{ due to (7) and (8),}$$

and if $[R_1(Nq^*,\omega^*) - (s^* + s'q^*)] < 0.$ (A5)

The last inequality is indeed true from (A4) due to the following analysis. The marginal profits for the firm are higher in better states of nature, therefore the integrand in (A4) is increasing in $\omega$. So, when it is evaluated at the lowest state it must be negative otherwise, a weighted average of the integrand over $\omega$ and better states cannot yield zero. $\blacklozenge$

Proof of Proposition 3: The shareholders' objective is:

$$\underset{D}{\text{Max}} \int_0^{\omega^*} [R(Q,\omega) - s^*Q(N,s^*)]\, f(\omega)d\omega + \int_{\omega^*}^{\Omega} D\, f(\omega)d\omega + \int_{\omega^*}^{\Omega} (R(Q,\omega) - s^*Q - D]\, f(\omega)d\omega$$

subject to the condition $Q = N(D)q^*$.

Subtracting and adding $s'q^*Q$ to the above expression, we may rewrite the objective as,

$$\underset{D}{\text{Max}} \int_0^{\omega^*} [R(Q,\omega) - s^*Q - s'q^*Q]\, f(\omega)d\omega + \int_{\omega^*}^{\Omega} (R(Q,\omega) - s^*Q - s'q^*Q]\, f(\omega)d\omega + s'q^*Q$$

s.t. $Q = N(D)q^*$.

The marginal effect of debt on the firm's shareholder objective is

$$\int_0^{\omega^*} [R_1(Q,\omega) - s^* - s'q^*](\partial Q / \partial D) f(\omega)\, d\omega$$
$$+ \int_{\omega^*}^{\Omega} [R_1(Q,\omega) - s^* - s'q^*](\partial Q / \partial D)\, f(\omega)\, d\omega + s'q^*(\partial Q / \partial D).$$

Since $Q = N(D)q^*$, we may rewrite the above expression as

$$\int_0^{\omega^*} [R_1(Q,\omega) - s^* - s'q^*](\partial Q / \partial D) f(\omega)\, d\omega$$
$$+ \{\int_{\omega^*}^{\Omega} [R_1(Q,\omega) - s^* - s'q^*]\, f(\omega)\, d\omega\} \frac{\partial N(D)}{\partial D} q^* + s'q^* \frac{\partial N(D)}{\partial D} q^*. \qquad \text{(A6)}$$

The first term in (A6) is negative. This is because, (A5) states that

$$R_1(Q,\omega^*) - (s^* + s'q^*) < 0$$

$$\Rightarrow \quad R_1(Q,\omega) - (s^* + s'q^*) < 0, \qquad \omega < \omega^* \text{ since } R_{12} > 0.$$

The second term of (A6) is zero from (A4).

The third term in (A6) is positive since $s' > 0$, and $\partial N(D) / \partial D > 0$.

Hence (A6) simplifies to

$$\int_0^{\omega^*} [R_1(Q,\omega) - s^* - s'q^*](\partial Q / \partial D) f(\omega)\, d\omega + s'q^* \frac{\partial N(D)}{\partial D} q^*. \qquad \text{(A7)}$$

The marginal effect of debt on shareholder value represented in (A7) reflects two opposing effects. The first term, which is negative, captures the cost due to the conflict of incentives between shareholders and bondholders. Each additional dollar of debt increases the output chosen by the shareholders to a level higher than that desired by the bondholders. This distortion reduces the value of the firm's debt, and therefore, decreases the loan proceeds received by the shareholders. The second term of (A7), which is positive, captures the benefit associated with convincing more suppliers to service the firm and the consequent increase in production to a level that is closer to the efficient contract benchmark. Despite the two opposing effects, for small levels of debt the benefits dominate the costs. We can verify this easily in a neighborhood of $D = 0$. In particular, at $D = 0$, there is no default, hence $\omega^* = 0$. Therefore, the first term of (A7) is zero. The second

term though, is a constant and is strictly positive. Therefore, at D = 0, the marginal impact of debt on shareholder value reduces to

$$(\partial N(D) / \partial D)\, q^* s' q^*.$$

From (17), $\partial N(D) / \partial D > 0$. $\quad (\partial N(D) / \partial D)\, q^* s' q^* > 0.$

=> Only a debt level D strictly greater than zero can be optimal.

