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Strategic Spin-Offs

Ping LIN*

May 3, 2001

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. The firm chooses not to spin-off (and remain self-sufficient) if the number of downstream firms, $n$, is small; a complete spin-off if $n$ is large; and a partial spin-off if $n$ is in the intermediate range. Spin-offs can lower welfare by worsening the double-marginalization problem.

JEL Classification: L13, L22, L42

Keywords: Spin-off, commitment, vertical relationship, externality.

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1 Introduction

During the 1990s, rapid technological progress in the global economy has been accompanied by a wave of spin-offs. In 1995, corporations spun off $48 billion worth of stock and about $70 billion in 1996\(^1\). Among the most noteworthy spin-offs, was the voluntary spin-off of AT&T’s communication equipment arm and acclaimed Bell Labs research unit in 1996 as Lucent Technologies Inc., and its computer division as NCR Corp. In April 1999, Siemens Group announced its decision to spin off the Siemens Semiconductor Group as a 100% subsidiary under the name Infineon Technologies AG, becoming the largest spin-off in European history. The goal of this paper is to provide a strategic theory of when and why firms find it attractive to generate spin-offs and to shed light on the welfare consequences of such a strategy.

Two hypotheses regrading the motives of spin-offs can be found in the literature of financial restructuring, both related to value creation. 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 (Krishnaswami and Subramaniam (1999)). In particular, spin-offs

\(^1\)Treasury & Risk Management, January/February, 1997.
isolate slow-growth segments of a large company and thus help provide financial clarity to investors.

The economic literature, on the other hand, has not paid much attention to spin-offs and their welfare effects, presumably because of the belief that, unlike mergers, spin-offs increase the number of firms and thus must always be pro-competitive. While some companies (General Motors, e.g.) do choose to break up its line of products into competing units, many spin-offs in practice take place in a vertical market structure whereby an increase in the number of firms does not necessarily lead to higher degree of competition. The spin-off of Lucent Technologies by AT&T, for example, is a kind of cross-industry spin-off wherein the spun off unit and the continuation unit have a supplier-customer relationship.\(^2\) Prior to the spin off, AT&T was the main customer of its communication equipment unit. Now Lucent also supplies equipments to other telecommunication service providers such as MCI/WorldCom, British Telecommunications, and the 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.\(^3\) In situations like this, one wonders why would a company spin off its input unit which then supplies an input to its competitors in the final product market.\(^4\)

\(^2\)To a certain extent, Siemens AG’s spinning off Infineon also belongs to this type. Like Infineon’s other computer chips customers, Siemens AG also makes computers itself.

\(^3\)Photonics Spectra News, November 1996.

\(^4\)See Pack and Saggi (2001) for a model in which technology transfer to a supplier may help a firm’s downstream competitor but yet the firm finds it profit maximizing to engage in it.
The paper offers an explanation of why spin-offs may occur based on strategic considerations. The theory I propose here is as follows. 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 rival firms by increasing upstream competition and thus reducing the input price (a “helping the rivals effect”). This negative externality prevents the newly-created upstream unit from expanding. Following a spin-off, the independent spun-off unit does not have to worry about the downstream business of its parent firm. While it may hurt the parent company, such “sub-optimal” behavior on the part of the spun-off unit enables the firm to increase its share of the input market in a credible way and thus forces its upstream competitors to be less aggressive.

Using a model with linear demand and Cournot firms at both the upstream and the downstream markets, I examine the spin-off decision by a given downstream firm. I first study the case of direct entry whereby the firm concerned enters the input market without a spin-off and then serves other downstream competitors (along with the incumbent upstream supplier). I then consider two spin-off strategies of the firm. Under a partial spin-off, the downstream firm continues to be self-sufficient in input supply. Under a complete spin-off, on the other hand, the parent firm has to buy the input from the upstream suppliers at the market price. Which strategy maximizes the joint profits of the parent company and the spun-off firm depends on the degree of competition in the downstream market. The following results are
obtained. The firm never chooses to enter directly into the input market, due to the “helping the rivals effect”. It will choose a complete spin-off if the number of downstream producers is large \((n \geq 8)\). If the number of downstream firms is small \((n < 4)\), no-spin-off (and no entry) is the best decision. If \(n\) is in the intermediate range \((4 \leq n \leq 7)\), a partial spin-off maximizes joint profits.

