THE MAKE-OR-BUY DECISION IN THE PRESENCE OF A RIVAL:
STRATEGIC OUTSOURCING TO A COMMON SUPPLIER

Anil Arya
The Ohio State University

Brian Mittendorf
Yale School of Management

David E. M. Sappington
University of Florida

August 2007
The Make-or-Buy Decision in the Presence of a Rival:
Strategic Outsourcing to a Common Supplier

Abstract

Firms routinely decide whether to make essential inputs themselves or buy the inputs from independent suppliers. Conventional wisdom suggests that a firm will not buy an input for a price above its in-house cost of production. We show that this is not necessarily the case when a monopolistic input supplier also serves the firm's retail rival. In this case, the decision to buy the input (and thus become one of the supplier's customers) can limit the incentive the supplier would otherwise have to provide the input on particularly favorable terms to the retail rival. Thus, a retail competitor may pay a premium to outsource production to a common supplier in order to raise its rivals' costs.

Keywords: Competition; Make-or-Buy; Outsourcing.
1. Introduction

Firms commonly confront the choice of making critical inputs themselves or buying the inputs from independent suppliers. Conventional wisdom suggests that the sourcing decision may simply be a matter of comparing internal production costs with the prices charged by external suppliers, and choosing the least costly alternative. However, the make-or-buy choice can be far more complex in practice. The literature has noted, for example, that sourcing decisions can be influenced by fears of supplier hold-up, concerns about leakage of proprietary information, the need to ensure timely and reliable supply of high-quality inputs, and prospective gains from cultivating long-term alliances with suppliers.

We focus on the strategic competitive considerations that can influence sourcing decisions, demonstrating that these considerations alone can reverse the conventional wisdom. We show that a rival’s reliance on a supplier may prompt a firm to outsource to the same supplier rather than produce inputs internally even when the outsourcing is more costly than internal production. This preference for outsourcing to a common supplier arises because it can reduce the supplier’s vested interest in the firm’s competitor, and thereby induce the supplier to deliver the input to the rival on less favorable terms.

We analyze a setting in which an incumbent firm can either make an essential input itself or buy the input from a monopoly supplier. The supplier also sells the input to the firm’s upstart retail rival. If the incumbent retailer makes the input itself in this setting, its rival becomes the supplier’s only customer, leaving the supplier with a strong interest in the rival’s success in the retail market. To encourage such success (and thereby increase the rival’s demand for the input), the supplier will provide the input to the rival on particularly favorable terms. In contrast, if the incumbent retailer decides to buy the input, the supplier will serve both the incumbent and its rival, and therefore be less inclined to favor the rival. We demonstrate that this strategic benefit from purchasing an input from a common external supplier can induce a firm to outsource production of the essential input even when the supplier’s quoted price exceeds the firm’s cost of in-house production.

We also show that despite a divergence between the price and the cost of the input, industry
production patterns generally are efficient, as the least-cost producer of the input generally supplies the input in equilibrium. In addition, we demonstrate that an incumbent retailer’s make-or-buy decision can influence the entry decisions of potential competitors. In particular, the prospect of higher input prices induced by an incumbent retailer’s decision to buy an essential input can deter potential entrants from entering the industry.

These primary conclusions are initially developed in a setting where the incumbent must outsource either all or none of its input needs and where the entrant must buy the input from the monopoly supplier. The conclusions are then shown to hold in other circumstances, including those in which: (i) the incumbent can choose to make a portion of its inputs and outsource the remainder; (ii) the entrant can make the input if it chooses to do so; and (iii) the entrant can buy the input from either the supplier or the incumbent retailer.

To emphasize the strategic competitive considerations in our analysis, we intentionally abstract from other potential determinants of make-or-buy decisions that have received considerable attention in the literature. In particular, the extant literature has examined the long-term dynamics of supplier/buyer interactions (Demski 1997) and the possibility of learning-by-doing (Anderson and Parker 2002; Chen 2005). The literature has also stressed practical difficulties associated with ensuring desired levels of input quality and concerns about revealing proprietary information in outsourcing arrangements (Demski and Sappington 1993; Chen et al. 2006). Furthermore, existing studies have noted that technology spillovers can advantage rivals under outsourcing (Van Long 2005), cost structures can promote reciprocal outsourcing (Spiegel 1993), and outsourcing to a common supplier can avoid redundant fixed costs (Shy and Stenbacka 2003).

Earlier work on strategic outsourcing focuses on settings where the input supply is not perfectly elastic. To illustrate, Salop and Scheffman (1983, 1987) consider a setting where retail producers face an upward-sloping supply curve for the input. This upward-sloping curve may reflect the rising marginal costs of competitive suppliers, for example. In this setting, increased demand for the input increases the market price for the input by increasing the marginal cost of producing the input. The higher input price can increase the costs of rival retail producers and thereby benefit the
retail producer that chooses to buy more than the cost-minimizing amount of the input. In a model with Cournot competition both upstream and downstream, Schrader and Martin (1998) demonstrate the value of excessive outsourcing in order to reduce the market supply of a vital input that is available to rival downstream producers, and thereby hinder the rivals’ retail operations.\(^1\) Buehler and Haucap (2006) show that outsourcing that increases production costs can be mutually profitable for downstream producers when the higher production costs allow them to commit to less intense market competition.

Our analysis complements these earlier works by considering strategic outsourcing in a setting where the input supplier has monopolistic pricing power and produces with constant returns to scale. With a constant cost technology, if the input supplier had no market power and so was a price-taker, the sourcing decision of a retail producer would not affect its rival’s input price. In contrast, when the input supplier has market power, a retail firm’s decision to produce the input itself can cause the supplier to “play favorites” by reducing the input price it charges to its only customer, the retail rival. To preclude such rational favoritism by the monopoly supplier, a retail producer may be willing to buy the input from the common supplier, even at a price that exceeds the retailer’s marginal cost of producing the input.

The setting we examine might arise, for example, when local retailers enjoy some pricing power but are beholden to a large national supplier of a key product. One might think that the retailers in such a setting would be anxious to reduce their dependence on the dominant supplier by developing an alternate input supply. However, we demonstrate that this may not be the case, since reduced dependence on the dominant supplier can induce the supplier to offer the input to the retail rival on more favorable terms.

The analysis proceeds as follows. Section 2 describes the key elements of our base model. Section 3 identifies the nature and the magnitude of the strategic competitive advantage that

\(^1\) In the extreme setting where a limited, fixed supply of a vital input is available, a downstream producer may engage in excessive outsourcing in order to prevent its rivals from obtaining any of the key input, thereby precluding them from downstream production (e.g., Salinger 1988).
outsourcing to a common supplier can provide in this setting. Section 4 examines the impact of make-or-buy decisions on industry entry. Section 5 introduces expanded sourcing options for the competing retailers. Section 6 provides a brief summary and suggests directions for future research.

2. The Base Setting

An incumbent retail operator (“firm 1”) must decide whether to make a key input itself or purchase the input from a monopoly supplier. If firm 1 makes the input, it does so at unit cost \( c \). The supplier produces the input at unit cost \( c_s \) and charges firm 1 the unit wholesale price \( w_1 \). Each unit of retail output requires exactly one unit of the input. Firm 1 makes its sourcing decision after learning the price at which it can purchase the input from the monopoly supplier.\(^2\)

Both firm 1 and the supplier recognize that firm 1 will ultimately face retail competition from an entrant in this base setting. The entrant (“firm 2”) always purchases the essential input from the monopoly supplier. This procurement pattern might arise, for example, if the entrant initially lacks the infrastructure required to make the input.\(^3\) Upon firm 2’s entry into the industry, the supplier specifies \( w_2 \), the unit price at which it will sell the input to firm 2. We allow \( w_2 \) to differ from \( w_1 \) because uniform pricing may not be the profit-maximizing strategy for the supplier when input prices for different firms are set at different points in time.

Firms 1 and 2 engage in Cournot competition. For expositional simplicity, the retail competitors are assumed to incur no costs other than input costs. Consumer demand for the homogeneous retail product is represented by a linear, downward-sloping (inverse) demand function

\[
p = a - q_1 - q_2, \quad \text{where } p \text{ is the price of the product, and } q_i \text{ is the quantity of the product}
\]

\(^2\) We assume that the firm’s make-or-buy decision cannot be subsequently reversed, reflecting the fact that long lead times often are required to implement major procurement policies. In keeping with our focus on the incumbent’s strategic outsourcing considerations, we also assume that the supplier can credibly commit not to change the input prices it announces publicly. Thus, we abstract from any incentives the supplier might have to: (i) hold up the incumbent after it has committed to buy the input; and (ii) disadvantage one of the retail competitors by secretly reducing the input price charged to the firm’s retail rival. Rey and Tirole (2007) discuss the incentives that input suppliers may have to offer secret price concessions and review the relevant literature.

\(^3\) Section 5 considers additional procurement possibilities for firm 2.
supplied by firm \( i \) \((i = 1, 2)\).\(^4\) The market price of the retail product is realized after the firms make their output decisions simultaneously and independently. Figure 1 summarizes the sequence of events in this base setting.

![Figure 1. Timing in the Base Setting.](image)

One might suspect that firm 1 would always adopt the least costly mode of operation and refuse to pay a price for the input that exceeds its in-house production cost. However, as the next section reveals, this intuition ignores the fact that firm 1’s sourcing decision can affect the price that the supplier subsequently charges firm 2 for the input.

