Strategic Spin-offs of Input Division

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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 reduces the input price for 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, forcing the upstream competitors to behave less aggressively, a task direct entry could not accomplish. Spin-offs occur in equilibrium if and only if the number of downstream firms exceeds a certain threshold level. If several producers can each spin off their input division, a spin-off by one firm can trigger a spin-off by another firm that would not take place otherwise. Spin-offs lower welfare by worsening the double-marginalization problem.

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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 are ending a relationship with their suppliers that began 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 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. While 80% of its sales were to GM in 1999, Delphi is targeting a 50/50 ratio of GM to non-GM business by the end of 2002.² Since its separation from Ford, Visteon has been broadening its customer case, 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 percent of the Lucent venues came from other competitors of AT&T (*Photonics Spectra News*, November 1996).

These observations raise a puzzling question: Why would a company

¹Nippondenso, 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.

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

spin off its input unit, which would then help 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 choose to spin off certain divisions so as to reduce the costs of managing giant firms. In the literature of financial restructuring, two hypotheses regarding the motives of spin-offs can be found, both focusing on the effects of spin-offs on shareholders (Krishnaswami and Subramaniam (1999)). According 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 profits in the input market, such entry by the firm benefits its downstream rivals by increasing input supply (a "*helping the rivals effect*"), thus hurting downstream business of the parent firm. This negative externality in turn prevents the newly-created upstream unit from expanding. Following a spin-off, however, the independent input unit does not have to worry about the downstream parent firm when making its supply decision — it maximizes its

own profit only. While it may hurt the parent company, such a “sub-optimal” behavior on the part of the spun-off unit enables it to increase its share of the input market in a credible way and thus forces its upstream competitor to behave less aggressively.³. Because of this commitment value of a spin-off, the collective profits of the parent firm and the spun-off unit (or the wealth of their shareholders) may end up increasing after a spin-off under certain conditions.

The paper first examines the spin-off decision by a given downstream firm which initially produces the input in-house. Under direct entry, the firm enters the input market without a spin-off and then serves other downstream competitors (along with the incumbent upstream supplier). In the paper, I show that due to the strategic value mentioned above, a spin-off shifts the reaction curve of the spun-off unit outwards and shifts that of the incumbent supplier inwards, relative to direct entry. The firm chooses a spin off if the number of downstream firms exceeds a certain threshold level ($n > 6$ for linear demand), a result which is quite intuitive as the gain from committing to expansion in the input market increases with the number of downstream customers.

The prediction of the model, namely that increased competition in the downstream market can lead to spin-offs, is consistent with what has been happening in the automobile and telecommunications industries in the United States. The recent restructuring by the American automobile manufacturers is largely a response to massive entry of the Japanese automakers (in terms of direct investment as well export) into the U.S. market during the 1980s and 1990s. In the telecommunications industry, new entrants into the

³According 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.”

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.⁴

In order to study the interdependence of spin-off decisions by oligopolists, I also examine the case of competing spin-offs whereby two downstream firms simultaneously decide on whether or not to spin off their input division. As argued above, a spin-off enables a firm to credibly expand in the input market. In an oligopoly situation, spin-off by one firm can lead to a spin-off by another that would not have occurred by its own. This “forced spin-off” can take place because a spin-off by a competitor hurts other self-sufficient firms by lowering input price their downstream competitors pay. This lowered profits from remaining self-sufficient enhances the incentive for spin-off. The result of “forced spin-off” is consistent with the observed speedy spin-off of Visteon one year after GM’s spin-off of Delphi.⁵ Analysis of the competing spin-offs

⁴The 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).

⁵Visteon 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*

also reveals that spin-offs take place if the number of downstream firms is large, as is the case in the basic model.

The effects of spin-offs on output, price and welfare are also studied. In this model, a spin-off always reduces welfare and raises the price of the final product. This is so because a spin-off imposes the standard double marginalization problem on the parent firm, which in turn shifts industry output from the parent firm to those downstream firms who already suffer from the double markup problem. The loss due to the increased double marginalization is so large that it outweighs the benefit of increased upstream competition caused by a spin-off so that welfare may end up declining. This negative welfare effect of break-ups mirrors that of Economides and Salop (1992) who argued that for complementary products, mergers reduce prices and increase welfare.

This paper is related to the recent literature on vertical separation. Bonanno and Vickers (1988) considered a duopoly model with two pairs of manufacturers and retailers. In their model, firms compete in prices in the final product markets, and vertical separation between a manufacturer and its retailer raises the wholesale price above marginal cost of production and thus shifts the latter's reaction curve outwards. This upward shift reaction curve in turn softens competition between the retailers, thus making vertical separation profitable. In other words, vertical separation in Bonanno and Vickers serves as a commitment device to high prices in the retail markets. This is analogous to the present paper where a spin-off enables a firm to commit to a large output in the upstream market. However, vertical separation in Bonanno and Vickers requires that one manufacturer not supply the retailer of the other manufacturer. Consequently, the "helping the rivals *Free Press*, May 19, 2000).