The intuition for these results is as follows. The basic trade-off associated with entering into the input market mentioned earlier is present under both direct entry and spin-offs. Entry into the input market enables a firm to capture profits from the upstream market but at the same time hurts its downstream business. In the model considered here, the negative effect is so strong that direct entry is never profitable for the firm. A spin-off confers a strategic advantage on the firm: Since the spin-off does not have to worry about its downstream parent unit, it behaves more aggressively (relative to a wholly owned unit), thereby forcing its upstream competitors to concede a portion of their market shares. When downstream market competition is intense \((n \geq 8)\), the downstream business is not as important and thus a complete spin-off becomes attractive. When \(n\) is in the intermediate range, the firm chooses a partial spin-off so as to realize the strategic advantage in the input market while still protecting its downstream business by making the input in house.

I also examine the effects of spin-offs on output, price and welfare. A complete spin-off always reduces welfare and raises the price of the final
product. Since it buys the input at the market pricing, the parent company under a complete spin-off suffers from the standard double marginalization 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. Consequently, social welfare declines under a complete spin-off. A partial spin-off, on the other hand, improves social welfare and lowers the price of the final product. This is so because a partial spin-off enhances upstream competition without pushing the downstream parent firm into the double marginalization problem.

The prediction of the model that increased competition in the downstream market can lead to spin-offs is consistent with what has been happening in the telecommunications industry in the United States. Since the break-up of AT&T in 1984, new entrants into the industry have been emerged, 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 market. The local phone companies are in turn allowed to participate in the long distance market. The removals of the regulatory barriers on different segments of 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.
This paper is related to several studies in the existing industrial organization literature. First, several authors have recently studied divisionalization strategies of firms, whereby companies, such as General Motors, choose the number of (autonomous) divisions before these divisions compete in the product market.\textsuperscript{5} The use of divisions can creditably enable firms to commit to large output level, thereby increasing their market shares. Unlike my paper here, however, this branch of studies focuses on horizontal settings and hence does not address the issue of commitment value created by a spin-off in the upstream market.

In an important paper, Tan and Yuan (1997) consider firm incentive for divestitures in a model with two firms (or shopping malls) each supplying a group of products. Products across the two firms are substitutes while that within each group are complements. Divestiture by a firm (selling off a subset of its product lines) imposes a negative externality on the complementary goods within its group and thus raises the prices levels of these complements. However, this increase in prices of its own goods softens the competition from the other firm. This indirect, “cross-group” effect leads to divestitures by both firms. Although also addressing the incentive for break-ups, the model of Tan and Yuan differs from my in that firms in their model do not have supplier-customer relationships. As a result, the directly effect of a spin-off in my model, namely to supply other downstream competitors, is not

\textsuperscript{5}See Baye, Croker and Ju (1996) for analysis of divisionalization strategies in a homogeneous product setting, and Yuan (1999) and Saggi and Vettas (2001), in a differentiated product setting.
present in their model. However, their result that divestitures reduce social welfare is parallel to the negative welfare effect of spin-offs in the present paper. As these authors pointed out, this negative welfare effect of break-ups corresponds to that of Economides and Salop (1992) who argued that for complementary products, mergers reduce prices and increase welfare.

Finally, my paper is related to recently studies of incentives for vertical separation in oligopoly. For example, Bonanno and Vickers (1988) show that vertical separation can be used to reduce upstream competition in an duopoly. Cyrenne (1994) analyzed a vertical integration-vertical separation game in a model and demonstrated that vertical separation and vertical integration can co-exist in equilibrium. In these models, vertical separation means that a manufacturer and its retailer stay as separate firms and a manufacturer does not supply the retailers of other manufacturers. Thus, the “helping the rivals effect” of a spin-off, which is the driving force behind all the results in my paper, is not present in these models.

The rest of the paper is organized as follows. Section 2 sets up the basic model and presents a general argument regarding the strategic value of spin-offs. Section 3 considers the benchmark case that the candidate firm for spin-off is self-sufficient in input supply. Section 4 and section 5 analyze partial spin-off and complete spin-off, respectively. Section 6 examines welfare effects of spin-offs and discusses policy implications. Section 7 concludes.
2 The Model

There are initially one upstream firm, $U_2$, and $n \geq 2$ downstream firms indexed by $D_i$, $i = 1, 2, ..., n$. 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. 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 $c_T$. The marginal cost of producing the input is $c$ for both $D_1$ and $U_2$. Thus, the marginal cost of production for the final product is $c + c_T$ for firm $D_1$, if it chooses to produce the input for itself, and is $w + c_T$ for other downstream firms.