### 3. Outcomes in the Base Setting

To analyze firm 1’s sourcing decision in the base setting, we first derive (in section 3.1) the outcomes that follow firm 1’s decision to make the input. Then we analyze (in section 3.2) the outcomes that follow firm 1’s decision to buy the input. We characterize the firm's make-or-buy decision in section 3.3. Subsequent sections consider variants of this base setting.

#### 3.1. The Make Regime

In the Cournot competition that follows its decision to make the input, firm 1 chooses its output \( q_1 \) to maximize its profit given its unit production cost and its rival’s output \( q_2 \).\(^5\) Formally, firm 1’s problem is:

\(\text{Formally},\)

\(...\)

\(\text{Formally},\)

---

\(^4\) The linear demand formulation facilitates succinct characterizations of equilibrium outcomes. We note, however, that the presumed demand structure can influence the qualitative nature of vertical interactions (Lee and Staelin 1997). Also, a restrictive implication of the linear demand formulation is that greater product differentiation can reduce channel profit (Choi 1991, 1996), though we focus on a setting with homogeneous retail products.

\(^5\) Backward induction is employed to characterize (subgame perfect) equilibrium outcomes throughout the ensuing analysis.
Maximize \( [a - q_1 - q_2] q_1 - c q_1 \). \hspace{1cm} (1)

Similarly, firm 2 chooses \( q_2 \) to maximize its profit given unit production cost \( w_2 \) (which is the unit price it pays to the supplier for the input) and rival output \( q_1 \). Formally, firm 2's problem is:

Maximize \( [a - q_1 - q_2] q_2 - w_2 q_2 \). \hspace{1cm} (2)

Solving (1) and (2) jointly yields equilibrium quantities as a function of the input price paid by firm 2. These quantities are \( q_1(w_2) = \frac{a - 2c + w_2}{3} \) and \( q_2(w_2) = \frac{a - 2w_2 + c}{3} \). Anticipating these retail outputs, the monopoly supplier sets the input price it will charge firm 2 so as to maximize its profit from selling the input to firm 2:

Maximize \( [w_2 - c_s] q_2(w_2) \) \( \Leftrightarrow \) Maximize \( [w_2 - c_s][a - 2w_2 + c]/3 \). \hspace{1cm} (3)

Performing the maximization in (3) yields the unit price at which the supplier will sell the input to firm 2 under the “make regime” (where firm 1 makes the input). This price is \( w_2^M = \frac{a + c + 2c_s}{4} \). Substituting this price into the expressions for quantities as a function of input prices yields equilibrium quantities \( q_1^M = \frac{5a - 7c + 2c_s}{12} \) and \( q_2^M = \frac{a + c - 2c_s}{6} \).\(^6\)

Substituting \( w_2^M \) and these equilibrium quantities into the expressions for profit in (1), (2), and (3) reveals that the profits of firm 1, firm 2, and the supplier in the make regime (denoted \( \Pi_1^M \), \( \Pi_2^M \), and \( \Pi_s^M \), respectively) are:

\[ \Pi_1^M = \frac{(5a - 7c + 2c_s)^2}{144}, \quad \Pi_2^M = \frac{(a + c - 2c_s)^2}{36}, \quad \text{and} \quad \Pi_s^M = \frac{(a + c - 2c_s)^2}{24}. \quad (4) \]

3.2. The Buy Regime

If firm 1 buys the input from the supplier, firm 1’s problem is as specified in (1) except \( w_i \) replaces \( c \) to reflect the fact that firm 1 pays input price \( w_i \) for each unit of the retail product it sells. Firm 2 continues to buy the input from the supplier in this “buy regime,” so firm 2's problem

\(^6\) We assume that \( a > \text{Maximum} \{ (7c - 2c_s)/5, 2c_s - c \} \) throughout the ensuing analysis. This assumption ensures that firms 1 and 2 both produce strictly positive output in the make regime in the base setting. The assumption also ensures that both firms serve some retail customers in the other settings that we analyze, except when firm 1’s sourcing decision deters firm 2’s entry into the industry. (See section 4.)
is as specified in (2). Performing the maximization in (1) and (2) jointly reveals that equilibrium quantities as a function of input prices in the buy regime are 

\[ q_1(w_1, w_2) = \frac{[a - 2w_1 + w_2]}{3} \]

and

\[ q_2(w_1, w_2) = \frac{[a - 2w_2 + w_1]}{3} \].

Anticipating these retail outputs, and given the input price charged to firm 1, the supplier sets \( w_2 \) to:

\[
\text{Maximize } w_2 \left( \frac{1}{3} [a - 2w_1 + w_2] + \frac{1}{3} [a - 2w_2 + w_1] \right).
\]

Performing the maximization in (5) reveals that the input price the supplier will charge firm 2 in the buy regime (as a function of \( w_1 \)) is

\[ w_2^B(w_1) = \frac{[a + c_s + 2w_1]}{4}. \]

This price is an increasing function of the price charged to firm 1 because firm 2 enjoys an increased competitive advantage as \( w_1 \) increases.\(^7\) This advantage allows the supplier to profitably increase the price it charges to firm 2 without diminishing too severely firm 2’s input purchases. Thus, from firm 1's viewpoint, a higher input price comes with the silver lining that it raises its rival’s cost.

Substituting \( w_2^B(w_1) \) into \( q_1(w_1, w_2) \) and \( q_2(w_1, w_2) \), and then substituting the identified equilibrium quantities into the relevant profit functions reveals that the profits of firm 1, firm 2, and the supplier in the buy regime for a given \( w_1 \) are, respectively:

\[
\begin{align*}
\Pi_1^B(w_1) &= \frac{[5a + c_s - 6w_1]^2}{144}, & \Pi_2^B(w_1) &= \frac{[a - c_s]^2}{36}, & \Pi_3^B(w_1) &= \frac{[a - c_s]^2}{24} + \frac{[w_1 - c_s][a - w_1]}{2}.
\end{align*}
\]

### 3.3. The Make-or-Buy Decision

Conventional wisdom suggests that firm 1 would never pay more to buy the input than its cost of making the input. However, as Lemma 1 reveals, this view fails to consider how firm 1’s sourcing decision affects the supplier’s interaction with firm 2.\(^8\)

**Lemma 1.** In the base setting, firm 1 will buy the input from the supplier if and only if

\[ w_1 \leq c + \frac{[c - c_s]}{6}. \]

---

\(^7\) Notice from \( q_1(w_2) \) and \( q_1(w_1, w_2) \) that as a firm’s unit cost of production increases, its equilibrium output decreases and the equilibrium output of its rival increases.

\(^8\) The proof of Lemma 1 and all other formal conclusions are provided in the appendix.
Lemma 1 indicates that when the supplier is the least-cost producer of the input (so $c_s < c$), firm 1 is willing to pay more than its internal cost of production to buy the input from the supplier. The premium firm 1 is willing to pay to buy the input reflects the advantage that firm 1 secures in its competition with firm 2 when firm 1 buys the input. The advantage arises because firm 1’s decision to buy the input induces the supplier to experience an opportunity cost of supplying the input to firm 2. This opportunity cost is the profit the supplier foregoes when firm 2’s retail success reduces firm 1’s retail output, and thus its demand for the input.\footnote{See Chen (2001) for related thoughts on the opportunity costs incurred by vertically-integrated suppliers.} This opportunity cost of selling the input to firm 2 induces the supplier to increase the price it charges firm 2 for the input. Formally, from the expressions derived in sections 3.1 and 3.2, the difference between the input price that firm 2 faces in the buy regime and in the make regime is $w_2^B(w_1) - w_2^M = [2w_1 - c - c_s]/4$. Therefore, if the supplier sells the input to firm 1 at cost, for example (so $w_1 = c$), firm 2’s input price in the buy regime will exceed its input price in the make regime by $[c - c_s]/4$. Because firm 1’s equilibrium profit increases as its rival’s cost increases, firm 1 is willing to pay a price above its own unit cost of production in order to buy the input from the (more efficient) supplier of the input.

In contrast, firm 1 is not even willing to pay $c$ to buy the input when the supplier’s cost exceeds firm 1’s cost (so $c_s > c$). In this case, if the supplier charges firm 1 $c$ (or less) in order to induce the firm to buy the input, the supplier suffers a loss on each unit that firm 1 buys. Consequently, the supplier finds it profitable to limit firm 1’s purchase of the input by reducing firm 1’s retail output, which is achieved by supplying the input to firm 2 at a lower price. This undesirable consequence of its decision to buy the input reduces firm 1’s incentive to do so. As a result, firm 1 will buy the input only if the supplier’s price is sufficiently far (i.e., $[c_s - c]/6$) below its own cost of production.

While firm 1 would be willing to pay $c + [c - c_s]/6$ for the input (from Lemma 1), a particularly efficient supplier might prefer to set a lower price in order to expand firm 1’s purchase
of the input. The expression for $\Pi_s^B(w_1)$ in (6) reveals that when firm 1 is committed to buying the input, the profit-maximizing input price for the supplier is $w_1 = (a + c_s)/2$. If this price is less than $c + [c - c_s]/6$ (as it will be when $c_s$ is sufficiently small relative to $c$, i.e., when $[3a + 4c_s]/7 \leq c$), the supplier will set this input price if it chooses to induce firm 1 to buy the input. If the supplier’s preferred input price exceeds the maximum price firm 1 is willing to pay for the input (as it will be when $[3a + 4c_s]/7 > c$), the supplier will set $w_1 = c + [c - c_s]/6$ when it chooses to induce firm 1 to buy the input.

