Strategic spin-offs of input divisions

Ping Lin[*]

Department of Economics, Lingnan University, Tuen Mun, N.T., Hong Kong

Abstract

When a downstream producer enters backward into the input market, a "helping the rivals effect" exists: Such entry hurts the firm's downstream business as it increases upstream competition and thus benefits its rival downstream firms. This negative externality prevents the newly-created upstream unit from expanding. A spin-off enables the firm to *credibly* expand in the input market, thereby forcing its upstream competitors to behave less aggressively. Spin-offs occur in equilibrium if and only if the number of downstream firms exceeds a threshold level. When there is more than one integrated firm, a spin-off by a firm can trigger spin-offs by others that would not occur otherwise.
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1. Introduction

Large corporations often voluntarily spin off their key input divisions. For example, The Big Three automakers in the United States recently ended a relationship with their suppliers that began in as early as 1918. In 1999, General Motors spun off component maker Delphi Automotive Systems, turning Delphi into the world's largest and most diversified supplier of auto components, systems and

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[*]Tel.: +852 2616 7203; fax: +852 2891 7940.

E-mail address: plin@ln.edu.hk.

modules. In June 2000, Ford Motor Co. spun off its parts supplier Visteon Corp, partly in response to the GM–Delphi spin-off. In the telecommunications industry, AT&T cut off its communication equipment arm and acclaimed Bell Labs research unit in 1996 to form Lucent Technologies Inc. (and its computer division to form NCR Corp).[1]

An immediate consequence of such spin-offs is, obviously, that the spun-off input division will supply downstream competitors of the parent company. For example, while 80% of its sales were to GM in 1999, Delphi was targeting a 50/50 ratio of GM to non-GM business by the end of 2002.[2] Likewise, Visteon has been broadening its customer base since its separation from Ford, now selling to GM, Nissan, Fiat, and Volkswagen, among others. In the case of the Lucent–AT&T spin-off, Lucent now supplies equipment to other telecommunication service providers such as MCI/WorldCom, British Telecommunications, and Cable & Wireless (USA). By the end of 1996, shortly after the spin-off, more than 50% of the Lucent revenues came from competitors of AT&T.[3]

These observations raise a puzzling question: Why would a company spin off its input unit which would then help its rival firms in the downstream market? If the company's goal is to capture the profits in the input market, why not enter the input market directly without a spin-off so that its external input supply decisions are better coordinated with its downstream business plans?

According to a conventional explanation of spin-offs, companies as they grow big may spin off certain divisions so as to reduce the costs of managing giant firms. In the literature of financial restructuring, two hypotheses can be found, both focusing on the effects of spin-offs on shareholders (Krishnaswami and Subramaniam, 1999). According to the core-operation hypothesis, spin-offs create value by removing unrelated businesses and allowing managers to focus attention on the core operations of a company. Spin-offs can also help eliminate the cross-subsidization that is common in large companies. The information hypothesis states that the separation of a firm's divisions into independently traded units through a spin-off enhances value because it mitigates information asymmetries about the firm. In particular, spin-offs isolate slow-growth segments of a large company and thus help provide financial clarity to investors.

The present paper offers a rationale of spin-offs based on strategic considerations. Consider the incentive of a self-sufficient producer in a two-tier industry to enter backward into the input market. While generating new revenues in the input market, such entry by the firm benefits its downstream rivals by increasing input supply (a "helping the rivals effect"), thus hurting its downstream business. This negative externality prevents the newly-created upstream unit from expanding. Following a spin-off, however, the independent input unit does not have to worry about the

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[1]Nippondenso, now one of the largest auto parts manufacturers in the world, was spun-off by Toyota Motors in 1947. According to a detailed study of Japanese spin-offs by Ito (1995), such spin-offs are generally quite prevalent in the Japanese auto parts industries and have increased over time.

[2]See *Detroit Free Press*, May 19, 2000 and *Buffalo Business First*, August 10, 1998.

[3]*Photonics Spectra News*, November 1996.

downstream parent firm—it maximizes its own profit only. While it may hurt the parent firm, such a "sub-optimal" behavior enables the spun-off unit to credibly expand in the input market, thus forcing its upstream competitors to concede a larger market share.[4] Because of this commitment value of a spin-off, the joint profits of the parent firm and the spun-off unit may be higher relative to the case of direct entry under certain conditions.

I study strategic spin-off decisions in the successive Cournot model à la Salinger (1988). The commitment effect of a spin-off is examined and conditions for profitable spin-offs are derived. It is shown that the output level of the input division of the vertically integrated firm is larger, whereas that of other (incumbent) input suppliers are smaller, under a spin-off than under direct entry. For linear demand, a spin-off occurs if and only if the number of downstream firms exceeds a threshold. I also study spin-off decisions by two integrated firms and show that a spin-off by one firm can trigger a spin-off by another that would not take place otherwise. This chain reaction in spin-offs is consistent with the observed speedy spin-off of Visteon by Ford in 2000, 1 year after GM's spin-off of Delphi.[5]

