University of Zurich

Socioeconomic Institute
Sozialökonomisches Institut

Working Paper No. 0305

Strategic Outsourcing Revisited

Stefan Buehler and Justus Haucap

July 2003

Socioeconomic Institute
University of Zurich

Working Paper No. 0305
Strategic Outsourcing Revisited

July 2003

Author's addresses Stefan Buehler
E-mail: sbuehler@soi.unizh.ch

Justus Haucap
E-mail: justus.haucap@unibw-hamburg.de

Publisher Sozialökonomisches Institut
Bibliothek (Working Paper)
Rämistrasse 71
CH-8006 Zürich
Phone: +41-1-634 21 37
Fax: +41-1-634 49 82
URL: www.soi.unizh.ch
E-mail: soilib@soi.unizh.ch

Strategic Outsourcing Revisited*

Stefan Buehler†
University of Zurich and University of St. Gallen

Justus Haucap‡
University of the Federal Armed Forces, Hamburg

14/07/2003

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. We 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' costs. We illustrate our analysis using a linear Cournot model.

JEL Classification: D43, L22, L23, L24.

*We are grateful to Ralf Dewenter, Dennis Gärtner, Daniel Halbheer, Armin Schmutzler, and seminar participants at the University of Zurich. Patrick Eugster provided excellent research assistance.

†University of Zurich, Hottingerstrasse 10, CH-8032 Zurich, Switzerland; e-mail: sbuehler@soi.unizh.ch.

‡University of the Federal Armed Forces Hamburg, Institute for Economic Policy, Holstenhofweg 85, D-22043 Hamburg, Germany; e-mail: justus.haucap@unibw-hamburg.de.

1 Introduction

Explaining the boundaries of the firm has been a core aspect of the economic theory of organization since Coase's (1937) seminal contribution to the theory of the firm. While much of the existing research has focussed on vertical integration, the reverse step, i.e. vertical disintegration or outsourcing, has become a widespread phenomenon in the industrialized world in more recent times. Examples for industries where outsourcing is a key feature in the organization of production abound: aircraft, cars, computers, mobile phones, audio/video systems, mechanical watches etc. Casual evidence suggests that information technology (IT) and other business services are regularly contracted out in a large number of industries (Domberger 1998). Not surprisingly, econometric studies assign a prominent role to outsourcing in various industries.[1] Therefore, understanding the economics of outsourcing should help explaining firms' boundaries.

Following Coase (1937), the choice of a firm's production mode has often been discussed in the context of transaction cost analysis, which argues, roughly speaking, that a firm's choice of its production mode is based on a comparison of the costs associated with internal transactions and transactions over the market. 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 more difficult, inducing firms to vertically integrate.[2] Based on this literature, Grossman and Helpman (2002) study the determinants of the equilibrium production mode (i.e. integration vs. outsourcing) in industries where inputs are fully or partially specialized.

A related strand of the literature has focused on international outsourcing, i.e. the fragmentation of production across borders. For instance, Feenstra and Hanson (1999) investigate how international outsourcing affects factor productivity and factor rewards in the U.S.[3] In a recent theoretical study, McLaren (2000) analyzes the relation of international openness and firms' outsourcing decisions. He provides an original theory of outsourcing, arguing that international openness "thickens" the market and thus allows for leaner, less integrated firms.

Finally, a number of papers have highlighted the role of strategic competition for a firm's decision to choose a particular production mode. For instance, Bonanno and

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

[2] See Holmström and Roberts (1998) for a recent survey of the literature on firm boundaries.

[3] Further contributions analyzing the effects of international outsourcing on the U.S. are e.g. Siegel and Griliches (1991) and Slaughter (2000). See Egger and Egger (2002) for an analysis of the impact of international outsourcing on European industries.

