With economies of scale, a vertically integrated firm can lower its upstream cost by supplying downstream competitors. The competitors may strategically choose not to purchase from the integrated firm, unless the latter’s price for the intermediate good is sufficiently lower than those of alternative suppliers. In a simple model of dynamic scale economies through learning by doing, equilibrium vertical disintegration occurs if and only if total industry profit is higher under vertical separation than under integration. The model bridges a logical gap in George Stigler’s classic theory on vertical organization, and sheds light on the widely observed phenomenon of vertical disintegration.

1. Introduction

A widely observed business phenomenon is vertical disintegration, the separation of a firm’s vertically related businesses into independent firms. In recent years, for instance, AT&T has spun off its equipment division, which became Lucent Technologies; GM has divested its auto parts division, Delphi; and IBM has sold off its data networking division, Global Networks. Although the economic literature has devoted much attention to vertical integration, there has been less study on the causes and effects of vertical disintegration.

This paper suggests a theory of vertical disintegration, built on an idea from George Stigler’s classical paper, “The Division of Labor Is Limited by the Extent of the Market”(Stigler, 1951). Stigler envisioned a theory of vertical organization as the following: Initially, markets were small and firms integrated their production of inputs. As markets grew, the upstream division of some firms were disintegrated to take advantage of specialization and economies of scale, and became suppliers for
the downstream industry. There is, however, a logical gap in Stigler’s argument. It is not clear why a specialized division of an integrated firm cannot exploit economies of scale and supply the downstream industry, in much the same way as an independent firm. In other words, why is vertical disintegration needed?

To understand why economies of scale may lead to vertical disintegration, I believe a key is to consider horizontal competition. Even though a firm’s upstream division can experience the same economies of scale as an independent firm, the former may not have the same ability as the latter to sell to the unintegrated downstream firms. With economies of scale in the upstream production, the integrated firm can lower the costs of its upstream division if it sells the intermediate good to its (downstream) rivals. The common ownership of the upstream and downstream divisions may mean that the integrated firm cannot credibly commit not to confer a cost advantage to its downstream division in the (possibly future) downstream competition. But the (potential) competitors may then choose not to purchase from the integrated firm, unless the latter’s price is substantially lower than those of unintegrated suppliers. This can motivate the integrated firm to vertically disintegrate.

There is evidence that the difficulty in selling intermediate goods to rival firms has been an important motive for several firms’ recent vertical disintegration. AT&T’s sell-off of its equipment division, for instance, is believed to be motivated by its concern that the downstream competitors are unwilling to purchase from its equipment division. According to some industry observers, “growing competition in the local and long-distance markets put (AT&T’s) service group increasingly at odds with key customers of AT&T’s huge equipment division . . . . If customers did choose to buy from (AT&T’s) Network Systems, they reached for their wallets reluctantly” (Kirkpatrick, 1995, p. 85).1 Similar concerns are believed to be behind GM’s divestiture of its auto parts division into an independent company. In explaining this divestiture, Delphi commented that “Other vehicle manufactures have been, to varying degrees, reluctant to purchase components extensively from a supplier owned by GM . . . . We believe this is attributable in part to concerns that the related profits would strengthen GM” (Tait, 1999).2 But why would a firm not purchase from a supplier, if that supplier offers a better price or a higher quality than its competitors? Our analysis will show

---

1. Notice that the specialized equipment division of AT&T could exploit economies of scale and supply the downstream firms, as it did for many years when its customers were not in competition with AT&T’s downstream business.

2. Similarly, avoiding competition with firms that are also customers on another level of the vertical chain is said to be the reason for IBM’s sale of its Global Networks.
that such seemingly puzzling claims indeed have theoretical merits; and economies of scale, in turn, provide a motive for a downstream competitor’s strategic purchasing behavior.

We consider a simple model where the upstream division of an integrated firm may produce in two periods. Its period 2 marginal cost decreases in its period 1 output. The upstream division’s potential purchaser in period 1 is a downstream firm that will compete with the integrated firm’s downstream division in period 2. There exist a competitive fringe of upstream producers who are willing to supply to any downstream firm at a competitive price in both periods. The integrated firm can choose to disintegrate vertically before period 1. Under the assumption that a downstream firm’s profit is lower when its rival’s marginal cost is lower, we show that in period 1 the stand-alone downstream firm will not purchase the intermediate good from the integrated firm unless the latter’s price is sufficiently below the competing price. In equilibrium, vertical disintegration occurs if and only if it increases the joint industry profits. This result comes about because, with higher industry profit, the integrated firm can compensate the downstream competitor’s reduced period 2 profit with a sufficiently low period 1 input price, without resorting to vertical disintegration. But if the industry profit is higher under vertical disintegration, disintegration would be more profitable for the integrated firm than charging the lower period 1 input price. We also note that our result holds for different forms of competition in the downstream market. In particular, vertical disintegration can occur when the downstream market is in the familiar forms of Cournot or Bertrand competition.

In a broad sense, the issue of vertical disintegration is also one concerning the boundary of a firm. The modern theory of the firm, which has its origin in Coase (1937), recognizes that there are costs associated with transactions both within and across firms (e.g., Williamson, 1985; Grossman and Hart, 1986). Although asset specificity and incomplete contracts can lead to opportunistic behavior and thus the need to integrate transactions within a firm, the ownership of assets in a relationship by one party may distort investment (effort) incentives, and this tends to limit the extent of integration. The focus of this approach has been on comparing costs internal to a transaction, between organizing the transaction within a firm or through the market. Complementary to the transaction-cost based approach, the present paper emphasizes that strategic considerations in horizontal

3. Related to this approach, Holmes (1995, 1999) and McLaren (2000) have shown that there is a link between the thickness (size) of a market and the tendencies for firms to vertically disintegrate.
competition are important in determining the vertical boundary of the firm.

