Exclusive Dealing Competition in Asymmetric Markets

by

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This paper develops a theoretical model of exclusive dealing (ED) between a dominant input supplier and a smaller rival supplier in vertically related markets with asymmetric sizes and differentiated products. We characterize equilibrium outcomes and welfare effects. When product differentiation is low, manufacturers single-source to soften downstream competition, yielding upstream monopoly with shared rents. In such a case, the dominant supplier prevails with large market asymmetry, while the smaller rival can win when preference in the small market is strong. With high differentiation, manufacturers choose different suppliers. As an implication, ED may enhance welfare by reducing double marginalization and intensifying downstream competition.

Keywords: exclusive dealing, market asymmetry, supplier competition, vertical contracts, welfare-enhancing exclusive dealing

JEL classification code: L13, L42, K21, D43, L41

1 Introduction

Exclusive Dealing (ED) refers to contractual agreements in which a manufacturer commits to purchasing inputs exclusively from a single supplier. Such agreements have long been a focus of antitrust scrutiny, as they can allow incumbent firms to deter the entry of more efficient competitors, thereby reducing social welfare. The debate over the impact of ED on market efficiency was significantly shaped by the 'Chicago School Argument,' advanced by Posner (2009) and Bork (1978), which suggests that a rational buyer would never enter into an exclusive dealing contract with an incumbent supplier if a more efficient entrant is available. According to this argument, the benefits of receiving from a more efficient supplier outweigh any potential compensation an incumbent could offer for losses incurred due to the exclusive dealing.

Despite the Chicago School's influential view, many scholars have challenged

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the argument by considering various market environments where incumbent suppliers can effectively compensate downstream manufacturers for their losses through ED contracts. For instance, Rasmusen, Ramseyer, and Wiley Jr (1991) and Segal and Whinston (2000) explore the role of scale economies, while Abito and Wright (2008) examine downstream competition. Fumagalli, Motta, and Rønde (2012) introduce the role of innovation, and DeGraba (2013) and Calzolari and Denicolò (2013, 2015) focus on market dominance. Kitamura, Matsushima, and Sato (2018) consider the role of complementary inputs, whereas Ide, Montero, and Figueroa (2016) analyze discounting as a barrier to entry. Particularly relevant to our study is DeGraba (2013), who finds that a dominant input supplier can use its size to prevent a small rival from competing in the market through ED.

This paper examines ED competition in vertically related markets with asymmetric market sizes. We adopt the extended Hotelling (1929) framework developed by Hwang and Mai (1990) and Liang, Hwang, and Mai (2006), commonly referred to as *the barbell model*, in which two manufacturers are located at opposite ends of a unit-length characteristic line, each serving consumers that are concentrated at the endpoints of the line market segment. These endpoints represent two distinct markets that differ in size and consumer preferences. In this setting, manufacturers in both large and small markets can choose between a dominant supplier and a smaller rival supplier. Unlike DeGraba (2013), who restricts ED competition to the small market by assuming that the large-market manufacturer must purchase from the dominant supplier, our model allows ED competition to occur in both markets. We also relax the assumptions of product homogeneity and constant demand by introducing horizontal and vertical product differentiation and elastic demand. This more general framework reveals that the dominant supplier's ability to exclude its rival through ED may be significantly weakened when buyers in both markets have supplier choice and when demand is sensitive to product attributes. These highlight the importance of market structure and demand conditions in shaping the outcomes of ED competition.

A real-world example of the model presented in this paper is the microprocessor market. As of 2016, Intel dominated the consumer CPU market with a commanding 81.9% share, while AMD held a significantly smaller share at 18% (Pyrinis, 2019). However, in 2017, AMD introduced its high-performance Ryzen processors, strategically targeting the gaming PC market (Hayes, 2021). By the end of 2017, AMD had captured 82% of the gaming computer segment, while Intel's share dropped to 18%. Consequently, AMD's overall market share increased to approximately 30%, while Intel retained 70% of the total CPU market.