Vickers (1988) show that if franchise fees can be used to extract retailers' surplus, a manufacturer will choose vertical separation as its organizational mode, since vertical separation induces more friendly behavior from its rival manufacturer and thus facilitates collusion.[4] Gal-Or (1999) explores how asymmetric information between a manufacturer and a retailer affects a manufacturer's decision to integrate with or separate from a retailer. Chen (2002) examines the effects that economies of scale in the upstream production process may have on vertical disintegration decisions. Finally, in a recent contribution, Shy and Stenbacka (2003) analyze how firms may use their organizational production mode as an instrument of strategic competition. In their model, differentiated Bertrand duopolists can either undertake irreversible investments into in-house production facilities for an input, or they can buy that input from a subcontractor, but at higher variable cost.

In this paper, we build on the latter work on strategic outsourcing and propose a *reduced-form* approach towards analyzing sequential strategic outsourcing. More specifically, we suppose that two (potentially asymmetric) firms decide sequentially about outsourcing the production of a non-specific input good to an existing input market. As in Shy and Stenbacka (2003), we assume that the duopolists face a trade-off between making irreversible investments and incurring higher marginal cost when making their "make-or-buy" decisions. However, we also let the input price vary with the industry's vertical structure, since a firm's outsourcing decision will typically affect the input market equilibrium. This aspect has been largely ignored in the previous literature.[5] By allowing for a price effect in the input market, we are able to place strategic outsourcing in the broader context of strategic competition in vertically-related oligopolies. In particular, we are able to explore under what conditions outsourcing may serve as an instrument of collusion in the final product market and when outsourcing may be geared towards raising rivals' cost.[6]

To analyze strategic sequential outsourcing decisions, we adopt an approach originally proposed by Nilssen and Sørgard (1998) for the analysis of sequential horizontal mergers. That is, we use the taxonomy of business strategies introduced by Fudenberg and Tirole (1984) to provide a general discussion of the potential strategic outsourcing equilibria.

[4] In a related paper, 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.

[5] For 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. (forthcoming) that considers input price effects.

[6] The 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.

In particular, we discuss the role of changes in input prices associated with sequential outsourcing for determining the equilibrium. Furthermore, we provide a Cournot model with linear demand as a specific example to illustrate our analysis.

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 outsources the production of its input whereas the other produces the input internally. Intuitively, the difference follows from the fact that in our analysis, there is always a trade-off between making irreversible investments and incurring higher marginal cost. This contrasts with Shy and Stenbacka's analysis, where a single firm that outsources must cover the entire sunk cost of the input producer, and outsourcing will thus always be more costly than in-house production if only one of the two firms outsources.[7]

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 increase its own marginal cost (this particular behavior of the first firm will be called a "Puppy Dog" strategy). Unsurprisingly, an asymmetric equilibrium where the first firm outsources so as to prevent outsourcing by the second firm (the "Top Dog" strategy) does not exist. The intuition is again straightforward: The first firm will actually benefit from the second firm's marginal cost increase associated with outsourcing, provided that it has not already outsourced. The first firm will thus not be willing to prevent outsourcing by own outsourcing.

Third, there may be a symmetric equilibrium where the first firm's outsourcing induces the second firm to outsource (the first firm here adopts a "Fat Cat" strategy). 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 (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

[7] In effect, Shy and Stenbacka (2003) are imposing that outsourcing becomes equivalent to setting up an input market that was inexistent before that firm's decision to outsource. The input to be outsourced in their model is therefore best understood as being specifically tailored to the needs of the production of the final good under consideration.

cost increase. The first firm will then strategically prevent successive outsourcing.

Summing up, we find that outsourcing the production of the input good generally softens competition in the final product market. 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 it 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, and in section 3 we discuss the various candidate equilibria. As a specific example, we present a linear Cournot model 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 some retail market. Each of the firms $i = A, B$ operates a firm-specific technology characterized by the tuple $\{c_i, F_i\}$ to produce a non-specific input good (e.g. electricity), i.e., 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 outsource the production of the input good, i.e. they may buy the input good from an input market at equilibrium market price w. 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

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

In general, the equilibrium input market price w will be a function of the firms' outsourcing decisions $V_i, i = A, B$, since the latter affect the level of demand in the input market. Therefore, we henceforth write the equilibrium input market price as $w(V_A, V_B)$. In the following, we shall make use of the following basic assumptions:

(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 manufacturing 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.[8] Since we want to focus on strategic outsourcing in this paper, we shall exclude such cases. (A2) implies that a firm's decision to outsource the production of the input good increases the equilibrium price in the input market, since demand in the input market increases with vertical *separation*. This contrasts with the literature on vertical foreclosure,[9] where a firm's decisions to integrate usually implies that it will strategically withhold supply from the input market, so that input market prices increase with vertical *integration*. This crucial difference arises since in our model a firm's decision to outsource increases demand in the input market, but does not affect supply.[10] Firm i's strategic outsourcing decision thus deals with a trade-off similar to that in Shy and Stenbacka (2003): Firms face irreversible investment costs F_i and constant marginal costs c_i in the case of in-house production, and higher marginal cost $w(\cdot) > c_i$ in the case of outsourcing.

We denote firm i's reduced form profit by $\pi_i(V_A, V_B), i = A, B$.[11] For the following discussion, it is helpful to introduce a number of profit differentials that characterize the profitability of a firm's outsourcing decision, where the subscript denotes the firm under consideration and the superscript indicates whether only one or both firms decide to outsource (see Table 1).

Table 1: Profit differentials associated with outsourcing

profit differential	description
$\Delta_A^1 := \pi_A(1,0) - \pi_A(0,0)$	profitability of A's outsourcing alone
$\Delta_A^2 := \pi_A(1,1) - \pi_A(0,1)$	profitability of A's outsourcing when B also outsources
$\Delta_B^1 := \pi_B(0,1) - \pi_B(0,0)$	profitability of B's outsourcing alone
$\Delta_B^2 := \pi_B(1,1) - \pi_B(1,0)$	profitability of B's outsourcing when A also outsources
$\Delta_{-B}^1 := \pi_A(0,1) - \pi_A(0,0)$	effect of B's outsourcing alone on A
$\Delta_{-B}^2 := \pi_A(1,1) - \pi_A(1,0)$	effect of B's outsourcing on A when A has outsourced

Using the profit differentials introduced in Table 1, we can distinguish four different types of play:

[8] For instance, consider the case where $c_A < w(V_A, V_B) \leq c_B$. In this case, outsourcing will be a dominant strategy for firm B.

[9] Sey Rey and Tirole (forthcoming) for a comprehensive survey of the foreclosure literature.

[10] That is, a firm's decision to outsource implies that it no longer produces the input good.

[11] Note that various forms of product market competition (e.g. Cournot or Bertrand with differentiated products) are consistent with this setup.

(i) $\Delta_B^1 < 0; \Delta_B^2 < 0$: Firm B's dominant strategy is to produce the input good in-house ($V_B = 0$), i.e., firm B will "make" rather than "buy" the input good, independent 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, i.e., firm B will "buy" rather than "make" the input good, independent 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 the production of the input good 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 again. More specifically, it is [not] profitable for firm B to outsource the production of the input good 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) of play occurs, 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 the production mode themselves, however, are void of strategic interactions, since firm B has a dominant strategy in both cases (in-house production under type (i) and outsourcing under type (ii)). Types (i) and (ii) of play are thus ruled out by (A1). In the following, we therefore focus on type (iii) and type (iv) of play. To analyze firms' decisions under these types, it is useful to apply the well-known taxonomy of business strategies introduced by Fudenberg and Tirole (1984). Table 2 reproduces the different strategies for the sequential outsourcing game under consideration.

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).

More specifically, if outsourcing makes firm A tough (i.e. prevents further outsourcing by firm B), firm A should "make" rather than "buy" the input good if outsourcing by B increases its profit. That is, A should choose the low activity level ($V_A = 0$) to look soft or inoffensive (Puppy Dog). However, if outsourcing by B decreases its profit, A should

Table 2: Taxonomy of business strategies

Should A outsource for strategic reasons?		
	Outsourcing by A ...	
	... *prevents* outsourcing by B. ($\Delta_B^1 > 0 > \Delta_B^2$)	... *triggers* 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"

"buy" from the input market so as to prevent B's outsourcing, i.e. A should choose the high activity level ($V_A = 1$) to look tough or aggressive (Top Dog).