It remains to determine precisely when the supplier will induce firm 1 to buy the input. The supplier will do so when the maximum profit it can achieve by inducing firm 1 to buy the input exceeds the maximum profit it can secure by selling the input only to firm 2. Proposition 1, which follows from (4), (6), and Lemma 1, identifies when this will be the case.

**PROPOSITION 1.** In the base setting, firm 1’s equilibrium make-or-buy decision and the input prices it faces are as follows:

(i) Firm 1 makes the input if $c \leq c_s$. Firm 1 buys the input if $c > c_s$.

(ii) If $c_s < c < [3a + 4c_s]/7$, firm 1 pays unit price $w_1 = c + [c - c_s]/6$.

(iii) If $c \geq [3a + 4c_s]/7$, firm 1 pays unit price $w_1 = (a + c_s)/2$.

Property (i) of Proposition 1 reveals that the producer with the lowest cost always makes the input in equilibrium. Thus, even though strategic considerations can cause procurement prices to diverge from cost, unregulated economic activity ensures that the input is produced at minimum cost in this base setting.

The qualitative conclusions reflected in Proposition 1 persist more generally. They persist, for example, if firms 1 and 2 produce differentiated retail products and/or if the firms engage in price competition rather than quantity competition.\(^{10}\) In all cases, the incumbent retail producer gains by buying an input (even at a premium) from a more efficient supplier that serves a retail

\(^{10}\) Details are available from the authors.
rival. By purchasing the input from the same supplier as its retail rival, the incumbent reduces the supplier’s vested interest in the rival’s success, and thereby limits the supplier’s favorable treatment of the rival.\footnote{Favorable treatment in our streamlined model takes the form of a reduction in input prices. More generally, a supplier could employ other means to enhance the success of its sole customer. For example, the supplier might pay a slotting allowance, offer generous terms for returned items, and/or grant exclusive access to new products.}

The incumbent’s preference for buying the input in our model arises because the outsourcing decision induces the supplier to subsequently increase the price it charges the entrant for the input. Thus, the fact that the supplier sets the input price for the entrant after it sets the corresponding price for the incumbent is an important feature of our model. This timing, which we have specified exogenously, is in fact the timing preferred by the supplier. To demonstrate this preference, recall that when $c_s < c$, the supplier can charge firm 1 a premium for the input if it waits to set firm 2’s input price until after firm 1 has chosen whether to make or buy the input. Firm 1 is only willing to pay a price above $c$ for the input if its decision to outsource induces the supplier to increase the input price that it charges to firm 2. If the supplier set $w_2$ before firm 1 made its sourcing decision, firm 1 would anticipate no strategic advantage from outsourcing, and so would never pay more than $c$ for the input. Thus, the supplier prefers to set $w_2$ after setting $w_1$, as presumed in the base setting.

**Proposition 2.** The supplier achieves greater profit when it sets $w_2$ after, rather than before, firm 1 has made its sourcing decision.

Proposition 2 confirms that the presumed sequence of events in Figure 1 will arise when the supplier can determine when to set the input prices charged to the incumbent and the entrant.

### 3.4. The Option to Make and Buy

The analysis to this point has assumed that firm 1 must outsource either all or none of its input needs. Now suppose that firm 1 can choose to make a fraction ($m \in [0,1]$) of its input needs
internally and outsource the remaining fraction \((1 - m)\). In this setting, given input prices and rival output levels, firms 1 and 2 will choose their outputs to maximize the expressions in (7) and (8), respectively:

\[
\text{Maximize } \left[a - q_1 - q_2\right] q_1 - w_1 \left[1 - m\right] q_1 - cmq_1. \tag{7}
\]

\[
\text{Maximize } \left[a - q_1 - q_2\right] q_2 - w_2 q_2. \tag{8}
\]

The solutions to these problems yield \(q_1(m, w_2) = \left[a - 2cm - 2w_1(1 - m) + w_2\right]/3\) and \(q_2(m, w_2) = \left[a - 2w_2 + w_1(1 - m) + cm\right]/3\). Given these equilibrium quantity functions, the supplier will choose \(w_2\) to maximize:

\[
\text{Maximize } \left[w_1 - c_s\right]\left[1 - m\right] q_1(m, w_2) + \left[w_2 - c_s\right] q_2(m, w_2). \tag{9}
\]

The solution to this problem is readily shown to be \(w_2(m) = \{a + c_s[m + 1] + 2w_1[1 - m] + cm\}/4\). Anticipating the impact of its sourcing decision on firm 2’s input price, firm 1 chooses the extent of its outsourcing to:

\[
\text{Maximize } \left[a - q_1(m, w_2(m)) - q_2(m, w_2(m))\right] q_1(m, w_2(m)) - [w_1(1 - m) + cm] q_1(m, w_2(m))
\]

subject to: \(0 \leq m \leq 1\). \tag{10}

As Proposition 3 reports, the solution to this maximization problem entails firm 1 making either all or none of its input needs. Furthermore, firm 1’s sourcing decision is influenced by \(w_1\) precisely as specified in Lemma 1. Therefore, the key conclusion in the base setting extends to settings where the incumbent can outsource a fraction of its input needs.

Proposition 3 also reports that firm 1 might choose to make only a fraction of its input needs in the presence of nonlinear cost structures. For example, suppose firm 1’s marginal cost of producing the input internally increases with the extent of its internal production. In particular, suppose firm 1’s unit cost of producing the input is \(c(m) = cm^\gamma\), where \(\gamma \geq 0\). \(^{13}\) In this setting,

\(^{12}\) Notice that this input price for firm 2 varies with \(m\), so firm 1’s outsourcing decision affects firm 2’s input costs.

\(^{13}\) The equilibrium output of both firms will be strictly positive for all \(\gamma\) in this setting if \(a > \text{Maximum } \{[7c - 2c_s]/5, 2c_s\}\).
firm 1 often will rely on both internal and external input supply to avoid unduly high production costs. Furthermore, as Proposition 3 reports, firm 1 generally will outsource more than the cost-minimizing fraction of the inputs it needs so as to induce the supplier to charge firm 2 a higher price for inputs. Proposition 3 refers to \( m^* \), the fraction of its inputs that firm 1 will make in equilibrium, and \( m^{**} \), the corresponding fraction of inputs that minimize firm 1’s operating costs.

**Proposition 3.** In the setting where partial outsourcing (\( m \in [0,1] \)) is feasible, firm 1’s sourcing decisions for all \( w_i \geq c_s \) are as follows.

(i) If \( \gamma = 0 \):
\[
m^* = 1 \quad \text{if} \quad w_i > c + \frac{[c - c_s]}{6} \quad ; \quad m^* = 0 \quad \text{otherwise}.
\]
Also, \( m^{**} = 1 \) if \( w_i > c \); \( m^{**} = 0 \) otherwise.

(ii) If \( \gamma > 0 \):
\[
m^* = 1 \quad \text{if} \quad w_i > \gamma + 1 + \frac{[\gamma + 1]c - \gamma c}{6} \quad ; \quad m^* = \left[ \frac{c_s + 6 w_i}{7(\gamma + 1)c} \right]^{\frac{1}{\gamma}} \quad \text{otherwise}.
\]
Also, \( m^{**} = 1 \) if \( w_i > [\gamma + 1]c \); \( m^{**} = \left[ \frac{w_i}{(\gamma + 1)c} \right]^{\frac{1}{\gamma}} \) otherwise.

(iii) \( m^* \leq m^{**} \) for all \( \gamma \geq 0 \).

Property (iii) of Proposition 3 confirms that even when firm 1 outsources only a fraction of its input needs, it will often outsource more (and it will never outsource less) than the cost-minimizing fraction. The extensive outsourcing limits the supplier’s incentive to provide the input to firm 2 on particularly favorable terms, and therefore increases firm 1’s profit by raising its rival’s costs. Thus, the key qualitative conclusion derived in the base setting persists in the more general setting where firm 1 can choose to rely on the supplier for only a fraction of its input requirements.

4. The Make-or-Buy Decision and Entry Deterrence

The analysis to this point has assumed that firm 2 always enters the industry. To examine the impact that firm 1’s make-or-buy decision can have on entry, suppose that firm 2 must incur a fixed
entry cost $I \geq 0$ if it wishes to enter the industry after observing firm 1's sourcing decision.\footnote{The base setting can be viewed as a special case of the entry setting in which $I = 0$.}

If firm 1 decides to make the input in this “entry setting”, firm 2 will enter the industry if and only if the variable profit it secures in the make regime ($\Pi^M_2$, as defined in (4)) exceeds its entry cost ($I$). In contrast, if firm 1 chooses to buy the input, firm 2 will enter the industry if and only if the variable profit it secures in the buy regime ($\Pi^B_2$, as defined in (6)) exceeds $I$.\footnote{Notice from (6) that $\Pi^B_2(\cdot)$ is independent of $w_1$, i.e., firm 2’s profit in the buy regime does not vary with firm 1’s input price. Therefore, $\Pi^B_2(w_1)$ is written simply as $\Pi^B_2$.}

Therefore, if firm 2’s entry costs are sufficiently low or sufficiently high, firm 1’s procurement decision will not affect firm 2’s entry decision. In particular, if $\Pi^M_2$ and $\Pi^B_2$ both exceed $I$, firm 2 will always enter the industry. In contrast, if $\Pi^M_2$ and $\Pi^B_2$ are both less than $I$, firm 2 will never enter the industry. For intermediate values of $I$, firm 1’s sourcing decision will affect firm 2’s entry decision, as Lemma 2 reports.

