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Strategic Outsourcing Revisited*

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21/10/2004

Abstract

This paper analyzes a sequential game where firms decide about outsourcing the production of a non-specific input good to an imperfectly competitive input market. We apply the taxonomy of business strategies introduced by Fudenberg and Tirole (1984) to characterize the different equilibria and find that outsourcing generally softens competition in the final product market. If firms anticipate the impact of their outsourcing decisions on input prices, there may be equilibria where firms outsource so as to collude or to raise rivals' cost. We illustrate our analysis using a linear Cournot model.

JEL Classification: D43, L22, L23, L24.

Keywords: outsourcing, oligopoly, business strategy, input prices, vertical structure.

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1 Introduction

Outsourcing has become a widespread phenomenon in the industrialized world in recent times. Examples for industries where outsourcing is a key feature of the organization of production abound: aircraft, cars, computers, mobile phones, audio/video systems, mechanical watches etc. Casual evidence suggests that information technology (IT) and related business services are regularly contracted out in a large number of industries (Domberger 1998), and econometric studies assign a prominent role to outsourcing in various industries.¹ Yet, it is probably fair to say that the industrial organization literature on outsourcing is relatively thin.²

In a recent paper in this journal, Shy and Stenbacka (2003) have provided the first intra-industry analysis of the strategic incentives that oligopoly firms face when outsourcing the production of inputs.³ In their model, differentiated Bertrand duopolists can either undertake investments into in-house production facilities for a specialized input, or they can buy that input from a subcontractor, but at higher variable cost. Hence, if firms do not want to bear the fixed cost of investing into in-house production facilities, they have to incur higher marginal cost for sourcing the input over the market.

The present paper analyzes a similar trade-off, but differs from Shy and Stenbacka in three crucial aspects: (i) We focus on outsourcing the production of a *non-specific* input rather than an input specifically tailored to the needs of final good production. The equilibrium market price of this non-specific input will depend on the vertical structure of the industry, since a firm's outsourcing decision affects input demand (and possibly

¹See e.g. Abraham and Taylor (1996), Fixler and Siegel (1999), Feenstra and Hanson (1999), Holmes (1999), and Görzig and Stephan (2002).

²Following Coase (1937), the choice of a firm's production mode has traditionally been discussed in the context of *transaction cost analysis*. Prominent contributions by Williamson (1985), Grossman and Hart (1986), and Hart and Moore (1990) have further pointed out that asset specificity and incomplete contracts tend to make the organization of market transactions difficult, thereby limiting the scope for outsourcing. Based on this literature, Grossman and Helpman (2002) have studied the determinants of the equilibrium production mode (i.e. integration vs. outsourcing) in industries where inputs are fully or partially specialized. Another strand of the literature has focused on *international outsourcing*, i.e. the fragmentation of production across borders. For instance, McLaren (2000) has analyzed the relation of international openness and firms' outsourcing decisions.

³There are a number of related earlier contributions. Bonanno and Vickers (1988) show that, if franchise fees can be used to extract retailers' surplus, a manufacturer will choose vertical separation as its production mode, as it induces more friendly behavior from its rival manufacturer and thus facilitates collusion. Gal-Or (1999) explores how asymmetric information between a manufacturer and a retailer affects integration decisions. Chen (forthcoming) examines the effects that economies of scale may have on production mode decisions. Finally, Jansen (2003) gives conditions under which vertical separation is chosen by some upstream firms, while vertical integration is chosen by others in the equilibrium of a symmetric model with Cournot competition downstream.

also input supply), as suggested by the literature on successive oligopolies. We feel that it is natural to account for changes in input prices, even though the previous outsourcing literature has largely ignored them.⁴

(ii) We analyze *sequential* rather than simultaneous firm decisions about the production mode. In this setting, we study the conditions under which the first-mover may adopt outsourcing to raise rivals' cost,⁵ and when outsourcing may serve as an instrument of collusion in the final product market.

(iii) We propose a *reduced-form approach* towards analyzing outsourcing decisions to accommodate for various forms of product market competition (including Bertrand competition with differentiated products, as in Shy and Stenbacka). With the reduced-form profit functions in place, we adopt the taxonomy of business strategies introduced by Fudenberg and Tirole (1984) to provide a general discussion of the potential strategic outsourcing equilibria. Finally, we illustrate our analysis using a linear Cournot model as a specific example.

Our main results are the following: *First*, in contrast to Shy and Stenbacka (2003), we find that there may be asymmetric equilibria where one firm buys the input from an existing input market, whereas the other firm produces the input internally. The difference stems from the fact that we consider a non-specific input good, whereas Shy and Stenbacka focus on a specific input good. In their setting, equilibria with only one firm outsourcing cannot occur, as this firm would have to both cover the entire fixed cost of the supplier and face higher marginal costs than with in-house production.⁶ In our setting, asymmetric equilibria may emerge, as the non-specific input good may be bought from an existing market without having to cover the entire fixed cost of any given supplier.