The insight that the structure of vertical organization may depend on horizontal competition has been explored by several authors. Bonanno and Vickers (1988) study the incentives for firms to choose vertical separation when two-part tariff contracts are available. They consider a model where two manufacturers sell their differentiated products through two retailers, and each manufacturer chooses whether to vertically integrate its retailer or to keep the retailer as a separate firm. Vertical separation occurs in their model as a device for the manufacturers to collude to higher retail prices by raising the wholesale price above the marginal cost. Gal-Or (1999) considers the possible asymmetric information between a manufacturer and a retailer, and shows how this, together with horizontal competition, affects a manufacturer’s choice of whether to vertically integrate or separate its sales forces. The present paper is more closely related to Chen (2001), where a vertically integrated firm’s downstream pricing incentive is altered by its consideration of upstream profits, which in turn motivates a competitor to choose its supplier according to whether the supplier is owned by the integrated firm. However, while strategic purchasing behaviors by independent downstream firms result in vertical disintegration here, they result in vertical integration there. The reason for the opposite outcomes is that in Chen an upstream producer has an exogenous cost advantage; while here an upstream producer’s cost advantage is endogenous: its ability to exploit economies of scale depends on the purchases of its competitors.4

In the rest of the paper, we set up the model in Section 2, conduct the analysis in Section 3, and discuss the robustness of the results in Section 4. We conclude in Section 5.

2. The Model

The model has two periods, t1 and t2, with no discounting. There are two producers, A and B, in a downstream industry. At t1, B needs to purchase $s > 0$ units of an intermediate good produced in the upstream industry. Producer $U$ in the upstream industry has a unique access to a technology allowing it to produce the intermediate good at constant marginal cost $m$ during t1 but at constant marginal cost $c(l_1)$ during t2, where $l_1$ is $U1’s output in t1, with $c(0) = m$, $c'(l_1) < 0$ and $c''(l_1) > 0$ for $l_1 \geq 0$. That is, there exist scale economies for $U$ through learning by

4. Lin (2002) has also explored how strategic considerations in horizontal competition may motivate a firm to spin off its input division. However, he does not consider economies of scale and downstream competitors’ possible strategic purchasing behavior.
doing. We define \( m_1 \equiv c(s) < m \). The learning by doing here is adopted from a model in Gilbert (1989, p. 496–497). There is also a competitive fringe of upstream producers who are willing to supply the intermediate good at price \( m \) in both periods.\(^6\)

Initially, \( A \) and \( U \) are vertically integrated and the integrated firm is called \( I \). In \( t_2 \), both \( A \) and \( B \) will produce in the downstream industry.\(^7\) Each unit produced by \( A \) or \( B \) requires one unit of the intermediate good. Assume that the cost to acquire this input is the only cost for both \( A \) and \( B \).

We assume that if \( U \) and \( A \) are part of firm \( I \), the actions of \( U \) and \( A \) will be chosen to maximize \( I \)'s payoff and \( U \) cannot publicly commit to an internal transfer price to \( A \) that does not \( \text{ex post} \) maximize the joint profit of \( I \). This assumption implies that the internal transfer price between \( U \) and \( A \) will be set at \( U \)'s true marginal cost (see, e.g., Coughlan and Wernerfelt, 1989; Chen and Riordan, 2003). As we shall discuss later in Section 4, the qualitative nature of our results will not change even if the internal transfer price between \( U \) and \( A \) is above \( U \)'s true marginal cost, as long as it is below the price that \( U \) will charge the independent firm \( B \).

The game is as follows:

- Before the start of \( t_1 \), \( I \) decides whether or not to disintegrate. Disintegration means that \( U \) will be sold to a separate owner and becomes an independent upstream producer, with the sale price determined by a competitive capital market; and without the ownership of \( U \), \( I \) will simply be called \( A \).
- In \( t_1 \), if there is no disintegration, \( U \) posts its intermediate good price, \( w_I^1 \); and if there is disintegration, \( U \) posts its price, \( w_D^1 \). A competitive upstream fringe supplier simultaneously posts price \( m \). Firm \( B \) then purchases the intermediate good. For our purpose, it is not necessary to specify why \( B \) needs the intermediate good in \( t_1 \). It could be that in \( t_1 \), \( B \) produces some final good in the downstream market considered here or in some other industry. For convenience we assume that each

5. Our results would be essentially the same if other upstream firms also have scale economies that would lower marginal cost in period 2 to, say, \( m' \), by producing \( q_1 \geq s \) in period 1, with \( m_1 < m' < m \). What is important for our analysis is that \( U \) can better explore scale economies than other upstream producers. This seems plausible in light of some recent cases of vertical disintegration, where the disintegrating firms tend to be market leaders.

6. Alternatively, we could assume that there is another independent upstream producer who has constant marginal cost \( m \) in supplying the intermediate good in both periods. The competitive fringe assumption makes the exposition easier since we do not need to treat the fringe firms as strategic players in the game.

7. Our analysis extends to situations where \( A \) has multiple downstream competitors. See the discussion in Section 4. Notice that to simplify the analysis, we have assumed no downstream competition in period 1.
of the $s$ units of the intermediate good has a constant value $v > m$ to $B$ and the amount of $s$ is fixed.

- In $t_2$, $U$ (with or without disintegration) again first posts the input price at a spot market, against the competitive fringe’s price $m$. $A$ and $B$ then compete in the downstream market, the intermediate good is purchased and outputs are produced.

The active players in this game include $I$, $U$, $A$, and $B$; and without vertical disintegration, the decisions of $U$ and $A$ coincide with that of $I$.\(^8\) A subgame perfect Nash equilibrium here is a profile of strategies by all players together with the condition that the price for $U$ on the capital market equals the expected profit of $U$, such that the players’ strategies induce a Nash equilibrium in every subgame of the game. When $I$ is indifferent between disintegration or no disintegration, we assume that it will choose no disintegration (as it would be the case if there were transaction costs associated with organization changes).