effect” of a spin-off, which is the driving force behind all the results in the present paper, is not present in Bonnano and Vickers. By allowing the spun-off unit to serve other downstream competitors of the parent firm, my paper identifies the strategic role of a spin-off in expanding a firm’s market share in the input market.⁶

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 this literature, the central question is whether an acquisition of an input supplier by a downstream producer can be anti-competitive as it reduces competition in the input market and thus raises the input prices other downstream producers have to pay. In a model with two tiers of Cournot firms, Salinger (1988) derives conditions under which vertical mergers can indeed raise the input price. Salinger, however, abstracted from the motivation of such mergers and focused on their effect. Ordover, Saloner and Salop (1990) showed that vertical foreclosure can emerge as an equilibrium outcome in the model they considered. The new insight of my paper is to show that a spin-off (a vertical disintegration) frees the firm from this “helping the rivals effect” and therefore serves as a commitment device in the input market. Moreover, while the usual focus is on the anti-competitive effects of mergers,⁷ my paper shows that vertical separations may also be welfare reducing.

The rest of the paper is organized as follows. Section 2 sets up the basic model (with linear demand) and considers the benchmark case that the downstream firm is self-sufficient in input supply. Direct entry is analyzed

⁶In a recent paper, Chen (2002) shows that vertical disintegration can help realize the economies of scale in upstream production (which is absent in the present paper). Chen focused on the strategic effect of vertical disintegration on the purchasing behavior of downstream producers, whereas the present paper emphasizes the strategic effect of a spin-off on upstream suppliers.

⁷In fact, this line of research has paid much attention to deriving practical criteria to be used by antitrust authorities in merger cases.

in Section 3, and spin-offs in Section 4. Section 6 examines welfare effects of spin-offs. Section 7 concerns the robustness of the results for general demands and extends the basic model to the case of competing spin-offs by downstream firms. Section 8 concludes the paper.

2 The Model

There are initially one upstream firm, U_2 , and $n \geq 2$ downstream firms indexed by D_i , $i = 1, 2, \dots, n$. The upstream firm supplies an input (an intermediate good) to all the n downstream firms, except D_1 , which then transform the input into a final product. Firm D_1 is able to produce the input itself. The unit costs of producing the input for D_1 and U_2 are c_1 and c_2 , respectively. Assume that one unit of final product requires exactly one unit of input (the fixed-coefficient technology). The price of the intermediate good is denoted by w . The unit cost of transforming the input into the final product is normalized to zero. Thus, the marginal cost of production for the final product is c_1 for firm D_1 (except in the case of a spin-off) and is w for other downstream firms.

Equipped with the input technology, D_1 can choose any of the following three options:

- *Self-sufficiency*: D_1 makes the input in house, transfers it into the final product and then competes in the final product market with the other downstream firms who buy the input from U_2 .
- *Direct entry to the upstream market*: Not only does it produce the input for itself, D_1 also supplies the input to the other downstream firms by creating an upstream unit which competes with incumbent supplier U_2 in selling the input to other downstream producers.

- *Spin-off*: The input division of the original firm D_1 becomes a separate supplier, U_1 , which competes with the incumbent U_2 in supplying the input to all downstream firms, including the parent firm which continues with the traditional downstream business of D_1 .

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. Therefore, the objective of U_1 is to maximize its own profit under a spin-off, whereas it is to maximize the joint profits of U_1 and D_1 under direct entry.

For simplicity, the demand for the final product is given by $p = a - Q$. The backward induction procedure used to solve the equilibrium in each of the cases below is standard (as was used in the analysis of Salinger (1988)).

3 Self-sufficiency

Under self-sufficiency, firm D_1 produces the input for itself. Thus, firm U_2 is the sole supplier of the input to other $(n - 1)$ downstream producers.

Given the input price, w , set by U_2 , the marginal cost of making the final product is c_1 for D_1 and w for other downstream firms. For the linear demand assumed, the corresponding Cournot quantities are

$$q_1(w) = \frac{a - nc_1 + (n - 1)w}{n + 1} \quad (1)$$

for firm D_1 , and

$$q_i(w) = \frac{a - nw + (n - 2)w + c_1}{n + 1} = \frac{a - 2w + c_1}{n + 1} \quad (2)$$

for D_i , $2 \leq i \leq n$. The derived demand for the input supplied by U_2 is thus

$$Q_2(w) = (n - 1)q_2(w) = \frac{(n - 1)(a - 2w + c_1)}{n + 1}$$

i.e.,

$$w = \frac{a + c_1}{2} - \frac{1}{2} \frac{n+1}{n-1} Q_2. \quad (3)$$

Facing the derived demand, U_2 simply sets the price at the monopoly level.

$$w^* = \frac{a + c_1 + 2c_2}{4} \quad (4)$$

The resulting equilibrium quantities for downstream producers, after algebraic simplifications, are

$$q_1^* \equiv q_1(w^*) = \frac{(n+3)a - (3n+1)c_1 + 2(n-1)c_2}{4(n+1)},$$

and

$$q_2^* = \dots = q_n^* \equiv q_2(w^*) = \frac{(a + c_1 - 2c_2)}{2(n+1)}.$$

The equilibrium output for the industry is thus

$$Q^* = q_1^* + (n-1)q_2^* = \frac{(3n+1)a - (n+3)c_1 - 2(n-1)c_2}{4(n+1)} \quad (5)$$

In equilibrium, the profit of firm D_1 is

$$\pi_1^* = (a - Q^* - c_1)q_1^* = \left[\frac{(n+3)a - (3n+1)c_1 + 2(n-1)c_2}{4(n+1)} \right]^2 = (q_1^*)^2.$$

Note that π_1^* is a decreasing function of n . As competition in the downstream market intensifies, firm D_1 's profit declines. In the limit where n approaches infinity, $\pi_1^* = (a - 3c_1 + 2c_2)^2/16$.

