Exclusive dealing in the presence of a vertically integrated firm*

Ventas exclusivas en presencia de una empresa verticalmente integrada

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Abstract

This study constructs a successive Cournot model to investigate the possibility that a separated upstream input supplier can solely sell the intermediate good to a separated downstream manufacturer through an exclusive contract in the presence of a vertically integrated rival. We find that the separated firms are indifferent on whether to sign the exclusive contract or not if the downstream party is less efficient than the integrated firm in producing the final good. Next, the separated firms with an efficient downstream party are indifferent between signing or not signing, willing to sign, and not willing to sign the exclusive contract if the upstream cost differential is relatively low, medium, and high, respectively. Finally, signing such an exclusive contract does not increase consumer surplus and social welfare.

Key words: *Exclusive dealing, vertical integration, successive Cournot model.*

JEL Classification: *L12, L41, L42.*

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Resumen

Este trabajo construye un modelo sucesivo de Cournot para investigar que un proveedor de insumos realice ventas exclusivas a un productor en presencia de un competidor verticalmente integrado. Se encuentra que las empresas se encontrarán indiferentes en tener un contrato de exclusividad si el productor es menos eficiente en la producción del bien que la firma integrada. Asimismo, la firma de un contrato de exclusividad dependerá del diferencial de costos del proveedor del insumo. Finalmente, un contrato de exclusividad no aumenta el excedente del consumidor o el bienestar social.

Palabras clave: *Tratos exclusivos, integración vertical, modelo de Cournot.*

Clasificación JEL: *L12, L41, L42.*

1. Introduction

Exclusive dealing is a vertical purchase agreement that requires a buyer to consume specific products from only one seller.[1] In some countries (e.g., Australia, Europe, and the United States), such an agreement may violate the antitrust law by lessening the competition in an industry, raising concerns from the antitrust authorities in those countries.[2] However, Posner (1976) and Bork (1978), two prominent advocates of the Chicago School of thought, oppose this view by advancing the well-known classic argument on exclusive dealing that a rational buyer has no incentive to sign an exclusive purchase contract offered by an inefficient supplier.

Since exclusive dealing can be observed in many industries (Lafferty *et al.*, 1984; Heide *et al.*, 1998; Cooper *et al.*, 2005), several researchers employ different frameworks from the model in the Chicago School's classic argument and are able to unearth some conditions under which exclusive dealing occurs (Rasmusen *et al.*, 1991; Yong, 1996; Bernheim and Whinston, 1998; Segal and Whinston, 2000; Farell, 2005; Fumagalli and Motta, 2006; Simpson and Wickelgren, 2007; Abito and Wright, 2008; Fumagalli *et al.*, 2009; DeGraba, 2013; Kitamura *et al.*, 2014, 2017, 2018; Liu and Meng, 2021).

Motivated by the controversy among economists on exclusive dealing, this paper leverages a variant of the successive Cournot model developed by Salinger (1988) to investigate the possibility that a separated upstream input supplier can solely sell the intermediate good to a separated downstream manufacturer

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1 https://www.ftc.gov/advice-guidance/competition-guidance/guide-antitrust-laws/single-firm-conduct/exclusive-supply-or-purchase-agreements

2 https://en.wikipedia.org/wiki/Exclusive_dealing

through an exclusive contract in the presence of a vertically integrated rival.[3] The successive Cournot model, where the firms in every production stage compete in quantity, prevents the elimination of double marginalization that arises under Bertrand competition (Gaudet and Van Long, 1996). Indeed, prior studies have mostly focused on price competition among sellers.[4] Therefore, the central novelty of this paper lies in its use of a successive Cournot model to reexamine the Chicago School's classic argument.

Several studies simultaneously consider exclusive dealing and vertical integration. Chen and Riordan (2007) prove that a vertically integrated firm can use an exclusive contract to prevent competition from an equally efficient upstream rival and cartelize the downstream market. However, our paper is interested in exploring conditions that allow a separated upstream firm to use an exclusive contract to prevent competition from a vertically integrated rival. Next, unlike the earlier literature, Nocke and Rey (2018) and Rey and Verge (2020) do not focus on the entry deterrence effect of exclusive contracts but pay attention to the changes in firms' trading behavior post-contract. This feature is also taken into account in our paper. Moreover, we are particularly motivated by the successive Cournot model, which has never been employed in studies on exclusive dealing.

It is salient to note that our model configuration is commonly observed in the real-world setting. For example, in 2019, Taiwan Semiconductor Manufacturing Company (TSMC) won an exclusive contract to provide chips for Apple Inc. [5] In the absence of such an exclusive contract, TSMC would have to compete with other rivals, such as Samsung Electronics Co., Ltd., in the chip market. Indeed, Apple Inc. and Samsung Electronics Co., Ltd. are also rivals in the downstream market, namely the global smartphone market.

The possibility that exclusivity appears in equilibrium in this model depends on two main channels. The first channel indicates that an exclusive contract will be attainable if the seller faces not-too-severe competition in the upstream market. This channel has been discussed by several studies in exclusive dealing literature, such as Yong (1996), Farrell (2005), Fumagalli *et al.* (2009), and Kitamura *et al.* (2017). The second channel is derived from the literature on vertical integration and market foreclosure.[6] It should be noted that an integrated firm may yield profit from both upstream and downstream markets. Its upstream behavior is, therefore, based on the strategic and marginal upstream

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3 The successive Cournot model developed by Salinger (1988) and its variants are well established in theoretical industrial organization. See, for example, Gaudet and Van Long (1996), Spencer and Raubitschek (1996), Ishikawa and Lee (1997), Ishikawa and Spencer (1999), and Lin and Saggi (2007).

4 Farell (2005) allows sellers to engage in Cournot competition in the Chicago three-party model and shows that the exclusivity equilibrium can occur.

5 https://www.taiwannews.com.tw/en/news/3551431?fbclid=IwAR2IhSGMbmWrOaA73BQds7DwFgt94eyZhy75bcEvBXTXzSuOgjISACTpbhI

6 In addition to Salinger (1988), Nocke and White (2007), Wang *et al.* (2011), and Reisinger and Taratino (2015) also discuss vertical integration and market foreclosure.

profit effects that influence its downstream and upstream profits, respectively (Wang *et al.*, 2011).[7]

Based on the two channels mentioned above, the upstream market competition becomes less (more) intense if the marginal upstream profit effect is weak (strong) or the strategic effect is strong (weak), resulting in the exclusivity equilibrium being more (less) likely to occur. In particular, suppose the marginal upstream profit effect is outweighed by the strategic effect. In that case, the vertically integrated firm has no incentive to supply input to its downstream rival, leading to indifference in the separated firms' contract decisions.

We derived three main results as follows. First, the separated firms are indifferent on whether to sign the exclusive contract or not if the downstream party is less efficient than the integrated firm in producing the final good. Second, the separated firms with an efficient downstream party are indifferent between signing or not signing, willing to sign, and not willing to sign the exclusive contract if the upstream cost differential is relatively low, medium, and high, respectively. Third, signing such an exclusive contract does not increase consumer surplus and social welfare.

The remainder of this paper is organized as follows. Section 2 describes the model. Section 3 analyzes a regime in which the separated downstream manufacturer is less efficient than the vertically integrated firm in producing the final good. In Section 4, we discuss a regime in which the condition of the regime considered in the preceding section is reversed. The impact of exclusive dealing on consumer surplus and social welfare will be evaluated in Section 5. Lastly, we conclude the paper in Section 6.