To allow for more general results, we shall not restrict our analysis to any specific model of competition in $t_2$. Instead, we shall work with reduced-form functions and assume simply that there is a unique and stable Nash equilibrium in each of the subgames in $t_2$. In $t_2$, without vertical disintegration, the downstream equilibrium outputs and profits of $A$ and $B$ are assumed to be $\tilde{q}_i(c_A, c_B)$ and $\tilde{\pi}_i(c_A, c_A)$, respectively, for $i = A, B$, where $c_A$ and $c_B$ are $A$’s and $B$’s marginal costs. With disintegration, the equilibrium outputs and profits of firms $A$ and $B$ in $t_2$ are assumed to be $q_i(c_A, c_B)$ and $\pi_i(c_A, c_B)$, respectively. Notice that $\tilde{q}_i(c_A, c_B)$ and $\tilde{\pi}_i(c_A, c_B)$ may differ from $q_i(c_A, c_B)$ and $\pi_i(c_A, c_B)$. This is because if $B$ purchases input from $U$ and $U$ is part of the integrated $I$, $I$ may profit from its upstream sales to $B$ and may take this into account in deciding its downstream division’s ($A$’s) actions.\(^9\) However, if the marginal cost of $U$ is $m$ and it supplies $B$ at price $m$, $U$ (and hence $I$) would receive no profit from supplying $B$. We thus assume $\tilde{\pi}_B(m, m) = \pi_B(m, m)$. In addition, we assume that the reduced-form equilibrium output and profit functions have the following properties:

\[
\frac{\partial Y_i(c_A, c_B)}{\partial c_i} < 0, \quad \frac{\partial Y_i(c_A, c_B)}{\partial c_j} > 0 \quad \text{for } Y = \tilde{\pi}
\]

and $\pi, i, j = A, B$, and $i \neq j$. \(A1\)

---

8. The other upstream suppliers act as the competitive fringe that is always willing and able to supply $B$ at price $m$. The competitive fringe is not treated as an active player of the game.

9. See the examples in Section 3 and more detailed analysis in Chen (2001). The equilibrium outcome when there is no disintegration may depend on whether or not $B$ purchases from $U$, but this will not be an issue here because, as we shall see later, in equilibrium $B$ will purchase from $U$ in $t_2$. 
\[
\frac{\partial (\tilde{\pi}_A(c_A, c_B) + \tilde{\pi}_B(c_A, c_B))}{\partial c_A} < 0. \tag{A2}
\]

\[
\frac{\partial^2 \tilde{\pi}_B(c(l_1), m)}{\partial l_1^2} > 0. \tag{A3}
\]

\[m = \arg \max_{w \leq m} (w - m_1)(q_A(w, w) + q_B(w, w)). \tag{A4}\]

\[s > \frac{\tilde{\pi}_B(m, m) - \tilde{\pi}_B(m_1, m)}{m}. \tag{A5}\]

Assumption (A1) says that a firm’s equilibrium profit in period 2 increases in its rival’s cost and decreases in its own cost. Assumption (A2) says that without disintegration the joint profits of \(A\) and \(B\) in \(t_2\) decrease in \(A\)’s marginal cost. Assumption (A3) implies that when competing with \(A\) in \(t_2\) without disintegration, \(B\)’s equilibrium profit decreases in \(U\)’s first period output (which reduces \(c_A\) in period 2) at a decreasing rate. Assumption (A4) is related to the profits of the up- stream producers under vertical separation. Under vertical separation all downstream firms face identical prices for their inputs, and (A4) says that \(U\) should set this price equal to that charged by the competitive fringe. Assumption (A4) is satisfied as long as \(m - m_1\) is not too large, or \(U\) faces effective competition from other suppliers. Assumption (A5) is related to \(U\)’s first period input price \((w_1^I)\) for \(B\) under vertical integration; this price will be set to make \(B\) indifferent between purchasing from \(U\) or from the competitive fringe. Assumption (A5) says that \(s\) is not too small, which will be used in Lemma 1 to ensure that in equilibrium \(w_1^I\) is not negative. These assumptions hold in a variety of models. In particular, they can hold if firms produce a homogeneous product downstream and compete in quantities, or if firms produce differentiated products downstream and compete in prices. We shall later provide two such examples.

3. Analysis

In this section, we first consider equilibrium outcomes in the subgame where \(I\) chooses no vertical disintegration. We next consider equilibrium outcomes in the subgame following \(I\)’s disintegration. The equilibrium choice of \(I\) on whether or not to disintegrate is then characterized. The section ends with two examples.

Our analysis will be facilitated by the observation that, in any subgame perfect Nash equilibrium of the game, at \(t_2\) \(U\) must post \(m\) for the intermediate good and it is optimal for \(B\) (and for \(A\) as well if \(I\) is disintegrated) to purchase from \(U\) at price \(m\). This is because \(U\)’s constant marginal cost at \(t_2\) is always weakly below that of the competitive fringe.
since \( c(0) \equiv m \) and \( c(q) < m \) for \( q > 0 \), and \( U \) competes with the fringe suppliers in prices on a spot market.\(^{10}\) The usual Bertrand-competition logic means that in equilibrium \( U \) will offer the intermediate good at price \( m \), same as the competitive fringe. If \( U \)’s marginal cost is also \( m \), then in equilibrium any independent downstream firm may purchase from either \( U \) or a competitor; and if \( U \)’s marginal cost is below \( m \), as it would be the case if \( q > 0 \), then in equilibrium any independent downstream firm must purchase from \( U \).

### 3.1 Without Disintegration

Starting from the subgame where in \( t1 \) firm \( B \) purchases \( l_1 \geq 0 \) from \( U \) at \( w^I_1 \leq m \) and \( s - l_1 \) from a competitive supplier at \( m \), the Nash-equilibrium profits of \( I \) and \( B \) in \( t2 \) will be \( \tilde{\pi}_A(c(l_1), m) + (m - c(l_1))\tilde{q}_B(c(l_1), m) \) and \( \tilde{\pi}_B(c(l_1), m) \), because in equilibrium of period 2 \( U \) will post price \( m \) for the intermediate good and \( B \) will purchase from \( U \).

The combined profits in \( t1 \) and \( t2 \) for \( I \) and \( B \) are, respectively,

\[
\tilde{\pi}_I = (w^I - m)l_1 + \tilde{\pi}_A(c(l_1), m) + (m - c(l_1))\tilde{q}_B(c(l_1), m),
\]

\[
\tilde{\pi}_B = (v - w^I_1)l_1 + (v - m)(s - l_1) + \tilde{\pi}_B(c(l_1), m).
\]

Let

\[
l_1(w^I_1) \equiv \arg \max_{0 \leq l_1 \leq s} [(v - w^I_1)l_1 + (v - m)(s - l_1) + \tilde{\pi}_B(c(l_1), m)]
\]

and let \( w^*_I \) be such that

\[
w^*_I \equiv \arg \sup_{w^I_1 \leq m} [(w^I_1 - m)l_1 + \tilde{\pi}_A(c(l_1), m) + (m - c(l_1))\tilde{q}_B(c(l_1), m)]
\]

Let \( l_1(w^*_I) \equiv l^*_1 \). Then, \( w^*_I \) is the equilibrium input price posted by \( U \) in \( t1 \), and \( l^*_1 \) is the equilibrium quantity that \( B \) purchases from \( U \) in \( t1 \), starting from the subgame where \( I \) chooses not to disintegrate.