The profits of other downstream firms D_i , $i \geq 2$, and the profit of the upstream supplier U_2 are

$$\pi_i^* = \pi_2^* = (a - Q^* - w^*)q_2^* = \left[\frac{(a + c_1 - 2c_2)}{2(n+1)} \right]^2 \quad (6)$$

and

$$\pi_{U_2}^* = (w^* - c_2)(n-1)q_2^* = \frac{n-1}{n+1} \frac{(a + c_1 - 2c_2)^2}{8}, \quad (7)$$

respectively.

4 Direct Entry Into the Upstream Market

Under direct-entry, D_1 produces the input not only for its own use, but also sells it to other downstream users. Hence, in addition to the number of input it needs for its own production of the final product, D_1 needs to decide on the quantity it sells to other downstream firms. For the ease of exposition, we denote as U_1 the unit of the firm that is responsible for supplying the input to outsiders. The key under the direct entry arrangement is that, unlike the case of spin-off to be considered later, D_1 and U_1 remain to be under the same management of the old firm and, hence, their decisions are made so as to maximize their joint profits.

The gain to the firm associated with entry into the upstream market is the profit generated from supplying other downstream firms, which can be attractive when competition downstream is very intense and competition upstream is not. The problem with this entry, however, is that it increases competition in the input market, thereby benefiting the downstream rival firms of D_1 . For the model considered here, it turns out that such a negative effect is so strong that direct entry is never a profitable choice. We show this next.

Let Q_1 and Q_2 denote the units of input produced by U_1 and U_2 , respectively. The total input production is thus $q_1 + Q_1 + Q_2$, with q_1 denoting the quantity of input D_1 produces for its own use. Note that the unit cost is c_1 for both q_1 and Q_1 . Given input price w , competition among the n downstream firms determines q_1 and the output of other downstream firms q_i , $i \geq 2$, which are the same as derived in the previous section, namely,

$$q_1(w) = \frac{a - nc_1 + (n-1)w}{n+1} \quad \text{and} \quad q_2(w) = \dots = q_n(w) = \frac{(n-1)(a - 2w + c_1)}{n+1}.$$

The derived demand for the input, which is now supplied by U_2 and U_1 , is

thus

$$Q_1 + Q_2 = (n - 1)q_2(w) = \frac{(n - 1)(a - 2w + c_1)}{n + 1},$$

i.e.,

$$w = \frac{a - c_T + c_1}{2} - \frac{1}{2} \frac{n + 1}{n - 1} (Q_1 + Q_2). \quad (8)$$

The equilibrium input price is determined by competition between U_1 and U_2 .

In deciding how much input it sells upstream, U_1 must take into account the effect of its decision on the total profits of U_1 and D_1 . Writing q_1 as a function of Q_1 and Q_2 by substituting equation (8) into $q_1(w)$, we have

$$q_1 = \frac{a - c_1}{2} - \frac{Q_1 + Q_2}{2}. \quad (9)$$

The total profits of U_1 and D_1 are equal to $\pi_{U_1} + \pi_{D_1}$ where

$$\pi_{U_1} = (w - c_1)Q_1 = \left[\frac{a - c_1}{2} - \frac{n + 1}{n - 1} \frac{Q_1 + Q_2}{2} \right] Q_1 \quad (10)$$

and

$$\pi_{D_1} = (p - c_1)q_1 = [a - c_1 - (Q_1 + Q_2 + q_1)] q_1.$$

Using (9), we can rewrite π_{D_1} as

$$\pi_{D_1} = \left[\frac{a - c_1}{2} - \frac{Q_1 + Q_2}{2} \right]^2. \quad (11)$$

The above expression for π_{D_1} clearly shows the negative externality the newly-created upstream unit imposes on the downstream unit D_1 . Given the output level of U_2 , an increase in U_1 's output level, Q_1 , always hurts the downstream unit. It does so by lowering the input price and hence increasing the market shares of other downstream competitors.

Although an increase in Q_1 can be profitable to the upstream unit, straightforward derivations yield that

$$\frac{\partial \pi_{U_1}}{\partial Q_1} + \frac{\partial \pi_{D_1}}{\partial Q_1} = -\frac{(n+3)Q_1 + 2Q_2}{2(n-1)} < 0.$$

Therefore, the negative effect of 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), regardless of the value of Q_2 . The following result is thus obtained:

Proposition 1 Assume that $p = a - Q$. Direct-entry by D_1 into the input market never occurs in this model.