The prediction of the model that spin-offs occur when the number of downstream firms is large is consistent with what has been happening in the automobile and telecommunications industries in the United States. The recent restructuring by American automobile manufacturers is largely a response to massive entry of Japanese automakers into the US market during the 1980s and 1990s (by means of direct investment and export). In the telecommunications industry, new entrants into the industry have been emerging since the break-up of AT&T in 1984, and are posing a serious threat to the traditional local phone companies and long distance carriers. The US Congress in 1996 passed a Telecommunication Act which allows AT&T and other long distance companies, as well as cable TV companies, to participate in local phone markets. The local phone companies are in turn allowed to participate in the long distance market. The removal of regulatory barriers on different segments of the telephone service markets substantially boosts the demand for telecommunication equipment. It is under this atmosphere of increased competition in the downstream service market that AT&T decided to spin off its upstream telecommunication equipment arm to form Lucent Technologies Inc.[6]

This paper is related to the literature on vertical separation. Recently, Chen (2005) shows that vertical disintegration can help realize the economies of scale in upstream production (which is absence in the present paper). While Chen focused on the

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[4]According to a comment from *Buffalo Business First* (August 10, 1998), "separation itself from General Motors will enable Delphi Automotives to more aggressively go after non-GM business in North America and around the world."

[5]Visteon Chairman, President and CEO Pestillo admitted that GM's spin-off of Delphi pushed Ford to move more quickly on independence for Visteon than it would have (*Detroit Free Press*, May 19, 2000).

[6]The findings are also consistent with some observations in the Japanese machine tools industry from the 1960s to the early 1980s. During this period, the demand for machine tools increased significantly, largely due to the booming Japanese automobile industry. Several automakers such as Toyota Motors and Mazda first established their machine tool division for in-house use, and subsequently entered backward into the machine tool industry by spinning off these divisions as independent subsidiaries (Chokki, 1986).

strategic effect of vertical disintegration on purchasing behavior of downstream producers, the present paper emphasizes the strategic effect of a spin-off on upstream suppliers. Bonanno and Vickers (1988) considered vertical separation in a model with two pairs of manufacturers and retailers. Vertical separation raises the wholesale price above marginal cost and thus shifts outwards the reaction curve of the retailers (who compete in prices). This softens competition between the retailers, making vertical separation profitable. This is analogous to the commitment value of a spin-off (in the upstream market) in the present paper. However, vertical separation in Bonanno and Vickers requires a manufacturer not to supply the retailer of the other manufacturer, thus removing the "helping the rivals effect", which is the driving force behind all the results in the present paper.[7]

The "helping the rivals effect" of a spin-off in my model has been studied in the literature on vertical foreclosure, although from the opposite angle. In that literature, the central question is whether an acquisition of an input supplier by a downstream producer can be anti-competitive as it may raise the input prices for other downstream producers. In a model with two tiers of Cournot firms, Salinger (1988) derives conditions under which vertical mergers can indeed raise input prices. Ordover et al. (1990) showed that vertical foreclosure can emerge as an equilibrium outcome in the model they considered. Chen (2001) offers the new insight that downstream rival firms may choose to purchase input from an integrated supplier, as opposed to an unintegrated supplier, even at a higher price because this would induce the integrated firm's downstream unit to be less aggressive in price competition in the final product market. The new insight of my paper is that a spin-off (vertical disintegration) frees a firm from the "helping the rivals effect" and therefore serves as a commitment device in the input market.

The rest of the paper is organized as follows. Section 2 sets up the basic model. Section 3 contains the successive Cournot model in which some general results are derived as well as specific results for linear demand. Section 4 studies spin-off decisions between two vertically integrated firms. Some other possible settings are considered in Section 5, including price competition where I show that the strategic effect of a spin-off is the opposite (making rival upstream firms more aggressive). Furthermore, the basic model is related to the recent literature on multilateral bargaining in vertical industries. Section 6 concludes.

2. The basic model

There are initially $m - 1$ upstream firms indexed by U_2, $U_3, \ldots$, and U_m, $m \geqslant 2$, and n downstream firms indexed by D_1, $D_2, \ldots$, and D_n, $n \geqslant 2$. All downstream firms, except D_1, buy an input from the upstream firms and then transform it into the final

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[7]In vertical oligopoly models, Gal-Or (1991, 1995) investigate the commitment effects of input contracting and how they interact with the presence of private information on the part of retailers. The study of horizontal mergers by Salant et al. (1983) also highlights the commitment effect of keeping a firm's *competing* divisions as independent units.

product. D_1 is capable of producing the input itself. One unit of final product requires exactly one unit of the input (fixed-coefficient technology). The unit cost of producing the input is c for D_1 and each upstream firm. For simplicity, both c and the cost of transforming the input into the final product are normalized to zero. The demand for the final product is given by $p = p(Q)$.

Equipped with the input production technology, D_1 has the following three options:

- *Direct entry to the upstream market*: D_1 enters the upstream sector as a vertically integrated firm and competes with the incumbent upstream firms in supplying the input to other downstream firms. It also competes with other downstream firms in the final product market. The input it needs is made in-house.
- *Spin-off*: The input division of the original firm D_1, denoted as U_1, becomes a separate supplier, which competes with incumbent suppliers in supplying the input to all downstream firms, including the parent firm which continues with its traditional downstream business.
- *No-entry*: D_1 remains vertically integrated and does not sell input to other downstream firms.