Conversely, if outsourcing makes firm A soft (i.e. triggers further outsourcing by firm B), firm A should "buy" rather than "make" the input good if outsourcing by B increases its profit. That is, A should choose the high activity level ($V_A = 1$) to look soft or inoffensive (Fat Cat). However, if outsourcing by B decreases its profit, A should "make" rather than "buy" the input good so as to prevent B's outsourcing, i.e. A should choose the low activity level ($V_A = 0$) to look tough or aggressive (Lean & Hungry Look).

3 Analyzing Outsourcing Equilibria

In this section, we discuss whether and how the candidate equilibria put forward in Table 2 come about in the sequential outsourcing game under consideration. 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

Let us start with a discussion of the cases where outsourcing by firm B increases firm A's profit (the first row in Table 2, 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 thus becomes

a less aggressive competitor.[12] 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 a 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).[13] 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 the condition $\pi_A(1,1) > \pi_A(0,0)$ is satisfied. This 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 2, 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 in the outsourcing game under consideration, firm A will never adopt the Top Dog strategy. To see why firm A will never adopt this strategy, observe that the condition ($\Delta_{-B}^1 < 0$) does not make sense in this particular game. 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

[12] Of 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.

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

will not be willing to prevent B's outsourcing by own 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 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

The above analysis suggests that in addition to saving fixed costs, a firm's decision to outsource the production of the input good serves to soften competition in the final product market. Clearly, the softening of competition is most effective if both firms find it profitable to outsource. A sequence of two outsourcing decisions—an outsourcing wave—may thus 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.[14]

If only one firm finds it profitable to outsource the production of the input good, the motive of softening competition still persists. However, the adoption of a Puppy Dog strategy by the first firm also reflects a raising rival's cost motive. Given that the softening of competition is attained by increasing marginal cost, each firm would prefer the other firm to outsource (the Top Dog strategy will thus never be adopted). As it turns out, it is the first firm—having a first-mover advantage—that decides about the allocation of the cost increase.

Finally, if the softening of competition associated with successive outsourcing is insufficient to compensate the first firm for its marginal cost increase, it will adopt the Lean & Hungry Look strategy and not outsources so as to avoid triggering outsourcing by firm B.

[14] Recall that, if market conditions are such that type (ii) of play 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.

4 An Example: Linear Cournot Duopoly

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

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

where q_i is the quantity produced by firm i 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.[15] 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 from the above discussion 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. The firms' profits are summarized in Table 3 for the various industry configurations.

Table 3: Firm profits in the linear Cournot model

	$\pi_i(0,0)$	$\pi_i(0,1)$	$\pi_i(1,0)$	$\pi_i(1,1)$
firm A	$\frac{(a+c-2\alpha c)^2}{9b} - F$	$\frac{(a+w(0,1)-2\alpha c)^2}{9b} - F$	$\frac{(a+c-2\alpha w(1,0))^2}{9b}$	$\frac{(a+w(1,1)-2\alpha w(1,1))^2}{9b}$
firm B	$\frac{(a+\alpha c-2c)^2}{9b} - F$	$\frac{(a+\alpha c-2w(0,1))^2}{9b}$	$\frac{(a+\alpha w(1,0)-2c)^2}{9b} - F$	$\frac{(a+\alpha w(1,1)-2w(1,1))^2}{9b}$

With these profits in mind, it is straightforward to calculate explicit expressions for the reduced-form profit differentials introduced above (see Table 4). In the following subsections, we shall use these expressions for discussing the conditions under which the various outsourcing equilibria described in section 3 may come about. We consider each of the candidate equilibria in turn.

[15] For 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 $\alpha_i > 1$.