Therefore, a positive level of debt is unambiguously optimal for the firm. ♦

Proof of Corollary 2: The optimal level of debt D is chosen to maximize

$$\underset{D}{Max} \int_0^{\omega^*} [R(Q,\omega) - s^* Q(N,s^*)]\, f(\omega) d\omega + \int_{\omega^*}^{\Omega} D\, f(\omega) d\omega + \int_{\omega^*}^{\Omega} (R(Q,\omega) - s^* Q - D]\, f(\omega) d\omega.$$

Which results in the following first order condition:

$$\int_0^{\Omega} [R_1(Q,\omega) - s^*](\partial Q / \partial D)\, f(\omega)\, d\omega = 0.$$

Since $\partial Q / \partial D > 0$, the above first order condition holds only at that level of output $Q^*$, where

$$\int_0^{\Omega} [R_1(Q^*,\omega) - s^*] f(\omega)\, d\omega = 0. \qquad \text{(A8)}$$

A comparison of (A8) and (12) indicates that this output level is the efficient contract benchmark level. ♦

## References


Alchian, A.A., and S. Woodward, "The Firm is Dead: Long Live the Firm," *Journal of Economic Literature*, 26 (1988), 65-79.

Aron, D., "Using the Capital Market as a Monitor: Corporate Spinoffs in an Agency Framework," *RAND Journal of Economics*, 22 (1991), 505-518.

Berger, P., and E. Ofek, "Diversification's Effect on Firm Value," *Journal of Financial Economics*, 37 (1995), 39-65.

Brander, J., and T. Lewis, "Oligopoly and Financial Structure: The Limited Liability Effect," *American Economic Review*, 76 (1986), 956-970.

Campbell, T., and W. Kracaw, "Corporate Risk Management and the Incentive Effects of Debt," *Journal of Finance*, 45 (1990), 1673 - 1686.

Coeyman, M., "Driving Down Costs Becomes Industry Imperative," *Chemical Week*, 154 (January 26, 1994), 35-36.

Dasgupta, S., and K. Sengupta, "Sunk Investment, Bargaining and Choice of Capital Structure," *International Economic Review*, 34 (1993), 203-220.

Fitzgerald, K., "Proprietary Information -- Should Suppliers Share It?" *Purchasing*, 121 (October 3, 1996), 55-56.

Fulcher, J., "A Source of Wealth," *Manufacturing Systems*, 14 (August 1996), p. 13.

Fulghieri, P., and S. Nagarajan, "Financial Contracts as Lasting Commitments: The Case of a Leveraged Oligopoly," *Journal of Financial Intermediation*, 2 (1992), 2-32.

Helper, S., "Strategy and Irreversibility in Supplier Relations: The Case of the U.S. Automobile Industry," *Business History Review*, 65 (1991a), 781-824.

Helper, S., "How Much Has Really Changed Between U.S. Automakers and Their Suppliers?" *Sloan Management Review*, 32 (1991b), 15-28.

Helper, S., and D. Levine, "Long-Term Supplier Relations and Product-Market Structure," *Journal of Law Economics and Organization*, 8 (1992), 561 - 581.

Klein, B., R.A. Crawford, and A.A. Alchian, "Vertical Integration, Appropriable Rents, and Competitive Contracting Process," *Journal of Law and Economics*, 21(1978), 297-326.

Kleindorfer, P., and G. Knieps, "Vertical Integration and Transaction-Specific Sunk Costs," *European Economic Review*, 19 (1982), 71-87.

Krishnaswami, S., and V. Subramaniam, "Information Asymmetry, Valuation, and the Corporate Spin-off Decision," working paper, University of New Orleans, 1997.

Leland, H., "Theory of the Firm Facing Uncertain Demand," *American Economic Review*, 62 (1972), 278-291.

Maksimovic, V., "Capital Structure in Repeated Oligopolies," *RAND Journal of Economics*, 19 (1988), 389-407.

Maksimovic, V., "Product Market Imperfections and Loan Commitments," *Journal of Finance*, 45 (1990), 1641-1653.

Milgrom, P., and J. Roberts, *Economics, Organization, and Management*, Prentice Hall, Englewood Cliffs, NJ, 1992.

Pettigrew, A., "Information Control as a Power Resource," *Sociology*, 6 (1972), 187-204.

Ravenscraft, D., and F. Scherer, "Mergers, Sell-offs, and Economic Efficiency," mimeo, Brookings Institution, Washington D.C., 1987.

Selten, R., "Reexamination of the Perfectness Concept for Equilibrium Points in Extensive Games," *International Journal of Game Theory*, 4 (1975), 25-55.

Tirole, J., *The Theory of Industrial Organization*, MIT Press, Cambridge, MA, 1990.

Von Ungern-Sternberg, T., "Excess Capacity as a Commitment to Promote Entry," *Journal of Industrial Economics*, 37 (1988), 113-122.