2. The Model

This paper considers a variant of the successive Cournot model developed by Salinger (1988), in which a separated upstream input supplier (firm U) and a separated downstream manufacturer (firm D) compete with a vertically integrated firm (firm I) in terms of quantity in the upstream and downstream markets, respectively. The intermediate (final) goods produced in the upstream (downstream) market are assumed to be homogeneous. Firm U can offer an exclusive contract with a non-negative lump-sum reimbursement F to solely sell

[7] The strategic effect influences the integrated firm to reduce its input supply to its downstream rival. In doing so, the separated downstream firm's marginal cost rises since the input price increases. As a result, the separated downstream firm lowers its final good quantity. The integrated firm then increases its downstream output and earns a higher profit because of strategic substitutes. On the contrary, the marginal upstream profit effect induces the integrated firm to increase its input supply to the separated downstream firm and earns a higher upstream profit.

input to firm D.[8] Following the literature on exclusive dealing (e.g., Fumagalli and Motta, 2006), we assume that the seller offering the contract is less efficient than its rival. Specifically, firm U produces the intermediate good with a non-negative marginal cost m, while the integrated firm has a lower upstream marginal cost normalized to *zero*. The downstream production of firm D (firm I) incurs a transforming cost c_D (c_I) by converting one unit of the intermediate good to one unit of the final good. We assume that $\min(c_D, c_I) = 0$ and $\max(c_D, c_I) = c \geq 0$, for simplicity. Thus, m (c) can be referred to as the cost differential in the upstream (downstream) market. In addition, the vertically integrated firm produces the final good internally by using its own intermediate good because of the upstream cost advantage.

The final good market, whose inverse demand function is given in a linear form as:[9]

(1) $$p(Q) = 1 - Q$$

where p denotes the price of the final good, Q is the quantity demanded of the final good, and market clearing requires that Q equals the sum of the downstream outputs by firm D (q_D) and firm I (q_I), i.e., $Q = q_D + q_I$.

The game in question consists of three stages. In the first stage, firm U offers an exclusive contract to firm D to which the latter decides whether to accept or reject. In stage 2, given the contract status in the first stage, the available upstream firms engage in quantity competition to supply the intermediate good to the separated downstream manufacturer by taking into account firm D's derived demand which is determined at the market-clearing level (Ghosh *et al.*, 2022). Finally, given the market-clearing input price, the final good producers determine their outputs in the third stage. We employ the following figure to clarify the trade structure among the firms in both exclusivity and non-exclusivity cases. It should be noted that the broken line in Figure 1 appears only in the non-exclusivity case, while such a direction vanishes otherwise.

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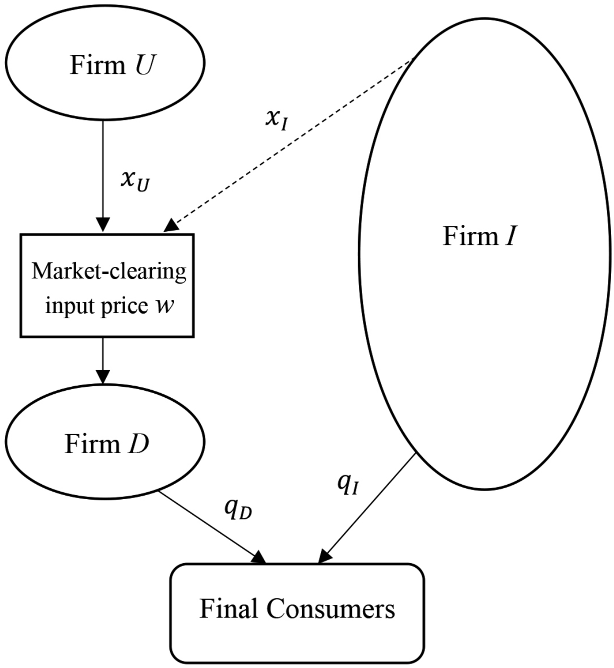
8 The assumption of a lump-sum reimbursement in exclusive contracts has been widely accepted in theoretical studies. See, for example, Fumagalli and Motta (2006), Fumagalli *et al.* (2012), DeGraba (2013), Kitamura *et al.* (2017), and Lin (2022). Since they allow the sellers to choose prices, a per-unit discount is no longer necessary. In contrast, adopting a per-unit discount or a two-part reimbursement in exclusive dealing models with upstream Cournot competition may be interesting. We leave this extension for future research.

9 The result in Section 3 (Regime A) is robust for a general demand function. See Appendix A for the proof.

FIGURE 1
THE MARKET STRUCTURE



In what follows, we analyze two regimes regarding the efficiency of the separated downstream manufacturer and the vertically integrated firm in producing the final good. First, we describe the case in which firm D is less efficient than firm I in producing the final good. We denote this case as Regime A. Next, we consider the setting in which firm D is more efficient than firm I in the downstream market, the case we term Regime B.

3. Regime A

Suppose that firm D's marginal downstream transforming cost is higher than that of firm I, i.e., $c_D \geq c_I$. As mentioned earlier, we assume that the higher one equals c and the lower one equals *zero*, i.e., $c_D = c$ and $c_I = 0$.

We first analyze the equilibrium results in the absence of an exclusive contract between the separated firms, i.e., firm D rejects the exclusive contract from firm U. In this case, firm I can compete with firm U in supplying the intermediate good to the separated downstream firm. By using backward induction, we solve the game from the downstream stage.

Firm *D*'s and firm *I*'s profit functions are expressed as follows:

$$\pi_D^{AN} = \left(p^{AN} - c - w^{AN}\right) q_D^{AN} \tag{2.1}$$

$$\pi_I^{AN} = p^{AN} q_I^{AN} + w^{AN} x_I^{AN} \tag{2.2}$$

where the superscript *"AN"* denotes variables associated with the non-exclusivity case in Regime A, *w* represents the input price offered to firm *D*, and $x_j (j = U,I)$ is firm *j*'s quantity of the intermediate good supplied to firm *D*.

By differentiating $\pi_i^{AN} (i = D,I)$ with respect to q_i^{AN} and letting it equal *zero*, we derive the first-order conditions as follows:

$$\frac{\partial \pi_D^{AN}}{\partial q_D^{AN}} = 1 - 2q_D^{AN} - q_I^{AN} - c - w^{AN} = 0 \tag{3.1}$$

$$\frac{\partial \pi_I^{AN}}{\partial q_I^{AN}} = 1 - q_D^{AN} - 2q_I^{AN} = 0 \tag{3.2}$$

Solving (3.1) and (3.2) simultaneously yields:

$$q_D^{AN} = \frac{1}{3}\left(1 - 2c - 2w^{AN}\right) \tag{4.1}$$

$$q_I^{AN} = \frac{1}{3}\left(1 + c + w^{AN}\right) \tag{4.2}$$

We observe from (4) that a rise in the input price will reduce the downstream output of the separated downstream manufacturer while increasing that of the integrated firm. The rationale behind these comparative statics is that a hike in the input price will increase firm *D*'s marginal cost and decrease its output. Meanwhile, firm *I*'s downstream output will increase because of strategic substitutes.