Second, asymmetric equilibria are typically driven by the changes in input prices associated with outsourcing. It is thus crucial to incorporate input price effects into the analysis of strategic outsourcing. To see this, consider an asymmetric equilibrium where the first firm strategically abstains from outsourcing so as to induce outsourcing by the second firm. The rationale of the first firm's behavior is straightforward: By preventing an initial increase of the input price, the second firm is induced to outsource and thus

⁴For instance, McLaren (2000, fn 17) states: "It would be natural to allow the inputs to affect marginal costs as well, but the resulting price effects would be a tremendous source of additional complication [...]" To our knowledge, there is only one other paper (on the relation of trade liberalization and strategic outsourcing) by Chen et al. (2004) that considers input price effects.

⁵The notion of raising rivals' cost is familiar from Salop and Scheffman (1983, 1987). It is extensively applied in the industrial organization literature on vertical foreclosure (see Rey and Tirole (forthcoming) for a recent survey).

⁶That is, outsourcing becomes equivalent to setting up an input market that was inexistent before that firm's decision to outsource.

to increase its own marginal cost. Unsurprisingly, there is no reversed asymmetric equilibrium where the first firm outsources so as to prevent outsourcing by the second firm: The first firm is not willing to prevent outsourcing by own outsourcing, as it will benefit from the second firm’s marginal cost increase associated with outsourcing, provided that it has not already outsourced.

Third, there may be a symmetric equilibrium where the first firm’s outsourcing induces the second firm to outsource. In this equilibrium, firms successively outsource production to the input market to raise their marginal costs, thereby softening competition in the final product market. That is, a “wave” of consecutive outsourcing decisions may serve as a collusive device. Interestingly, there may also be a symmetric equilibrium where the first firm does not outsource to avoid triggering outsourcing by the second firm. This equilibrium may emerge if the softening of competition generated by a wave of outsourcing decisions is insufficient to compensate the first firm for its marginal cost increase.

In sum, our analysis suggests that outsourcing generally softens competition in the product market, irrespective of whether product market decisions are strategic complements or strategic substitutes. In the symmetric equilibrium where both firms source the input good over the market (the outsourcing wave), the softening of competition is collusive in nature. In the asymmetric equilibrium where only the second firm outsources, the softening of competition is strategically induced by the first firm, but the second firm’s marginal cost increase is self-inflicted. Finally, the first firm will strategically avoid triggering an outsourcing wave if the softening of competition associated with outsourcing is insufficient to increase its profit.

The remainder of the paper is organized as follows: In Section 2 we introduce the basic setup of our analysis, before we discuss the various candidate equilibria in section 3. For illustrative purposes, a linear Cournot model is presented in section 4. Section 5 concludes.

2 The Basic Setup

Consider a duopoly where two firms sell a final product (e.g. aluminium) to their customers in a retail market. Each of the firms $i = A, B$ operates a firm-specific technology represented by (c_i, F_i) , where c_i and F_i denote the marginal and fixed cost, respectively, of producing a non-specific input good (e.g. electricity). That is, potentially one of the firms may have a cost advantage in producing the non-specific input good. Assume that firms transform the input good into the final product at constant marginal cost.

Now, suppose that rather than producing the input good in-house, firms may out-

source the production of the input good, i.e. they may avoid the fixed cost of producing the input in-house and buy it from an input market at an equilibrium market price w instead. It is natural to assume that to avoid the fixed cost of in-house production, firms must shut down their in-house production facilities. That is, even in the absence of binding long-term delivery contracts with input suppliers, firms cannot switch back from outsourcing to in-house production without facing significant costs for re-installing in-house production facilities. We therefore impose that firms can credibly commit to their mode of organization.

Assume w.l.o.g. that firm A decides about its mode of organization before firm B , and let V_i reflect firm i 's outsourcing decision ("make-or-buy") such that

$$V_i = \begin{cases} 0, & \text{if there is no outsourcing ("make"),} \\ 1, & \text{if there is outsourcing ("buy"),} \end{cases} \quad i = A, B.$$

In general, firm i 's equilibrium profit will be a function of outsourcing decisions $V_i, i = A, B$. To account for various forms of product market competition (e.g. Cournot or differentiated Bertrand), we adopt a reduced-form approach and denote equilibrium profits by $\pi_i(V_A, V_B), i = A, B$. Similarly, we write the equilibrium input market price as $w(V_A, V_B)$. In the following, we shall make use of the following basic assumptions on the input price:

(A1) $w(V_A, V_B) > c_i, i = A, B$.

(A2) $w(V_A, V_B)$ is increasing in $V_i, i = A, B$.