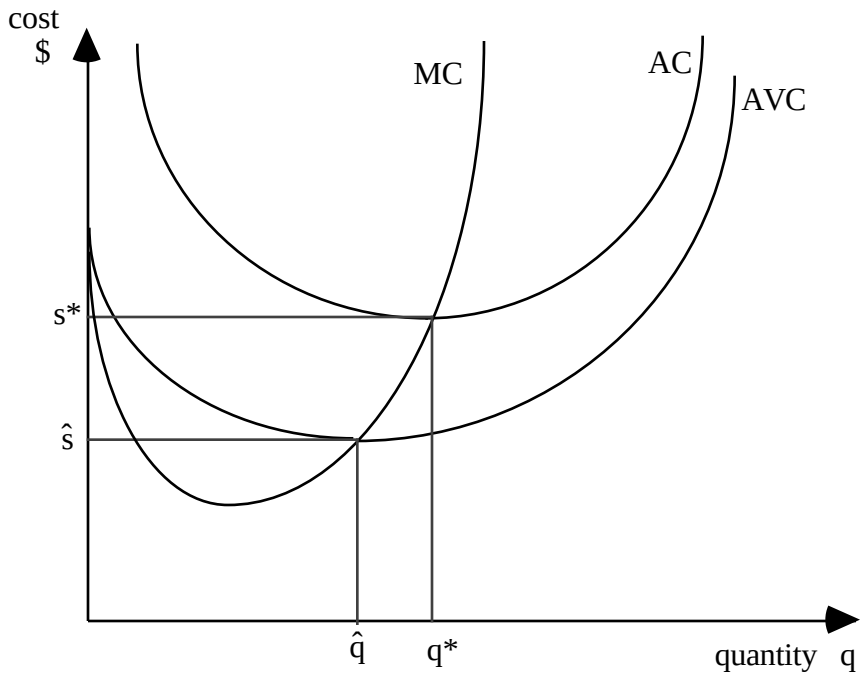
Wiesmann, G., "European Industry Resists Pressure on Prices," Chemical Week, 154 (March 9, 1994), 34-35.

Williamson, O., *Markets and Hierarchies: Analysis and Antitrust Implications*, The Free Press, New York, 1975.

## List of Notations

| | |
|---|---|
| $Q$ | Variable representing the quantity of output produced by the firm. |
| $Q^*$ | First best output level for the firm. |
| $\omega$ | That state of nature ($\omega$) when the firm is just able to pay off its debt obligations. |
| $P(Q,\omega)$ | The stochastic price of the end product produced by the firm. |
| $R(Q,\omega)$ | The stochastic revenue function of the firm net of production and other costs, but *not* net of procurement costs. |
| $\Pi(Q,\omega)$ | The state dependent profits of the firm. |
| $M(Q,D)$ | Expected marginal gains accruing to the shareholders from production. |
| $r$ | The price per unit of the input, announced by the firm. |
| $D$ | Face value of debt of the firm. |
| $\rho$ | Probability of solvency of the firm. |
| $S(D)$ | Total shareholder value of the firm. |
| $B(D)$ | Total bondholder value of the firm. |
| $q$ | Quantity of output produced by each supplier. |
| $s(q)$ | The marginal cost function of each supplier. |
| $s'(q)$ | The first derivative of the marginal cost function $s(q)$ with respect to $q$. |
| $\hat{q}$ | Quantity of output that minimizes the average variable cost of each supplier. |
| $q^*$ | Output level at which each supplier breaks-even on a total cost basis. |
| $\hat{s}$ | Minimum average variable cost of each supplier. |
| $s^*$ | Minimum average total cost of each supplier. |
| $N(D)$ | Equilibrium number of suppliers servicing a firm with debt D, when the suppliers correctly anticipate the firm's propensity for opportunism. |

**Figure 1: Supplier's Cost Curves**




MC = Marginal Cost function; AVC = Average Variable Cost function;

AC = Total Average Cost function

s* = Minimum total average cost; $\hat{s}$ = Minimum average variable cost

## Endnotes

[1] Source: U.S. Bureau of Census (1992). Also see Fulcher (1996).

[2] For additional discussion, see Alchian and Woodward (1988), Klein, Crawford, and Alchian (1978), Von Ungern-Sternberg (1988), and Williamson (1975).

[3] "Hardball is Still GM's Game," Business Week, August 8, 1994, p: 26.

[4] "Cut Costs or Else ...," Business Week, March 22, 1993, p: 28-29.

[5] "Pssst! Want to Sell to Wal-Mart?" Apparel Industry Magazine, August 1996, p: 18-19. See also "Clout! More and More Retail Giants Rule the Marketplace," Business Week, December 21, 1992, p: 66-73.