The key difference between a spin-off and direct entry is that the new upstream unit, U_1, is under independent management in the case of a spin-off whereas it is a part of the downstream firm D_1 under direct entry. Thus, the objective of U_1 is to maximize its own profit under a spin-off, but to maximize the joint profits of U_1 and D_1 under direct entry. The strategic effect of a spin-off is analyzed below.

3. The successive Cournot model

Following Salinger (1988), I consider in this section the case that input price is determined by Cournot competition at both levels of the industry: The downstream firms choose their output levels given the input price, leading to the derived demand for input; the upstream firms then compete in Cournot fashion with respect to the derived demand. The standard backward induction procedure is used to derive the equilibrium.

3.1. Direct entry vs. spin-off

Under direct entry, the input division of D_1, namely U_1, is still under the management of D_1. Let q_1 denote the units of input that U_1 produces for D_1's own use and Q_1 the units of input it produces for selling to other downstream firms. Given the input price w determined by competition among upstream firms, downstream firms compete in Cournot fashion. Note that the marginal cost of production is $c = 0$ for D_1 and w for all other downstream firms. Let $q_j(w)$ and $\pi_{D_j}(w)$ denote, respectively, the resulting equilibrium quantity and profit of D_j in the

downstream market, $1 \leqslant j \leqslant n$. Obviously, D_1's output and profit both increase with the costs of its rival firms.

Lemma 1. *Under direct entry both $q_1(w)$ and $\pi_{D_1}(w)$ increase with w.*

Since D_1 makes the input it needs (q_1) in house, the derived demand for input is $Q_d(w) \equiv q_2(w) + \cdots + q_n(w)$. Facing this derived demand, upstream firms choose quantities simultaneously. Denoting the output levels of incumbent input suppliers by Q_i, $2 \leqslant i \leqslant m$, and let $Q_{-1} \equiv Q_2 + \cdots + Q_m$. The derived demand for input can be rewritten as $w = w(Q_d)$, where $Q_d = Q_1 + Q_{-1}$. The total input production is thus $q_1 + Q_1 + Q_{-1}$.

Under direct entry, U_1 maximizes total profits $\pi_{U_1}(Q_1, Q_{-1}) + \pi_{D_1}(w)$ when choosing Q_1, where $\pi_{U_1}(Q_1, Q_{-1})$ is the profit of U_1 in selling input externally. For given Q_{-1}, the best response of U_1 is thus determined by the first-order condition

$$\frac{\partial \pi_{U_1}(Q_1, Q_{-1})}{\partial Q_1} + \frac{\partial \pi_{D_1}(w)}{\partial w} \frac{\partial w}{\partial Q_1} = 0. \tag{1}$$

The second term on the left-hand-side of the equation captures the "*helping the rivals effect*": An increase in Q_1 lowers the input price facing the downstream rival firms of D_1 ($\partial w / \partial Q_1 < 0$), which of course hurts D_1 $((\partial \pi_{D_1}(w))/\partial w > 0$ by Lemma 1). Thus, the above first-order condition implies that for given Q_{-1} the optimal Q_1 for U_1 lies in the range where $\partial \pi_{U_1}/\partial Q_1 > 0$.

Under a spin-off, however, U_1 is independent and hence maximizes its *own* profit only. Its best response to Q_{-1} is thus determined by

$$\frac{\partial \pi_{U_1}(Q_1, Q_{-1})}{\partial Q_1} = 0.$$

This results in an output level greater than that implied by (1) for any given Q_{-1}. Therefore, a spin-off shifts the reaction curve of U_1 outwards: A spin-off enables U_1 to credibly expand in the input market. This commitment effect in turn forces other upstream firms to contract their output, leading to a larger equilibrium quantity and greater profit for U_1 under the standard stability condition of Cournot equilibrium.[8]

Proposition 1. *Suppose that firms compete in Cournot fashion at both upstream and downstream levels. Then, for general demand function $p(Q)$, the spun-off unit produces a larger quantity and its upstream competitors each produce a smaller quantity under a spin-off than under direct entry.*

Expansion by U_1 of course hurts the downstream business of its parent firm D_1. Thus, whether or not a spin-off is profitable relative to direct entry depends on the benefits and costs it generates. Below, I consider the case with linear demand: $p = a - Q$.

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[8]In addition to the commitment effect, a spin-off also raises the derived demand for input as D_1 now also sources input externally instead of making it in house. This second effect further shifts the reaction curve of U_1 outwards. One could alternatively assume that D_1 continues to make input in-house after a spin-off, in which case the demand-pulling effect would be absent. See the later part of this section for discussions of this alternative case.