Note that one unit of the final good requires one unit of the intermediate good, i.e., $q_D = x_U + x_I$. By (4.1), we obtain firm *D*'s derived demand for the intermediate good as:

$$w^{AN} = \frac{1}{2} - c - \frac{3}{2}\left(x_U^{AN} + x_I^{AN}\right) \tag{5}$$

By (4) and (5), we obtain:

(6.1) $$\frac{dq_D^{AN}}{dx_U^{AN}} = \frac{dq_D^{AN}}{dx_I^{AN}} = 1 > 0$$

(6.2) $$\frac{dq_I^{AN}}{dx_U^{AN}} = \frac{dq_I^{AN}}{dx_I^{AN}} = -\frac{1}{2} < 0$$

From (6), we learn that a rise in the input supply from either firm *U* or firm *I* will increase (decrease) firm *D*'s (firm *I*'s) downstream output. The logic behind this result is as follows. Recall that from (5), a higher input supply from firm *U* or firm *I* will decrease the input price. It is followed by a decline in the separated downstream manufacturer's marginal cost, leading to higher downstream output. Consequently, the integrated firm's downstream output falls because of strategic substitutes.

We proceed to the upstream stage, where firm *U* and firm *I* compete in quantity. Firm *U*'s profit function is as follows:

(7) $$\pi_U^{AN} = \left(w^{AN} - m\right) x_U^{AN}$$

By using (2.2), (4), (5), and (7), we differentiate $\pi_j^{AN}\left(j = U, I\right)$ with respect to x_j^{AN} and let it equal *zero* to obtain the first-order conditions as follows:[10]

(8.1)
$$\frac{d\pi_U^{AN}}{dx_U^{AN}} = \overbrace{\frac{\partial \pi_U^{AN}}{\partial w^{AN}} \frac{\partial w^{AN}}{\partial x_U^{AN}}}^{\text{input price effect }(-)} + \overbrace{\frac{\partial \pi_U^{AN}}{\partial x_U^{AN}}}^{\text{direct effect }(+)} = \left(x_U^{AN}\right)\left(-\frac{3}{2}\right) + \left(w^{AN} - m\right) = \frac{1}{2} - m - c - 3x_U^{AN} - \frac{3}{2} x_I^{AN} = 0$$

(8.2)
$$\frac{d\pi_I^{AN}}{dx_I^{AN}} = \overbrace{\frac{\partial \pi_I^{AN}}{\partial q_D^{AN}} \frac{dq_D^{AN}}{dx_I^{AN}}}^{\text{strategic effect }(-)} + \overbrace{\frac{\partial \pi_I^{AN}}{\partial w^{AN}} \frac{\partial w^{AN}}{\partial x_I^{AN}}}^{\text{input price effect }(-)} + \overbrace{\frac{\partial \pi_I^{AN}}{\partial x_I^{AN}}}^{\text{direct effect }(+)} = \left(-q_I^{AN}\right)(1) + \left(x_I^{AN}\right)\left(-\frac{3}{2}\right) + \left(w^{AN}\right) = -c - x_U^{AN} - \frac{5}{2} x_I^{AN} < 0$$

We find, from (8.1), that firm *U*'s intermediate good quantity has two effects on its profit. The first term on the right-hand side of this equation is denoted as the *input price effect*. This effect shows that a decrease in firm *U*'s input supply increases the input price for firm *D*, and such a rise in the input price causes

10 Note that the effect of x_I^{AN} on π_I^{AN} through q_I^{AN} vanishes due to the envelop theorem.

a higher profit for the separated upstream firm. Thus, the input price effect is negative. On the contrary, the second term in (8.1), labeled as the *direct effect*, is positive. It is because a fall in firm *U*'s quantity of the intermediate good directly decreases its profit. Accordingly, the reaction function of the separated upstream firm can be obtained by letting the sum of the two effects equal *zero*.

Similarly, the input price effect and the direct effect of firm *I*'s input supply on its profit also appear in the first derivative of π_I^{AN} with respect to x_I^{AN} captured by the second and third terms on the right-hand side of (8.2), respectively. Furthermore, Eq. (8.2) introduces a new term, which is referred to as the *strategic effect*. The direct implication of this effect is that a fall in firm *I*'s input supply will increase the input price for its downstream rival. A higher input price will raise firm *D*'s marginal cost, which will subsequently reduce its output. However, the decrease in firm *D*'s output will raise the integrated firm's profit by increasing its downstream output due to strategic substitutes. Hence, the strategic effect is negative.

As shown in (8.2), the first derivative of firm *I*'s input supply on its profit is always negative since the positive direct effect is outweighed by the remaining negative effects. Thus, the integrated firm's optimal decision is not to supply the intermediate good to its downstream rival, i.e., $x_I^{AN} = 0$. The intuition behind this result is as follows. Recall the assumption that firm *I* is more efficient than firm *D* in producing the final good. In this scenario, the vertically integrated firm has no incentive to supply the intermediate good to the separated downstream manufacturer, forcing firm *D* to purchase the intermediate good from the less efficient input supplier *U,* thereby increasing firm *D's* marginal cost. Therefore, firm *D*'s output shrinks while firm *I* increases its downstream output through strategic substitutes. From firm *I*'s perspective, the extra profit from the downstream market outweighs the foregone revenue in its upstream potential input supply.

Based on the above discussion, we establish:

Proposition 1: *In the absence of an exclusive contract between the separated firms, the vertically integrated firm has no incentive to supply the intermediate good to its downstream rival if the rival is less efficient in producing the final good.*

This result differs from the conventional wisdom in which an efficient input supplier has no incentive to give up its profit from selling the intermediate good. However, by introducing a vertically integrated firm that is efficient in both upstream and downstream markets, we can prove that the integrated firm has no incentive to earn profit from supplying input to its downstream rival.

Based on the result derived in Proposition 1, it is abundantly apparent that the separated firms are indifferent on whether to sign the exclusive contract or not since firm *I*'s decision is independent of the separated firms' contract status. Therefore, we conclude with the following proposition:

Proposition 2: *Suppose the separated downstream manufacturer is less efficient than the vertically integrated firm in producing the final good. The separated firms are indifferent between signing and not signing the exclusive contract.*

Posner (1976) and Bork (1978) suggest that an inefficient seller cannot be a sole supplier by offering an exclusive contract to a rational buyer. However, in this section, we prove that an inefficient separated input supplier will always solely sell the intermediate good to an inefficient separated downstream manufacturer in the presence of a vertically integrated rival, regardless of the exclusivity status.

4. Regime B

This section considers the case where the separated downstream firm is more efficient than the vertically integrated firm in producing the final good, i.e., $c_D \leq c_I$. We follow the assumption laid down in Section 2, that $c_D = 0$, $c_I = c$. Further, we invoke the following assumptions for the analysis of this regime:

Assumption 1: $c < \frac{5}{7}$. This assumption guarantees that the final good producers can both survive in the downstream market.

Assumption 2: $m < \frac{1}{2} + \frac{c}{2}$. This assumption ensures that firms U and D produce positive quantities of the intermediate and final goods when they sign an exclusive contract.