**Lemma 1:**

\[
w^*_I = w^*_1 \equiv m - \frac{\tilde{\pi}_B(m, m) - \tilde{\pi}_B(m_1, m)}{s} \in (0, m)
\]

and \( l^*_1 = s \).

**Proof.** Given any \( w^I_1 \), by assumption (A3),

\[
\frac{\partial^2 \tilde{\pi}_B}{\partial l^2_1} = \frac{\partial^2 \tilde{\pi}_B(c(l_1), m)}{\partial l^2_1} > 0,
\]

\(^{10}\) We consider only spot transactions in the upstream market. As we shall discuss later, the main insight of our analysis will not change if contracts, such as requirement contracts, are available.
implying that $R_B$ is strictly convex in $l_1$. Thus $l_1(w^1_i)$ must be either 0 or $s$, and hence

$$l_1(w^1_i) = \begin{cases} 
0 & \text{if } (v - m)s + \tilde{\pi}_B(m, m) > (v - w^1_i)s + \tilde{\pi}_B(m_1, m) \\
 s & \text{if } (v - m)s + \tilde{\pi}_B(m, m) \leq (v - w^1_i)s + \tilde{\pi}_B(m_1, m)
\end{cases}$$

where recall $m = c(0)$ and $m_1 = c(s)$.

Let $\tilde{w}_1$ be such that

$$(v - m)s + \tilde{\pi}_B(m_1, m) = (v - \tilde{w}_1)s + \tilde{\pi}_B(m_1, m).$$

Because $\tilde{\pi}_B(m, m) > \tilde{\pi}_B(m_1, m)$ and by assumption (A5), $\tilde{w}_1$ exists uniquely and $\tilde{w}_1 \in (0, m)$. Hence, if $\tilde{w}_1$ is posted by $U$ in $t1$, $B$ would find it optimal to purchase $s$ from $U$ in $t1$. It would therefore not be optimal for $U$ to choose $w^1_i < \tilde{w}_1$.

Now, for any $w^1_i > \tilde{w}_1$, we have $l_1(w^1_i) = 0$, and

$$(v - \tilde{w}_1)s + \tilde{\pi}_B(m_1, m) + \tilde{\pi}_A(c(l_1(\tilde{w}_1)), m) + (\tilde{w}_1 - m)l_1(\tilde{w}_1)$$

$$= (v - m)s + \tilde{\pi}_B(m_1, m) + \tilde{\pi}_A(m_1, m) + (m - m_1)\tilde{\pi}_B(m_1, m)$$

(because $l_1(\tilde{w}_1) = s$)

$$> (v - m)s + \tilde{\pi}_B(c(0), m) + \tilde{\pi}_A(c(0), m) + (m - m)\tilde{\pi}_B(m, m)$$

(from assumption A2)

$$= (v - m)s + \tilde{\pi}_B(m, m) + \tilde{\pi}_A(c(l_1(w^1_i)), m) + (m - c(l_1(w^1_i)))\tilde{\pi}_B(c(l_1(w^1_i)), m) + (w^1_i - m)l_1(w^1_i).$$

where we notice that $l_1(w^1_i) = 0$ for $w^1_i > \tilde{w}_1$. Thus, for any $w^1_i > \tilde{w}_1$,

$$\tilde{\pi}_A(c(l_1(\tilde{w}_1)), m) + (m - c(l_1(\tilde{w}_1)))\tilde{\pi}_B(c(l_1(\tilde{w}_1)), m) + (\tilde{w}_1 - m)l_1(\tilde{w}_1)$$

$$> \tilde{\pi}_A(c(l_1(w^1_i)), m) + (m - c(l_1(w^1_i)))\tilde{\pi}_B(c(l_1(w^1_i)), m)$$

$$+ (w^1_i - m)l_1(w^1_i).$$

This proves that the optimal $w^1_i$ for $U$ is

$$w^1_i^* = \tilde{w}_1 = m - \frac{\tilde{\pi}_B(m, m) - \tilde{\pi}_B(m_1, m)}{s} \in (0, m),$$

and in equilibrium $l^*_1 = s$. □

Therefore, without disintegration, in period 1 $U$ will post $\tilde{w}_1$ as its input price and $B$ will purchase all $s$ units from $U$; and in period 2 $U$ will post $m$ as its input price and $B$ will also purchase all inputs.
from $U$. Hence, in equilibrium, the total industry profit in $t_2$ without disintegration is
\[ \tilde{\pi}_A(m_1, m) + (m - m_1)\tilde{q}_B(m_1, m) + \tilde{\pi}_B(m_1, m); \]
and, because
\[ (\bar{w}_1 - m)s = -(\tilde{\pi}_B(m, m) - \tilde{\pi}_B(m_1, m)), \]
the combined profit in $t_1$ and $t_2$ for $I$ without disintegration is
\[ \bar{R}_I^* = \tilde{\pi}_A(m_1, m) + (m - m_1)\tilde{q}_B(m_1, m) + \tilde{\pi}_B(m_1, m) - \tilde{\pi}_B(m, m). \] (1)

To interpret $\bar{R}_I^*$, we may consider $I$ as a market leader in $t_2$, since it has a potential cost advantage in the upstream production. Due to its leadership position, $I$ is able to extract the full industry profits in $t_2$ net of the “outside-option” profit of $B$ when the latter purchases input in $t_1$ from the competitive fringe ($\tilde{\pi}_B(m, m)$). The upstream division of the integrated $I$, $U$, is able to fully internalize the consequences of its price in $t_1$ on the entire profits of the vertical structure.