The asymmetry in this model is driven by two factors. The first is the difference in the market size as demonstrated above. The second is the differences in consumers' willingness to pay. In this context, original equipment manufacturers (OEMs) that produce Intel-based computers compete against those producing AMD-based computers. These OEMs represent the two manufacturers in our

model, with the option to source processors from either Intel, the dominant supplier, or AMD, the smaller rival. The two manufacturers sell their computers in two asymmetric markets: the general PC market and the gaming PC market. In the general PC market, consumers exhibit a higher willingness to pay for general-purpose computers compared to gaming computers. Conversely, in the gaming PC market, consumers prefer gaming computers over general-purpose ones. However, because general computers are more broadly used, the market for general PCs is significantly larger than that for gaming PCs. Thus, in the microprocessor market, Intel and AMD exhibit horizontal differentiation in that they serve different main purposes and vertical differentiation in that consumers in each PC market have a different willingness to pay for the final products. This real-world phenomenon is the motivation to consider horizontal and vertical product differentiation in our model.

Regarding the antitrust issue, Intel was accused of abusing its dominant market position after AMD filed an antitrust complaint with the European Commission in 2000 and the US Federal Trade Commission in 2005. Intel also reportedly paid Dell and Toshiba for using only Intel-based processors (FTC, 2010). This paper, therefore, provides a theory that models the competition between suppliers similar to that between Intel and AMD. Among other close examples are the chipset industry and the cloud computing market. In the mobile chipset industry, Qualcomm, the dominant player, was fined €997 million by the European Commission for ED contracts with manufacturers, including Apple, Samsung, and LG (European Commission, 2018). The smaller rival, MediaTek, has carved out positions in mid-range and gaming-focused segments by offering performance-optimized chipsets at more competitive prices.[1] In the cloud computing sector, dominant providers such as Microsoft and Amazon Web Services (AWS) have faced growing antitrust scrutiny over exclusive dealing and restrictive licensing that disadvantage rivals. Microsoft, for instance, settled with CISPE (Cloud Infrastructure Services Providers in Europe) for €20 million in 2024 after being accused of penalizing customers who used non-Microsoft cloud platforms (Reuters, 2024).[2]

Our model yields several novel findings. First, when transportation costs for

[1] In the mobile chipset industry, product differentiation spans both vertical and horizontal dimensions. Qualcomm focuses on offering a broad range of features and high general performance to meet diverse market needs. In contrast, MediaTek emphasizes optimizing battery efficiency, targeting consumers who prioritize power-saving performance. This strategic focus allows MediaTek to compete in segments less reliant on premium multi-feature chipsets.

[2] The cloud computing industry is characterized by two major market segments: enterprise-oriented and developer-oriented. The enterprise-oriented segment targets large enterprises with complex requirements, such as compliance, security, and scalability, with dominant players like AWS and Microsoft Azure leading this space. In contrast, the developer-oriented segment caters to small teams, startups, and individual developers, emphasizing cost-effectiveness, ease of use, and simplicity, as exemplified by providers such as DigitalOcean. In terms of vertical differentiation, enterprise-oriented products offer superior quality in reliability, security, compliance, scalability, and advanced capabilities such as data analytics and artificial intelligence, while developer-oriented products excel in user-friendliness and affordability, making them more attractive to smaller developers and startups.

final goods are low, downstream price competition is intense and manufacturers source from the same supplier to mitigate price competition, even at the cost of facing monopoly input prices. In this scenario, the winning supplier secures ED contracts in both markets, achieving upstream monopoly power. Crucially, however, the supplier internalizes downstream incentives and shares the monopoly rent with the manufacturers through compensation (transfer) fees, ensuring manufacturers' engagement in the ED scheme. Second, when transportation costs are high, product differentiation weakens downstream competition and manufacturers contract with different suppliers. In this setting, each supplier has an incentive to offer a lower input price to strengthen its downstream partner's competitive position. This outcome leads to more competitive input pricing, thereby avoiding monopoly distortions.