4.1. Non-exclusivity

Suppose the separated downstream manufacturer rejects the exclusive contract from the separated upstream input supplier. In this case, the vertically integrated firm can join the upstream competition to supply the intermediate good to the separated downstream firm. Again, we solve this subgame by backward induction, starting from the downstream stage, wherein firm D and firm I maximize profit functions as follows:

(9.1) $$\pi_D^{BN} = \left(p^{BN} - w^{BN}\right) q_D^{BN}$$

(9.2) $$\pi_I^{BN} = \left(p^{BN} - c\right) q_I^{BN} + w^{BN} x_I^{BN}$$

where the superscript *"BN"* denotes variables associated with the non-exclusivity case in Regime B.

Differentiating (9) with respect to the downstream outputs and letting them equal *zero* yield the first-order conditions as:

(10.1) $$\frac{\partial \pi_D^{BN}}{\partial q_D^{BN}} = 1 - 2q_D^{BN} - q_I^{BN} - w^{BN} = 0$$

(10.2) $$\frac{\partial \pi_I^{BN}}{\partial q_I^{BN}} = 1 - q_D^{BN} - 2q_I^{BN} - c = 0$$

Solving (10.1) and (10.2) simultaneously yields:

(11.1) $$q_D^{BN} = \frac{1}{3}\left(1 + c - 2w^{BN}\right)$$

(11.2) $$q_I^{BN} = \frac{1}{3}\left(1 - 2c + w^{BN}\right)$$

Note that $q_D = x_U + x_I$. We obtain firm *D*'s derived demand of the intermediate good by (11.1) as:

(12) $$w^{BN} = \frac{1}{2} + \frac{c}{2} - \frac{3}{2}\left(x_U^{BN} + x_I^{BN}\right)$$

We proceed to the upstream stage, where the separated input supplier and the vertically integrated firm compete to supply the intermediate good to manufacturer *D*. Firm *U*'s profit function can be expressed as follows:

(13) $$\pi_U^{BN} = \left(w^{BN} - m\right)x_U^{BN}$$

By using (9.2), (11), (12), (13), and differentiating $\pi_j^{BN}\left(j = U, I\right)$ with respect to x_j^{BN}, then letting it equal *zero*, we obtain the first-order conditions as follows:[11]

(14.1) $$\frac{d\pi_U^{BN}}{dx_U^{BN}} = \overbrace{\frac{\partial \pi_U^{BN}}{\partial w^{BN}}\frac{\partial w^{BN}}{\partial x_U^{BN}}}^{\text{input price effect }(-)} + \overbrace{\frac{\partial \pi_U^{BN}}{\partial x_U^{BN}}}^{\text{direct effect }(+)} = x_U^{BN}\left(-\frac{3}{2}\right) + \left(w^{BN} - m\right) = \frac{1}{2} - m + \frac{c}{2} - 3x_U^{BN} - \frac{3}{2}x_I^{BN} = 0$$

[11] The effect of x_I^{BN} on π_I^{BN} through q_I^{BN} vanishes due to the envelope theorem.

(14.2)

$$\frac{d\pi_I^{BN}}{dx_I^{BN}} = \overbrace{\frac{\partial \pi_I^{BN}}{\partial q_D^{BN}}\frac{dq_D^{BN}}{dx_I^{BN}}}^{\text{strategic effect }(-)} + \overbrace{\frac{\partial \pi_I^{BN}}{\partial w^{BN}}\frac{\partial w^{BN}}{\partial x_I^{BN}}}^{\text{input price effect }(-)} + \overbrace{\frac{\partial \pi_I^{BN}}{\partial x_I^{BN}}}^{\text{direct effect }(+)} = \left(-q_I^{BN}\right)(1) + \left(x_I^{BN}\right)\left(-\frac{3}{2}\right) + \left(w^{BN}\right) = c - x_U^{BN} - \frac{5}{2}x_I^{BN} = 0$$

We learn from (14) that the effects of $x_j^{BN}\left(j=U,I\right)$ on π_j^{BN} are similar to those in (8). However, Eq. (14.2) differs from (8.2) in that the strategic and input price effects do not always outweigh the direct effect. It is because the vertically integrated firm *I* is now less efficient than the rival firm *D* in the downstream market. Therefore, firm *I* focuses more on its upstream profit if its upstream cost advantage is high enough. In this scenario, firm *I* will raise its upstream output to compete with its upstream rival to earn higher upstream profit. Moreover, when firm *I* increases its input supply to firm *D*, its downstream rival's marginal cost reduces due to a decrease in the input price. Ultimately, firm *D*'s downstream output becomes higher, and then firm *I* can earn more upstream profit by supplying the intermediate good to its downstream rival.

Solving (14.1) and (14.2) simultaneously yields the interior solutions of x_U^{BN} and x_I^{BN} as:

(15.1) $$x_U^{BN} = \frac{5}{24} - \frac{c}{24} - \frac{5m}{12}$$

(15.2) $$x_I^{BN} = -\frac{1}{12} + \frac{5c}{12} + \frac{m}{6}$$

It follows from (15) that firm *U* and firm *I* will joint supply the intermediate good to manufacturer *D* if $\frac{1}{2} - \frac{5c}{2} < m < \frac{1}{2} - \frac{c}{10}$. However, if $m \le \frac{1}{2} - \frac{5c}{2}$, firm *U* will be the sole input supplier to manufacturer *D*, i.e., $x_I^{BN} = 0$. On the contrary, the vertically integrated firm will be the sole input supplier to its downstream rival, i.e., $x_U^{BN} = 0$, if $m \ge \frac{1}{2} - \frac{c}{10}$.[12] The equilibrium outcomes in the non-exclusivity case are reported in Table 1 hereunder.

12 We calculate from (15) that both x_U^{BN} and x_I^{BN} are positive when $\frac{1}{2} - \frac{5c}{2} < m < \frac{1}{2} - \frac{c}{10}$. When $m \le \frac{1}{2} - \frac{5c}{2}$, $x_I^{BN} \le 0$, and when $m \ge \frac{1}{2} - \frac{c}{10}$, $x_U^{BN} \le 0$.