3.2 With Disintegration

With disintegration, the equilibrium input price in period 2 will be $m$ for both $A$ and $B$. Thus $B$ is willing to purchase from $U$ at any price $w_1 \leq m$ in period 1. By assumption (A4), the equilibrium profit of $U$ in $t_2$ is then
\[ (m - m_1)(q_A(m, m) + q_B(m, m)). \]

Therefore, in equilibrium, the total industry profit in $t_2$ with disintegration is
\[ \pi_A(m, m) + \pi_B(m, m) + (m - m_1)(q_A(m, m) + q_B(m, m)), \]
and the combined profit in $t_1$ and $t_2$ for $I$ (including those of $U$ and $A$) is
\[ R_I^* = \pi_A(m, m) + (m - m_1)(q_A(m, m) + q_B(m, m)). \]
where we have already set $(m - m)s = 0$.

3.3 The Disintegration Decision

**Proposition 1:** In equilibrium, there is disintegration if and only if the total industry profit in period 2 is higher under disintegration than under integration; that is, if and only if
\[ \pi_A(m, m) + \pi_B(m, m) + (m - m_1)(q_A(m, m) + q_B(m, m)) > \tilde{\pi}_A(m_1, m) + \tilde{\pi}_B(m_1, m) + (m - m_1)\tilde{q}_B(m_1, m). \] (E1)
Proof. In equilibrium, I will choose vertical disintegration if and only if its two-period combined profits are higher under disintegration. Now,

\[ R^*_I - \tilde{R}^*_I = \pi_A(m, m) + (m - m_1)(q_A(m, m) + q_B(m, m)) \]
\[ - (\bar{\pi}_A(m_1, m) + (m - m_1)\bar{q}_B(m_1, m) - \bar{\pi}_B(m, m + \bar{\pi}_B(m_1, m)) \]
\[ = \pi_A(m, m) + \pi_B(m, m) + (m - m_1)(q_A(m, m) + q_B(m, m)) \]
\[ - (\bar{\pi}_A(m_1, m) + (m - m_1)\bar{q}_B(m_1, m) + \bar{\pi}_B(m_1, m)), \]

which is positive if and only if

\[ \pi_A(m, m) + \pi_B(m, m) + (m - m_1)(q_A(m, m) + q_B(m, m)) > \bar{\pi}_A(m_1, m) + (m - m_1)\bar{q}_B(m_1, m) + \bar{\pi}_B(m_1, m). \]

Proposition 1 has a rather simple explanation. By selling to B in \( t_1 \), U (and hence A) will gain a strategic advantage during \( t_2 \) when A competes with B. This makes B unwilling to purchase from U in \( t_1 \), unless U’s price is sufficiently lower than those of alternative suppliers. If the industry profit in \( t_2 \) is higher without I’s vertical disintegration, U will be able to compensate B’s reduced profit in \( t_2 \) by selling the input to it at a sufficiently low price in \( t_1 \), and thus no vertical disintegration will occur. On the other hand, if the industry profit in \( t_2 \) is higher with I’s vertical disintegration, I would choose disintegration instead of compensating B through a lower price in \( t_1 \).\(^{11}\)

In most oligopoly models, if \( m_1 \) is close to \( m \) (or scale economies are not too significant), we would expect that (E1) holds, because under vertical disintegration the downstream firms facing higher upstream prices tend to charge higher downstream prices, which tends to increase industry profits.

Notice that if B were willing to purchase s from U at \( w_1 = m \) in period 1, that is, if either there were no economies of scale or B did not behave strategically in input purchase, I would choose to disintegrate only when its own profit in \( t_2 \), not the industry profit, is higher under disintegration. Because I’s profit in \( t_2 \) without disintegration is \( \bar{\pi}_A(m_1, m) + (m - m_1)\bar{q}_B(m_1, m) \), and its profit in \( t_2 \) under disintegration is \( \pi_A(m, m) + (m - m_1)(q_A(m, m) + q_B(m, m)) \), we have

**Remark 1:** Assume

\[ \bar{\pi}_A(m_1, m) + (m - m_1)\bar{q}_B(m_1, m) \]
\[ \geq \pi_A(m, m) + (m - m_1)(q_A(m, m) + q_B(m, m)). \]  \( \text{(E2)} \)

\(^{11}\) We note that in the model here, because the industry profit in \( t_1 \) is a constant, comparing industry profits in \( t_2 \) would be the same as comparing combined industry profits in both \( t_1 \) and \( t_2 \).
Then there is no vertical disintegration if $B$ would purchase $s$ from $U$ at $w_1^* = m$.

Thus, if condition (E2) holds, vertical disintegration can occur only because of the presence of economies of scale and the strategic purchasing behavior of $D_2$.

In the next two examples, we show that under plausible conditions, both (E1) and (E2) can be satisfied when downstream producers are either Cournot or Bertrand competitors in period 2.

**Example 1:** In $t_2$, firms produce a homogeneous product downstream, where the market demand is $Q = 1 - p$. Assume also $c(l_1) = \frac{1}{2 + l_1}, \ s \in [\frac{1}{3}, 8], m = \frac{1}{2}, m_1 = c(s) \in [\frac{1}{10}, \frac{3}{7}]$.

Provided that the equilibrium is interior, we have:

\[ \tilde{q}_A(c_A, c_B) = \frac{1 - 2c_A + c_B}{3} = q_A(c_A, c_B), \]
\[ \tilde{q}_B(c_A, c_B) = \frac{1 - 2c_B + c_A}{3} = q_B(c_A, c_B); \]
\[ \tilde{\pi}_A(c_A, c_B) = \left( \frac{1 - 2c_A + c_B}{3} \right)^2, \]
\[ \tilde{\pi}_B(c_A, c_B) = \left( \frac{1 - 2c_B + c_A}{3} \right)^2; \]
\[ \pi_A(c_A, c_B) = \left( \frac{1 - 2c_A + c_B}{3} \right)^2 = \tilde{\pi}_A(c_A, c_B), \]
\[ \pi_B(c_A, c_B) = \left( \frac{1 - 2c_B + c_A}{3} \right)^2 = \tilde{\pi}_B(c_A, c_B). \]

All of our assumptions are satisfied. Furthermore,

\[ \pi_A(m, m) + \pi_B(m, m) + (m - m_1)(q_A(m, m) + q_B(m, m)) \]
\[ - (\tilde{\pi}_A(m_1, m) + (m - m_1)\tilde{q}_B(m_1, m) + \tilde{\pi}_B(m_1, m)) \]
\[ = \frac{1}{9}(1 + 2m_1 - 3m)(m - m_1) > 0 \text{ if and only if } m < \frac{1 + 2m_1}{3}. \]