Table 4: Profit differentials in the linear Cournot model

profit differential	
$\Delta_B^1 := \pi_B(0,1) - \pi_B(0,0) =$	$\frac{(a+\alpha c-2w(0,1))^2}{9b} - \frac{(a+\alpha c-2c)^2}{9b} + F$
$\Delta_B^2 := \pi_B(1,1) - \pi_B(1,0) =$	$\frac{(a+\alpha w(1,1)-2w(1,1))^2}{9b} - \frac{(a+\alpha w(1,0)-2c)^2}{9b} + F$
$\Delta_{-B}^1 := \pi_A(0,1) - \pi_A(0,0) =$	$\frac{(a+w(0,1)-2\alpha c)^2}{9b} - \frac{(a+c-2\alpha c)^2}{9b}$
$\Delta_{-B}^2 := \pi_A(1,1) - \pi_A(1,0) =$	$\frac{(a+w(1,1)-2\alpha w(1,1))^2}{9b} - \frac{(a+c-2\alpha w(1,0))^2}{9b}$

4.1 Puppy Dog

Recall from Table 2 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 of Table 4 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

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

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

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

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 2, 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

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

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

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

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

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

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),[16] and the smaller the marginal cost increase $(w(1,1)-c)$ when both firms outsource.

4.3 Lean & Hungry Look

As indicated in Table 2, 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

$$w(1,1)-c<2\alpha\left[w(1,1)-w(1,0)\right], \tag{6}$$

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

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

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, $\Delta^1_{-B} < 0$ cannot be satisfied. The linear Cournot model under consideration nicely illustrates this finding. In order to satisfy $\Delta^1_{-B} < 0$, 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 our 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 level of fixed cost F is such that it does not dominate the strategic incentives for outsourcing (not outsourcing, respectively).[17] In Figure 1, the curve labelled $\Delta^2_B - \Delta^1_B$ indicates how outsourcing by firm A affects the profitability of firm B's outsourcing for various values of $w(1,1)$.[18] The two other curves show how outsourcing by firm B affects the profit of firm A (Δ^1_{-B} and Δ^2_{-B}, respectively). Since $w(V_A, V_B)$ is increasing in $V_i, i = A, B$ by (A2), we solely consider cases where $w(1,1) > 3$.

First note that, independent of the value of $w(1,1)$, firm A is positively affected by B's outsourcing alone ($\Delta^1_{-B} > 0$). 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 ($\Delta^2_B - \Delta^1_B < 0$). Since the profit of firm A is positively affected by B's outsourcing alone ($\Delta^1_{-B} > 0$), A will adopt the Puppy Dog strategy. If $w(1,1)$ is at an intermediate level, successive outsourcing is

[17] For 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.

[18] For instance, if outsourcing by A prevents further outsourcing ($\Delta^1_B > 0 > \Delta^2_B$), we have $\Delta^2_B - \Delta^1_B < 0$. Conversely, if outsourcing by A triggers further outsourcing ($\Delta^1_B < 0 < \Delta^2_B$), we have $\Delta^2_B - \Delta^1_B > 0$.