[6] Quasi-rent of a resource may be defined as the return required in excess of what is necessary to maintain its current operation. This excess return usually goes towards recovering fixed costs. See also Alchian and Woodward (1988).

[7] Milgrom and Roberts (1992) provide a comprehensive discussion of the costs associated with long-term contracts. We discuss some of these costs in section 3.

[8] This phenomenon is similar to the analysis in Brander and Lewis (1986) and Campbell and Kracaw (1990), where an increase in financial risk exacerbates the incentives for the shareholders to increase the operating risk of the firm. It is also similar to the analysis in Maksimovic (1988) where under limited liability, output levels are larger when the firm is levered, than when it is unlevered.

[9] This assumption simplifies the exposition, but is not crucial to the model. The results obtain as long as the amount of input required is increasing in the output of the firm.

[10] This is equivalent to the Spence-Mirrlees inequality or the Sorting condition in the signaling literature.

[11] The fact that $Q^S$ is greater than $Q^B$ may be seen as follows. From (6), $Q^S$ is such that

$$\int_{\omega^*}^{\Omega} \Pi_1(Q^S, \omega)\, f(\omega) d\omega = 0, \qquad \text{(F1)}$$

and using (5), $Q^B$ is such that

$$\int_0^{\omega^*} \Pi_1(Q^B,\omega)\, f(\omega)d\omega \;=\; 0. \qquad \text{(F2)}$$

Since $\Pi_{12} > 0$, note that if $\Pi_1(Q^S,\omega^*)$ were positive then (F1) would not hold. This is because if $\Pi_1(Q^S,\omega^*) > 0$, then,

$$\Rightarrow \qquad \Pi_1(Q^S,\omega) > 0 \quad \omega > \omega^*. \qquad (\text{since } \Pi_{12} > 0)$$

Therefore a weighted average of $\Pi_1(Q^S)$ over the range $[\omega^*,\Omega]$ would be strictly positive. Hence, for (F1) to hold it must be that case that $\Pi_1(Q^S,\omega^*) < 0$. A similar reasoning would yield that $\Pi_1(Q^B,\omega^*) > 0$.

$$\Rightarrow \qquad \Pi_1(Q^B,\omega^*) \;>\; \Pi_1(Q^S,\omega^*).$$

And since $\Pi_{11} < 0$, $\quad \Rightarrow Q^B < Q^S$.

[12] Perhaps, in a more realistic situation we should consider a monopolist announcing both the input price and the quantity required in a take-it or leave-it contract. Even under such contracts, opportunism is costly when we recognize that the monopolist foregoes revenues in its output market should one or more of the suppliers decide not to supply at all.

[13] See American Salesman, January 1997, pp. 18 - 19.

[14] See Purchasing, Jan. 11, 1996, pp. 71-72; Purchasing, Mar. 7, 1996, pp. 54-55; Business Week, Apr. 17, 1995, pp. 78-80; Business Week, Sept. 2, 1996, pp. 60-62; and Sales & Marketing Management, Nov. 1994, p. 16.

[15] These results are available from the author upon request.

[16] The use of financing choice as a commitment mechanism is not new. In the context of imperfect competition, Brander and Lewis (1986) use debt financing, and Maksimovic (1990) uses loan commitments as commitment mechanisms that help extract strategic benefits from industry rivals.

[17] If we considered a multi-period model and allowed for costless renegotiation of debt, then debt financing may no longer be a credible commitment. Stockholders can presumably repurchase the debt, and then expropriate the suppliers who are servicing the firm. On the other hand, in a more realistic model, repurchases are costly when we incorporate the holdout problem, the informational

asymmetry between the insiders and outside investors, and other transaction costs. Fulghieri and Nagarajan (1992) show that even when repurchases are otherwise costless, the commitment value of debt is preserved if we allow for informational asymmetry between insiders and outsiders. Rather than work with a complicated model that incorporates asymmetric information and transaction costs, we focus instead on this simple one period model that disallows costless repurchases of debt.

[18] A case in point is that of Wikes Inc., which discovered that its recently acquired carpet manufacturing subsidiary, Collins & Aikman, had potential product liabilities arising from violations of federal flammability standards for carpets. The estimated cost of this oversight was more than 20% of the purchase price of the subsidiary.

[19] See also Coyeman (1994) which argues that a steep increase in the market share of private labels caused Proctor & Gamble to put pressure on its raw material and packaging suppliers to aggressively cut their prices (despite P&G's reputation of being quite "reasonable.")

[20] The results are available from the author upon request.