3.2. Linear demand

Consider direct entry first. Recall that under direct entry the marginal cost is 0 for D_1 and w for other downstream firms D_j, $j = 2, \ldots, n$. Cournot competition downstream yields the following quantities:

$$q_1(w) = \frac{q + (n-1)w}{n+1} \quad \text{and} \quad q_2(w) = \cdots = q_n(w) = \frac{a - 2w}{n+1}.$$

The derived demand for input is thus

$$Q_d = Q_1 + Q_{-1} = q_2(w) + \cdots + q_n(w) = \frac{(n-1)(a-2w)}{n+1},$$

or equivalently

$$w = \frac{a}{2} - \frac{1}{2}\frac{n+1}{n-1}Q_d. \tag{2}$$

Facing this demand for input, the upstream firms choose quantities Q_i simultaneously. In choosing Q_1, U_1 must take into account the effect on the total profits of U_1 and D_1. Writing q_1 as a function of Q_1 and Q_{-1} by substituting Eq. (2) into $q_1(w)$, we have

$$q_1 = \frac{a}{2} - \frac{Q_1 + Q_{-1}}{2}. \tag{3}$$

Thus

$$\pi_{U_1} = wQ_1 = \left[\frac{a}{2} - \frac{n+1}{n-1}\frac{Q_1 + Q_{-1}}{2}\right]Q_1 \tag{4}$$

and

$$\pi_{D_1} = pq_1 = [a - (q_1 + Q_1 + Q_{-1})]q_1.$$

Using (3), we can rewrite π_{D_1} as

$$\pi_{D_1} = \left[\frac{a}{2} - \frac{Q_1 + Q_{-1}}{2}\right]^2. \tag{5}$$

The "*helping the rivals effect*" is obvious: An increase in Q_1 always lowers π_{D_1}. Although an increase in Q_1 can be profitable to U_1, straightforward derivations yield that

$$\frac{\partial \pi_{U_1}}{\partial Q_1} + \frac{\partial \pi_{D_1}}{\partial Q_1} = -\frac{(n+3)Q_1 + 2Q_{-1}}{2(n-1)} < 0.$$

Therefore, for linear demand the negative effect of an increase in Q_1 on the downstream parent firm is so strong that the best choice that maximizes the total profits of U_1 and D_1 is $Q_1 = 0$ (no entry), for any given Q_{-1}.

Lemma 2. *Assume that $p = a - Q$. Direct entry by D_1 into the input market never occurs in the double Cournot model.*

We next turn to spin-off. Under a spin-off, the entire input production line of D_1 gets spun off to form the independent firm U_1. Like all other downstream producers, D_1 now has to purchase the input at market price w from upstream firms.

Straightforward derivations yield the following profits for input suppliers and downstream producers under a spin-off:

$$\pi_{U_i}^{S} = \frac{na^2}{(m+1)^2(n+1)}, \quad i = 1, 2, \ldots, m, \tag{6}$$

and

$$\pi_{D_j}^{S} = \frac{m^2a^2}{(m+1)^2(n+1)^2}, \quad j = 1, \ldots, n. \tag{7}$$

Under no-entry, D_1 produces the input in-house and the other downstream producers buy the input from incumbent upstream firms. In equilibrium, D_1's profit under no-entry equals

$$\pi_{D_1}^{NE} = \left(\frac{(2m+n-1)a}{2m(n+1)}\right)^2. \tag{8}$$

Noting Lemma 2, a spin-off occurs if and only if it is more profitable than no-entry, i.e., if and only if $\pi_{U_1}^{S} + \pi_{D_1}^{S} > \pi_{D_1}^{NE}$, which is equivalent to

$$\delta(m,n) \equiv \frac{[n(n+1)+m^2]a^2}{(m+1)^2(n+1)^2} - \frac{1}{4}\frac{(2m+n-1)^2a^2}{m^2(n+1)^2} > 0. \tag{9}$$

It can be shown that $\delta(m,n)$ increases in n and the solution to $\delta(m,n) = 0$ for given m is

$$n^*(m) = \frac{2m^3 + m^2 - 1 + 2m\sqrt{m^4 + 4m^3 - 4m^2 - 2m + 2}}{(m-1)(3m+1)}.$$

If $m = 2$, then $n^* = 5.84$, i.e., at least six downstream firms have to be active for a spin-off to occur in this case. Furthermore, Maple plotting shows that $n^*(m)$ is an increasing function of m.[9]

Proposition 2. *For linear demand, a spin-off occurs if and only if $n > n^*(m)$. In addition, $n^*(m)$ increases with m.*

This result is easy to understand. As the number of downstream firms rises, the demand for the input is higher, making entry into the input sector (via a spin-off) a more attractive option. However, for a larger m the upstream sector is more competitive, implying that a spin-off is less likely to occur, other things being equal.

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[9]For example, $n^*(4) = 7.98$ and $n^*(6) = 10.57$.

4. Competing spin-offs

The analysis so far has focused on spin-off decision by a single firm. In reality, of course, spin-off choices are available to all vertically integrated firms. Like any other decisions in oligopoly, spin-off decisions by different firms are also interdependent. For example, the spin-off of the Visteon by the Ford Motor Company in 2000 was to a great extent a response to General Motor's spin-off of its input division, Delphi, in 1999.

To extend the above model, assume that in addition to firm D_1, there is another downstream producer, called D_0, which is initially self-sufficient and, if it wishes, can spin off its input division as a separate company, which we denote as U_0. Further assume that initially there is only one upstream firm, that is $m = 2$.[10] In this enlarged model, thus, there are $n + 1$ downstream producers, $D_0, D_1, D_2, \ldots, D_n$, with D_0 and D_1 being capable of producing the input on their own. The upstream suppliers include the original incumbent U_2 and the spun-off units of D_0 and D_1, if they choose to do so. Our focus here is on the interaction of spin-off decisions by D_0 and D_1. As before, the unit costs of input production are normalized to zero for all firms, and the demand for the final product is linear.