Assumption (A1) imposes that the equilibrium price in the input market is strictly higher than the internal marginal cost of either firm producing the input good. Intuitively, this means that there is a mark-up in the input market associated with imperfect competition. Note that (A1) also restricts attention to non-trivial strategic outsourcing: If (A1) is violated, outsourcing will be a dominant strategy for at least one of the firms, as outsourcing not only allows to eliminate investments costs F_i , but also reduces perceived marginal costs.⁷ Since we want to focus on *strategic* outsourcing in this paper, we shall exclude such cases.

Assumption (A2) implies that a firm's decision to outsource production of the input good raises the equilibrium input price w , since an increase in the number of firms purchasing in the input market enhances input demand. As noted, the previous outsourcing literature has largely ignored the demand-enhancing effect of outsourcing decisions. Yet,

⁷For instance, consider the case where (A1) is violated since $c_A < w(V_A, V_B) \leq c_B$. In this case, outsourcing will be a dominant strategy for firm B .

demand-induced input price effects are crucial for understanding strategic behavior in vertically-related industries. It is therefore not surprising that input price effects play a prominent role in well-known models of successive oligopolies. For example, both Salinger (1988, p. 352) and Abiru et al. (1998) show that input prices may rise if more firms purchase in the input market. At this point, it is important to note that—with the firms’ reduced-form profits properly interpreted—(A2) also allows for retail firms being active as sellers in the input market if they decide to engage in in-house production. In this case, a firm’s decision to outsource will not only enhance input demand but may also reduce input supply, reinforcing the positive input price effect of outsourcing discussed above. Since the supply effect (if any) will reinforce the demand effect, we shall abstract from the supply side effect and focus on the demand effect below.

Given this setting, firm i ’s strategic outsourcing decision deals with a trade-off similar to that in Shy and Stenbacka: Firm i faces fixed investment costs F_i and constant marginal costs c_i in the case of in-house production, and no fixed costs, but higher marginal costs $w(\cdot) > c_i$ in the case of outsourcing.

For the following discussion, it is helpful to introduce the following notation.

Notation 1 (profit differentials) For $k = 1, 2, i = A, B$, let Δ_i^k denote the profitability of outsourcing by firm i , where k indicates the total number of outsourcing firms. Similarly, let Δ_{-i}^k denote the effect of firm i ’s outsourcing on the competitor’s profit. More specifically,

$$\begin{aligned}\Delta_A^1 &:= \pi_A(1, 0) - \pi_A(0, 0); & \Delta_A^2 &:= \pi_A(1, 1) - \pi_A(0, 1); \\ \Delta_B^1 &:= \pi_B(0, 1) - \pi_B(0, 0); & \Delta_B^2 &:= \pi_B(1, 1) - \pi_B(1, 0); \\ \Delta_{-B}^1 &:= \pi_A(0, 1) - \pi_A(0, 0); & \Delta_{-B}^2 &:= \pi_A(1, 1) - \pi_A(1, 0).\end{aligned}$$

We can now distinguish four different types of strategic interaction:

- (i) $\Delta_B^1 < 0; \Delta_B^2 < 0$: Firm B ’s dominant strategy is to produce the input good in-house ($V_B = 0$), irrespective of firm A ’s decision. Firm A will thus decide to outsource the production of the input good if $\Delta_A^1 \geq 0$.
- (ii) $\Delta_B^1 > 0; \Delta_B^2 > 0$: Firm B ’s dominant strategy is to outsource ($V_B = 1$) and pay the market price w , irrespective of firm A ’s decision. Firm A will thus decide to outsource if $\Delta_A^2 \geq 0$.
- (iii) $\Delta_B^1 > 0 > \Delta_B^2$: Firm B ’s optimal choice of V_B depends on firm A ’s choice of V_A . More specifically, it is [not] profitable for firm B to outsource if firm A has decided to “make” [“buy”] the input good. Firm A will thus be willing to outsource—thereby strategically *preventing* B ’s outsourcing—if $\pi_A(1, 0) > \pi_A(0, 1)$.

- (iv) $\Delta_B^1 < 0 < \Delta_B^2$: Firm B 's optimal choice of V_B depends on firm A 's choice of V_A . More specifically, it is [not] profitable for firm B to outsource if firm A has decided to “buy” [“make”] the input good. Firm A will thus be willing to outsource—thereby strategically *triggering* B 's outsourcing—if $\pi_A(1, 1) > \pi_A(0, 0)$.