**Lemma 2.** In the entry setting:

(i) If $c > c_s$ and $I \in (\Pi^B_2, \Pi^M_2]$, firm 2 enters the industry if and only if firm 1 makes the input.

(ii) If $c < c_s$ and $I \in (\Pi^M_2, \Pi^B_2]$, firm 2 enters the industry if and only if firm 1 buys the input.

Property (i) of Lemma 2 reflects the fact that when the supplier is the least-cost producer of the input, the supplier faces an opportunity cost of selling the input to firm 2 in the buy regime. This opportunity cost reflects the profit the supplier foregoes when firm 2’s retail success reduces firm 1’s retail output, and thus firm 1’s purchase of the input. The opportunity cost causes the supplier to raise the price it charges firm 2 for the input, which reduces firm 2’s profit in the buy regime below the profit it secures in the make regime (i.e., $\Pi^B_2 < \Pi^M_2$). If firm 2’s entry cost is above $\Pi^B_2$ but below $\Pi^M_2$, firm 2 will enter the industry if and only if firm 1 makes the input.

Property (ii) of Lemma 2 reflects the fact that when the incumbent retailer is the least-cost
producer of the input, the supplier can only induce firm 1 to buy the input at a price below $c$. The supplier will charge firm 2 a relatively low price for the input in the buy regime in order to promote firm 2’s retail success and thereby reduce firm 1’s (non-remunerative) purchase of the input. Thus, firm 2 secures greater profit in the buy regime than in the make regime (i.e., $\Pi_2^B > \Pi_2^M$) when $c < c_s$. Consequently, if firm 2’s entry cost is intermediate between $\Pi_2^M$ and $\Pi_2^B$, firm 2 will enter the industry if and only if firm 1 buys the input.

To assess the equilibrium outcome in the entry setting, it is necessary to compare the supplier’s profit when entry is deterred and when entry is induced. When firm 2 does not enter the industry, firm 1 is the monopoly provider of the retail product, and it produces output $[a - c]/2$ in the make regime and $[a - w_i]/2$ when it faces input price $w_i$ in the buy regime. It is readily verified that firm 1’s profit in the make regime ($\hat{\Pi}_1^M$) and in the buy regime given input price $w_i$ ($\hat{\Pi}_1^B(w_i)$) are:

$$\hat{\Pi}_1^M = \frac{[a - c]^2}{4} \quad \text{and} \quad \hat{\Pi}_1^B(w_i) = \frac{[a - w_i]^2}{4}.$$  \hspace{1cm} (11)

The supplier earns no profit when there is no entry and firm 1 makes the input. When firm 2 does not enter the industry and firm 1 buys the input, the supplier’s profit is $[w_i - c_s]q_1(\cdot)$. Summarizing:

$$\hat{\Pi}_s^M = 0 \quad \text{and} \quad \hat{\Pi}_s^B(w_i) = [w_i - c_s][a - w_i]/2.$$  \hspace{1cm} (12)

Recall from Lemma 2 that when $c > c_s$ and $I \in (\Pi_2^B, \Pi_2^M)$, entry is deterred (only) when firm 1 buys the input. Therefore, firm 1’s profit will be $\hat{\Pi}_1^B(w_i)$ if it buys the input and $\hat{\Pi}_1^M$ if it makes the input. The relevant expressions for firm 1’s profit in (4) and (11) reveal that firm 1 will buy the input if and only if $w_i \leq c + [a + c - 2c_s]/6$. Notice that this maximum price firm 1 is willing to pay to buy the input exceeds the corresponding maximum price reported in Lemma 1. Firm 1 is willing to pay more for the input in the present setting than in the base setting with no entry barriers (i.e., $I = 0$) because the buy regime can provide the added bonus of entry deterrence here.

The equilibrium value of $w_i$ in this setting will be less than the maximum amount firm 1 is
willing to pay for the input if the supplier prefers a lower input price in order to increase firm 1’s purchase of the input. The expression for \( \hat{\Pi}_S^B(w_1) \) in (12) reveals that if firm 1 is committed to buying the input, the profit-maximizing input price for the supplier is \( w_1 = \frac{a + c_S}{2} \). This price is less than the maximum amount firm 1 will pay for the input if and only if \( c \geq \frac{2a + 5c_S}{7} \). From (12), when \( c > c_S \) the supplier always secures greater profit when firm 1 buys the input than when firm 1 makes the input. Therefore, the buy regime will arise in the entry setting when \( c > c_S \). Furthermore, if \( I \in (\Pi_2^M, \Pi_2^B) \), entry will be deterred. In contrast, firm 1 will make the input when it is the least-cost producer of the input (\( c < c_S \)). In this case, entry is deterred when \( I \in (\Pi_2^M, \Pi_2^B) \). These conclusions are presented in Proposition 4.

**Proposition 4.** In the entry setting:

(i) Firm 1 buys the input in equilibrium if and only if \( c > c_S \).

(ii) For \( I \in (\text{Minimum } \{ \Pi_2^M, \Pi_2^B \}, \text{Maximum } \{ \Pi_2^M, \Pi_2^B \}) \), firm 1’s make-or-buy decision deters firm 2’s entry into the industry.

Proposition 4 reports that the least-cost provider of the input supplies the input regardless of the height of the prevailing entry barriers. The primary effect of entry barriers is to alter the maximum amount firm 1 will pay to buy the input from the common supplier. The altered willingness to pay arises because firm 1’s sourcing decision may deter entry, and thereby increase firm 1’s retail profit.16

5. Additional Procurement Options

We have simplified the analysis to this point by assuming that the entrant must purchase the input from the supplier. We now allow for two additional procurement options. Section 5.1 extends the base setting to allow the entrant to make the input if it chooses to do so. Section 5.2 allows the entrant to buy the input from either the supplier or the incumbent retail producer.

---

16 In Salop and Scheffman (1987), an incumbent’s decision to outsource the production of a critical input can raise the market price of the input, and thereby make industry participation unduly costly for an entrant.
5.1 The Entrant’s Make-or-Buy Decision

Consider the base setting with the exception that firm 2, like firm 1, can choose to make the input at unit cost $c$. Proposition 5 describes the equilibrium procurement decisions and input prices in this setting.

**Proposition 5.** When firm 2 can make the input itself, the equilibrium sourcing decisions and input prices are as follows:

(i) Firms 1 and 2 both make the input if $c \leq c_s$. Both firms buy the input from the supplier if $c > c_s$.

(ii) If $c_s < c \leq (a + 2c_s)/3$, both firms pay unit price $w_1 = w_2 = c$.

(iii) If $(a + 2c_s)/3 < c \leq (3a + 4c_s)/7$, firm 1 pays unit price $w_1 = c + 3(c - (a + 2c_s)/3)/8$ and firm 2 pays unit price $w_2 = c$.

(iv) If $(3a + 4c_s)/7 < c \leq (a + c_s)/2$, firm 1 pays unit price $w_1 = c + [(a + c_s)/2 - c]/2$ and firm 2 pays unit price $w_2 = c$.

(v) If $c \geq (a + c_s)/2$, both firms pay unit price $w_1 = w_2 = (a + c_s)/2$.

To understand the conclusions in Proposition 5, notice that firm 2’s make-or-buy decision has no strategic consequences because firm 2 is the last party to enter the industry. Therefore, firm 2 will pay at most $c$ for the input. Recognizing this fact, the supplier will set $w_2$ no higher than $c$ when it chooses to induce firm 2 to buy the input. The supplier will set an even lower input price ($(a + c_s)/2$) when it is sufficiently efficient that its preferred (monopoly) price is less than $c$, as reflected in property (v) of Proposition 5.

When the supplier’s cost advantage ($c - c_s$) is limited, the supplier will optimally charge firm 2 the most it will pay for the input ($c$), regardless of firm 1’s procurement decision. Therefore, under the condition specified in property (ii) of Proposition 5, both firms will buy the input from the supplier at price $c$. When the supplier’s cost advantage is more pronounced, the price it charges
firm 2 for the input varies with firm 1’s make-or-buy decision. If firm 1 buys the input, the supplier will charge firm 2 the most it is willing to pay for the input (c) because the supplier does not wish to diminish unduly firm 1’s demand for the input. In contrast, if firm 1 makes the input, the supplier will charge firm 2 a lower price for the input in order to enhance firm 2’s competitive position and thus its purchase of the input. To avoid endowing firm 2 with this advantage, firm 1 will pay a premium (w_1 > c) to buy the input, as reflected in properties (iii) and (iv) in Proposition 5.

Proposition 5 reveals that the key qualitative conclusions drawn in the base setting persist when firm 2 can make the input itself if it chooses to do so. Firms will tend to buy key inputs from a common supplier in order to prevent the supplier from favoring a competitor. Proposition 5 also reveals a tendency for retail competitors with similar operating characteristics and opportunities to pursue similar procurement policies.