Equipped with the input technology, $D_1$ has (at least) three options available:

- **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. $D_1$ creates a new, upstream unit denoted as $U_1$ which competes with the incumbent $U_2$ in selling the input to other downstream producers.
• Spin-off: The original firm $D_1$ breaks into an upstream firm $U_1$, which competes with the incumbent $U_2$ in supplying the input, and a downstream 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 an independent entity under a spin-off whereas it is a part of the downstream firm $D_1$ under direct entry.

2.1 The Strategic Value of Spin-offs

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. Suppose that firms compete in Cournot fashion in both the downstream and the upstream markets. Given the input price, $w$, set in the upstream market, the downstream producers compete by choosing quantities. These quantities in turn determine the derived demand for the input. Let $\pi_{D_1}(w)$ denote the reduced form profit of $D_1$ from the downstream market. Note that in the absence of a spin-off $\pi_{D_1}(w)$ increases with $w$ because for a higher input price, the cost-advantage that $D_1$ enjoys over other downstream competitors, $w - c$, is greater. Now consider the case of direct entry where $D_1$ enters backward into the input market. When choosing the amount 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 $\pi_{U_1}(Q_1, Q_2)$ represents the firm’s profit from the selling the input in the upstream market to other $(n - 1)$ downstream producers, and $Q_2$ the output level of the in-
cumbent supplier $U_2$. The input price is determined by Cournot competition between $U_1$ and $U_2$. The reaction function of $U_1$ is then determined by the first order condition:

$$\frac{\partial \pi_{U_1}(Q_1, Q_2)}{\partial Q_1} + \frac{\partial \pi_{D_1}(w)}{\partial w} \frac{\partial w}{\partial Q_1} = 0 \quad (1)$$

Since competition upstream will drive down the input price (the “helping the rivals effect”) and $\frac{\partial \pi_{D_1}(w)}{\partial w} > 0$, the second term on the left-hand-side of equation (1) 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 implied by equation (1) for all $Q_2$. Therefore, a spin-off shifts the reaction curve of $U_1$ outwards. Under the standard stability condition regarding Cournot equilibrium, this shift leads to a larger equilibrium quantity for $U_1$ and a smaller equilibrium quantity for $U_2$, and thus higher upstream profit for $U_1$. Of course, the input price will go down as a result of expansion by $U_1$, lowering the downstream profit of the original firm $D_1$. This basic trade-off determines whether or not a spin-off is a sensible strategy in this model. One expects that the trade-off will shift in the direction in favor of a spin-off if the downstream business is not very profitable (say, when the number of downstream firms is very large).
The above general arguments have ignored certain details associated with a spin-off. For example, under a spin-off, the original firm $D_1$ also purchases the input from the upstream suppliers. Thus the derived demand for the input is higher under a spin-off than under direct entry where $D_1$ makes the input it uses in house. The resulting higher demand for the input will shift the reaction curves of both $U_1$ and $U_2$ upwards. To isolate the shift of reaction curve caused by the strategic value of a spin-off from the shift caused by the increase in input demand, I will consider two spin-off situations: partial spin-off and complete spin-off. Under a partial spin-off, downstream firm $D_1$ continues to produce the input for itself, whereas under a complete spin-off the entire input production line of the original firm $D_1$ is spun off (to become $U_1$) and thus $D_1$ has to buy the input from the upstream suppliers at the market price, like other downstream producers. Under both types of spin-off, the spun-off firm is under an independent management. The analysis of a partial spin-off highlights the strategic value of spin-offs in the model, whereas the scenario of a complete spin-off resembles more real world spin-off situations.

In the rest of the paper, I assume that the demand for the final product is given by $p = a - Q$. 

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3 Self-sufficiency: The Benchmark Case.