TABLE 1
THE EQUILIBRIUM OUTCOMES IN THE NON-EXCLUSIVITY CASE IN REGIME B

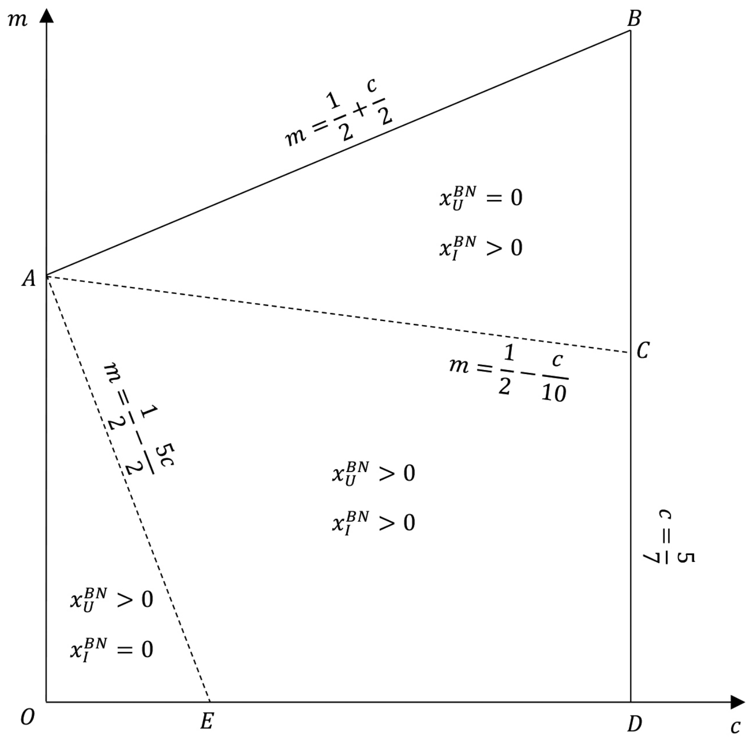
	$m \le \frac{1}{2} - \frac{5c}{2}$	$\frac{1}{2} - \frac{5c}{2} < m < \frac{1}{2} - \frac{c}{10}$	$m \ge \frac{1}{2} - \frac{c}{10}$
x_U^{BN}	$\frac{1}{6} + \frac{c}{6} - \frac{m}{3}$	$\frac{5}{24} - \frac{c}{24} - \frac{5m}{12}$	0
x_I^{BN}	0	$-\frac{1}{12} + \frac{5c}{12} + \frac{m}{6}$	$\frac{2c}{5}$
q_D^{BN}	$\frac{1}{6} + \frac{c}{6} - \frac{m}{3}$	$\frac{1}{8} + \frac{3c}{8} - \frac{m}{4}$	$\frac{2c}{5}$
q_I^{BN}	$\frac{5}{12} - \frac{7c}{12} + \frac{m}{6}$	$\frac{7}{16} - \frac{11c}{16} + \frac{m}{8}$	$\frac{1}{2} - \frac{7c}{10}$
w^{BN}	$\frac{1}{4} + \frac{c}{4} + \frac{m}{2}$	$\frac{5}{16} - \frac{c}{16} + \frac{3m}{8}$	$\frac{1}{2} - \frac{c}{10}$
π_D^{BN}	$\left(\frac{1}{6} + \frac{c}{6} - \frac{m}{3}\right)^2$	$\left(\frac{1}{8} + \frac{3c}{8} - \frac{m}{4}\right)^2$	$\left(\frac{2c}{5}\right)^2$
π_U^{BN}	$\frac{3}{2}\left(\frac{1}{6} + \frac{c}{6} - \frac{m}{3}\right)^2$	$\frac{3}{2}\left(\frac{5}{24} - \frac{c}{24} - \frac{5m}{12}\right)^2$	0
π_I^{BN}	$\left(\frac{5}{12} - \frac{7c}{12} + \frac{m}{6}\right)^2$	$\left(\frac{7}{16} - \frac{11c}{16} + \frac{m}{8}\right)^2 +$ $\left(\frac{5}{16} - \frac{c}{16} + \frac{3m}{8}\right)\left(-\frac{1}{12} + \frac{5c}{12} + \frac{m}{6}\right)$	$\frac{1}{4} - \frac{c}{2} + \frac{9c^2}{20}$

We depict Figure 2 to visually illustrate the impact of the cost differentials, i.e., *m* and *c*, on the upstream market competition in the non-exclusivity case.

Here, the vertical line BD denotes the restriction in Assumption 1, in which our feasible area is on the left-hand side of the line $\left(c < \frac{5}{7}\right)$. Line AB indicates the restriction in Assumption 2, where the feasible area is beneath the line $\left(m < \frac{1}{2} + \frac{c}{2}\right)$. In addition, line AC (AE) represents the equality $m = \frac{1}{2} - \frac{c}{10}$ $\left(m = \frac{1}{2} - \frac{5c}{2}\right)$. According to Table 1, area OAE (ABC) is linked to the case where firm *U* (firm *I*) is the sole input supplier to manufacturer *D*. Otherwise, area ACDE depicts the scenario when the separated downstream firm purchases the intermediate good from both suppliers.

The intuition behind this result is as follows. Given the downstream cost differential (*c*), a sufficiently low upstream cost differential (*m*) indicates that the vertically integrated firm is not efficient enough relative to the separated upstream firm. It follows that firm *I*'s potential profit from supplying input to its

FIGURE 2
THE UPSTREAM COMPETITION IN THE NON-EXCLUSIVITY CASE IN REGIME B



downstream rival is low. In this scenario, the foregone profit from the upstream market is more than compensated by the extra benefit attained in the final good market when firm *D* is supplied only by the less efficient upstream firm. Next, if the upstream cost differential is high enough, the separated upstream firm is too inefficient, forcing it to shut down its production. Finally, if the upstream cost differential is medium, neither firm *U* nor firm *I* is too inefficient such that none of them is deterred from supplying the intermediate good to firm *D*.

Based on the preceding discussion, we establish the following proposition:

Proposition 3: *Suppose the separated downstream manufacturer is more efficient than the vertically integrated firm in producing the final good. Given the downstream cost differential, the upstream market outcomes in the absence of the exclusive contract between the separated firms will be one of the following three cases:*

(i) If the upstream cost differential is low enough, i.e., $m \leq \frac{1}{2} - \frac{5c}{2}$, *the separated upstream firm becomes the sole input supplier of the separated downstream manufacturer.*

(ii) If the upstream cost differential is high enough, i.e., $m \geq \frac{1}{2} - \frac{c}{10}$, *the vertically integrated firm becomes the sole input supplier of the separated downstream manufacturer.*

(iii) If the upstream cost differential is in an intermediate range, i.e., $\frac{1}{2} - \frac{5c}{2} < m < \frac{1}{2} - \frac{c}{10}$, *the separated upstream firm and the vertically integrated firm will joint supply the intermediate good to the separated downstream manufacturer.*

4.2. Exclusivity

We proceed to the case in which manufacturer D accepts the exclusive contract from supplier U. It follows that the vertically integrated firm is effectively deterred from supplying the intermediate good to its downstream rival. By referring to Table 1, the separated firms' respective equilibrium profits under exclusivity are obtained as follows:[13]

$$\pi_D^{BE} = \left(\frac{1}{6} + \frac{c}{6} - \frac{m}{3}\right)^2 + F^{BE} \tag{16.1}$$

$$\pi_U^{BE} = \frac{3}{2}\left(\frac{1}{6} + \frac{c}{6} - \frac{m}{3}\right)^2 - F^{BE} \tag{16.2}$$

where the superscript "*BE*" is associated with variables under exclusivity in Regime B.

4.3. Contract decision

We first analyze the contract decision when $m \leq \frac{1}{2} - \frac{5c}{2}$. In this interval, the operating profits of the respective firms are the same either when supplier U and manufacturer D sign or do not sign an exclusive contract. Recall that that the vertically integrated firm has no incentive to supply the intermediate good to its downstream rival in both scenarios. It follows that the optimal fixed payment supplier U needs to deliver to manufacturer D is *zero*, i.e., $F^{BE} = 0$, and

[13] The firms' operating profits are the same as those in the non-exclusivity case when $m \leq \frac{1}{2} - \frac{5c}{2}$ since firm I will not supply its intermediate good to its downstream rival if the separated firms do not sign the contract.

the separated firms are indifferent between signing or not signing that contract. The intuition behind Proposition 3 applies to this result.