5 Spin-Off

Under a spin-off, the entire input production line of D_1 gets spun off to form the separate upstream firm U_1 . Like all other downstream producers, D_1 now has to purchase the input at market price w from suppliers U_1 and U_2 .

Given w , all n downstream firms are now on equal footing each having a marginal cost of w . The corresponding Cournot output level for each of them is

$$q_i = \frac{a - w}{n + 1},$$

which yields the following derived demand for the input

$$w = a - \frac{n+1}{n}Q, \quad \text{where } Q = nq_i.$$

Relative to the derived demand in the previous sections, a spin-off raises the demand for the input. Not only does D_1 now buy the input in the upstream market, the other $(n-1)$ downstream firms each demand a larger quantity of

the input for a given w because D_1 now no longer possesses a cost-advantage over them.

Facing the above derived demand, U_1 and U_2 compete by choosing quantities. In equilibrium we have:⁸

$$Q_1^S = \frac{n(a - 2c_1 + c_2)}{3(n+1)} \quad \text{and} \quad Q_2^S = \frac{n(a - 2c_2 + c_1)}{3(n+1)}. \quad (12)$$

The resulting equilibrium input price is

$$w^S = a - \frac{n+1}{n}(Q_1^{CS} + Q_2^{CS}) = \frac{a + c_1 + c_2}{3}. \quad (13)$$

Straightforward derivations yield the following profits for the suppliers and each downstream producer:

$$\begin{aligned} \pi_{U_1}^S &= (w^S - c_1)Q_1^S = \frac{n(a - 2c_1 + c_2)^2}{9(n+1)}, \\ \pi_{U_2}^S &= (w^S - c_2)Q_2^S = \frac{n(a - 2c_2 + c_1)^2}{9(n+1)} \end{aligned} \quad (14)$$

and

$$\begin{aligned} \pi_{D_i}^S &= (a - Q_1^S - Q_2^S - w^S) \frac{Q_1^S + Q_2^S}{n} \\ &= \frac{(2a - c_1 - c_2)^2}{9(n+1)^2}, \quad i = 1, \dots, n. \end{aligned} \quad (15)$$

Whether or not a spin-off is a sensible strategy depends on whether it increases the joint profits of U_1 and D_1 (or the joint wealth of their shareholders). Comparing the above profits with that under no-spin-off, i.e. self-sufficiency, we have $\pi_{U_1}^S + \pi_{D_1}^S > \pi_{D_1}^*$ if and only if

$$R(n) \equiv \frac{n(a - 2c_1 + c_2)^2}{9(n+1)} + \frac{(2a - c_1 - c_2)^2}{9(n+1)^2} \quad (16)$$

$$\begin{aligned} &- \left[\frac{(n+3)a - (3n+1)c_1 + 2(n-1)c_2}{4(n+1)} \right]^2 \\ &> 0. \end{aligned} \quad (17)$$

⁸To guarantee positive output level for both suppliers, I assume that $a > 2c_1 - c_2$ and $a > 2c_2 - c_1$.

Note that as n goes to infinity, $R(n)$ approaches $(a - 2c_1 + c_2)^2/9 - (a - 3c_1 + 2c_2)^2/16$ which is positive (by noting footnote 7). On the other hand, it is straightforward to show that $R(2) < 0$. We thus have the following result.⁹

Proposition 2 Assume that $p = a - Q$. There exists a threshold level n^* , $2 < n^* < +\infty$, such that a spin-off is profitable if and only if $n > n^*$.

As downstream competition intensifies (n goes up), D_1 's profit declines under both self-sufficiency and a spin-off. However, in the case of a spin-off, the spun-off unit's profit, $\pi_{U_1}^S$, increases because an increase in n raises the demand for input, thereby benefiting upstream suppliers. It can be shown that the collective profits of U_1 and D_1 under spin-off decline with n when n is small and increase with it when n is large, and that $R(n)$ increases with n . The critical level n^* is thus unique.

For the special case that $c_1 = c_2$, $R(n)$ simplifies to

$$R(n) = \frac{(a - c_1)^2 (7n^2 - 38n - 17)}{144(n + 1)^2}.$$

Thus, $n^* = 19 + 4\sqrt{30})/7 = 5.84$, as determined by $R(n^*) = 0$.

Proposition 1 is intuitive. As mentioned earlier, the basic trade-off of a spin-off decision is that it enables the firm to capture upstream profit at the expense of its downstream profits (because of *the helping the rivals effect*). The upstream profit generated by a spin-off increases, of course, with the number of downstream producers to be captured. Thus, the benefit of a spin-off increases with n . On the other hand, the losses in downstream profit decline with n . For a small n (< 5.84 if $c_1 = c_2$), the firm can dominate the downstream market through its cost-advantage and thus there is a lot to

⁹Equation $R(n) = 0$ has only one positive root.

lose if it chooses a spin-off. But for a large n , the traditional business of D_1 becomes less important, thus making a spin-off a more attractive option.

If $c_1 \neq c_2$, the threshold level n^* depends on the value of the cost parameters. Table 1 below contains some simulation results regarding how n^* changes with c_1 and c_2 (for the case $a = 100$).