Therefore, there is vertical disintegration if and only if $3m < 1 + 2m_1$, which holds if $\frac{1}{4} < m_1 < \frac{1}{2}$, or if $s \in [\frac{1}{3}, 2)$. For $s \in [2, 8], m_1 \leq \frac{1}{4}$ and there will be no vertical disintegration. We also note that (E2) holds in this example for all $m_1$. In fact, one can verify that under general demand conditions and for Cournot competition, (E1) holds if $m_1$ is close to $m$ and (E2) always holds.
**Example 2:** In $t_2$, $A$ and $B$ produce differentiated products, where their respective demand functions are

$$q_A = 1 - 2p_1 + p_2, \quad \text{and} \quad q_B = 1 - 2p_2 + p_1.$$  

Again, assume $c(l_1) = \frac{1}{2 + l_1}, s \in [\frac{1}{3}, 8], m = \frac{1}{2}, m_1 = c(s) \in [\frac{1}{10}, \frac{3}{7})$.

Provided that the equilibrium is interior, $c_A \leq c_B \leq m$, and $B$ purchases input from $U$ at price $c_B$ when $U$ produces the input at cost $c_A$, the equilibrium outputs and profits in $t_2$ for $A$ and $B$ are:

$$\bar{q}_A(c_A, c_B) = \frac{1}{15}(10 - 3c_B - 7c_A), \quad \bar{q}_B(c_A, c_B) = \frac{2}{15}(5 - 6c_B + c_A);$$

$$\bar{\pi}_A(c_A, c_B) = \frac{1}{225}(10 - 3c_B - 7c_A)(6c_B + 5 - 11c_A),$$

$$\bar{\pi}_B(c_A, c_B) = \frac{2}{225}(5 - 6c_B + c_A)^2.$$  

On the other hand, if $I$ is disintegrated, the equilibrium outputs and profits for $A$ and $B$, given their marginal costs as $c_A$ and $c_B$, will be

$$q_A(c_A, c_B) = \frac{2}{15}(5 - 7c_A + 2c_B),$$

$$q_B(c_A, c_B) = \frac{2}{15}(5 + 2c_A - 7c_B);$$

$$\pi_A(c_A, c_B) = \frac{2}{225}(5 - 7c_A + 2c_B)^2,$$

$$\pi_B(c_A, c_B) = \frac{2}{225}(5 + 2c_A - 7c_B)^2.$$  

We note that $3c_A + 10 - 13c_B > 0$ in order for the equilibria to be interior, and thus

$$\bar{\pi}_B(c_A, c_B) - \pi_B(c_A, c_B) = \begin{cases} \frac{2}{225}(c_B - c_A)(3c_A + 10 - 13c_B) > 0 & \text{if } c_B > c_A \\ 0 & \text{if } c_B = c_A. \end{cases}$$

All of our assumptions are satisfied. We have:

$$\pi_A(m, m) + \pi_B(m, m) + (m - m_1)(q_A(m, m) + q_B(m, m))$$

$$- (\bar{\pi}_A(m_1, m) + (m - m_1)\bar{q}_B(m_1, m) + \bar{\pi}_B(m_1, m))$$

$$= \frac{1}{225}(25 + 49m_1 - 74m)(m - m_1) > 0 \text{ if and only if } m < \frac{49}{74}m_1 + \frac{25}{74}.$$  

12. We notice that here $\bar{\pi}_i(c_A, c_B) \neq \pi_i(c_A, c_B)$ if $c_A \neq c_B$. 


Therefore, there is vertical disintegration if and only if $m < \frac{49}{74}m_1 + \frac{25}{74}$, which holds if $\frac{12}{49} < m_1 < \frac{1}{2}$, or if $s \in \left[\frac{1}{3}, \frac{25}{12}\right)$. For $s \in \left[\frac{25}{12}, 8\right)$, $m_1 \leq \frac{12}{49}$ and there will be no vertical disintegration. We also have

$$\tilde{\pi}_A(m_1, m) + (m - m_1)\tilde{q}_B(m_1, m)$$

$$- [\pi_A(m, m) + (m - m_1)(q_A(m, m) + q_B(m, m))]=$$

$$= \frac{1}{225}(52m - 5 - 47m_1)(m - m_1),$$

which is non-negative if $52m - 5 - 47m_1 \geq 0$, or, because $m = \frac{1}{2}$ by assumption, if $m_1 \leq \frac{21}{47}$. Thus, both (E1) and (E2) are satisfied if $m_1 \in \left(\frac{12}{49}, \frac{21}{47}\right]$, or if $s \in \left[\frac{1}{3}, \frac{25}{12}\right)$.

Therefore, in both examples, there is equilibrium vertical disintegration if $m - m_1$ is not too large; and, when vertical disintegration does occur, it is often (but not always) due to the presence of both economies of scale and the strategic purchasing behavior of downstream rivals (i.e., both (E1) and (E2) are satisfied).

We note that, as Example 1 suggests, our disintegration result does not necessarily depend on A’s and B’s actions being strategic complements. It is interesting to compare this with other results in the literature. In a model where two manufacturers simultaneously choose whether or not to vertically disintegrate their respective retail divisions, Moorthy (1988) has found that disintegration occurs only if the retailers’ actions are strategic complements, because a manufacturer’s disintegration tends to increase its own retail price, which can increase the other firm’s retail price and thus makes disintegration potentially profitable only if the prices are strategic complements. In our model, strategic complementarity is not required for disintegration, because the equilibrium vertical structure is not determined by how a single firm’s profit may change in $t2$ (as in Moorthy), but rather by how the industry profit may change in $t2$. When A and B are Cournot competitors and their actions are not strategic complements, vertical disintegration does not raise A’s equilibrium profit, but it can raise industry profit and thus B’s profit; and when this happens a smaller compensation for B is needed in $t1$ for it to be willing to purchase from $U$, and thus I’s total profits in two periods can be higher under disintegration.