There are three possible cases: (i) no spin-off, whereby D_0 and D_1 both make their input in-house and the other downstream producers buy input from U_2; (ii) spin-off by one firm (either D_0 or D_1), whereby the non-spin-off firm remains self-sufficient and the other downstream firms buy input from the upstream industry which now is a duopoly; and (iii) spin-offs by both D_0 and D_1, in which case all $n + 1$ downstream producers source the input externally.[11]

The profits of D_0 and D_1 in each of the three cases are given below:

(i) Self-sufficiency by both D_0 and D_1:

$$\pi_{D_0}^* = \pi_{D_1}^* = \frac{(n + 5)^2 a^2}{36(n + 2)^2}.$$

(ii) Spin-off by D_0 (the case of spin-off by D_1 only is symmetric):

$$\pi_{U_0}^{S} = \frac{n a^2}{18(n + 2)}, \quad \pi_{D_0}^{S} = \frac{4 a^2}{9(n + 2)^2}, \quad \text{and} \quad \pi_{D_1}^{NS} = \frac{(n + 6)^2}{36(n + 2)^2}.$$

(iii) Spin-off by both D_0 and D_1:

$$\pi_{U_0}^{SS} = \pi_{U_1}^{SS} = \frac{(n + 1)^2 a^2}{16(n + 2)}, \quad \text{and} \quad \pi_{D_0}^{SS} = \pi_{D_1}^{SS} = \frac{9 a^2}{16(n + 2)^2}.$$

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[10]For $m > 2$, the analysis also goes through with qualitatively the same results as obtained here (Proposition 3).

[11]It is not necessary to consider the case of direct entry, because as we showed in the basic model the best response of a firm under direct entry is to not supply other downstream competitors, regardless of the output level of other supplier(s).

The *stand-alone incentive* for spin-off, which equals the gain in profit if a firm switches to spin-off while the other firm does not, is thus

$$\Delta_1 \equiv (\pi_{U_0}^{S} + \pi_{D_0}^{S}) - \pi_{D_0}^{*} = \frac{(n^2 - 6n - 9)a^2}{36(n+2)^2}.$$

The *competitive incentive* for spin-off, which equals the gain in profit if a firm switches to spin-off given that the other firm has chosen spin-off, is given by

$$\Delta_2 \equiv (\pi_{U_1}^{SS} + \pi_{D_1}^{SS}) - \pi_{D_1}^{NS} = \frac{(5n^2 - 21n - 45)a^2}{144(n+2)^2}.$$

Assume that D_0 and D_1 make spin-off decisions independently and simultaneously. Then, neither firm choosing spin-off is a Nash equilibrium if and only if $\Delta_1 \leqslant 0$ and both firms choose spin-off if and only if $\Delta_2 > 0$. It is easy to show that Δ_1 and Δ_2 have the following properties: (i) Both are increasing functions of n; (ii) $\Delta_1 = 0$ if $n = 3 + \sqrt{18} = 7.24$ and $\Delta_2 = 0$ if $n = (21 + 3\sqrt{149})/10 = 5.76$; and (iii) $\Delta_1 < \Delta_2$ for all $n \geqslant 2$. We thus have the following results regarding the (pure strategy) Nash equilibrium of the spin-off game between D_0 and D_1:

Proposition 3. *Assume that $p = a - Q$. Then,*

(i) *if $n = 5.76$, no firm chooses to spin off its input division;*
(ii) *if $n > 7.24$, both firms choose spin-off; and*
(iii) *if $5.76 < n \leqslant 7.24$, two Nash equilibria coexist: one in which neither firm chooses spin-off and the other in which both D_0 and D_1 spin off their input divisions.*

The general pattern that spin-offs do not occur if n is small and will occur if n is large matches the result in Proposition 2, with similar intuition. It is interesting to note that $\Delta_1 < 0$ and $\Delta_2 > 0$ for n between 5.76 and 7.24 ($n = 6$ or 7). In this case, a firm's best response is to not spin off its input division if the other firm chooses no-spin-off, but is to spin it off if the other firm chooses a spin-off, leading to coexistence of two Nash equilibria. For n in this range, the "helping the rivals" effect of a spin-off by a firm outweighs its benefit if the other firm remains self-sufficient, so it will not unilaterally spin off its input division (i.e., the stand-alone incentive is negative). However, if the other firm spins off its input division, a firm that remains self-sufficient gets hurt so much as its downstream marker share shrinks that the competitive incentive for spin-off becomes positive. This *competitive spin-off* result is consistent with the observed "forced spin-off" of Visteon by the Ford Motor Company in 2000 after General Motor spun off Delphi in 1999, as mentioned in Section 1 of the paper.