Table 1. Critical value of n^* as a function of (c_1, c_2)

n^*	$c_2 = 10$	$c_2 = 20$	$c_2 = 30$	$c_2 = 40$
$c_1 = 10$	5.84	6.84	8.49	12.17
$c_1 = 20$	5.03	5.84	7.00	9.11
$c_1 = 30$	4.14	4.93	5.84	7.22
$c_1 = 40$	2.85	3.87	4.79	5.84

As can be seen, n^* decreases with c_1 and increases with c_2 . This implies that firm D_1 is less likely to spin off its input division if its unit cost is lower or if the unit cost of the upstream competitor is higher. This (seemingly counter-intuitive) result can be understood as follows. Recall that a spin-off is profitable if and only if $\pi_{U_1}^S + \pi_{D_1}^S > \pi_{D_1}^*$. Consider a reduction in c_1 . By (14) and (15), as c_1 decreases, both $\pi_{U_1}^S$ and $\pi_{D_1}^S$ go up. This is so because a lower c_1 leads to a larger cost-advantage of U_1 in the upstream market and at the same time a lower input price in the downstream market (which benefits all downstream firms under a spin-off). However, a decrease in c_1 also causes $\pi_{D_1}^*$ to increase, because it raises the cost-advantage of D_1 under self-sufficiency. As both $\pi_{U_1}^S + \pi_{D_1}^S$ and $\pi_{D_1}^*$ increase, the net effect is that $\pi_{U_1}^S + \pi_{D_1}^S - \pi_{D_1}^*$ shifts down as a function of n , increasing n^* and making a spin-off less likely to occur.

Similarly, an increase in c_2 will raise the spun-off unit's profit, $\pi_{U_1}^S$, but lower the downstream parent firm's profit, $\pi_{D_1}^S$, assuming a spin-off occurs. However, in the absence of a spin-off, a larger c_2 implies a higher input price for the unintegrated downstream firms and thus benefits D_1 , so $\pi_{D_1}^*$ goes up.

The net effect is that $\pi_{U_1}^S + \pi_{D_1}^S - \pi_{D_1}^*$ shifts down, leading to a larger critical n^* .

6 Welfare Effect of Spin-offs

Spin-offs in this model affect welfare in two ways. On the one hand, they tend to improve social welfare by increasing competition in the input market. On the other hand, since the parent firm D_1 has to buy input at a market price above marginal cost, a spin-off shifts the downstream production from the once self-sufficient D_1 to other less efficient firms.¹⁰ Therefore, spin-offs worsen the standard double marginalization problem in a two-tier industry. The net effect of a spin-off on welfare thus depends on the magnitudes of these two opposing forces. For linear demand, it turns out that a spin-off lowers the equilibrium output, and raises both the input price and the final price, thereby reducing welfare.

Proposition 3 $w^* < w^S$, $Q^* > Q^S$ and $p^* < p^S$.

Proof. By (4), (13) and that $a + c_1 - 2c_2 > 0$, one can easily see that $w^* < w^S$.

By equations (5) and (12), we have $Q^* - Q^S > 0$ if and only if $\Delta \equiv n(a + c_1 - 2c_2) + 3(a - 3c_1 + 2c_2) > 0$. Since $n \geq 2$ and $a + c_1 - 2c_2 > 0$, we have

$$\Delta \geq 2(a + c_1 - 2c_2) + 3(a - 3c_1 + 2c_2) = 5a - 4c_1 + 2c_2,$$

which is positive be $a > 2c_1 - c_2$. ■

¹⁰ As D_1 's marginal cost goes up, its Cournot equilibrium output decreases and that of other downstream firms increases.

Although increasing competition in the input market, a spin-off ends up raising the input price because it raises the demand for input. First, the demand for input is higher because D_1 now outsources its input. Second, since D_1 now no longer enjoys a cost-advantage over its downstream competitors, the quantity demanded for the input by these rivals increases, given the input price. The resulting higher demand for the input leads to an increase in input price. A higher input price in turn increases the production costs for all downstream firms, leading to a lower aggregate output and higher final price. Therefore, consumers suffer from a spin-off.

The effects of a spin-off on firm profits are mixed. First, consider the incumbent supplier U_2 . While increased competition due to U_1 's entry tends to hurt it, U_2 may end up better off because of the higher demand for input. Direct comparison of (7) and (14) reveals that $\pi_{U_2}^S > \pi_{U_2}^*$ if and only if $n < 9$. For large n ($n > 9$), U_2 loses too much as U_1 steals business from its $(n - 1)$ former customers. As a result, U_2 ends up worse off in this case. Second, how does a spin-off affect other downstream producers than D_1 ? In general, they should be better off because a spin-off erodes the cost-advantage that D_1 once enjoyed over them. From (6) and (15), we have $\pi_{D_2}^S > \pi_{D_2}^*$ so long as $a - 5c_1 + 4c_2 > 0$ (which always holds unless c_1 is relatively large).

Due to algebraic complexity, the net welfare effect of a spin-off cannot be determined analytically. Numerical simulations showed that a spin-off is always welfare-reducing in this model. Given the basic intuition that spin-offs worsen the double markup problem, I believe this conclusion is in general valid.