Following Kitamura *et al.* (2018), the separated firms will sign the exclusive contract if their joint profit post-contract is no less than that in the absence of exclusivity, i.e., $\pi_U^{BE} + \pi_D^{BE} \geq \pi_U^{BN} + \pi_D^{BN}$. When $m \geq \frac{1}{2} - \frac{c}{10}$, we derive the difference in the separated firms' joint profits between exclusivity and non-exclusivity cases by referring to (16) and Table 1 as follows:[14]

$$\text{(17)} \qquad \left(\pi_U^{BE} + \pi_D^{BE}\right) - \left(\pi_U^{BN} + \pi_D^{BN}\right) = \frac{5}{2}\left(\frac{1}{6} + \frac{c}{6} - \frac{m}{3}\right)^2 - \left(\frac{2c}{5}\right)^2 < 0$$

We find, from (17), that the exclusive contract cannot be signed by the separated firms. The economic intuition behind this result is as follows. When $m \geq \frac{1}{2} - \frac{c}{10}$, the separated upstream firm is sufficiently inefficient in producing the intermediate good. In this case, it cannot earn enough extra profit post-contract to compensate the separated downstream firm. Thus, exclusivity cannot appear in equilibrium in this interval.

Finally, we discuss the contract decision when $\frac{1}{2} - \frac{5c}{2} < m < \frac{1}{2} - \frac{c}{10}$. From (16) and Table 1, we derive the separated firms' joint profit difference as follows:

$$\text{(18)} \qquad \left(\pi_U^{BE} + \pi_D^{BE}\right) - \left(\pi_U^{BN} + \pi_D^{BN}\right) = \left(-\frac{1}{24} + \frac{5c}{24} + \frac{m}{12}\right)\left(\frac{13}{48} - \frac{17c}{48} - \frac{13m}{24}\right)$$

The first term on the right-hand side of (18) is positive since $m > \frac{1}{2} - \frac{5c}{2}$. Thus, the overall sign of this equation depends on the second term only. We therefore obtain:[15]

$$\text{(19)} \qquad \left(\pi_U^{BE} + \pi_D^{BE}\right) - \left(\pi_U^{BN} + \pi_D^{BN}\right) \gtreqless 0 \text{ if } m \lesseqgtr \frac{1}{2} - \frac{17c}{26}$$

---

14 We can rewrite the joint profit difference as $\left[\frac{\sqrt{10}}{2}\left(\frac{1}{6}+\frac{c}{6}-\frac{m}{3}\right)+\left(\frac{2c}{5}\right)\right]\left[\frac{\sqrt{10}}{2}\left(\frac{1}{6}+\frac{c}{6}-\frac{m}{3}\right)-\left(\frac{2c}{5}\right)\right]$. The former term $\frac{\sqrt{10}}{2}\left(\frac{1}{6}+\frac{c}{6}-\frac{m}{3}\right)+\left(\frac{2c}{5}\right)$ is positive because of Assumption 2, while the latter, $\frac{\sqrt{10}}{2}\left(\frac{1}{6}+\frac{c}{6}-\frac{m}{3}\right)-\left(\frac{2c}{5}\right)$, can be rewritten as $\frac{\sqrt{10}}{6}\left(\frac{1}{2}+\left(\frac{1}{2}-\frac{6\sqrt{10}}{25}\right)c-m\right)$. We then obtain $\frac{\sqrt{10}}{6}\left(\frac{1}{2}+\left(\frac{1}{2}-\frac{6\sqrt{10}}{25}\right)c-m\right) \leq \frac{\sqrt{10}}{6}\left(\frac{1}{2}-\frac{c}{10}-m\right) \leq 0$ since $m \geq \frac{1}{2}-\frac{c}{10}$.

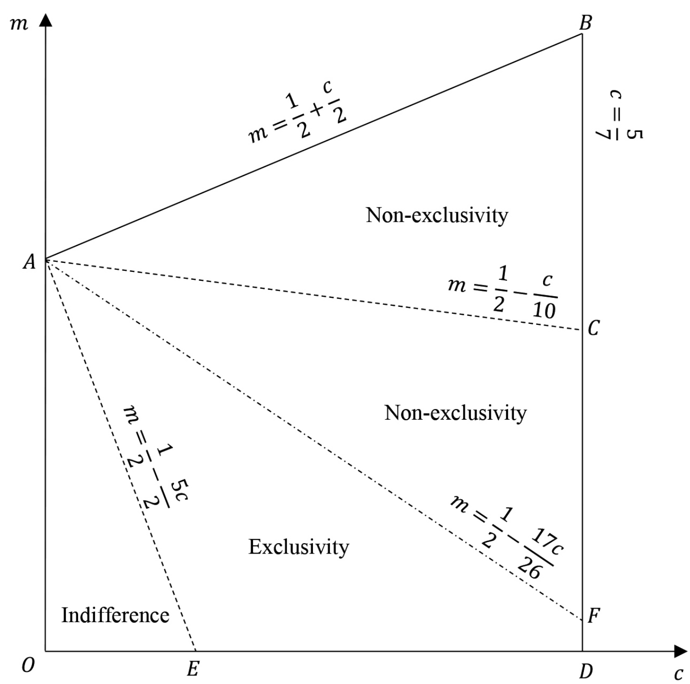
15 The sign of the second term on the right-hand side of (18) is positive, equal to *zero*, or negative when m is less than, equal to, or greater than $\frac{1}{2}-\frac{17c}{26}$.

We find from (19) and the currently considered interval that if $\frac{1}{2}-\frac{5c}{2}<m\le\frac{1}{2}-\frac{17c}{26}$, the separated firms are willing to sign the exclusive contract, while the reverse occurs otherwise. These results can be explained as follows. When the upstream cost differential satisfies $\frac{1}{2}-\frac{5c}{2}<m\le\frac{1}{2}-\frac{17c}{26}$, the separated upstream firm is not sufficiently inefficient in producing the intermediate good. On the one hand, given this condition, the integrated firm still has an incentive to provide input for firm *D* in the non-exclusivity case, leading to a small profit for firm *U*. On the other hand, since firm *U* is not too inefficient, signing the contract creates a large enough extra profit. As a result, the separated firms' joint profit post-contract becomes higher such that the contract will be signed.

Next, if $\frac{1}{2}-\frac{17c}{26}\le m<\frac{1}{2}-\frac{c}{10}$, the economic intuition of the case when $m\ge\frac{1}{2}-\frac{c}{10}$ carries over to this case such that the non-exclusivity result will appear in equilibrium.

Premised on the preceding analysis, we use Figure 3 to illustrate the cost differentials' impact on the separated firms' exclusive contract decision.