5. Other settings

5.1. Partial spin-off

In the model studied so far, the parent firm buys the input in the upstream market after a spin-off. Alternatively, one could consider the case that the parent firm continues to make the input in house (with the constant returns to scale technology for input production). I call this alternative setting partial spin-off.[12]

To see the difference between a partial spin-off and a spin-off, we use the framework where there is only one integrated firm, namely D_1. Also assume that demand is linear and $m = 2$, namely, there is only one input supplier prior to the entry of U_1. It is straightforward to show that the profits of U_1 and D_1 in this case are

$$\pi_{U_1}^{PS} = \frac{a^2(n-1)}{18(n+1)} \quad \text{and} \quad \pi_{D_1}^{PS} = \frac{a^2(n+5)^2}{36(n+1)^2},$$

respectively.

Comparing them with the profits under a spin-off derived in Section 3, we have that $\pi_{U_1}^{S} + \pi_{D_1}^{S} > \pi_{U_1}^{PS} + \pi_{D_1}^{PS}$, if and only if

$$\frac{n}{9(n+1)} + \frac{4}{9(n+1)^2} > \frac{n-1}{18(n+1)} + \frac{(n+5)^2}{36(n+1)^2},$$

which holds if and only if $n > 7$.

This can be understood as follows: While a partial spin-off enables D_1 to obtain input at marginal cost of production and thus confers it with a cost advantage over its rival firms, this however represents a disadvantage for U_1 as it reduces the market shares of its customers $D_2, \ldots,$ and D_n. If n is large ($n > 7$), the second effect dominates the first effect and thus a spin-off is more profitable than a partial spin-off.

By (8), $\pi_{U_1}^{PS} + \pi_{D_1}^{PS} > \pi_{D_1}^{NE}$, if and only if

$$\frac{n-1}{18(n+1)} + \frac{(n+5)^2}{36(n+1)^2} > \frac{(n+3)^2}{16(n+1)^2}$$

which holds if and only if $n > 3.67$.

Combining the above two observations and noting Proposition 2 for $m = 2$, we have the following result.

Proposition 4. *Assume that $p(Q) = a - Q$. Then, the vertically integrated firm does not enter the input sector if $n < 4$; it enters the input sector with a partial spin-off if $4 \leqslant n \leqslant 7$ and with a spin-off if $n > 7$.*

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[12]This alternative case requires physically creating another production line, as opposed to transforming the existing one into an independent unit as under a spin-off. A partial spin-off can also be regarded as the case where the spun-off unit treats its parent firm more favorably by selling it input at marginal cost, while charging other downstream firms a higher price.

5.2. Price competition upstream

Suppose that input prices are determined by price competition, instead of quantity competition. Downstream firms are still Cournot type.[13] If there are more than one upstream firms initially, input prices are driven down to marginal cost even without entry of D_1 into the input sector. In this case, there is no incentive for D_1 to enter the upstream sector unless it has a cost advantage in input production. To make the analysis non-trivial, assume that the marginal cost of input production is $c = 0$ for D_1 as before but is $c_2 > 0$ for other input suppliers. Also assume that if D_1 enters the upstream market, it continues to produce the input it needs in house (as in the case of a partial spin-off).

First, suppose that there are more than one upstream firm initially ($m \geqslant 3$). In this case, price competition upstream yields $w_2 = w_3 = \cdots = w_m = c_2$. By entering the upstream market and setting its input price at $c_2 - \varepsilon$, D_1 is able to capture the entire input market.[14] This can be accomplished regardless whether D_1 enters the input market directly or via a spin-off: D_1 is in fact indifferent between the two options. Such entry is obviously profitable, because undercutting rival suppliers' input prices by ε has almost no effect on its downstream business, but allows D_1 to obtain the entire input market.

The analysis is much different if $m = 2$, namely, there is only one upstream firm initially. In this case, input price prior to D_1's entry is not equal to marginal cost. Rather, it is set by U_2 at the monopoly level. It is straightforward to show that in this case the monopoly input price is $w = (a + 2c_2)/4$ and D_1's profit equals

$$\pi_{D_1}^0 = \left[\frac{(n+3)a + 2(n-1)c_2}{4(n+1)} \right]^2.$$

If D_1 enters the upstream market (with or without a spin-off) and competes with U_2, input price will then be driven down to c_2 (or $c_2 - \varepsilon$). This significant drop in input price benefits other downstream firms and consequently hurts D_1's downstream profitability. The resulting profits of D_1 and U_1 are

$$\pi_{U_1} = c_2(n-1)\frac{(a-2c_2)}{n+1} \quad \text{and} \quad \pi_{D_1} = \left[\frac{a + (n-1)c_2}{n+1} \right]^2.$$

It can be shown that $\pi_{U_1} + \pi_{D_1} < \pi_{D_1}^0$ for all feasible parameter values (i.e., $c_2 < a/2$).[15] Therefore, it does not pay D_1 to enter the input market if $m = 2$.

In sum, unlike in the case of quantity competition, the strategic effect of a spin-off disappears under price competition in the upstream market. If initially there is more than one upstream firm, D_1 with a cost advantage in input production will enter the upstream market without a spin-off. If the upstream market initially is a monopoly,

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[13]To study the case with price competition downstream, one would need a model with differentiated products.

[14]Assume that c_2 is not too high so that the monopoly input price of D_1 is above c_2.