7 Extensions

In this section, I extend the basic model in two ways. First, I show that the basic idea of the model, namely that spin-offs enable a firm to credibly expand in the input market, can be illustrated using general profit functions and oligopoly reaction functions. Second, in order to shed light on the interdependence of spin-off decisions in oligopoly, I extend the earlier considered “partial spin-off model” to the case that two firms simultaneously make spin-off decisions.

7.1 Commitment value of a spin-off under general demand

Suppose that firms compete in Cournot fashion in both the downstream and the upstream markets. Given input price, w , the downstream producers compete by choosing quantities. As in the previous sections, the marginal cost of D_1 and that of other downstream firms are c_1 and w , respectively, under self-sufficiency or direct-entry. These quantities in turn determine the derived demand for the input. Let $\pi_{D_1}(w)$ denote the reduced form profit function of D_1 from the downstream market. Note that in the absence of a spin-off $\pi_{D_1}(w)$ increases with w , the marginal cost of its downstream competitors.

Now consider the case of direct entry where D_1 enters backward into the input market. When choosing the level of the input (denoted as Q_1) to be sold by the new unit U_1 , the firm maximizes the total profits $\pi_{U_1}(Q_1, Q_2) + \pi_{D_1}(w)$, where $\pi_{U_1}(Q_1, Q_2)$ is the profit of U_1 from the selling input to other $(n - 1)$ downstream producers, and Q_2 the output of the incumbent supplier U_2 . The input price depends on both Q_1 and Q_2 . The reaction function of U_1 in the

input market is then determined by the first order condition:

$$\frac{\partial \pi_{U_1}(Q_1, Q_2)}{\partial Q_1} + \frac{\partial \pi_{D_1}(w)}{\partial w} \frac{\partial w}{\partial Q_1} = 0 \quad (18)$$

Since $\frac{\partial w}{\partial Q_1} < 0$ (the “*helping the rivals effect*”) and $\frac{\partial \pi_{D_1}(w)}{\partial w} > 0$ (as noted above), the second term on the left-hand-side of equation (18) is negative. Thus, for given Q_2 the optimal Q_1 for U_1 must lie in the range where $\frac{\partial \pi_{U_1}}{\partial Q_1} > 0$.

Under a spin-off, however, the reaction function of U_1 , which is now independent of D_1 , is determined by maximization of its own profit only:

$$\frac{\partial \pi_{U_1}(Q_1, Q_2)}{\partial Q_1} = 0.$$

This results in an output level greater than the one determined by (18), for any given Q_2 . Therefore, a spin-off shifts the reaction curve of U_1 outwards. Therefore, the commitment effect of a spin-off which was present in the linear model considered earlier continues to exist for cases with general demand functions. Under standard stability condition regarding Cournot equilibrium, this shift in reaction curve leads to a larger equilibrium quantity and greater profit for U_1 .¹¹

7.2 Competing Spin-offs

The analysis so far has focused on spin-off decisions 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

¹¹A spin-off also causes an increase in the derived demand for the input, as now firm D_1 no longer produces its input in-house. Thus, a spin-off has two effects on the reaction curve of U_1 . The first is the outward shift caused by the commitment effect of a spin-off, as discussed above. The second effect, which further shifts the reaction curve of U_1 outwards, is due to the increase in the derived demand for input. Of course, the reaction curve of incumbent supplier, U_2 , also shifts outwards as a result of a higher input demand. But the commitment effect of a spin-off enables U_1 to behave more aggressively than otherwise.

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 our previous 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 . In this enlarged model, thus, there are $n + 1$ downstream producers, $D_0, D_1, D_2, \dots, D_n$, with D_0 and D_1 being capable of producing the input on their own.¹² 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 in the previous sections, the unit costs of input production of D_1 and U_2 are c_1 and c_2 , respectively, and the demand for the final product is linear. For simplicity, assume that the unit cost of input production of D_0 (and U_0 in the case of a spin-off) is the same as that of D_1 : $c_0 = c_1$. Under this assumption, the incentive for spin-off is symmetric for D_0 and D_1 .

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), in which case 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 the $n + 1$ downstream producers buy the input from the input suppliers U_0 and U_1 , which are newly spun-off units, and U_2 .¹³

¹²In order for us to discuss meaningfully the 'helping the rivals' effect of a spin-off, we need U_2 to supply other unintegrated firms all the time, and thus not make a spin-off decision.

¹³It is unnecessary 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 profits of D_0 and D_1 and the input prices for these three cases, derived in the Appendix, are given below:

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

$$\pi_{D_0}^* = \pi_{D_1}^* = \frac{1}{36(n+2)^2} [(n+5)a - 2(2n+1)c_1 + 3(n-1)c_2]^2,$$

and

$$w_2^* = \frac{a + 2c_1 + 3c_2}{6}. \quad (19)$$

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

$$\pi_{U_0}^S = \frac{n(a-c_1)^2}{18(n+2)}, \quad \pi_{D_0}^S = \frac{4(a-c_2)^2}{9(n+2)^2},$$

$$\pi_{D_1}^{NS} = \frac{1}{36(n+2)^2} [(n+6)a - 3(n+2)c_1 + 2nc_2]^2,$$

and

$$w_{02} = \frac{a + 3c_1 + 2c_2}{6}. \quad (20)$$

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

$$\pi_{U_0}^{SS} = \pi_{U_1}^{SS} = \frac{(n+1)(a-2c_1+c_2)^2}{16(n+2)},$$

$$\pi_{D_0}^{SS} = \pi_{D_1}^{SS} = \frac{(3a-2c_1-c_2)^2}{16(n+2)^2},$$

and

$$w_{012} = \frac{a + 2c_1 + c_2}{4}. \quad (21)$$

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 given by

$$\Delta_1 \equiv (\pi_{U_0}^S + \pi_{D_0}^S) - \pi_{D_0}^*.$$

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

$$\Delta_2 \equiv (\pi_{U_1}^{SS} + \pi_{D_1}^{SS}) - \pi_{D_1}^{NS}.$$

Assume that D_0 and D_1 make spin-off decisions independently and simultaneously. Thus, neither firm chooses spin-off is a Nash equilibrium if and only if $\Delta_1 \leq 0$ and both firms choose spin-off if and only if $\Delta_2 > 0$.

For the case that $c_1 = c_2 = c$, we have

$$\Delta_1 = \frac{(a-c)^2(n^2 - 6n - 9)}{36(n+2)^2} \quad \text{and} \quad \Delta_2 = \frac{(a-c)^2(5n^2 - 21n - 45)}{144(n+2)^2}.$$

which 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 $n \geq 2$. We thus have the following result regarding the (pure strategy) Nash equilibrium of the spin-off game between D_0 and D_1 :

Proposition 4. *Assume that $p = a - Q$ and $c_0 = c_1 = c_2$. Then,*

- (i) *if $n \leq 5.76$, no firm chooses to spin off its input division;*
- (ii) *if $n > 7.24$, both firms choose spin-off; and*
- (iii) *if $5.76 < n \leq 7.24$, then 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 3, with similar intuition. It is interesting to note that for n between 5.76 and 7.24 (or $n = 6$ or 7), a firm's best action is no-spin-off if the other firm chooses no-spin-off, but is spin-off if the other firm chooses a spin-off. 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 the firm will not unilaterally spin off its input division in this case ($\Delta_1 < 0$). However, if the other firm is going to spin off its input division, a firm that remains self-sufficient gets hurt because spin-off by the competitor lowers the input price for other downstream competitors (see (19) and (20)). The losses from “doing nothing” leads to a stronger spin-off incentive in this case (so $\Delta_2 > 0$). 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 the Introduction of the paper.¹⁴

8 Conclusions

When a self-sufficient producer enters backward into the upstream input market, a “helping the rivals effect” exists: such entry increases the degree of competition in the input market, thereby driving down the input costs of the firm’s downstream competitors. This negative effect hurts the traditional downstream business of the firm and thus limits its expansion in the input market. We show that spin-offs confer a strategic advantage on the firm. By freeing the spun-off unit from having to worry about the downstream businesses of its parent company, spin-offs enable it to credibly expand its upstream business. This in turn forces the upstream competitor to behave less aggressively than they would in the absence of a spin-off. Spin-offs increase the joint profits of the spun-off firm and its parent company, as long as the number of downstream firms is large.

While different spin-offs in practice are in general driven by distinct motives, I believe that the strategic aspect of a spin-off identified in my paper is

¹⁴Although it goes down if only one firm chooses spin-off, the input price is higher if both firms choose spin-off ($w_{012} > w_2$). Thus, spin-offs raise input price, as in Proposition 3, as in equilibrium either both firms choose spin-off or none of them does.

present in every spin-off situation. Having recognized the commitment value of a spin-off, one is perhaps less puzzled by recent spin-offs in the automobile and telecommunications industries in the United States.

The US antitrust laws do not have explicit provisions governing corporate spin-offs, and policy makers as well as economists have paid a great deal of attention to detrimental effects on competition of vertical integrations (or mergers and acquisitions in general), rather than of vertical separations. This is so perhaps because of a belief that vertical separations should be in general pro-competitive as they increase the number of firms in an industry. Our analysis shows that spin-offs in a two-tier vertical setting can lower social welfare under certain conditions.

Besides the strategic value of spin-offs focused in this paper, another constraint a vertically integrated firm might face in reality is that its downstream competitors may not want to procure their inputs from the firm for fear that doing so would reveal their business plans and product designs to the downstream unit of the integrated firm. For instance, one main factor in the AT&T-Lucent case was that prior to the spin-off, the Baby Bells, which had been the biggest customers of AT&T, became reluctant to buy from AT&T, a competitor in cellular markets and a potential competitor in local markets. In such a situation, a spin-off not only confers the spun-off firm a strategic advantage in the input market, as analyzed in the present model, it also gives the continuing downstream firm more freedom to compete without having to be concerned about offending other downstream input buyers.¹⁵

I assumed Cournot competition in the present model. One can also examine spin-off incentives in the case where input suppliers compete in Bertrand fashion. Since input suppliers' decisions under Bertrand competition are

¹⁵See Miles and Woolridge (1999) for a detailed study of the spin-off of Lucent Technologies by AT&T.