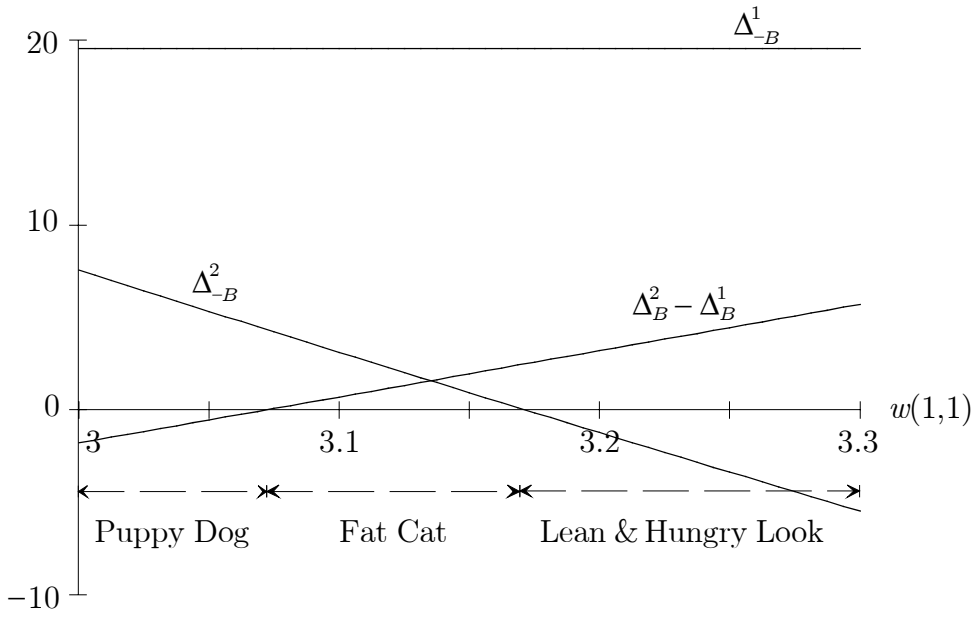

Figure 1: Taxonomy of firm A's business strategies for the parameter values $a = 50, b = 1, c = 1, \alpha = 4, w(1,0) = 2.9, w(0,1) = 3$, and $3 < w(1,1) \leq 3.3$.

profitable from B's point of view ($\Delta^2_B - \Delta^1_B > 0$). 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

As we have shown in this paper, firms in vertically related industries may strategically outsource the production of an input good to an imperfectly competitive input market so as to soften competition in the final product market. More specifically, if firms face a trade-off between making irreversible investments and incurring higher marginal cost when making their "make-or-buy" decisions, 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 firm that moves first 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.[19]

(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 production to the input market 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 apply to various forms of product market competition. They suggest that to better understand the economics of outsourcing, it is crucial to account for the price effects of outsourcing both at the downstream and the upstream level of the industry. In fact, upstream price effects of 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.

[19] As was pointed out above, a reversed asymmetric equilibrium where the first firm outsources so as to prevent outsourcing by the second firm (a Top Dog strategy) does not exist, as the first firm will actually benefit from the second firm's increase of marginal cost associated with outsourcing, provided that it has not already outsourced.

References

Abraham, K.G., Taylor, S.K. (1996): Firms' Use of Outside Contractors, *Journal of Labor Economics* 14, 394-424.

Chen, Y. (2002): Vertical Disintegration, University of Colorado at Boulder (mimeo).

Chen, Y., Ishikawa, J., Zhihao, Y. (forthcoming): Trade Liberalization and Strategic Outsourcing, *Journal of International Economics*.

Coase, R. (1937): The Nature of the Firm, *Economica* 4, 386-405.

Domberger, S. (1998): *The Contracting Organization: A Strategic Guide to Outsourcing*. Oxford University Press, Oxford.

Egger, H., Egger, P. (2002): How International Outsourcing Affects Price-Cost Margins in European Industries, University of Zurich (mimeo).

Feenstra, R., Hanson, G. (1999): The Impact of Outsourcing and High-technology Capital on Wages: Estimates for the United States 1979-1990, *Quarterly Journal of Economics* 114, 907-940.

Fixler, D.J., Siegel, D. (1999): Outsourcing and Productivity Growth in Services, *Structural Change and Economic Dynamics* 10, 177-194.

Fudenberg, D., Tirole, J. (1984): The Fat-Cat Effect, the Puppy-Dog Ploy and the Lean and Hungry Look, *American Economic Review* 74, 361-368.

Gal-Or, E. (1999): Vertical Integration or Separation of the Sales Function as Implied by Competitive Forces, *International Journal of Industrial Organization* 17, 641-662.

Görzig, B., Stephan, A. (2002): Outsourcing and Firm-level Performance, German Institute for Economic Research (DIW Berlin) (mimeo).

Grossman, S., Hart, O. (1986): The Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration, *Journal of Political Economy* 94, 691-719.

Grossman, S., Helpman, E. (2002): Integration versus Outsourcing in Industry Equilibrium, *Quarterly Journal of Economics* 117, 58-119

Hart, O., Moore, J. (1990): Property Rights and the Nature of the Firm, *Journal of Political Economy* 98, 1119-1158.

Holmes, T.J. (1999): Localization of Industry and Vertical Disintegration, *Review of Economics and Statistics* 81, 314-325.

Holmström, B., Roberts, J. (1998): The Boundaries of the Firm Revisited, *Journal of Economic Perspectives* 12, 73-97.

Jansen, J. (2003): Coexistence of Strategic Vertical Separation and Integration, *International Journal of Industrial Organization* 21, 699-716.

McLaren, J. (2000): Globalization and Vertical Structure, *American Economic Review* 90, 121-138.