5.3 Will the Incumbent Retailer Supply the Entrant?

Now return to the setting where firm 2 cannot make the input itself. However, suppose that when firm 1 makes the input, it can sell the input to firm 2. Thus, firm 1 can compete with the supplier for firm 2’s business in the make regime. The competition proceeds as follows. After firm 1 chooses to make the input, firm 1 and the supplier simultaneously and independently announce a price at which each will sell the input to firm 2. Firm 2 then chooses its preferred supplier, after which firms 1 and 2 engage in Cournot retail competition.

First consider the case where the supplier’s cost of producing the input is less than firm 1’s corresponding cost (so c_s ≤ c). Even if firm 1 makes the input in this case, the supplier will employ its cost advantage to supply the input to firm 2. To see why, notice that the supplier will find it profitable to undercut any price above c_s set by firm 1. This is the case because a small price reduction will have little impact on the subsequent competition between the firms but will secure profit from supplying the input to firm 2. Consequently, in equilibrium, the supplier will sell the

17 Prohibitions on resale of the input, for example, can preclude such competition in the buy regime.
input to firm 2 at unit price \( w_2 = \text{Minimum} \{ c, [a + c + 2e_s]/2 \} \). It is readily verified that this equilibrium price leads to (weakly) lower profit for both firm 1 and the supplier under the make regime when firm 1 has the ability to sell to firm 2 than when firm 1 lacks this ability. Thus, firm 1’s preference to buy the input when \( c_s < c \), as characterized in Proposition 1, becomes more pronounced when firm 1 has the ability to supply the input to firm 2.

Now, consider the case where firm 1’s unit cost of supplying the input is less than the supplier’s corresponding cost (so \( c < c_s \)). In this case, firm 1 can profitably undercut any price above \( c \) the supplier sets. In equilibrium, firm 1 will sell the input to firm 2 at unit price \( c_s \). Using \( q_1(w_2) \) and \( q_2(w_2) \) from section 3.1, firm 1’s profit in this setting when it makes the input is:

\[
[a - q_1(c_s) - q_2(c_s)]q_1(c_s) - c q_1(c_s) + [c_s - c]q_2(c_s)
\]

\[
= \frac{5a - 7c + 2c_s}{144} - \frac{3a + 11c - 14c_s}{48}(a + c - 2c_s).
\]  

Expression (13) reveals that firm 1’s profit in the make regime is the profit it secures when it cannot sell the input to firm 2 (recall expression (4)) less a second term. The second term is positive when \( c_s - c \) is small, and negative when \( c_s - c \) is large. The varying sign of this second term reflects two conflicting effects that arise when firm 1 can sell the input to firm 2. First, firm 1 can secure wholesale profit when it is able to sell the input to firm 2 at a price above \( c \). Second, competition between the two input producers reduces the equilibrium price that firm 2 pays for the input to \( c_s \). The lower input price for firm 2 reduces firm 1’s equilibrium retail profit. It can be shown that when \( c \) is sufficiently small, the wholesale profit firm 1 anticipates exceeds the loss in retail profit firm 1 faces because of firm 2’s enhanced competitive position.

When \( c < c_s \), the supplier will earn no profit if firm 1 decides to make the input. Therefore, the supplier will be particularly interested in inducing firm 1 to buy the input. However,

---

18 The minimum term reflects the fact that the supplier may prefer to set a price below the minimum price at which firm 1 is willing to supply the input. In the special case where \( c = c_s \), competition between the two parties with identical expected costs drives equilibrium profits to zero. Without loss of generality, we assume firm 2 buys the input from the supplier in equilibrium in this special case.
firm 1 is less inclined to buy the input, given the wholesale profit it can secure in the make regime by selling the input to firm 2. On balance, as Proposition 6 reports, firm 1 will make the input if and only if its cost of doing so is sufficiently small.

**Proposition 6.** In the setting where firm 1 can supply the input to firm 2, there exists a $\delta > 0$ such that the equilibrium outcomes are as follows:

(i) If $c \leq c_s - \delta$, firm 1 makes the input. If $c > c_s - \delta$, firm 1 buys the input.

(ii) If $c_s - \delta < c < c_s$, firm 1 pays $w_1 = \frac{[5a + c_s] - 4\sqrt{(a-c)^2 + 5(c_s - c)(a-c_s)}}{6}$.

(iii) If $c_s \leq c < \frac{a + 2c_s}{3}$, firm 1 pays $w_1 = c + [a + c_s - 2c]/6$.

(iv) If $\left[\frac{a + 2c_s}{3}\right] \leq c < \frac{3a + 4c_s}{7}$, firm 1 pays $w_1 = c + [c - c_s]/6$.

(v) If $c \geq \left[\frac{3a + 4c_s}{7}\right]$, firm 1 pays $w_1 = \frac{a + c_s}{2}$.

Property (i) of Proposition 6 provides the (perhaps surprising) conclusion that the make regime is less likely to arise in equilibrium when firm 1 acquires the ability to sell the input to firm 2 in the make regime. The reason is that, when it makes the input, firm 1 will compete with the supplier for firm 2’s business. This competition will produce a lower input price for firm 2, which enhances firm 2’s position in its retail competition with firm 1. To avoid this unfavorable outcome, firm 1 is more inclined to buy the input from the supplier, as this procurement arrangement enables firm 1 to credibly commit not to compete in supplying the input to firm 2.

A different conclusion would arise if firm 1 could not make the input itself but could acquire the capacity to do so by merging with supplier. In this case, the decision to make the input would constitute a decision to merge with the supplier, which would lead the vertically integrated entity either to set an input price that softens competition in the retail market (e.g., Chen 2001; Arya et al.

---

19 This conclusion reflects the fact that the critical value of $c$ below which firm 1 prefers to make the input is less than $c_s$. Furthermore, properties (ii) – (iv) of Proposition 6 reveal that the equilibrium value of $w_1$ in the buy regime in this setting is (at least weakly) greater than the corresponding value in the base setting (as characterized in Proposition 1, where firm 1 is unable to supply the input to firm 2).
or to make it unduly costly for the entrant to operate in the industry (e.g., Salinger 1998; Ordover et al. 1990).

6. Conclusion

We have examined how strategic competitive considerations can influence make-or-buy decisions in a setting where the input supplier has monopolistic pricing power and produces with constant returns to scale. We have shown that a retail producer may be willing to pay a premium to outsource production of an input to a supplier that also serves a retail rival. Outsourcing production to the common supplier reduces the supplier’s vested interest in the rival’s success, and thereby limits the supplier’s incentive to deliver the input to the rival on particularly attractive terms. Therefore, because outsourcing to a common supplier enables a producer to “buy” both the input and more favorable competitive conditions, a producer may be willing to pay more for the outsourced input than its own cost of producing the input.

This strategic benefit of outsourcing could help to explain industry inertia in outsourcing in some settings. Although it might appear that some firms are outsourcing the production of inputs to common suppliers “just because everybody’s doing it” (Weidenbaum 2005), our analysis suggests that inertia in outsourcing could reflect more strategic considerations. One firm’s decision to buy an input from a supplier can make it rational for other firms to do the same, even if they are compelled to pay a premium to buy the input. Such outsourcing can benefit a firm by undermining prevailing implicit alliances among suppliers and retail rivals, particularly in the presence of pronounced supplier concentration.

Our analysis has proceeded in a simple setting where some factors that can influence make-or-buy decisions in practice were intentionally excluded. In particular, economies of scale, duplicative fixed costs, long-term supply chain relations, and issues of product quality all were

---

20 Rey and Tirole (2007) provide a comprehensive review of the literature on vertical foreclosure.

21 Buehler and Haucap (2006) provide additional analysis of the conditions under which such herding in outsourcing decisions will and will not arise.
excluded to highlight the strategic competitive effects of primary interest. It is important to note, though, that these other factors also can add key strategic considerations to the make-or-buy decision. For example, in the presence of economies of scale, firms may jointly opt to outsource to a supplier that quotes a constant unit price in order to relax the particularly intense price competition that would otherwise arise (Cachon and Harker 2002). Even in the absence of intrinsic economies of scale, competing firms that would otherwise be tempted to undertake fixed investments to reduce marginal cost for competitive advantage may prefer outsourcing as a means of committing to less intense competition (Grahovak and Parker 2003; Gilbert et al. 2006). Joint consideration of these issues, and the implications of these issues for equilibrium channel structures, is an important direction for future research.
APPENDIX

Proof of Lemma 1.

From (4) and (6), the difference between firm 1’s profit when it buys the input and when it makes the input is $\Pi_1^B(w_1) - \Pi_1^M = \left[ 7c - c_s - 6w_1 \right] \left[ 10a - 7c + 3c_s - 6w_1 \right] / 144$. Substituting the expression for $w_2^B(w_1)$ into $q_1(w_1, w_2)$ as specified in section 3.2 yields $q_1(w_1) = [5a + c_s - 6w_1] / 12$. To secure positive profit in the buy regime, firm 1 will set $q_1(w_i) > 0$ if and only if $w_i < [5a + c_s] / 6$. This upper bound on $w_i$ and the maintained assumption that $a > [7c - 2c_s] / 5$ imply that $10a - 7c + 3c_s - 6w_1 > 0$. Hence, firm 1 will buy the input if and only if $7c - c_s - 6w_1 \geq 0$, i.e., if and only if $w_i \leq c + [c - c_s] / 6$.