We also note that the higher industry profits under equilibrium vertical disintegration are achieved by higher industry prices. Thus, here the private choice of vertical disintegration reduces social surplus. This raises interesting questions about public policies towards firms’ vertical organization choices. In the United States and many other
countries, there is an important asymmetry in the antitrust treatment of vertical integration and vertical disintegration, where the former, but not the latter, is often scrutinized for possible anticompetitive effects. Our analysis suggests that such asymmetric treatment may not be justified from economic theory.13

4. Discussion

For convenience and transparency, we have constructed a highly stylized model to make our basic point. We now discuss some alternative modeling possibilities to gain insight about the robustness of our result. We consider in turn the following: alternative formulations of scale economies; alternative assumptions on internal transfer prices within a vertically integrated firm; the possibility of A’s having multiple competitors in the downstream market; and the use of vertical contracts instead of spot transactions in the input market.14

4.1 The Nature of Scale Economies

We have in our model assumed that the scale economies are of a dynamic nature—they arise due to learning by doing. Alternatively, we may consider a one-period model where U has a unique access to a specialized technology that enables it to produce quantity q at the following cost function:

\[
C(q) = \begin{cases} 
mq & \text{if } q < \bar{q} \\
(m - m_1)\bar{q} + m_1q & \text{if } q \geq \bar{q},
\end{cases}
\]

where \(0 \leq m_1 < m\). Under this formulation, U’s average cost declines beyond a certain output level, \(\bar{q}\).

To modify the other aspects of the model, suppose that after I decides whether or not to disintegrate U and A, U announces its price for any independent downstream firm who also has the option to purchase from the competitive fringe at price \(m\). B may or may not be able to commit to a supplier, before A and B simultaneously choose their strategies in the downstream market.

13. We need to be cautious, however, not to jump into the conclusion that there should necessarily be antitrust regulations concerning vertical disintegration. There are many other economic activities for which the private and social incentives differ; and government intervention is not always called for.

14. Even if our results are robust with respect to these variations—and to a certain extent indeed they will be—we must be aware that the robustness of our results is still limited, because there are other possible variations to our model that we have not considered. However, it seems that the issues discussed below would be most relevant and most of concern in the context of our model.
It can be shown in this setting that if $B$ is able to commit to a supplier before downstream strategies are chosen, then when $\bar{q}$ is neither too small nor too large, which implies that $U$’s marginal cost can be lower than $m$ only if it supplies both $A$ and $B$, $I$ will choose to disintegrate if and only if the joint industry profits are higher under disintegration, and disintegration can again occur under either Cournot or Bertrand competition. However, if such commitment is not possible, then disintegration tends not to occur. This is because without committing to a supplier, it would be optimal for $B$ to purchase from any supplier with the lowest price, once downstream prices or outputs are chosen, and hence $I$ will be able to realize the economies of scale by supplying $B$ without vertical disintegration. Thus, the nature of economies of scale, namely whether they occur in a dynamic or a statical setting, may or may not affect our result, depending on whether commitment to a supplier can be made before downstream actions are taken.

The advantage of formulating our basic model in a two-period setting, in which scale economies arise from learning by doing, is that the realization of cost advantages of the vertically integrated firm depends on the purchase of its downstream rival in a natural way, independent of whether a downstream firm can commit to a supplier before downstream competition takes place. But there are also disadvantages with this approach. The assumption that $B$ is the only firm purchasing on the input market in $t1$ appears to be somewhat artificial. It is possible to extend the model to allow $A$ to produce in $t1$ and thus also to demand input from the upstream market in $t1$; but the calculations would be much more complicated and, as long as $B$’s purchase in $t1$ would still allow $U$ to (further) exploit economies of scale and reduce costs in $t2$, the basic insight would not be much different. Furthermore, the assumption that there are only two periods is also motivated by making the model tractable. Similar strategic considerations would be present if there is learning-by-doing over many periods.

15. On the other hand, as we shall discuss later, in our original model the insight of our analysis will not change if commitment to a supplier can be made before downstream actions are taken.

16. The commitment may be made through some exclusive contracts, or, if relationship-specific investment to a supplier is needed, through such an investment. The importance of commitment in determining whether vertical disintegration will occur has also been pointed out by Coughlan and Wernerfelt (1989), although the mechanism through which commitment affects vertical structure in their model is very different.

17. Such on-going strategic considerations may prevent either $A$ or $B$ from attempting to vertically integrating backward after $U$ has been initially sold off, if our model is further extended to allow the possibility of such integration. Of course, legal costs due to antitrust concerns or other transaction costs may also prevent such integration.
4.2 Alternative Internal Transfer Prices

We have taken the view that different divisions of an integrated firm will act to maximize their joint profits and an upstream division cannot commit to any internal transfer price for its downstream division that is not ex post efficient. As a result, in t2 the internal transfer price between U and A would be set at marginal cost while U will change the independent firm B a higher price when possible. If U were to treat A the same as an independent firm and always charge the same price to A and B, the lowered marginal cost of U would not confer a cost advantage to A in its competition with B. There would then be no incentive for B not to purchase from U at t1 if U’s price is not higher than m. However, it is doubtful that the upstream and downstream divisions in an integrated firm can truly treat each other as independent firms. The fact that they belong to the same firm means that a division may have to act according to the joint interests of the firm. This is certainly the perception by rival firms in some situations. In the case of AT&T’s divesture of its equipment division (Network Systems), Dave Dorman, president of Pacific Bell, commented: “It’s difficult for (the CEO of Network Systems) to convince me that he has my best interests at heart when his name is AT&T” (Kirkpatrick, 1995).

The basic insight of our analysis, however, need not necessarily depend on the assumption that the internal transfer price within the vertically integrated firm is set at the true marginal cost. If public commitment on the internal transfer price can be made, then it may be optimal for the integrated firm to set this transfer price above the true marginal cost, as is shown in Pepall and Norman (2001). But as long as the internal transfer price within the integrated firm in period 2 is lower than m when U’s true marginal cost is \( m_1 < m \), firm B (who will pay m for the intermediate good) will have incentive not to purchase from the vertically integrated U in period 1 that will lead to U’s cost advantage in period 2. To sell to B in period 1, U will therefore have to charge a price sufficiently lower than m (the price from the competitive fringe). Thus, our result concerning equilibrium vertical disintegration (Proposition 1) can continue to hold.