If market conditions are such that type (i) or type (ii) is relevant, strategic interactions matter only insofar as they determine the firms' reduced-form profits $\pi_i, i = A, B$, by some form of imperfect product market competition. The firms' equilibrium choices of their production mode, however, are void of strategic interactions, since firm B has a dominant strategy in both cases (in-house production for type (i) and outsourcing for type (ii)). In the following, we limit the discussion to the more interesting types (iii) and (iv). To analyze firms' decisions for these two types, it is useful to apply the well-known taxonomy of business strategies introduced by Fudenberg and Tirole (1984). Table 1 reproduces the different strategies for the sequential outsourcing game under consideration.⁸ Using terminology familiar from Tirole (1988, 325), we will say that outsourcing makes firm A “tough” if it prevents further outsourcing by firm B (the left column of the table) and “soft” if it triggers further outsourcing by firm B (the right column).

<Table 1 around here>

3 Understanding Outsourcing Equilibria

We now discuss whether the candidate equilibria identified in Table 1 emerge in our sequential outsourcing game. In particular, we shall argue that the effect of outsourcing on the equilibrium input price $w(\cdot)$ is crucial for understanding strategic outsourcing decisions.

3.1 Candidate Equilibria

We start with a discussion of the cases where outsourcing by firm B increases firm A 's profit (the first row in Table 1, with $\Delta_{-B}^1 > 0$ or $\Delta_{-B}^2 > 0$, respectively).

First, consider the Puppy Dog strategy, where *firm A does not outsource so as to induce outsourcing by firm B*. Under these circumstances, we know that outsourcing by firm B alone is profitable ($\Delta_B^1 > 0$). Furthermore, B 's outsourcing increases A 's profit ($\Delta_{-B}^1 > 0$). Intuitively, the latter follows from the fact that, after outsourcing, firm B acquires the input good at higher marginal cost ($w(0, 1) > c_B$ by (A1)) and

⁸Note that the table summarizes the conditions for *strategic* outsourcing decisions. Clearly, the overall comparison of profits before and after outsourcing remains crucial for the firms' decisions.

thus becomes a less aggressive competitor.⁹ Also, outsourcing makes A tough and prevents further outsourcing by B ($\Delta_B^2 < 0$). This preemptive effect arises since after A 's outsourcing, additional outsourcing by B would yield an even higher input market price ($w(1, 1) > w(0, 1)$ by (A2)), making outsourcing less attractive from B 's point of view. Note that there is an interesting relation between the Puppy Dog strategy under sequential outsourcing and the industrial organization literature on raising rivals' cost, initiated by Salop and Scheffman (1983, 1987). In the latter, a raising rivals' cost effect is typically associated with aggressive behavior on the part of a vertically integrated firm (i.e. a firm that has not outsourced).¹⁰ In the sequential outsourcing game considered here, however, the raising rivals' cost effect is generated by soft or inoffensive play by the vertically integrated firm A . Therefore, A 's adoption of the Puppy Dog strategy may be viewed as a non-conventional way of raising rival's cost.

Second, consider the Fat Cat strategy, where *firm A outsources so as to induce outsourcing by firm B* . Under these conditions, outsourcing by B is profitable only if A has already outsourced ($\Delta_B^1 < 0 < \Delta_B^2$), and B 's outsourcing increases A 's profit ($\Delta_{-B}^2 > 0$). Intuitively, the latter effect follows from the fact that A 's initial outsourcing has increased its marginal cost to $w(1, 0) > c_A$ (by (A1)), making A a less aggressive competitor. Further outsourcing by B (re-)establishes a level playing field where both firms face even higher marginal cost of $w(1, 1) > w(1, 0) > c_B$ (by (A2)), thereby further softening competition. In equilibrium, A will be ready to trigger such a sequence of outsourcing decisions if $\pi_A(1, 1) > \pi_A(0, 0)$. The latter condition implies that successive outsourcing decisions soften competition sufficiently so as to overcompensate the disadvantage of higher marginal cost.

Let us now consider the cases where outsourcing by firm B decreases firm A 's profit (the second row in Table 1, with $\Delta_{-B}^1 < 0$ or $\Delta_{-B}^2 < 0$, respectively).

First, consider the Top Dog strategy, where *firm A outsources so as to prevent outsourcing by firm B* . Under these circumstances, we know that outsourcing by firm B alone is profitable ($\Delta_B^1 > 0$). Furthermore, B 's outsourcing reduces A 's profit ($\Delta_{-B}^1 < 0$). In the following, we want to argue that firm A will never adopt the Top Dog strategy. To understand why, observe that the condition ($\Delta_{-B}^1 < 0$) does not make sense in the outsourcing game under consideration. In fact, B 's outsourcing increases its marginal cost to $w(0, 1) > c_B$, making B a less aggressive competitor. As a result, B 's outsourcing will increase rather than decrease A 's profit in virtually any oligopoly model of product market competition. Hence, A will not be willing to prevent B 's outsourcing by own

⁹Of course, B 's outsourcing also eliminates the fixed cost F_B , but this is irrelevant for determining the intensity of competition in the product market.