Under self-sufficiency, firm $D_1$ produces the input for itself. $U_2$ is the sole supplier of the input to the other $(n-1)$ downstream producers. Not having to suffer from the standard double marginalization problem, $D_1$ has a cost advantage over its downstream rivals who have to buy the input from $U_2$.

Given the input price, $w$, set by $U_2$, the cost configuration for the downstream firms is $(c + c_T, w + c_T, w + c_T, ..., w + c_T)$. For the linear demand assumed, the corresponding Cournot equilibrium quantities downstream are

$$q_1(w) = \frac{a - n(c + c_T) + (n - 1)(w + c_T)}{n + 1} = \frac{a - nc + (n - 1)w - c_T}{n + 1}$$

(2)

for firm $D_1$, and

$$q_i(w) = \frac{a - n(w + c_T) + (n - 2)(w + c_T) + c + c_T}{n + 1} = \frac{a - 2w - c_T + c}{n + 1}$$

(3)

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

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

i.e.,

$$w = \frac{a - c_T + c}{2} - \frac{1}{2n - 1}Q_2.$$  

(4)

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

$$w^* = \frac{a + 3c - c_T}{4}$$

(5)

Note that the derived demand for the input does not approach to zero as $n$ goes to infinity.
The resulting equilibrium quantities, after algebraic simplifications, are

\[ q_1^* = \frac{(a - c - cT)(n + 3)}{4(n + 1)} \quad \text{and} \quad q_2^* = \ldots = q_n^* = \frac{(a - c - cT)}{2(n + 1)}. \]

The equilibrium output for the industry is

\[ Q^* = q_1^* + (n - 1)q_2^* = \frac{(a - c - cT)(3n + 1)}{4(n + 1)} \quad (6) \]

and the equilibrium profit of \( D_1 \) is

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

Note that \( \pi_1^* \) is a decreasing function of \( n \). As competition downstream intensifies, firm \( D_1 \)'s profit declines. In the limit where \( n \) approaches infinity, \( \pi_1^* = (a - c - cT)^2 / 16 \).

The profits of other downstream firm \( D_i, i \geq 2 \), and the profit of the upstream supplier \( U_2 \) are

\[ \pi_i^* = \pi_2^* = (a - cT - w^* - Q^*)q_2^* = \frac{(a - cT - w^*)^2}{4(n + 1)^2} \]

and

\[ \pi_{U_2}^* = (w^* - c)(n - 1)q_2^* = \frac{(n - 1)(a - c - cT)^2}{8(n + 1)}, \]

respectively.
4 Direct Entry Into the Upstream Market

Under direct entry into the upstream market, $D_1$ produces the input not only for its own use, it also sells the input to the 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 of the input it sells at the input market to other downstream competitors. 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 selling the input to 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 will drive down the input price, thereby helping 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 profitable. We show this next.

Let $Q_1$ and $Q_2$ denote the units of input produced by $U_1$ and $U_2$, respectively. Given the input price, $w$, and the marginal cost of $D_1$, $c_I + c$, the $n$ downstream firms compete in Cournot fashion. The resulting quantity for $D_1$ and the derived demand for the input, by $D_2, D_3, \ldots, D_n$, are the
same as in the previous section, namely,

\[ q_1(w) = \frac{a - nc + (n - 1)w - c_T}{n + 1} \]

and

\[ Q_1 + Q_2 = (n - 1)q_2(w) = \frac{(n - 1)(a - 2w + c - c_T)}{n + 1}. \]

The derived demand for the input is

\[ w = \frac{a - c_T + c}{2} - \frac{1}{2} \frac{n + 1}{n - 1}(Q_1 + Q_2). \tag{7} \]

The equilibrium input price, however, is determined by competition between \( U_1 \) and \( U_2 \), rather than set by \( U_2 \) alone. Of course, 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 (7) into \( q_1(w) \), we have

\[ q_1 = \frac{a - c - c_T}{2} - \frac{Q_1 + Q_2}{2}. \tag{8} \]

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

\[ \pi_{U_1} = (w - c)Q_1 = \left[ \frac{a - c - c_T}{2} - \frac{n + 1}{n - 1} \frac{Q_1 + Q_2}{2} \right] Q_1 \tag{9} \]

and

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

Using (8), we can rewrite \( \pi_{D_1} \) as

\[ \pi_{D_1} = \left[ \frac{a - c - c_T}{2} - \frac{Q_1 + Q_2}{2} \right]^2. \tag{10} \]
The above expression for $\pi_{D_1}$ 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 unit 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 all $Q_2$. Thus, we have the following result:

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

### 5 Partial Spin-off

Under a partial spin-off, the newly created upstream unit $U_1$ is under an independent management. Therefore, when choosing its output $U_1$ does not have to take into account the profits of $D_1$: it chooses $Q_1$ to maximize only its profit $\pi_{U_1} = (w - c)Q_1$ as opposed to the joint profits $\pi_{U_1} + \pi_{D_1}$. Given this, the input price is thus determined by the standard (symmetric) Cournot competition between $U_1$ and $U_2$. 
The derived demand for the input under a partial spin-off is the same as in the previous section (equation (7)), since the initial downstream unit $D_1$ continues to produce the input in house. Given this derived demand for the input, upstream duopoly Cournot quantities under a partial spin-off are

$$Q_{PS}^1 = Q_{PS}^2 = \frac{(a - c - c_T)(n - 1)}{3(n + 1)}$$

and the equilibrium input price is

$$w_{PS} = \frac{a + 5c - c_T}{6}.$$  \hspace{1cm} (12)

By equations (2) and (3), the resulting equilibrium output level downstream is thus

$$q_{PS}^1 = q_1(w_{PS}) = \frac{(a - c - c_T)(n + 5)}{6(n + 1)}$$

for firm $D_1$, and

$$q_{PS}^2 = ... = q_n^PS = \frac{Q_{PS}^1 + Q_{PS}^2}{n - 1} = \frac{2(a - c - c_T)}{3(n + 1)}$$

for other downstream producers.

Consequently, the profits for $U_1$ and $D_1$ are

$$\pi_{U_1}^{PS} = (w_{PS} - c)Q_{PS}^1 = \frac{(a - c - c_T)^2(n - 1)}{18(n + 1)}$$

and

$$\pi_{D_1}^{PS} = \left[ a - c - c_T - q_{PS}^1 - (n - 1)q_{PS}^2 \right] q_{PS}^1 = \frac{(a - c - c_T)^2(n + 5)^2}{36(n + 1)^2},$$

respectively.
As the degree of downstream competition increases \((n \text{ goes up})\), \(\pi_{PS}^{D_1}\) declines, as expected. However, \(\pi_{PS}^{U_1}\) rises because the derived demand for the input increases with \(n\).\(^7\) In the limit \((n \to \infty)\), \(\pi_{U_1}^{PS} + \pi_{D_1}^{PS}\) approaches \(\lambda^2/18 + \lambda^2/36 = \lambda^2/12\), where \(\lambda \equiv (a - c - c_T)\). Recall that the profit of \(D_1\) under self-sufficiency goes to \(\lambda^2/16\) as \(n\) goes to infinity. The next proposition shows that a partial spin-off is more profitable relative to self-sufficiency if the number of downstream producers is not small.

**Proposition 2** \(\pi_{U_1}^{PS} + \pi_{D_1}^{PS} > \pi_1^*\) if and only if \(n \geq 4\).

**Proof.** By the expressions of the profit functions, \(\pi_{U_1}^{PS} + \pi_{D_1}^{PS} > \pi_1^*\) if and only if
\[
\frac{(n+5)^2}{36(n+1)^2} + \frac{n-1}{18(n+1)} > \frac{(n+3)^2}{16(n+1)^2}
\]
which simplifies to
\[
4(n+5)^2 + 8(n+1)(n-1) > 9(n+3)^3.
\]
Further simplifications reveal that the above inequality holds if and only if \(3n^2 - 14n + 11 > 0\), i.e., \(n > 3.67\). \(\blacksquare\)

The reason that a partial a spin-off can increase total profits for the firms relative to self-sufficiency is as follows. The basic trade-off associated with entering into the input market remains present here under a spin-off, namely that entry into the input market enables \(U_1\) to capture profits from the upstream market but at the same time hurts the downstream profitability of

\(^7\)The sum of \(\pi_{U_1}^{PS}\) and \(\pi_{D_1}^{PS}\) decreases in \(n\).
When downstream market competition is intense \((n \geq 4)\), the downstream business is not as important as it is for a smaller \(n\). As a result, the upstream (duopoly) profits are large enough to offset the downstream losses.