[15]The derived demand for input by $D_2, \ldots, D_n$ is $w = a/2 - (n+1)/(2(n-1))Q$. So, $c_2 < a/2$ is needed for U_2 to survive even without competition from U_1.

D_1 does not enter because doing so would lower the costs of its downstream rival firms by so much that its gains in upstream market do not justify its losses downstream.

5.3. Multilateral bargaining

The successive Cournot model used in the previous sections is a straightforward extension of the standard successive monopoly model.[16] While simple, this model, however, stipulates that downstream firms take the input price as given and thus does not capture the fact that downstream buyers often are big and have significant influence over input prices. Economists have recently begun to study vertical industry models where input prices are determined via bargaining among suppliers and customers. Among the few such studies, for instance, Horn and Wolinsky (1988) considered a bilateral bargaining game where suppliers and buyers are locked into pair-wise relationships.[17] Inderst and Wey (2003) and De Fontenay and Gans (forthcoming) study multilateral bargaining models in which every upstream firm bargains with every downstream firm. The primary focus of this line of research is the effect of mergers (both horizontal and vertical) on bargaining positions of all parties, input prices, and surplus division.[18]

5.3.1. General insight

An insight derived from this new literature is that vertical integration in general has two effects on input price determination and surplus division. First, vertical integration changes bargaining position of all parties. In particular, it weakens the bargaining positions of all rival downstream firms of the integrated firm by eliminating certain bargaining opportunities of these rival firms (De Fontenay and Gans, forthcoming). This means that a spin-off (vertical disintegration) weakens the bargaining positions of incumbent upstream firms by creating additional trading opportunities for their downstream customers. These are true even if downstream firms do not compete with each other.

Second, when downstream do compete and thus negative externalities are present, as in the present model, vertical integration enables the integrated firm to internalize these externalities: The integrated firm, when bargaining with non-integrated downstream firms, will internalize the effect of its supply on its own downstream firm (De Fontenay and Gans, forthcoming). In particular, it will contract supply to rival downstream firms.

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[16]Elberfeld (2001, 2002) recently uses the successive Cournot model to study the issues of equilibrium vertical structure and vertical integration.

[17]Milliou et al. (2003) also consider a bargaining model with pair-wise negotiations, but allow for a broader class of input contracts than do Horn and Wolinsky.

[18]Horn and Wolinsky (1988) and Inderst and Wey (2003) focus on effects of horizontal mergers. De Fontenay and Gans (forthcoming), which builds on Inderst and Wey, is probably the only study of vertical (dis)integration in a bargaining setting, to the best of my knowledge. Another study of the effects of horizontal mergers on bargaining positions is offered by Gal-Or (1999) in an insurers–hospitals setting.

When there is upstream competition, however, this contraction will lead to expansion by other upstream firms. This opposite incentive created by a vertical integration is pointed out in De Fontenay and Gans (forthcoming, p. 26). In the present model, such an opposite incentive is eliminated by a spin-off, enabling the spun-off unit to credibly expand in the upstream market. This is nothing but the strategic value of spin-offs emphasized in the successive Cournot model studied earlier. Because of this, the strategic value of spin-off should continue to be present in bargaining models, bilateral or multilateral.

5.3.2. Further observations

Besides the general intuition obtained above, we can also make some specific conjectures about the profitability of a spin-off, based on the analysis of De Fontenay and Gans.[19]

De Fontenay and Gans (forthcoming) considered the following sequential bargaining game where bargaining is bilateral (involving alternating offers), vertical (occurring between individual upstream and downstream firms), and sequential (only one pair of agents bargain at a time). Given the industry structure, each upstream–downstream pair, (U_i, D_j), negotiates over price and quantity supply terms (q_{ij}, t_{ij}) where q_{ij} denotes the quantity of input purchased and t_{ij}, a lump-sum transfer paid by D_j to U_i, $i \leqslant m$ and $j \leqslant n$.[20]

Assuming that players hold passive beliefs, which means that firms receiving unexpected offers do not revise their beliefs about the outcomes of other negotiations they do not participate in, De Fontenay and Gans show that the bargaining game under vertical separation (i.e., a spin-off) gives rise to the standard n-firm Cournot equilibrium where inputs are supplied at their marginal costs of production.[21] Thus, while the bargaining within each pair is bilaterally efficient (joint surplus is maximized), the equilibrium outcome of the entire game does not maximize industry profit. The reason for this is due to the negative externalities each pair imposes on other negotiations. The implications of such negative externality among supplier–customer pairs who engage in sequential bargaining are analyzed in Hart and Tirole (1990) and McAfee and Schwartz (1994) who also employ "passive beliefs". These authors show that a monopoly input supplier is unable to maximize industry profits

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[19]It is beyond the scope of this paper to explicitly solve a bargaining game.

[20]Specifically, bargaining takes place in the following extensive game. Given the order of pairs to negotiate in sequence, which is fixed and common knowledge, each pair negotiates bilaterally in a manner specified by Binmore et al. (1986), i.e., they alternate making offers to one another until they reach an agreement, and after an offer is rejected, there is an infinitesimal probability of an irrevocable breakdown in their negotiations. Once an agreement is reached, the next pair begins bargaining. If a breakdown occurs before an agreement is reached, the entire sequence of negotiations takes place again (in the same order as before), but without any pair whose negotiations have broken down previously. The game ends once all pairs have either agreed or suffered a breakdown. After the bargaining stage, production takes place and payoffs to each firm are realized.