¹⁰For example, a vertically integrated firm may refuse to deliver the input good to a vertically separated downstream competitor.

outsourcing.

Second, consider the Lean & Hungry Look strategy, where *firm A does not outsource so as to avoid triggering outsourcing by firm B*. Under these conditions, outsourcing by *B* is profitable only if *A* has already outsourced ($\Delta_B^1 < 0 < \Delta_B^2$), and *B*'s outsourcing reduces *A*'s profit ($\Delta_{-B}^2 < 0$). To understand the latter effect, suppose that *A* has already outsourced. Now, *B*'s decision to outsource will further raise the input market price to $w(1, 1) > w(1, 0)$ (by (A2)), thereby increasing *A*'s marginal cost. In equilibrium, *A* will adopt a Lean & Hungry Look strategy if the condition $\pi_A(0, 0) > \pi_A(1, 1)$ is satisfied. This condition implies that the softening of competition generated by successive outsourcing is insufficient to compensate *A* for its marginal cost increase.

3.2 Discussion

Our analysis supports Shy and Stenbacka's (2003) finding that outsourcing may serve as a collusive device by *jointly* raising marginal production costs. In our setting, a sequence of two outsourcing decisions—an outsourcing wave—may be viewed as an instance of collusion, if it is strategically triggered by the adoption of a Fat Cat strategy on the part of the firm that moves first.¹¹

Importantly, our analysis adds two related results: First, outsourcing may serve to soften competition even if, in equilibrium, *only one* of the firms outsources. Given that the softening of competition is attained by increasing marginal cost, each firm would prefer the other firm to outsource. It is the first firm—having a first-mover advantage—that decides about the allocation of the cost increase, adopting a Puppy Dog strategy. Second, it may happen that the softening of competition associated with jointly raising marginal costs is insufficient to compensate the first firm for its marginal cost increase. In this case, the first firm will adopt the Lean & Hungry Look strategy to avoid triggering an outsourcing wave.

4 A Linear Cournot Example

In this section, we illustrate the above analysis using a simple linear Cournot model. For this purpose, let us assume that the cost function of firm *i* is given by

$$C_i(q_i) = (1 - V_i)(\alpha_i c q_i + F) + V_i(\alpha_i w q_i), \quad i = A, B,$$

¹¹Recall that, if market conditions are such that type (ii) of strategic interaction occurs, *B*'s dominant strategy is to outsource irrespective of *A*'s decision. In this case, a sequence of two outsourcing decisions may occur for reasons unrelated to strategic considerations.

where q_i is firm i 's quantity and $F > 0$ is the fixed cost of producing in-house, i.e., both firms face the same fixed cost. The term $\alpha_i \geq 1$ represents firm i 's efficiency in transforming inputs into outputs.¹² Marginal costs are constant and given by

$$C'_i = \alpha_i[(1 - V_i)c + V_i w(V_i, V_j)],$$

depending on the firms' outsourcing decisions V_i and V_j , $i, j = A, B$, $i \neq j$. If firm i produces its input in-house ($V_i = 0$), the respective marginal cost for the input's production is c , while it is given by the input market price w if the firm is sourcing over the input market ($V_i = 1$). Recall that the equilibrium input price is given by $w(0, 1)$ when only firm B outsources. In the reverse case, where only firm A outsources, the wholesale price is $w(1, 0)$. Finally, the equilibrium input price is $w(1, 1)$ when both firms outsource. Inverse demand is given by $P(Q) = a - bQ$, where $P(Q)$ is the retail price, and $Q \equiv q_A + q_B$ is aggregate output. In the following, we assume for simplicity that $\alpha_B \equiv 1$ and $\alpha_A \equiv \alpha \geq 1$. That is, firm A is at best as efficient as firm B .

It is straightforward to calculate the following profit differentials for the linear Cournot example:

$$\begin{aligned} \Delta_B^1 &= \frac{1}{9b} (a + \alpha c - 2w(0, 1))^2 - \frac{1}{9b} (a + \alpha c - 2c)^2 + F; \\ \Delta_B^2 &= \frac{1}{9b} (a + \alpha w(1, 1) - 2w(1, 1))^2 - \frac{1}{9b} (a + \alpha w(1, 0) - 2c)^2 + F; \\ \Delta_{-B}^1 &= \frac{1}{9b} (a + w(0, 1) - 2\alpha c)^2 - \frac{1}{9b} (a + c - 2\alpha c)^2; \\ \Delta_{-B}^2 &= \frac{1}{9b} (a + w(1, 1) - 2\alpha w(1, 1))^2 - \frac{1}{9b} (a + c - 2\alpha w(1, 0))^2. \end{aligned}$$

In the subsections below, we shall use these expressions for discussing the conditions under which the various outsourcing equilibria described in section 3 may arise. We consider each of the candidate equilibria in turn.