What might be surprising is that a spin-off can yield higher profits than self-sufficiency while direct entry cannot. As shown in the previous section, the joint profits of \(U_1\) and \(D_1\) always decrease with \(Q_1\) for any \(\text{given } Q_2\), which is of course also true under a spin-off. How can it be possible that the joint profits are higher under a spin-off where the equilibrium \(Q_1\) is positive? The reason is that a spin-off forces \(U_2\) to lower its output from the monopoly level \(Q_2^*\) to the Cournot duopoly level \(Q_2^{PS}\). As \(Q_2\) declines and when \(n \geq 4\), \(U_1\) and \(D_1\) earn higher joint profits under a partial spin-off.

6 Complete Spin-Off

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

Given \(w\), the \(n\) downstream firms are now on equal footing each having a marginal cost of \(w + c_T\). The corresponding Cournot output of each downstream firm is

\[
q_i = \frac{a - w - c_T}{n + 1},
\]
yielding the following derived demand for the input

\[ w = a - c_T - \frac{n+1}{n} Q, \quad \text{where} \quad Q = n q_i. \]

Relative to the derived demand in the previous sections, a complete 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 demands a larger quantity of the input for a given \( w \) because \( D_1 \) now no longer possess a cost-advantage over them.

Facing the above derived demand, \( U_1 \) and \( U_2 \) compete in Cournot fashion, leading to the following equilibrium quantities under a complete spin-off:

\[ Q_{CS}^{U_1} = Q_{CS}^{U_2} = \frac{n(a - c - c_T)}{3(n + 1)}. \] (14)

The resulting equilibrium input price is then

\[ w_{CS} = a - c_T - \frac{n+1}{n}(Q_{CS}^{U_1} + Q_{CS}^{U_2}) = \frac{a - c_T + 2c}{3}. \] (15)

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

\[ \pi_{CS}^{U_1} = \pi_{CS}^{U_2} = (w_{CS} - c)Q_{CS}^{U_1} = \frac{n(a - c - c_T)^2}{9(n + 1)}, \]

and

\[ \pi_{CS}^{D_i} = (a - Q_{CS}^{U_1} - Q_{CS}^{U_2} - w_{CS} - c_T)\frac{Q_{CS}^{U_1} + Q_{CS}^{U_2}}{n} \]

\[ = \frac{4(a - c - c_T)^2}{9(n + 1)^2}, \quad i = 1, \ldots, n. \]
Comparing the above profits with those under a partial spin-off, we have

\[ \pi_{U_1}^{CS} + \pi_{D_1}^{CS} > \pi_{U_1}^{PS} + \pi_{D_1}^{PS} \]

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 after rearranging terms becomes

\[
\frac{1}{18} > \frac{(n+5)^2 - 16}{36(n+1)^2}.
\]

The above inequality, after further simplifications, is equivalent to \((n-7)(n+1) > 0\). Therefore, we have the following result.

**Proposition 3** Assume that \( p = a - Q \). A complete spin-off yields greater joint profits for \( U_1 \) and \( D_1 \) than does a partial spin-off if and only if \( n > 7 \).

As the number of downstream firms increases, a self-sufficient downstream unit becomes less and less profitable, as its price-cost margin, \( p - c - c_T \), shrinks and its output declines. Switching from a partial spin-off to a complete spin-off enables the firm to further shift its business from the less profitable downstream market to the upstream market. It does so by increasing the derived demand for the input: Relative to a partial spin-off, a complete spin-off increases the equilibrium quantities of all other \( n-1 \) downstream firms as it eliminates the cost-advantage that \( D_1 \) enjoyed under a partial spin-off. This increased demand for the input translates into greater profit for \( U_1 \). Such a business-refocusing strategy is profitable when \( n \) is sufficiently large.
Furthermore, since $D_1$ now has to buy the input from the upstream suppliers, $U_1$’s expansion in the upstream market under a complete spin-off actually benefits $D_1$, unlike in the case of a partial spin-off where an increase in the output $U_1$ reduces input price and helps the downstream competitors of $D_1$.