Proof of Proposition 1.

From (4) and (6), the difference between the supplier’s profit in the buy and make regimes is:

$$
\Pi_s^B(c + [c - c_s] / 6) - \Pi_s^M = \left[ c - c_s \right] \left[ 9a - 13c + 4c_s \right] / 18 \quad \text{if } c < [3a + 4c_s] / 7. \tag{A1}
$$
$$
\Pi_s^B([a + c_s] / 2) - \Pi_s^M = \left[ a - c \right] \left[ 3a + c - 4c_s \right] / 24 \quad \text{if } c \geq [3a + 4c_s] / 7. \tag{A2}
$$

Because $a > \text{Max} \left\{ [7c - 2c_s] / 5, 2c_s - c \right\}$ by assumption, $a > c$ and $a > c_s$.

If $c \leq c_s$, then $c < [3a + 4c_s] / 7$ and (A1) applies. The term $9a - 13c + 4c_s > 0$ because it exceeds $24[a - c_s] / 7 > 0$, which is the value of the term evaluated at $c = [3a + 4c_s] / 7$, the highest permissible value of $c$. Thus, $\Pi_s^B - \Pi_s^M$ has the same sign as $c - c_s$, and so the supplier will induce firm 1 to make the input.

Now suppose $c > c_s$. If (A1) applies, the preceding analysis explains why the supplier will induce firm 1 to buy the input. If (A2) applies, then $\Pi_s^B - \Pi_s^M = \left[ a - c \right] \left[ 3(a - c_s) + (c - c_s) \right] / 24 > 0$ because $c > c_s$ and $a > c$. Therefore, the supplier will again induce firm 1 to buy the input. This proves property (i).

Property (ii) follows from (A1) and property (iii) follows from (A2).

Proof of Proposition 2.

If the supplier sets $w_2$ before firm 1’s sourcing decision, the same outcomes arise whether $w_1$ is set first, $w_2$ is set first, or the two input prices are set simultaneously. Furthermore, the outcomes from the base setting arise if firm 1 chooses to make the input. In particular, the supplier’s profit will be $\Pi_s^M$, as specified in (4).

Let $\Pi_s^B(w_1, w_2)$ denote the supplier’s profit under the buy regime in the setting where $w_2$ is set before firm 1’s sourcing decision. Equilibrium outputs as a function of $w_1$ and $w_2$ will be
The supplier recognizes that firm 1 will be unwilling to pay more than \( c \) for its input, since firm 1’s sourcing decision has no effect on \( w_2 \) when \( w_2 \) is determined prior to firm 1’s sourcing decision. Consequently, the supplier’s problem when it wishes to induce firm 1 to buy the input is:

\[
\text{Maximize} \quad \left[ w_1 - c_s \right] \left[ a - 2w_1 + w_2 \right] / 3 + \left[ w_2 - c_s \right] \left[ a - 2w_2 + w_1 \right] / 3 \quad \text{subject to} \quad w_1 \leq c.
\]

The solution to this problem is readily shown to entail: (i) \( w_1 = c \) and \( w_2 = [a + 2c + c_s] / 4 \) if \( c < [a + c_s] / 2 \); and (ii) \( w_1 = w_2 = [a + c_s] / 2 \) if \( c \geq [a + c_s] / 2 \). Substituting these input prices into \( \Pi_s^B(w_1, w_2) \), and comparing it to the corresponding expression for the supplier’s profit when firm 1 makes the input yields the following analog to Proposition 1 for the setting where \( w_2 \) is set prior to firm 1’s make-or-buy decision.

(i) Firm 1 makes the input if \( c \leq c_s \). Firm 1 buys the input if \( c > c_s \).
(ii) If \( c_s < c < [a + c_s] / 2 \), firm 1 pays unit price \( w_1 = c \).
(iii) If \( c \geq [a + c_s] / 2 \), firm 1 pays unit price \( w_1 = [a + c_s] / 2 \).

Comparing this finding with Proposition 1 reveals that the outcomes in the base setting and the present setting are identical if \( c \leq c_s \) or if \( c \geq [a + c_s] / 2 \). For the remaining values of \( c \), the difference between the supplier’s profit in the base setting \( \Pi_s^B(w_1) \) in (6) and its profit in the present \( \Pi_s^B(w_1, w_2) \) is readily shown to be:

\[
\Pi_s^B(c + [c - c_s] / 6) - \Pi_s^B(c, [a + 2c + c_s] / 4) = \frac{[c - c_s][6a - 13c + 7c_s]}{72} \quad \text{if} \quad c_s < c < [3a + 4c_s] / 7.
\]

\[
\Pi_s^B([a + c_s] / 2) - \Pi_s^B(c, [a + 2c + c_s] / 4) = \frac{[a - 2c + c_s]^2}{8} \quad \text{if} \quad [3a + 4c_s] / 7 \leq c < [a + c_s] / 2.
\]

It is readily verified that both of these differences are positive, given the relevant values of \( c \). ■

**Proof of Proposition 3.**

Substituting \( q_1(m, w_2) \), \( q_2(m, w_2) \), and \( w_2(m) \) from section 3.4 into (10) produces an objective function that is convex in \( m \). Hence, the maximum lies at one of the boundary points, \( m = 0 \) or \( m = 1 \), which correspond to the “buy” and the “make” options, respectively. This proves property (i) of the proposition. Properties (ii) and (iii) are proved in three steps.

**Step 1.** For \( \gamma > 0 \), \( m^* = \text{Min} \left\{ \left[ \frac{c_s + 6w_1}{7(\gamma + 1)c} \right]^{1/\gamma}, 1 \right\} \).

Given \( w_1 \) and rival output \( q_2 \), firm 1 chooses \( q_1 \) to:
Maximize \[ q_i \rightarrow (a - q_1 - q_2)q_1 - w_1[1 - m]q_1 - [cm^\gamma]m q_1. \]

Given \( w_2 \) and \( q_1 \), firm 2 chooses \( q_2 \) to:

Maximize \[ q_2 \rightarrow (a - q_1 - q_2)q_2 - w_2q_2. \]

Solving these problems simultaneously yields \( q_1(m, w_2) = \frac{a - 2(1 - m)w_1 - 2cm^{\gamma+1} + w_2}{3} \) and \( q_2(m, w_2) = \frac{a - 2w_2 + (1 - m)w_1 + cm^{\gamma+1}}{3} \). Anticipating these equilibrium output functions, the supplier chooses \( w_2 \) to:

Maximize \[ w_2 \rightarrow (w_1 - c_s)[1 - m]q_1(m, w_2) + [w_2 - c_s]q_2(m, w_2). \]

The solution to this problem entails \( w_2(m) = \frac{a + c_s[m + 1] + 2[1 - m]w_1 + cm^{\gamma+1}}{4} \). Anticipating these reactions to its sourcing decision, firm 1 chooses \( m \) to:

Maximize \[ m \rightarrow (a - q_1(m, w_2(m)) - q_2(m, w_2(m)))[q_1(m, w_2(m)) - [w_1[1 - m] + cm^{\gamma+1}]q_1(m, w_2(m)) \]
subject to: \( 0 \leq m \leq 1 \). \hspace{1cm} (A3)

If the constraint in (A3) were not imposed, the solution to firm 1’s problem would be \( m = \left[ \frac{c_s + 6w_1}{7(\gamma + 1)c} \right]^{\frac{1}{\gamma}} \). Because \( a > \frac{7c - 2c_s}{5} \), this solution is the unique local maximum, and so is the solution to the constrained problem in (A3) if and only if it is feasible.

**Step 2.** For \( \gamma > 0 \), \( m^{**} = \text{Min} \left\{ \frac{w_1}{(\gamma + 1)c} \right\}^{\frac{1}{\gamma}}, 1 \right\}.

Firm 1 would minimize its cost of producing \( q_1 \) by choosing \( m \) to:

Minimize \[ m \rightarrow w_1[1 - m]q_1 + [cm^\gamma]m q_1 \] subject to \( 0 \leq m \leq 1 \). \hspace{1cm} (A4)

If the constraint in (A4) were not imposed, the solution to the problem would be \( m = \left[ \frac{w_1}{(\gamma + 1)c} \right]^{\frac{1}{\gamma}} \), which determines \( m^{**} \) if and only if \( m \leq 1 \).

**Step 3.** \( m^{**} \geq m^* \).

When \( \gamma = 0 \), the conclusion follows immediately from property (i) of the proposition and the fact that \( w_1 \geq c_s \). When \( \gamma > 0 \), \( \frac{w_1}{(\gamma + 1)c} - \frac{c_s + 6w_1}{7(\gamma + 1)c} = \frac{w_1 - c_s}{7(\gamma + 1)c} \geq 0 \). Therefore, \( \left[ \frac{w_1}{(\gamma + 1)c} \right]^{\frac{1}{\gamma}} \geq \)
Proof of Lemma 2.