4.1 Puppy Dog

Recall from Table 1 that, in equilibrium, firm A will adopt the Puppy Dog strategy and not outsource so as to induce outsourcing by firm B if both $\Delta_{-B}^1 > 0$ and $\Delta_B^1 > 0 > \Delta_B^2$ are satisfied. Inspection indicates that $\Delta_{-B}^1 > 0$ will always be satisfied, since $w(0, 1) > c$ by assumption (A1). Now consider the second condition. The first part of the second condition ($\Delta_B^1 > 0$) may be written as

$$(a + \alpha c - 2c)^2 - [a + \alpha c - 2w(0, 1)]^2 < 9bF. \quad (1)$$

¹²For instance, if firm i operates a 1:1 technology, firm i transforms one unit of the input good into one unit of the final good, and we therefore have $\alpha_i = 1$. For a less efficient firm, we have $\alpha_i > 1$.

Inspection indicates that for (1) to be satisfied, B 's increase of marginal cost ($w(0, 1) - c$) associated with outsourcing must be sufficiently small relative to the fixed cost F of producing the input in-house. That is, firm B 's marginal cost increase must not outweigh the fixed cost savings associated with outsourcing. Otherwise, outsourcing by firm B alone would not be profitable. The second part of the condition ($\Delta_B^2 < 0$) may be written as

$$(a + \alpha w(1, 0) - 2c)^2 - [a + \alpha w(1, 1) - 2w(1, 1)]^2 > 9bF. \quad (2)$$

Relation (2), i.e. $\Delta_B^2 < 0$, is more likely to hold the larger firm B 's marginal cost increase ($w(1, 1) - c$) is relative to firm A 's marginal cost increase $\alpha(w(1, 1) - w(1, 0))$, once firm A has outsourced. Intuitively, this means that outsourcing is the less attractive for firm B , the larger its own marginal cost increase and the smaller the raising rivals' cost effect on firm A . Furthermore, (2) is more likely to be satisfied if firm A is relatively efficient in transforming inputs into outputs (α is relatively small), i.e. outsourcing is less attractive for firm B if it faces an efficient competitor A .

4.2 Fat Cat

According to Table 1, the adoption of a Fat Cat strategy requires that both $\Delta_{-B}^2 > 0$ and $\Delta_B^1 < 0 < \Delta_B^2$ are satisfied. The first of these conditions, which concerns the effect of B 's outsourcing on A 's profit, can be written as

$$w(1, 1) - c > 2\alpha[w(1, 1) - w(1, 0)]. \quad (3)$$

Intuitively, (3) requires that firm B 's marginal cost increase ($w(1, 1) - c$) is large relative to firm A 's marginal cost increase $\alpha(w(1, 1) - w(1, 0))$, once firm A has outsourced. Obviously, the condition is more likely to be satisfied the higher A 's efficiency level (i.e. the smaller α). Now consider the condition $\Delta_B^1 < 0$, which can be written as

$$(a + \alpha c - 2c)^2 - [a + \alpha c - 2w(0, 1)]^2 > 9bF. \quad (4)$$

Relation (4) implies that, in contrast to the Puppy Dog case, firm B must face a large marginal cost increase ($w(0, 1) - c$), so as to make outsourcing unattractive despite of the fixed cost savings. Otherwise, outsourcing by firm B alone would be profitable. The condition $\Delta_B^2 > 0$, in turn, may be written as

$$(a + \alpha w(1, 0) - 2c)^2 - [a + \alpha w(1, 1) - 2w(1, 1)]^2 < 9bF. \quad (5)$$

This condition is simply the reverse of (2). That is, (5) is more likely to be satisfied the larger the raising rivals' cost effect on firm A , and the smaller the own marginal cost

increase. In this case, the condition is more likely to be satisfied if firm A is relatively inefficient (α is high).

However, for a Fat Cat strategy to be a part of an equilibrium, firm A also needs to prefer a situation where both firms outsource over one where both firms produce in-house ($\pi_A(1, 1) > \pi_A(0, 0)$); otherwise, firm A would not be willing to trigger successive outsourcing. As can be easily checked, $\pi_A(1, 1) > \pi_A(0, 0)$ is the more likely to hold the smaller $(w(1, 1) - c)(2\alpha - 1)$ is compared to the fixed cost, F . Hence, in equilibrium, the Fat Cat strategy is more likely to be adopted the smaller F , the more efficient firm A (the smaller α),¹³ and the smaller the marginal cost increase $(w(1, 1) - c)$ when both firms outsource.