FIGURE 3
THE SEPARATED FIRMS' CONTRACT DECISIONS IN REGIME B



In Figure 3, the exclusive contract occurs in area AEDF, the non-exclusivity equilibrium counterpart takes place in area ABF, and it is indifferent between exclusivity and non-exclusivity in area OAE. We summarize the results in the following proposition:

Proposition 4. *Suppose the separated downstream manufacturer is more efficient than the vertically integrated firm in producing the final good. Given the downstream cost differential, the separated firms' contract decision will be one of the following three cases:*

(i) If the upstream cost differential is relatively low, i.e., $m \leq \frac{1}{2} - \frac{5c}{2}$, *the separated firms will be indifferent between signing or not signing the contract.*

(ii) If the upstream cost differential is medium, i.e., $\frac{1}{2} - \frac{5c}{2} < m \leq \frac{1}{2} - \frac{17c}{26}$, *the exclusivity equilibrium occurs.*

(iii) If the upstream cost differential is relatively high, i.e., $m \geq \frac{1}{2} - \frac{17c}{26}$, *the non-exclusivity will appear in a unique equilibrium.*

Proposition 4 differs from the Chicago School's classic argument, concluding that an exclusivity equilibrium can never occur if the seller is inefficient. However, by introducing a vertically integrated rival with an inefficient downstream sector, we are able to show that the exclusive contract can be signed as a unique choice if the upstream cost differential is medium.[16]

5. Welfare Analysis

This section discusses the effect of exclusive dealing on consumer surplus and social welfare. Recall that the equilibria in the non-exclusivity and exclusivity cases are identical in Regime A and when $m \leq \frac{1}{2} - \frac{5c}{2}$ in Regime B. Therefore, the presence of an exclusive contract between firm U and firm D will not change the values of consumer surplus and social welfare under these circumstances.

[16] We find, from Propositions 2 and 4, that if the downstream cost differential is zero in both regimes, i.e., firm D and firm I are equally efficient in producing the final good, the separated firms are indifferent on whether to sign the exclusive contract or not. It is different from the result derived by Fumagalli and Motta (2006). Their paper shows that the exclusive agreements from an inefficient incumbent to two equally efficient downstream buyers are only signed when the buyers do not compete, and the incumbent pays zero reimbursements. The difference between ours and theirs is based on the competition modes in the vertically related markets and the impacts of the integrated rival's trading behaviors.

We proceed to discuss the two cases where $\frac{1}{2}-\frac{5c}{2}<m<\frac{1}{2}-\frac{c}{10}$ and $m\geq\frac{1}{2}-\frac{c}{10}$ in Regime B. It should be noted that the consumer surplus and social welfare functions are defined as follows:[17]

(20.1) $$CS=\int p(Q)dQ-pQ=\frac{1}{2}Q^2$$

(20.2) $$W=\pi_U+\pi_D+\pi_I+CS$$

By referring to Table 1 and (20), we derive that:[18]

(21.1) $$Q^{BE}-Q^{BN}=\begin{cases}\frac{1}{48}-\frac{5c}{48}-\frac{m}{24}<0 \text{ when } \frac{1}{2}-\frac{5c}{2}<m<\frac{1}{2}-\frac{c}{10}\\ \frac{1}{12}-\frac{7c}{60}-\frac{m}{6}<0 \text{ when } m\geq\frac{1}{2}-\frac{c}{10}\end{cases}$$

(21.2)
$$W^{BE}-W^{BN}=\begin{cases}-\frac{(131c+206m+41)(5c+2m-1)}{4608}<0 \quad \text{when } \frac{1}{2}-\frac{5c}{2}<m<\frac{1}{2}-\frac{c}{10}\\ \frac{11}{288}+\frac{43c}{720}-\frac{17m}{72}-\frac{1141c^2}{7200}-\frac{29cm}{72}+\frac{23m^2}{72}<0 \text{ when } m\geq\frac{1}{2}-\frac{c}{10}\end{cases}$$

From the above discussion and (21), we find that in both regimes, the consumer surplus represented by the total downstream output and the social welfare post-contract will not be improved. Thus, we conclude this result by the following proposition.

Proposition 5. *An exclusive contract between two separated firms in the presence of a vertically integrated rival will never increase consumer surplus and social welfare.*

This result is in line with conventional wisdom, in which an exclusive contract reduces the degree of competition among sellers, leading to higher prices, lower consumer surplus, and lower social welfare.

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17 The consumer surplus function $CS=\frac{1}{2}Q^2$ is followed by the linear demand $p(Q)=1-Q$.

18 Please see Appendix B for the proof that $W^{BE}-W^{BN}=\frac{11}{288}+\frac{43c}{720}-\frac{17m}{72}-\frac{1141c^2}{7200}-\frac{29cm}{72}+\frac{23m^2}{72}<0$ when $m\geq\frac{1}{2}-\frac{c}{10}$.

6. Concluding Remarks

Chicago School's classic argument on exclusive dealing has prompted controversy among scholars. This paper reexamines whether this argument is still valid in a successive Cournot model. We, therefore, consider a three-firm model in which a separated upstream input supplier offers an exclusive contract to a separated downstream manufacturer to prevent a vertically integrated firm from supplying the input to the downstream party. Meanwhile, the separated downstream manufacturer competes against the vertically integrated firm in the downstream market.

Three main results have been derived in the paper. First, the separated firms are indifferent on whether to sign the exclusive contract or not if the downstream party is less efficient than the integrated firm in producing the final good. Second, the separated firms with an efficient downstream party are indifferent between signing or not signing, willing to sign, and not willing to sign the exclusive contract if the upstream cost differential is relatively low, medium, and high, respectively. Third, signing such an exclusive contract does not increase consumer surplus and social welfare.

Our results are specific to the successive Cournot model, in which the upstream quantity competition is not widespread in the context of exclusive dealing. It would be interesting for future research to conduct a similar analysis involving upstream price competition. Moreover, it will be an appealing challenge for future research to adopt a per-unit discount or a mixed reimbursement to replace the assumption of lump-sum reimbursement in the exclusive contract when the sellers compete in quantity.

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Appendix A

This Appendix aims to show that the result in Regime A is robust for a general demand function. Let us denote the inverse demand function as:

(A.1) $$p = p(Q),\ p' < 0$$

In the non-exclusivity case, manufacturer *D*'s and firm *I*'s profit functions are the same as those in (2). By differentiating $\pi_i^{AN}\,(i = D, I)$ with respect to q_i^{AN} and letting it equal *zero*, we obtain the first-order conditions of the downstream stage as follows:

(A.2.1) $$\frac{\partial \pi_D^{AN}}{\partial q_D^{AN}} = \left(p^{AN}\right)' q_D^{AN} + p^{AN} - c_D - w^{AN} = 0$$

(A.2.2) $$\frac{\partial \pi_I^{AN}}{\partial q_I^{AN}} = \left(p^{AN}\right)' q_I^{AN} + p^{AN} - c_I = 0$$

The second-order and stability conditions require:

(A.3.1) $$\frac{\partial^2 \pi_D^{AN}}{\partial \left(q_D^{AN}\right)^2} = 2\left(p^{AN}\right)' + \left(p^{AN}\right)'' q_D^{AN} < 0$$

(A.3.2) $$\frac{\partial^2 \pi_I^{AN}}{\partial \left(q_I^{AN}\right)^2} = 2\left(p^{AN}\right)' + \left(p^{AN}\right)'' q_I^{AN} < 0$$

(A.3.3) $$\Delta^{AN} = \left[\frac{\partial^2 \pi_D^{AN}}{\partial \left(q_D^{AN}\right)^2}\right] \times \left[\frac{\partial^2 \pi_I^{AN}}{\partial \left(q_I^{AN}\right)^2}\right] - \left[\frac{\partial^2 \pi_D^{AN}}{\partial q_D^{AN}\,\partial q_I^{AN}}\right] \times \left[\frac{\partial^2 \pi_I^{AN}}{\partial q_I^{AN}\,\partial q_D^{AN}}\right] > 0$$

where $\frac{\partial^2 \pi_D^{AN}}{\partial q_D^{AN}\,\partial q_I^{AN}} = \left(p^{AN}\right)' + \left(p^{AN}\right)'' q_D^{AN} < 0$ and $\frac{\partial^2 \pi_I^{AN}}{\partial q_I^{AN}\,\partial q_D^{AN}} = \left(p^{AN}\right)' + \left(p^{AN}\right)'' q_I^{AN} < 0$.[19]

[19] The last two expressions are assumed to ensure that manufacturer *D*'s and firm *I*'s downstream marginal revenue curves are steeper than the final good demand curve. See Brander and Spencer (1985), Dixit (1986), and Hwang and Mai (1991).