Nilssen, T., Sørgard, L. (1998): Sequential Horizontal Mergers, *European Economic Review* 42, 1683-1702.

Rey, P., Tirole, J. (forthcoming): A Primer on Foreclosure, in: Armstrong, M., Porter, R.H. (Eds.): *Handbook of Industrial Organization*, Vol. 3. North-Holland, Amsterdam.

Salop, S.C., Scheffman, D.T. (1987): Cost Raising Strategies, *Journal of Industrial Economics* 36, 19-34.

Salop, S.C., Scheffman, D.T. (1983): Raising Rivals' Cost, *American Economic Review* 73, 267-271.

Shy, O., Stenbacka, R. (2003): Strategic Outsourcing, *Journal of Economic Behavior & Organization* 50, 203-224.

Siegel, D., Griliches, Z. (1991): Purchases Services, Outsourcing, Computers, and Productivity in Manufacturing, NBER Working Paper No. 3678, Cambridge (MA).

Slaughter, M.J. (2000): Production Transfer within Multinational Enterprises and American Wages, *Journal of International Economics* 50, 449-472.

Tirole, J. (1988): *The Theory of Industrial Organization.* MIT Press, Cambridge (MA).

Williamson, O. (1985): *The Economic Institutions of Capitalism.* Free Press, New York.

Working Papers of the Socioeconomic Institute at the University of Zurich

The Working Papers of the Socioeconomic Institute can be downloaded from http://www.soi.unizh.ch/research/wp/index2.html

0305 Strategic Outsourcing Revisited
Stefan Buehler and Justus Haucap, July 2003, 22 p.

0304 What does it take to sell Environmental Policy? An Empirical Analysis for Switzerland
Daniel Halbheer, Sarah Niggli and Armin Schmutzler, 2003, 30 p.

0303 Mobile Number Portability
Stefan Buehler and Justus Haucap, 2003, 12 p.

0302 Multiple Losses, Ex-Ante Moral Hazard, and the Non-Optimality of the Standard Insurance Contract
Michael Breuer, 2003, 18 p.

0301 Lobbying against Environmental Regulation vs. Lobbying for Loopholes
Andreas Polk and Armin Schmutzler, 2003, 37 p.

0214 A Product Market Theory of Worker Training
Hans Gersbach and Armin Schmutzler, 2002, 34 p.

0213 Weddings with Uncertain Prospects – Mergers under Asymmetric Information
Thomas Borek, Stefan Buehler and Armin Schmutzler, 2002, 37 p.

0212 Estimating Vertical Foreclosure in U.S. Gasoline Supply
Zava Aydemir and Stefan Buehler, 2002, 42 p.

0211 How much Internalization of Nuclear RiskThrough Liability Insurance?
Yves Schneider and Peter Zweifel, 2002, 18 p.

0210 Health Care Reform and the Number of Doctor Visits ? An Econometric Analysis
Rainer Winkelmann, 2002, 32p.

0209 Infrastructure Quality in Deregulated Industries: Is there an Underinvestment Problem?
Stefan Buehler, Armin Schmutzler and Men-Andri Benz, 2002, 24 p.

0208 Acquisitions versus Entry: The Evolution of Concentration
Zava Aydemir and Armin Schmutzler, 2002, 35 p.

0207 Subjektive Daten in der empirischen Wirtschaftsforschung: Probleme und Perspektiven.
Rainer Winkelmann, 2002, 25 p.

0206 How Special Interests Shape Policy - A Survey
Andreas Polk, 2002, 63 p.

0205 Lobbying Activities of Multinational Firms
Andreas Polk, 2002, 32 p.

0204 Subjective Well-being and the Family
Rainer Winkelmann, 2002, 18 p.

0203 Work and health in Switzerland: Immigrants and Natives
Rainer Winkelmann, 2002, 27 p.

0202 Why do firms recruit internationally? Results from the IZA International Employer Survey 2000
Rainer Winkelmann, 2002, 25 p.

0201 Multilateral Agreement On Investments (MAI) - A Critical Assessment From An Industrial Economics Point Of View
Andreas Polk, 2002, 25 p.