[21]The authors proved this for the bilateral duopoly case in their forthcoming paper (Proposition 2) and for the general $m \times n$ case in De Fontenay and Gans (2004) where agents are connected in a given network (or graph).

because it cannot credibly commit itself not to expand supply to subsequent downstream firms. As the result, the equilibrium entails Cournot outcome.

Applying the De Fontenay–Gans result directly to the present model, the payoff of D_1 under a spin-off is $\pi_{D_1}^{\text{Cournot}} - \sum_{i=1}^{m} t_{i1}^*$, where $\pi_{D_1}^{\text{Cournot}}$ is the standard n-firm Cournot profit, and the payoff of U_1 equals $\sum_{j=1}^{n} t_{1j}^*$.[22]

Although De Fontenay and Gans did not study the situation with an independent integrated firm that does not bargain with any other firm, the case of no-entry in the present model (where bargaining would involve only incumbent upstream firms and non-integrated downstream firms) may be similarly analyzed. Specifically, one can assume that D_1 here chooses its quantity of final product based on its expectation of the outcome of the bargaining game among other firms, and that participants of the bargaining game hold "passive beliefs" about unobserved actions of other players, including D_1. One can thus conjecture that the bargaining game under no-entry yields the same n-firm Cournot equilibrium, with D_1 receiving $\pi_{D_1}^{\text{Cournot}}$.

The benefits of a spin-off are thus that it enables U_1 to share a part of the industry (Cournot) profit with all downstream firms. Of course, the parent firm, D_1, also negotiates with and makes payments to upstream suppliers under a spin-off. Hence, the net gain to their joint profits is $\sum_{j=1}^{n} t_{1j}^* - \sum_{i=1}^{m} t_{i1}^*$, which one expects to be positive if n is large enough. For the present model, since firms are symmetry after a spin-off, we have that every upstream firm received the same amount of payment, so $\sum_{j=1}^{n} t_{1j}^* = (1/m)\sum_j \sum_i t_{ij}^*$, and every downstream firm payment is also the same, so $\sum_{i=1}^{m} t_{i1}^* = (1/n)\sum_i \sum_j t_{ij}^*$. We can thus conclude that the net gain of a spin-off is positive if and only if $n > m$. This observation is in accordance with the result obtained in the successive Cournot model.

6. Conclusion

This paper has shown that a spin-off of its input division by a vertically integrated firm confers a strategic advantage on the spun-off unit. In particular, a spin-off enables the input division to credibly expand upstream by freeing it from having to worry about the downstream businesses of its parent company. Such a strategic advantage is present in the successive Cournot model of Salinger (1988). A spin-off increases the joint profits of the spun-off unit and its parent firm if and only if the number of downstream firms exceeds a threshold level. While in practice different spin-offs may be driven by distinct motives, I believe that the strategic aspect of a spin-off identified here is quite prevalent. As mentioned in Section 1, such an effect has been explicitly emphasized by industrial analysts regarding the recent General Motor–Delphi case. It is also shown that when there are more than one integrated

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[22]The equilibrium payoffs in De Fontenay and Gans are in terms of reduced profit functions with a structure similar to Shapley value. It suffices here to write the equilibrium payments t_{ij}^* in general term. Furthermore, whether or not t_{1j} and t_{i1} are all positive is not crucial for the purpose of discussions here.

firm, a spin-off by one firm may lead to spin-offs by other firms that would otherwise not occur.

The strategic effect of a spin-off is also likely to be present in situations where upstream suppliers and downstream buyers bargain over input contracts. While there does not yet exist "work horse" vertical bargaining models in the literature, some insight is obtained from recent studies of multilateral bargaining (Inderst and Wey, and De Fontenay and Gans). In particular, a spin-off can be a means to prevent expansion by rival upstream firms by making the spin-off unit more aggressive.

With respect to welfare effect, there are two opposing forces at work. On the one hand, a spin-off tends to improve welfare because it increases competition in the input market. On the other hand, however, accompanying a spin-off is a production shift from the once self-sufficient D_1 to other downstream firms who have to source the input externally. This tends to worsen the standard double marginalization problem in a two-tier industry. In fact, the continuation firm downstream (D_1) also faces the double mark-up problem after it spins off its input division. For antitrust authorities, such a negative effect of a spin-off should be weighted against the competition-enhancing effect in the upstream market. In the successive Cournot model with linear demand, it is straightforward to show that a spin-off raises the price of the final product and lowers welfare.

Another issue not addressed in this model is the interaction between spin-off decisions and downstream entry. One could endogenize the number of firms by introducing free entry at some entry cost. Intuitively, spin-off should encourage entry into the downstream market because it makes it easier for new entrants to get access to the intermediate good. Anticipating additional sales to new entrants, vertically integrated firms may be more likely to spin off their input divisions. I believe the main results of the paper continue to hold in this new setting.

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