Totally differentiating (A.2.1) and (A.2.2) yields:

(A.4.1) $$\frac{dq_D^{AN}}{dw^{AN}} = \frac{\left[2\left(p^{AN}\right)' + \left(p^{AN}\right)'' q_I^{AN}\right]}{\Delta^{AN}} < 0$$

(A.4.2) $$\frac{dq_I^{AN}}{dw^{AN}} = -\frac{\left[\left(p^{AN}\right)' + \left(p^{AN}\right)'' q_I^{AN}\right]}{\Delta^{AN}} > 0$$

It is apparent from (A.4) that a hike in the input price causes a fall in the separated downstream manufacturer's output while increasing firm *I*'s downstream output. It is because an increase in w^{AN} raises manufacturer *D*'s marginal cost. As a result, q_D^{AN} decreases. By strategic substitutes, firm *I* will produce more in the final good market.

Note that one unit of input is sufficient to produce one unit of output, i.e., $q_D = x_U + x_I$. Let $w^{AN} = w^{AN}\left(x_U, x_I\right)$ be firm *D*'s derived demand of the intermediate good. By (A.4.1) and $q_D^{AN} = x_U^{AN} + x_I^{AN}$, we obtain:

(A.5) $$\frac{\partial w^{AN}}{\partial\left(x_U^{AN} + x_I^{AN}\right)} = \frac{\Delta^{AN}}{\left(2\left(p^{AN}\right)' + \left(p^{AN}\right)'' q_I^{AN}\right)} < 0$$

By (A.4) and (A.5), we obtain:

(A.6.1) $$\frac{dq_D^{AN}}{dx_U^{AN}} = \frac{dq_D^{AN}}{dx_I^{AN}} = 1 > 0$$

(A.6.2) $$\frac{dq_I^{AN}}{dx_U^{AN}} = \frac{dq_I^{AN}}{dx_I^{AN}} = -\frac{\left[\left(p^{AN}\right)' + \left(p^{AN}\right)'' q_I^{AN}\right]}{\left[2\left(p^{AN}\right)' + \left(p^{AN}\right)'' q_I^{AN}\right]} < 0$$

In the upstream stage, input supplier *U*, which maximizes the profit function as in (7), competes against firm *I* in a quantity fashion. By referring to (2.2), (7), (A.2), (A.5), and (A.6.1), the first-order conditions are derived as follows:[20]

[20] In (A.7.2), the effect of x_I^{AN} on π_I^{AN} through q_I^{AN} vanishes due to the envelope theorem. Moreover, we derive from (2.2), (A.2), (A.5), and (A.6.1) that the strategic effect equals $\left(p^{AN}\right)' q_I^{AN} = c_I - p^{AN} < 0$, the input price effect equals $x_I^{AN}\left[\frac{\Delta^{AN}}{\left(2\left(p^{AN}\right)' + \left(p^{AN}\right)'' q_I^{AN}\right)}\right] < 0$, and the direct equals $w^{AN} = \left(p^{AN}\right)' q_D^{AN} + p^{AN} - c_D > 0$. The strategic effect outweighs the

(A.7.1)

$$\frac{d\pi_U^{AN}}{dx_U^{AN}} = \overbrace{\left(\frac{\partial \pi_U^{AN}}{\partial w^{AN}}\right)\left(\frac{\partial w^{AN}}{\partial x_U^{AN}}\right)}^{\text{input price effect }(-)} + \overbrace{\frac{\partial \pi_U^{AN}}{\partial x_U^{AN}}}^{\text{direct effect }(+)} = x_U^{AN}\left[\frac{\Delta^{AN}}{\left(2\left(p^{AN}\right)' + \left(p^{AN}\right)'' q_I^{AN}\right)}\right] + \left(w^{AN} - m\right) = 0$$

(A.7.2)

$$\frac{d\pi_I^{AN}}{dx_I^{AN}} = \overbrace{\left(\frac{\partial \pi_I^{AN}}{\partial q_D^{AN}}\right)\left(\frac{dq_D^{AN}}{dx_I^{AN}}\right)}^{\text{strategic effect }(-)} + \overbrace{\left(\frac{\partial \pi_I^{AN}}{\partial w^{AN}}\right)\left(\frac{\partial w^{AN}}{\partial x_I^{AN}}\right)}^{\text{input price effect }(-)} + \overbrace{\frac{\partial \pi_I^{AN}}{\partial x_I^{AN}}}^{\text{direct effect }(+)} = \left(p^{AN}\right)' q_D^{AN} + c_I - c_D + x_I^{AN}\left[\frac{\Delta^{AN}}{\left(2\left(p^{AN}\right)' + \left(p^{AN}\right)'' q_I^{AN}\right)}\right] < 0$$

Since $\frac{d\pi_I^{AN}}{dx_I^{AN}} < 0,$ firm *I* will not supply its intermediate good to manufacturer *D* in the non-exclusivity case. The result in Regime A is robust for a general demand function accordingly.

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direct effect since the summation of the two is as $\left(p^{AN}\right)' q_D^{AN} + c_I - c_D < 0.$ In addition, the input price effect is also negative. As a result, $\frac{d\pi_I^{AN}}{dx_I^{AN}} < 0.$

Appendix B

This Appendix proves that the welfare difference between exclusivity and non-exclusivity cases in Regime B is negative when $m \geq \frac{1}{2} - \frac{c}{10}$. Let *f*(*c, m*) denote the function of this welfare difference derived in (21.2), i.e., $f(c,m) = \frac{11}{288} + \frac{43c}{720} - \frac{17m}{72} - \frac{1141c^2}{7200} - \frac{29cm}{72} + \frac{23m^2}{72}$.

We employ the following figure (Figure B.1) to determine the sign of *f*(*c, m*) when $m \geq \frac{1}{2} - \frac{c}{10}$. It should be noted that the horizontal (vertical) axis is for the downstream (upstream) cost differential. In addition, the solid curve represents *f*(*c, m*) = 0. The condition for this case and the two assumptions mentioned at the beginning of Regime B require that the feasible area is between the dash line $m = \frac{1}{2} + \frac{c}{2}$ and the dash-dot line $m = \frac{1}{2} - \frac{c}{10}$ with $c < \frac{5}{7}$. Since the feasible area is inside the solid curve, all the points of *c* and *m* located inside this area result in the same sign of *f*(*c, m*). Taking (*c, m*) = (0.6, 0.6) as an example yields *f*(0.6, 0.6) < 0. It follows that *f*(*c, m*) < 0 when $m \geq \frac{1}{2} - \frac{c}{10}$.

FIGURE B.1

A PLOT OF $f(c,m) = 0$ WHEN $m \geq \frac{1}{2} - \frac{c}{10}$ IN REGIME B