strategic complements, more aggressive behavior on the part of the spun-off firm U_1 would trigger more competitive behavior by the incumbent input supplier. One thus expects that spin-offs are less likely to occur in a price setting game than in a quantity setting game considered here. However, since (complete) spin-offs also increase the derived demand for the input, the incumbent input supplier will raise input price after a spin-off, which “softens” competition in the input market and thus enhances the incentive for a spin-off. Future research along this line is certainly worth pursuing. One difficulty with this approach is to build a model that incorporates (horizontal) product differentiation into a two-tier vertical model, especially when the number of upstream suppliers is not equal to that of the downstream producers.¹⁶

9 Appendix: Derivations of Profits for the Case of Competing Spin-offs

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

Given c_1 and input price w , the resulting Cournot output levels downstream are

$$q_0 = q_1 = \frac{a - (n+1)c_1 + (n-1)w + c_1}{n+2} = \frac{a - nc_1 + (n-1)w}{n+2} \quad (22)$$

and

$$q_2 = q_3 = \dots = q_n = \frac{a - (n+1)w + (n-2)w + 2c_1}{n+2} = \frac{a - 3w + 2c_1}{n+2}.$$

The derived demand for the input is thus

$$Q = (n-1)q_2 \quad \text{or} \quad w = \frac{a + 2c_1}{3} - \frac{(n+2)}{3(n+1)}Q.$$

¹⁶I do not know of any existing models in the literature that are suitable to accomplish this task.

Supplier U_2 sets input price at the monopoly level $w_2^* = (a + 2c_1 + 3c_2)/6$. Substituting w_2^* into (22), we get

$$q_0^* = q_1^* = \frac{(n+5)a - 2(2n+1)c_1 + 3(n-1)c_2}{6(n+2)}.$$

The profits of D_0 and D_1 are thus

$$\pi_{D_0}^* = \pi_{D_1}^* = (q_0^*)^2 = \left[\frac{(n+5)a - 2(2n+1)c_1 + 3(n-1)c_2}{6(n+2)} \right]^2.$$

Case (ii): Spin-off by D_0 only

Given input price w , the unit cost of production of D_1 is still c_1 but that of all other downstream firms are w . The downstream Cournot quantities are thus

$$q_1 = \frac{a - (n+1)c_1 + nw}{n+2} \quad (23)$$

and

$$q_0 = q_2 = \dots = q_n = \frac{a - (n+1)w + (n-1)w + c_1}{n+2} = \frac{a - 2w + c_1}{n+2}. \quad (24)$$

The derived demand for the input is $Q = nq_0$ or equivalently $w = \frac{a+c_1}{2} - \frac{(n+2)}{2n}Q$. Given this, Cournot competition between U_0 and U_2 yields the following input quantities and price:

$$q_0^I = \frac{n(a - c_1)}{3(n+2)}, \quad q_2^I = \frac{n(a + c_1 - 2c_2)}{3(n+2)}$$

and

$$w_{02} = \frac{a + 3c_1 + 2c_2}{6}.$$

Substituting w_{02} into (23) and (24), we get

$$q_1^S = \frac{(n+6)a - 3(n+2)c_1 + 2nc_2}{6(n+2)} \quad \text{and} \quad q_0^S = \frac{2(a - c_2)}{3n+6}.$$

Therefore,

$$\pi_{U_0}^S = \frac{(n+2)}{2n} (q_0^I)^2 = \frac{n(a-c_1)^2}{18(n+2)}, \quad \pi_{D_0}^S = (q_0^S)^2 = \frac{4(a-c_2)^2}{9(n+2)^2},$$

and

$$\pi_{D_1}^{NS} = (q_1^S)^2 = \frac{[(n+6)a - 3(n+2)c_1 + 2nc_2]^2}{36(n+2)^2}.$$

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

Given w , Cournot competition among all the $n+1$ downstream firms yields the quantities: $q_i(w) = (a-w)/(n+2)$, $i = 0, 1, \dots, n$. The derived demand for input is thus

$$Q = (n+1)q_i = \frac{n+1}{n+2}(a-w) \quad \text{or} \quad w = a - \frac{n+2}{n+1}Q.$$

Facing this demand, input suppliers U_0 , U_1 , and U_2 compete in Cournot fashion, yielding the following quantities

$$q_0^I = q_1^I = \frac{n+1}{n+2} \frac{a-2c_1+c_2}{4} \quad \text{and} \quad q_2^I = \frac{n+1}{n+2} \frac{a-3c_2+2c_1}{4}.$$

Substituting the output levels into the derived demand for input, we get the equilibrium level of input price: $w_{012} = (a+2c_1+c_2)/4$. Profits of the spun-off firms and their parent firms are

$$\pi_{U_0}^{SS} = \pi_{U_1}^{SS} = \frac{n+2}{n+1} (q_0^I)^2 = \frac{n+1}{n+2} \left(\frac{a-2c_1+c_2}{4} \right)^2,$$

and

$$\pi_{D_0}^{SS} = \pi_{D_1}^{SS} = (q_i(w_{012}))^2 = \left(\frac{3a-2c_1-c_2}{4(n+2)} \right)^2,$$

respectively.

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