4.3 Lean & Hungry Look

As indicated in Table 1, the Lean & Hungry Look strategy will be adopted in equilibrium if both $\Delta_B^1 < 0 < \Delta_B^2$ and $\Delta_{-B}^2 < 0$ are satisfied. Hence, compared to the Fat Cat strategy the only difference is that outsourcing by firm B has a negative rather than a positive effect on firm A 's profit ($\Delta_{-B}^2 < 0$). Rewriting this condition yields

$$w(1, 1) - c < 2\alpha [w(1, 1) - w(1, 0)], \quad (6)$$

which requires that firm A 's marginal cost increase $\alpha(w(1, 1) - w(1, 0))$ is large relative to firm B 's increase $(w(1, 1) - c)$. Note that (6) is more easily satisfied if firm A is relatively inefficient (α is high).

For a Lean & Hungry Look strategy to be a part of an equilibrium, however, firm A also needs to prefer a situation where no firm outsources over one where both firms outsource ($\pi_A(0, 0) > \pi_A(1, 1)$); otherwise, firm A would prefer successive outsourcing. This is more likely to be the case, the larger $(w(1, 1) - c)(2\alpha - 1)$ is compared to the fixed cost, F . Hence, a Lean & Hungry Look strategy is the more likely to emerge in equilibrium the larger F , the less efficient firm A is (the larger α), and the larger the marginal cost increase $(w(1, 1) - c)$ when both firms outsource.

4.4 Top Dog

Finally, consider the Top Dog strategy. We have pointed out above that, in equilibrium, firm A will never adopt this strategy, since outsourcing by firm B alone cannot hurt firm A . That is, $\Delta_{-B}^1 < 0$ cannot be satisfied. The linear Cournot model under consideration

¹³In combination with (5), this indicates that α must have an intermediate value for the Fat Cat strategy to emerge in equilibrium.

nicely illustrates this finding. In order to satisfy $\Delta_{-B}^1 < 0$, we would need to assume that $w(0, 1) < c$, which is in contradiction to assumption (A1).

4.5 A Numerical Example

In order to illustrate the above analysis, let us consider a numerical example of the linear Cournot model with the following parameter values: $a = 50, b = 1, c = 1, \alpha = 4, w(1, 0) = 2.9$ and $w(0, 1) = 3$. Furthermore, for each value of $w(1, 1)$, we assume that the fixed cost level F is such that it does not dominate the strategic incentives for outsourcing (not outsourcing, respectively).¹⁴ In Figure 1, the curve labelled $\Delta_B^2 - \Delta_B^1$ indicates how outsourcing by firm A affects the profitability of firm B 's outsourcing for various values of $w(1, 1)$.¹⁵ The two other curves show how outsourcing by firm B affects the profit of firm A (Δ_{-B}^1 and Δ_{-B}^2 , respectively). Since $w(V_A, V_B)$ is increasing in $V_i, i = A, B$ by (A2), we solely consider cases where $w(1, 1) > 3$.

<Figure 1 around here>

First note that, independent of the value of $w(1, 1)$, firm A is positively affected by B 's outsourcing alone ($\Delta_{-B}^1 > 0$). It follows immediately that the Top Dog will not be part of a strategy combination forming an equilibrium. If $w(1, 1)$ is relatively small, outsourcing by B alone is profitable, whereas successive outsourcing is not ($\Delta_B^2 - \Delta_B^1 < 0$). Since the profit of firm A is positively affected by B 's outsourcing alone ($\Delta_{-B}^1 > 0$), A will adopt the Puppy Dog strategy. If $w(1, 1)$ is at an intermediate level, successive outsourcing is profitable from B 's point of view ($\Delta_B^2 - \Delta_B^1 > 0$). Also, outsourcing by B affects firm A 's profit positively, and firm A will adopt the Fat Cat strategy so as to trigger outsourcing by firm B . Finally, if $w(1, 1)$ is large, successive outsourcing is still profitable from firm B 's point of view. However, outsourcing by firm B affects firm A 's profit negatively. Firm A will thus adopt the Lean & Hungry Look strategy.

5 Conclusions

We have shown that firms may strategically outsource the production of an input good to an imperfectly competitive input market so as to soften competition in the final product

¹⁴For example, if $w(1, 1)$ is in a medium range such that firm A should adopt the Fat Cat strategy for strategic reasons (see Figure 1), F must be sufficiently large for A 's profit to be higher with successive outsourcing than with no outsourcing.

¹⁵For instance, if outsourcing by A prevents further outsourcing ($\Delta_B^1 > 0 > \Delta_B^2$), we have $\Delta_B^2 - \Delta_B^1 < 0$. Conversely, if outsourcing by A triggers further outsourcing ($\Delta_B^1 < 0 < \Delta_B^2$), we have $\Delta_B^2 - \Delta_B^1 > 0$.

market. More specifically, if firms face a trade-off between bearing the fixed cost of in-house production at low variable cost and avoiding this fixed cost, but incurring higher marginal cost, and if, in addition, input prices vary with the industry's vertical structure, outsourcing may serve as an instrument of collusion or raising rivals' cost.