4.3 Multiple Downstream Competitors

In our model, A has only one downstream rival, B. We can relax this assumption and allow multiple downstream competitors. To be concrete, suppose that there is another independent downstream firm, C, that would also need certain amount of the input in t1 and would compete in t2 with A and B. In this case, both B and C would be concerned about how their purchases in t1 from U affect the competition in t2, and
would thus be reluctant to purchase from the vertically integrated $U$ in $t_1$ unless $U$’s price is sufficiently lower than $m$. There is, however, a complication that does not arise when $B$ is the only other downstream firm. For $B$ and $C$, not purchasing from the integrated firm is like a public good—it benefits the other competitor. Interestingly, our basic results are not changed by this modification of the model.

To be specific, suppose that $C$ also needs $s$ amount of the intermediate good in $t_1$ and $c(2s) \equiv m_2 < m_1 < m$. Again let $w_1^I$ be the input price $U$ offers to $B$ and $C$ in $t_1$ when $I$ is vertically integrated.

It should be clear that, same as in our original model, we must have $w_1^I < m$ here in any equilibrium. This is because the purchase of any competitor ($B$ or $C$) from the vertically integrated $U$ in $t_1$ lowers $U$’s downstream marginal cost in $t_2$, which increases $I$’s downstream division $A$’s profit but reduces $B$ and $C$’s profits in $t_2$. Thus, unless $w_1^I < m$, neither of the competitors will purchase from $U$ in $t_1$. If the industry profit in $t_2$ is higher under vertical integration, again $U$ will be able to compensate $B$ and $C$ through a lower input price $w_1^I$ in $t_1$ and no vertical disintegration will occur. On the other hand, if the industry profit in $t_2$ is higher under vertical separation, it would be optimal for $I$ to vertically disintegrate. Thus, multiple downstream competitors will also behave strategically in purchasing inputs, and Proposition 1 can continue to hold.\(^{18}\)

### 4.4 Allowing Vertical Contracts

To separate out results from any possible effects of vertical contracting, we have considered only spot transactions in the upstream market. It is possible, however, to generalize our insight to situations where vertical contracts can be used. We consider two such possibilities.

First, suppose that requirement contracts are available. That is, an upstream supplier can enter into a contract with a downstream firm that requires the latter to purchase all inputs from the former at a certain price. This has no effect on the analysis of first period decisions, but may change the equilibrium profits of both $A$ and $B$ in period 2 under the vertical integration of $U$ and $A$, when $U$’s (and hence $A$’s) marginal cost is $m_1 < m.\(^{19}\)$ Nevertheless, this will not change Proposition 1, and it continues to be true that vertical disintegration can occur when the second-period downstream competition is either

---

\(^{18}\) It is easy to see that our argument extends also to situations where $A$ has more than two downstream competitors.

\(^{19}\) When $B$ can commit to a supplier before downstream competition takes place and if $m_1 < m$, the vertically integrated $U$ may be able to sell to $B$ at an input price above the competitive level, $m$. See details in Chen (2001).
in Cournot or in Bertrand fashion. In fact, as we discussed in Section 4.1, when requirement contracts can be used, our basic argument can be made in a simpler one-period model where economies of scale are in the static form.

Second, suppose that two-part tariff contracts, \((w, T)\), can be used by a supplier, where \(w\) is the unit price and \(T\) is a fixed fee. This again has no effect on the analysis of first period decisions, although it may affect the second period outcome. It appears that vertical disintegration will again occur if it results in higher joint industry profits, but this is not surprising, because Bonanno and Vickers (1988) have already shown that equilibrium vertical separation could occur when two-part tariff contracts can be used. Notice, however, that the motivation for vertical separation in Bonanno and Vickers is rather different from the motivation here. In their model, vertical separation with transfer payments allows rival downstream firms to soften price competition, while in our model vertical disintegration occurs due to the strategic purchase behavior of the stand-alone downstream firm, and no transfer payment is needed.

5. Conclusion

This paper has offered an equilibrium theory of vertical disintegration. With economies of scale in the upstream production, an integrated firm can lower its cost by supplying to a downstream competitor. The competitor may in turn strategically choose not to purchase from the integrated firm, unless the latter’s price for the intermediate good is sufficiently lower than those from alternative sources. Vertical disintegration commits a downstream firm not to gain a strategic advantage from the potential lower cost of its upstream division at the expense of its rivals. It thus enables the upstream producer to supply downstream firms at a competitive price and to realize economies of scale. In equilibrium, vertical disintegration occurs if and only if it results in an industry profit that is higher than the industry profit under integration.

We should emphasize that a firm’s decision to vertically disintegrate is motivated by the presence of both economies of scale in its upstream production and the strategic purchasing behavior of its downstream competitors, in combination with the fact that the integrated upstream producer cannot commit not to give its downstream producer an advantage. Without the strategic purchasing behavior of the downstream competitors, there would be no need for a firm to vertically disintegrate in order to exploit economies of scale in its upstream production; and in the absence of economies of scale, or if the integrated upstream producer commits not to give its downstream
producer an advantage, the downstream competitors would have no incentive to behave strategically in choosing input suppliers. Our theory thus has two immediate implications. First, it clarifies the missing link in Stigler’s original argument of why firms vertically disintegrate, and suggests that the reason a separate upstream firm is needed in order to exploit economies of scale is the downstream firms’ strategic behavior in the input market. Second, it explains the economic rationale underlying some recent cases of vertical disintegration that may appear puzzling. Unlike in consumer markets, the identity of a supplier may matter to a buyer in the intermediate-good market, and a downstream firm may strategically “boycott” a supplier who is also a downstream rival. When the upstream producer’s cost is endogenous due to economies of scale, such a strategy can indeed be optimal.\(^{20}\)

More generally, our analysis suggests that, in addition to the factors internal to a transaction that has been the focus of the transaction-cost based approach, the forces external to a transaction—the forces of competition, can play a key role in determining the vertical boundary of a firm. A complete theory of the firm needs to incorporate considerations of both transaction costs and the constraints imposed by market competition.

**References**


\(^{20}\) The basic idea here has applications beyond the specific setting of this paper, as Preston McAfee pointed out in his lectures on “Vertical Integrations: Firm Strategies,” Federal Communication Commission, May 19–20, 2003. The independent firm may be reluctant to purchase input from a vertically integrated firm as long as there is some form of “lock-in” that would make the independent firm vulnerable in future competition. This effect can cause the integrated firm to spin off its upstream division.