### 6.1 Spin-off Decision

Let $v(n) \equiv \max\{\pi^*_1(n), \pi^{PS}_{U_1}(n) + \pi^{PS}_{D_1}(n), \pi^{CS}_{U_1}(n) + \pi^{CS}_{D_1}(n)\}$. Combining the previous propositions, we obtain the following result:

**Proposition 4** For the linear demand $p = a - Q$, the optimal form of organization for the original firm $D_1$ is given by

$$v(n) = \begin{cases} 
\pi^*_1(n), & \text{if } n < 4 \\
\pi^{PS}_{U_1}(n) + \pi^{PS}_{D_1}(n), & \text{if } 4 \leq n \leq 7 \\
\pi^{CS}_{U_1}(n) + \pi^{CS}_{D_1}(n), & \text{if } n > 7 
\end{cases}.$$ 

That is, the firm will remain self-sufficient if $n$ is smaller than 4, adopt the partial spin-off strategy if $n$ is between 4 and 7, and will choose complete spin-off if $n > 7$. The profit functions are depicted in Figure 1 below.

(Insert Figure 1 here.)

Because a spin-off represents a shift of core business from the downstream level to the upstream level in this model, the pattern of the optimal strategy as given in the above proposition comes at no surprise. If the degree of downstream competition is low ($n < 4$), the traditional business of the firm
concerned is still profitable and a spin-off, which would help downstream rival firms, is not justified. If there are a large number of downstream producers \((n > 7)\), entry into the upstream market by means of a spin-off is profitable as the market demand for the input is large and the negative effect of such entry on the old downstream unit is small. If the degree of downstream competition is in the intermediate range and thus the downstream business is still moderately attractive, shutting down the in-house production of the input is too costly. Therefore, the firm chooses instead a partial spin-off in this case.

7 Welfare Effect of Spin-offs

Spin-offs in this model affect welfare in two ways. On the one hand, spin-offs tend to improve social welfare as they increase competition in the input market. On the other hand, however, accompanying a spin-off is the production shift downstream from the once self-sufficient \(D_1\) to other downstream firms who have to rely on upstream suppliers for the input. Therefore, spin-offs worsen the standard double marginalization problem in a two-tier industry. In fact, under a complete spin-off, firm \(D_1\) also suffers from the double marginalization problem. Hence, relative to self-sufficiency, spin-offs have an effect of reducing welfare. The net effect of a spin-off on welfare thus depends on the magnitudes of the above two opposing forces. We can show the following results concerning the equilibrium output, final product price, social welfare, and the price of the input.
Proposition 5

(i) \( Q^{PS} > Q^* > Q^{CS} \) and \( p^{PS} < p^* < p^{CS} \) for all \( n \);

(ii) Relative to no spin-off, and for all \( n \), a partial spin-off improves social welfare and a complete spin-off reduces it; and

(iii) \( w^{PS} < w^* < w^{CS} \).

Proof. By equations (6), (11), (13), and (14), we have

\[
Q^* = \frac{(a-c-c_T)(3n+1)}{4(n+1)}
\]

\[
Q^{PS} = Q_1^{PS} + Q_2^{PS} + q_1^{PS} = \frac{2(n-1)(a-c-c_T)}{3(n+1)} + \frac{(n+5)(a-c-c_T)}{6(n+1)} = \frac{(5n+1)(a-c-c_T)}{6(n+1)}
\]

and

\[
Q^{CS} = Q_1^{CS} + Q_2^{CS} = \frac{2n(a-c-c_T)}{3(n+1)}.
\]

Straightforward comparison of the output levels yields the results in part (i).

To prove part (ii), note that whether or not the firm chooses a spin-off, all units of the total output of the industry are produced at the marginal cost \( c + c_T \), although the output allocations among firms vary. Thus, profit per unit of the output is always \( p - c - c_T \) for the industry regardless of which form of the industrial organization (self-sufficient, partial spin-off, or complete spin-off) is chosen. What are different under different organization forms are the aggregate output level and the way per unit profit is shared among the input suppliers and the downstream producers. These, together with the fact that social welfare is given by the area under the demand curve and above the level of \( c + c_T \), imply that welfare has the same rank as that of the equilibrium output levels given in part (i). This proves part (ii).

\[8\]Simulation results based on the derived profit functions and the corresponding consumer surplus under self-sufficiency and spin-offs were in confirmation with the general arguments presented here.
Part (iii) of the proposition follows by noting the expressions for the input price (5), (12), and (15), and that \( a - c - c_T > 0 \).