Our analysis of a reduced-form model has demonstrated that (depending on parameter values) three different types of equilibria may emerge:

(i) There may be an *asymmetric* outsourcing equilibrium where one firm produces the input good in-house whereas the other acquires it from the input market. In this equilibrium, the first-mover follows a Puppy Dog strategy and strategically abstains from outsourcing so as to not prevent outsourcing by the second firm. By preventing an initial increase of the input price, the second firm is induced to outsource and thus to increase its own marginal cost.

(ii) There may be a *symmetric* equilibrium where both firms outsource. In this equilibrium, the first firm decides to outsource so as to trigger further outsourcing by the second firm (the Fat Cat strategy). Firms successively outsource to mutually raise their marginal costs, thereby softening competition in the final product market. That is, firms may generate a wave of consecutive outsourcing decisions so as to collude in the retail market.

(iii) There may be another *symmetric* equilibrium where none of the firms outsources. In this equilibrium, the first firm does not outsource to avoid triggering outsourcing by the second firm (the Lean & Hungry Look strategy). Intuitively, this equilibrium may emerge if the softening of competition generated by a wave of outsourcing decisions is insufficient to compensate the first firm for its marginal cost increase. The first firm will then strategically prevent successive outsourcing.

Our results are based on a reduced-form analysis and apply irrespective of whether product market decisions are strategic substitutes or strategic complements. They suggest that it is crucial to account for the price effects of outsourcing *both* at the downstream and at the upstream level of the industry to better understand the economics of outsourcing decisions. In fact, upstream price effects associated with strategic outsourcing might be even more important in vertically-related industries with specific (rather than non-specific) input goods. Future research will have to address this question.

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Table 1: Taxonomy of business strategies

Should A outsource for <i>strategic</i> reasons?		
Outsourcing by A ...		
<i>... prevents</i> outsourcing by B . ($\Delta_B^1 > 0 > \Delta_B^2$)	<i>... triggers</i> outsourcing by B . ($\Delta_B^1 < 0 < \Delta_B^2$)	
Outsourcing by B ...		
... increases A 's profit. ($\Delta_{-B}^1 > 0$ or $\Delta_{-B}^2 > 0$)	No "Puppy Dog"	Yes "Fat Cat"
... decreases A 's profit. ($\Delta_{-B}^1 < 0$ or $\Delta_{-B}^2 < 0$)	Yes "Top Dog"	No "Lean & Hungry Look"

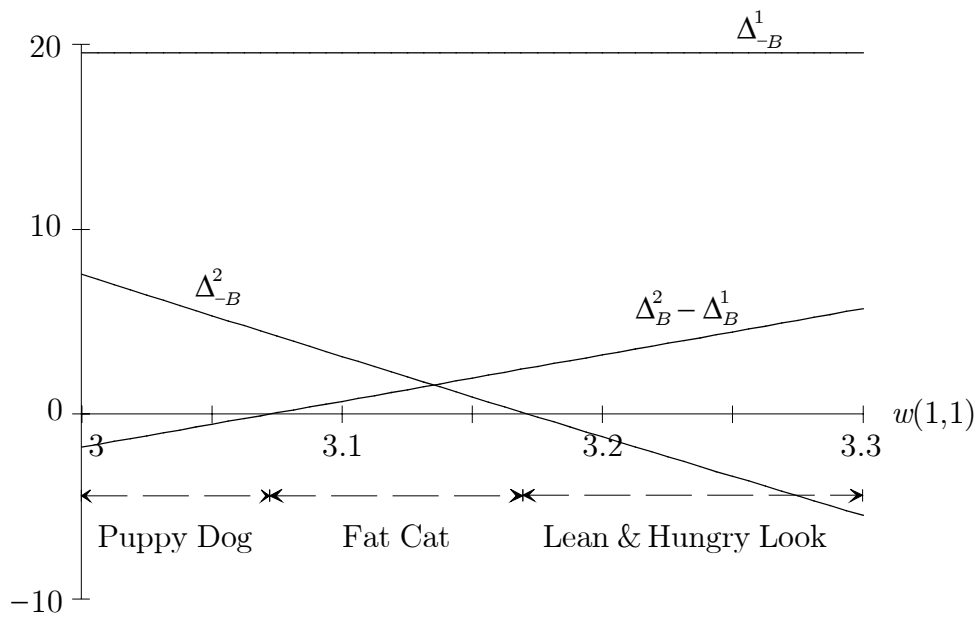


Figure 1: Taxonomy of firm A 's business strategies for the parameter values $a = 50, b = 1, c = 1, \alpha = 4, w(1, 0) = 2.9, w(0, 1) = 3$, and $3 < w(1, 1) \leq 3.3$.