From (4) and (6), the difference between firm 2’s profit in the buy regime ($\Pi_2^B$) and in the make regime ($\Pi_2^M$) is $\Pi_2^B - \Pi_2^M = [c_s - c][2a + c - 3c_s]/36$. When $c > c_s$, $\Pi_2^B - \Pi_2^M < 0$ because $- [c - c_s][2(a - c_s) + (c - c_s)]/36 < 0$. When $c_s > c$, $\Pi_2^B - \Pi_2^M > 0$ because $[c_s - c][2a + c - 3c_s]/36 > 0$. This inequality holds because $a > 2c_s - c$ implies $2a + c - 3c_s > c_s - c > 0$.

Proof of Proposition 4.

There are three cases to consider.

Case 1. $I \leq \text{Min} \{ \Pi_2^M, \Pi_2^B \}$.

In this case, firm 2 enters whether firm 1 makes or buys the input. Therefore, Proposition 1 applies, and firm 1 buys the input in equilibrium if and only if $c > c_s$.

Case 2. $I > \text{Max} \{ \Pi_2^M, \Pi_2^B \}$.

In this case, firm 2 never enters, whether firm 1 makes or buys the input. From (11), the most the supplier can charge firm 1 is $c$. Therefore, $w_1 = \text{Min} \{ c, [a + c_s]/2 \}$. Then, using (12):

$$\hat{\Pi}_S^B(c) - \hat{\Pi}_S^M = [a - c][c - c_s]/2, \quad \text{if } c < [a + c_s]/2, \quad \text{and}$$
$$\hat{\Pi}_S^B([a + c_s]/2) - \hat{\Pi}_S^M = [a - c_s]^2/8, \quad \text{if } c \geq [a + c_s]/2. \quad (A5)$$

(A5) implies that when $c < [a + c_s]/2$, the supplier will induce firm 1 to buy the input if and only if $c > c_s$. (A5) also implies that when $c \geq [a + c_s]/2 > c_s$, the supplier will induce firm 1 to buy the input. Therefore, firm 1 will buy the input if and only if $c > c_s$.

Case 3. $\text{Min} \{ \Pi_2^M, \Pi_2^B \} < I \leq \text{Max} \{ \Pi_2^M, \Pi_2^B \}$.

First, suppose $c > c_s$. In this case, firm 2 will enter if and only if firm 1 makes the input. Using (4) and (12):

$$\hat{\Pi}_S^B(c + [a + c - 2c_s]/6) - \Pi_S^M = [a + c_s - 2c][a + 13c - 14c_s]/36 \quad \text{if } c < [2a + 5c_s]/7, \quad \text{and}$$

$$\hat{\Pi}_S^B([a + c_s]/2) - \Pi_S^M = [(a - c_s)^2 + (a - c)^2 - 2(c - c_s)^2]/24 \quad \text{if } c \geq [2a + 5c_s]/7. \quad (A6)$$

If $c < [2a + 5c_s]/7$, then $\hat{\Pi}_S^B - \Pi_S^M = [a + c_s - 2c][[(a - c_s) + 13(c - c_s)]]/36$. When $c > c_s$, the supplier induces firm 1 to buy the input if and only if $a + c_s - 2c$ is positive. $a + c_s - 2c$ exceeds
The maximum value of \( \Pi_s^M \) in (4) occurs at the largest permissible value of \( c \), which is \( [5a + 2c_s]/7 \). Substituting this expression for \( c \) in \( \Pi_s^M \) in (4) yields \( 6[a - c_s]^2/49 \). Hence, from (A6), when \( c \geq [2a + 5c_s]/7 \), \( \hat{\Pi}_s^B - \Pi_s^M > [(1/8) - (6/49)][a - c_s]^2 > 0 \). Again, then, firm 1 buys the input in equilibrium.

Now suppose \( c < c_s \). In this case, firm 2 will enter if and only if firm 1 buys the input. If firm 1 buys the input, its profit is \( \hat{\Pi}_1^B(w_1) \) in (6). If firm 1 makes the input, its profit is \( \hat{\Pi}_1^M \) in (11). Comparing these expressions for profit reveals that firm 1 will buy the input if and only if \( w_1 \leq c - [a - c_s]/6 \). Therefore, \( w_1 = \text{Min} \{ c - [a - c_s]/6, [a + c_s]/2 \} = c - [a - c_s]/6 \) when \( c < c_s \). Consequently, (6) and (12) imply \( \Pi_s^B(c - [a - c_s]/6) - \hat{\Pi}_s^M = -[a - c_s]^2/18 - [c_s - c][3(a - c) + (a - c_s)]/6 < 0 \). Thus, the make regime prevails in equilibrium.

**Proof of Proposition 5.** The proof consists of the following eight findings.

**Finding 1.** If \( c \leq c_s \), firm 1 and firm 2 both make the input.

**Proof:** Firm 2 will never pay more than \( c \) for the input, regardless of whether firm 1 makes or buys the input. This is the case because the profit of a Cournot competitor declines as its (expected) input cost increases. The supplier will not sell the input at a price less than \( c_s \) because the resulting sale would generate negative profit for the supplier. Therefore, when \( c \leq c_s \), firm 2 will make the input. Recognizing that its own make-or-buy decision does not influence firm 2’s procurement decision, firm 1 faces a choice analogous to the choice faced by firm 2. The foregoing logic then explains why firm 1 also will make the input when \( c \leq c_s \).

**Finding 2.** If \( c > c_s \), firm 2 buys the input.

**Proof:** Firm 2 is indifferent between making the input and buying the input at price \( c \) because equilibrium outputs and expected costs are the same under the two procurement arrangements. When \( c > c_s \), the supplier strictly prefers the buy regime, because the supplier secures strictly positive profit \( (c - c_s) \) on each unit of the input it sells to firm 2.

**Finding 3.** If \( c > c_s \) and firm 1 makes the input, firm 2 will buy the input at unit price \( w_2^{MB} = \text{Min} \{ c, [a + 2c_s + c]/4 \} \).

**Proof:** Standard analysis of Cournot duopoly competition reveals that when firm \( i \)’s unit cost of production is \( k_i \), the equilibrium output and profit of firm \( i \) are, respectively, \( q_i(k_i, k_j) = [a - 2k_i + k_j]/3 \) and \( \pi_i(k_i, k_j) = [a - 2k_i + k_j]^2/9 \) (\( j \neq i, i, j = 1, 2 \)). As explained in the proof of Finding 1, firm 2 will never pay more than \( c \) for the input. This is the first term in the identified expression for \( w_2^{MB} \). The second term in the expression reflects the supplier’s preferred input price,
i.e., it is the value of $w_2$ that maximizes $[w_2 - c_s]q_2(c, w_2)$, where $q_2(\cdot)$ is as defined in this finding.

**Finding 4.** If $c > c_s$ and firm 1 buys the input, firm 2 will buy the input at unit price

$$w_2^{BB} = \begin{cases} \min \{c + [a + c_s]/2\} & \text{if } w_2^{MB} < [4c - a - c_s]/2, \\ \min \{c + [a + 2c_s - w_2^{MB}]/3\} & \text{if } w_2^{MB} \geq [4c - a - c_s]/2. \end{cases}$$

**Proof:** The $c$ in the identified expressions for $w_2^{BB}$ again reflects the fact that firm 2 will never pay more than $c$ for the input. The second term in the expressions reflects the profit-maximizing input price for the supplier. When firms 1 and 2 both buy the input, the supplier’s profit is $[w_1 - c_s]q_1(w_1, w_2) + [w_2 - c_s]q_2(w_1, w_2)$, where $q_1(\cdot)$ and $q_2(\cdot)$ are as defined in Finding 3. Given $w_1$, the supplier’s profit is maximized at $w_2 = [a + c_s + 2w_1]/4$. Therefore $w_2^{BB} = \min \{c, [a + c_s + 2w_1]/2\}$.

The maximum price that firm 1 will pay for the input is the largest value of $w_1$ for which firm 1 earns the same expected profit when it buys the input and when it makes the input. (From the proof of Finding 2, firm 2 will buy the input in both cases.) Formally, this maximum price is obtained by solving $\pi_1(c, w_2^{MB}) = \pi_1(w_1, w_2^{BB})$, which reveals that $w_1 = c + [w_2^{BB} - w_2^{MB}]/2$. If it wishes to induce firm 1 to buy the input, the supplier will choose $w_1$ to maximize:

$$[w_1 - c_s]q_1(w_1, w_2^{BB}) + [w_2^{BB} - c_s]q_2(w_1, w_2^{BB}). \quad (A7)$$

When $w_2^{BB} = c$, the expression in (A7) is maximized at $w_1 = [a + 2c + c_s]/4$. Similarly, when $w_2^{BB} = [a + c_s + 2w_1]/4$, the expression in (A7) is maximized at $w_1 = [a + c_s]/2$. In each case, $w_1$ can be written as $w_1 = [a + c_s + 2w_2^{BB}]/4$. Therefore, if the supplier induces firm 1 to buy the input, the supplier will set $w_1^{BB} = \min \{c + [w_2^{BB} - w_2^{MB}]/2, [a + c_s + 2w_2^{BB}]/4\}$. This can be rewritten as:

$$w_1^{BB} = \begin{cases} [a + c_s + 2w_2^{BB}]/4 & \text{if } w_2^{MB} < [4c - a - c_s]/2, \\ c + [w_2^{BB} - w_2^{MB}]/2 & \text{if } w_2^{MB} \geq [4c - a - c_s]/2. \end{cases}$$

Substituting these expressions for $w_1$ into $w_2^{BB} = \min \{c, [a + c_s + 2w_1]/4\}$ provides:

$$w_2^{BB} = \begin{cases} \min \{c, [3a + 3c_s + 2w_2^{BB}]/8\} & \text{if } w_2^{MB} < [4c - a - c_s]/2, \\ \min \{c, [a + c_s + 2c + w_2^{BB} - w_2^{MB}]/4\} & \text{if } w_2^{MB} \geq [4c - a - c_s]/2. \end{cases}$$

The finding follows immediately from this expression.
Finding 5. If \( c_S < c \leq [a + 2c_s]/3 \), firm 1 and firm 2 will both buy the input at unit price \( c \).