The effects of spin-offs on output and prices are easy to understand. Relative to self-sufficiency, a partial spin-off increases upstream competition without lowering the production efficiency of the downstream firm. Of course, following a partial spin-off the output level of the downstream firm \( D_1 \) drops and that of the other downstream firms rises. This means that a larger portion of the final product sold to the consumers involves the standard double marginalization problem. But the effect of increased competition upstream is so strong that input price and the final price end up lower under a partial spin-off. As a result, welfare is enhanced. Under a complete spin-off, however, the price of all units of the final product gets raised twice, once by the input suppliers and then by the downstream producers, from the respective marginal costs of production, before they reach the final consumers. This loss in downstream production efficiency raises the price of the final product and lowers welfare.

The result that \( w^{PS} < w^* < w^{CS} \) is also easy to understand. Relative to the benchmark case, a partial spin-off increases upstream competition without raising the derived demand for the input (because \( D_1 \) remains self-sufficient). As a result, input price declines in equilibrium. A complete spin-off, on the other hand, eliminates the cost advantage \( D_1 \) once enjoyed over other downstream firms and increases the demand for the input because \( D_1 \) now also purchases the input from the upstream market. These factors
are so strong that input price ends up increasing under a complete spin-off, despite of entry of $U_1$ into the input market.

7.1 Policy Implications

The above results have clear policy implications, namely that spin-offs, which increase the number of firms in the industry, are not always welfare improving. In particular, a complete spin-off in our model always reduces social welfare, although a partial spin-off always enhances welfare. As mentioned earlier, the efficiency loss created by a complete spin-off in this model stems from the fact that it raises the magnitude of the standard double marginalization problem through two channels. First, it exposes the continuation firm ($D_1$) to the problem of double marginalization. Second, such exposure shifts the industry output downstream from the more efficient firm toward those who have been already suffering from the problem. These effects tend to raise the input price as they increase the demand for the input. Precisely because of this, input price rises under a complete spin-off, rather than drops as one might expect when entry into the input market occurs. Higher input price and resource flow to less efficient producers result in an increase in the price of the final product and a reduction in social welfare. Such detrimental effects of spin-offs have been overlooked in the literature. This paper shows that they can be strong enough for spin-offs to be welfare-reducing.
8 Conclusion

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 the firm to credibly expand its upstream business. This in turn forces the upstream rival firms 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.

The current US antitrust laws do not have specific provisions governing corporate spin-offs. Yet our model shows that spin-offs can reduce welfare as they worsen the magnitude of the standard double marginalization problem. The possible negative welfare effects of spin-offs have been overlooked by economists and policy makers.

Although obtained in a simple model, the main results of the model would continue to hold in more general settings, as argued in section 2. The “helping the rivals effect” should in general exist whenever a downstream producer enters backward into the input market. The value of a spin-off as a commit-
ment device for expansion in the input market is not specific to the simple model considered here, although the result that direct entry never occurs may fail to hold for nonlinear demand. In general, one expects that the firm under direct entry may produce a positive quantity, albeit smaller than that under a spin-off, in the input market. Finally, if there is an upstream oligopoly rather than a duopoly, it should be clear that spin-offs are less likely to occur.

My model here focuses on the strategic value spin-offs can confer to a firm by freeing up its constraint in the input market. Another constraint an integrated firm might face in reality is that its downstream competitors may not want to procure their inputs from the firm for the fear that so doing would reveal their business plans and product designs to the downstream unit of the integrated firm. Such a situation is likely to arise if specific investments are necessary for making inputs for downstream customers.\(^9\) 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 downstream continuation firm more freedom to compete without having to be concerned about offending other downstream input buyers. A study of such strategic interaction in the downstream market and its implication for spin-offs seem warranted for future research.

\(^9\)For instance, one major factor in the AT&T-Lucent case was that prior to the spin-off the Baby Bells, which were 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. See Miles and Woolridge (1999) for a detail study of the spin-off of Lucent Technologies by AT&T.
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 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 up a model that incorporates product differentiation into a two-tier vertical model, especially when the number of upstream suppliers is not equal to that of the downstream producers. I do not know of any existing models in the literature that are suitable to accomplish this task.

References