Proof: Finding 2 implies that firm 2 will buy the input from the supplier in this setting. Finding 3 and the bounds on \( c \) in this setting imply that if firm 1 makes the input, firm 2 will pay unit price \( w_2^{MB} = c \geq [4c - a - c_s]/2 \).

Also, from Finding 4, \( w_2^{BB} = \min \{ c, [a + c + c_s]/3 \} = c \) and \( w_1^{BB} = c \) when \( w_2^{MB} = w_2^{BB} = c \).

If firm 1 makes the input (while firm 2 buys the input), the supplier’s profit is
\[
\pi_s^{MB}(w_2^{MB}) = [w_2^{MB} - c_s]q_2(c, w_2^{MB}).
\]
In contrast, if the supplier induces firm 1 to buy the input, the supplier’s profit is
\[
\pi_s^{BB}(w_1^{BB}, w_2^{BB}) = [w_1^{BB} - c_s]q_1(w_1^{BB}, w_2^{BB}) + [w_2^{BB} - c_s]q_2(w_1^{BB}, w_2^{BB}).
\]
With \( w_2^{MB} = w_2^{BB} = c \), \( \pi_s^{BB}(c, c) = [2/3][a - c_s][c - c_s] > [1/3][a - c_s][c - c_s] = \pi_s^{MB}(c) \).

Consequently, the supplier will induce both firms to buy the input at price \( c \) in this setting.

Finding 6. If \( [a + 2c_s]/3 < c \leq [3a + 4c_s]/7 \), firm 1 will buy the input at unit price \( c + 3c - a - 2c_s)/8 \), and firm 2 will buy the input at unit price \( c \).

Proof: Finding 2 implies that firm 2 will buy the input from the supplier in this setting. Finding 3 and the bounds on \( c \) in this setting imply that if firm 1 makes the input, firm 2 will pay unit price \( w_2^{MB} = [a + 2c_s + c]/4 \geq [4c - a - c_s]/2 \). Furthermore, from Finding 4, \( w_2^{BB} = c = \min \{ c, [3a + 7c + 2c_s]/12 \} \).

Also, from Finding 4, \( w_1^{BB} = c + [w_2^{BB} - w_2^{MB}]/2 \) in this setting. Consequently, \( w_1^{BB} = c + [3c - a - 2c_s]/8 \). Substituting these input prices into the supplier’s profit function reveals that \( \pi_s^{BB}(w_1^{BB}, w_2^{BB}) > \pi_s^{MB}(w_2^{MB}) \). Consequently, the supplier will induce both firms to buy the input at the specified prices.

Finding 7. If \( [3a + 4c_s]/7 < c \leq [a + c_s]/2 \), firm 1 will buy the input at unit price \( c + (a + c_s)/2 - c)/2 \), and firm 2 will buy the input at unit price \( c \).

Proof: Finding 2 implies that firm 2 will buy the input from the supplier in this setting. Finding 3 and the bounds on \( c \) in this setting imply that if firm 1 makes the input, firm 2 will pay unit price \( w_2^{MB} = [a + 2c_s + c]/4 < [4c - a - c_s]/2 \). Furthermore, from Finding 4, \( w_2^{BB} = c = \min \{ c, [a + c_s]/2 \} = c \).

Also, from Finding 4, \( w_1^{BB} = [a + c_s + 2w_2^{BB}]/4 \) in this setting. Consequently, \( w_1^{BB} = c + ((a + c_s)/2 - c)/2 \). Substituting these input prices into the supplier’s profit function reveals that \( \pi_s^{BB}(w_1^{BB}, w_2^{BB}) > \pi_s^{MB}(w_2^{MB}) \). Consequently, the supplier will induce both firms to buy the input at the specified prices.

Finding 8. If \( [a + c_s]/2 < c \leq [5a + 2c_s]/7 \), firm 1 and firm 2 will both buy the input at unit price \( [a + c_s]/2 \).
Proof: Finding 2 implies that firm 2 will buy the input from the supplier in this setting. Finding 3 and the bounds on \( c \) in this setting imply that if firm 1 makes the input, firm 2 will pay unit price \( w^{MB}_2 = \frac{a+2c_s+c}{4} < \frac{4c-a-c_s}{2} \). From Finding 4, \( w^{BB}_2 = \frac{a+c_s}{2} = \text{Min} \{ c, \frac{a+c_s}{2} \} \) and \( w^{BB}_1 = \frac{a+c_s+2w^{BB}_2}{4} \). Consequently, \( w^{BB}_1 = \frac{a+c_s}{2} \). Substituting these input prices into the supplier’s profit function reveals that \( \pi_s^{BB}(w^{BB}_1, w^{BB}_2) > \pi_s^{MB}(w^{MB}_2) \). Thus, the supplier will induce both firms to buy the input at the specified prices. ■

**Proof of Proposition 6.** The proof consists of the following three findings.

**Finding 1.** If \( c \geq \frac{a+2c_s}{3} \), the equilibrium outcome is the same whether firm 1 can sell the input to firm 2 or is unable to do so.

Proof: As explained in the text, when firm 1 can sell the input to firm 2 in the make regime, firm 1 will only undercut the input price the supplier sets for firm 2 \( (w_2) \) if this price exceeds \( c \). The supplier’s preferred value of \( w_2 \) is \( w^M_2 \) as specified in section 3.1. Under the maintained assumption, \( w^M_2 \leq c \). Therefore, firm 1’s ability to sell the input to firm 2 will not affect the supplier’s pricing or firm 2’s procurement decision. Consequently, properties (iv) and (v) of the proposition follow.

**Finding 2.** If \( c_s \leq c < \frac{a+2c_s}{3} \), firm 1 buys the input and pays \( w_1 = c + \frac{a+c_s-2c}{6} \).

Proof: In this case, \( w^M_2 > c \). Therefore, if firm 1 makes the input, firm 2 will face a lower input price. In particular, because \( c \geq c_s \), \( w_2 \) will be reduced to \( c \). Firm 1’s profit in this case will be \( [a-q_1(c)-q_2(c)]q_1(c) - c q_1(c) = (a-c)^2/9 \). Comparing this profit to \( \Pi_1^B(w_1) \) in (6) reveals that the highest unit price firm 1 will pay to buy the input in this setting is \( c + \frac{a+c_s-2c}{6} \). Because this price is less than the supplier’s preferred price of \( \frac{a+c_s}{2} \) (since \( c < \frac{a+2c_s}{3} \)), the supplier must set this lower price to induce firm 1 to buy the input. Therefore, the difference between the supplier’s profit in the buy regime and in the make regime is \( \Pi_s^B(c+\frac{a+c_s-2c}{6}) - [c - c_s]q_2(c) = [(a-c)^2+(a-c_s)(c-c_s)]/9 > 0 \), which provides Finding 2 and property (iii) of the proposition.

**Finding 3.** There exists a \( \delta > 0 \) such that: (i) for \( c_s - \delta < c < c_s \), firm 1 buys the input and pays \( w_1 = \bar{w} = \frac{5a+c_s}{6} - 4\sqrt{(a-c)^2 + 5(c_s-c)(a-c_s)}/6 \); and (ii) for \( c \leq c_s - \delta \), firm 1 makes the input.

Proof: In this case, \( w^M_2 > c \), so firm 1’s decision to make the input leads to a reduction in firm 2’s input price. Because \( c < c_s \) in this case, \( w_2 \) will be reduced to \( c_s \), and firm 2 will buy the input
from firm 1. Firm 1’s profit in this case will be as specified in (13). A comparison of this profit and the profit firm 1 secures in the buy regime (as specified in (6)) reveals that the maximum amount firm 1 will pay to buy the input from the supplier is $\bar{w}$. Because $c < c_s$, the maximum amount firm 1 will pay for the input is less than the supplier’s preferred price. Therefore, if the supplier induces firm 1 to buy the input, it will do so by setting $w_i = \bar{w}$.

It remains to determine whether the supplier will induce firm 1 to buy the input. The supplier makes no profit in the make regime. The supplier’s profit in the buy regime is $\Pi_s^B(\bar{w})$. $\Pi_s^B(\bar{w})$ is a concave function of $w_i$. Furthermore, $\bar{w}$ is less than the value of $w_i$ that maximizes the supplier’s profit, and is increasing in $c$. Therefore, the supplier will prefer the make regime to the buy regime for the values of $c$ below the identified cutoff. This cutoff is strictly below $c_s$ (i.e., $\delta > 0$) because $\Pi_s^B(\bar{w})$ is continuous and because $\Pi_s^B(\bar{w})$ approaches $(a - c_s)^2 / 9 > 0$ as $c$ approaches $c_s$. This proves properties (i) and (ii) of the proposition. ■
REFERENCES