Third, the rise of the winning supplier depends on the relative magnitudes of market asymmetry and the differences in consumers' valuation over the two final products. The dominant supplier can secure both ED contracts when the market asymmetry is sufficiently large relative to the difference in consumers' willingness to pay for the final product. In such a case, the large market generates enough profit for the dominant supplier to fund a higher transfer fee to the manufacturer in the smaller market. However, when the consumer's willingness to pay in the smaller market is high (reflecting stronger vertical differentiation), the small rival may secure both ED contracts by leveraging the rent of its home market to outcompete the dominant supplier in the large market.

Finally, we demonstrate that ED can enhance total welfare when manufacturers split their choice of suppliers, thereby intensifying upstream competition, mitigating double marginalization, and improving overall efficiency compared to scenarios without ED. These findings extend the standard theory of ED by demonstrating that ED contracts do not universally foreclose competition or reduce welfare. Instead, under ED competition and differentiated products, ED may serve as an instrument of pro-competitive vertical efficiency, leading to enhanced social welfare. Standard foreclosure-based models fail to recognize these efficiency effects as they tend to assume a single upstream incumbent monopolist rather than competing suppliers. As a policy implication, assessments of exclusive dealing practices should not be fixated solely on their foreclosure potential, but should also consider suppliers' competition in offering the ED.

Related literature on exclusive dealing contains three strands of market environments. The first strand considers an increase in the number of downstream buyers, generating negative externalities. Rasmusen, Ramseyer, and Wiley Jr (1991) and Segal and Whinston (2000) introduce scale economies, such that ED can create a negative externality among downstream buyers, preventing them from obtaining the benefits of entry. By taking ED, the incumbent supplier can profitably deter a more efficient supplier by exploiting the externality. Second, Simpson and Wickelgren (2007), Abito and Wright (2008), DeGraba (2013), Calzolari and Denicolò (2013, 2015), and Ide, Montero, and Figueroa (2016) argue that enhancing downstream competition by raising the number of downstream manufacturers can generate a negative externality. This externality

lowers the manufacturer's profit under no ED, and hence, the opportunity cost of ED, such that ED can deter a more efficient supplier from exploiting this externality.

The second strand examines the case where there is only one downstream firm. Aghion and Bolton (1987) take into account liquidated damages, pointing out that the downstream buyer has to reimburse the damage suffered by the incumbent supplier if it breaches an ED agreement. In the same downstream market structure, Yong (1996) introduces capacity constraint, Farrell (2005) analyzes the case where suppliers engage in Cournot competition, Fumagalli, Motta, and Rønde (2012) takes into consideration R&D investment, and Liu and Meng (2021) consider ED competition between the suppliers. The third strand introduces complementary inputs. Kitamura, Matsushima, and Sato (2018) construct a model where the manufacturer employs two complementary inputs: one from an incumbent supplier and the other from a potential entrant supplier.

The remainder of the paper is organized as follows. Section 2 provides the basic model. Section 3 elaborates on the downstream equilibria where manufacturers compete. Section 4 analyzes ED competition between the dominant input supplier and the small rival. In Section 5, we compare welfare under no ED and with ED. The final section concludes the paper.

2 The Basic Model

We use the extended Hotelling model developed by Hwang and Mai (1990) and Liang, Hwang, and Mai (2006), known as the barbell model, to incorporate vertically related markets, as illustrated in Figure 1. As a variant of the Hotelling spatial model, the unique feature of the barbell model is that it assumes consumers are located at each of the endpoints of the Hotelling line market segment rather than along the line to capture the contrasting preferences of two groups of consumers over two distinct products. Two competing manufacturers, A and B, require either input d or r in producing final goods. Input d is produced by a dominant input supplier d, while a small rival supplier produces input r. Manufacturers convert a unit of input into a unit of a final good.

There are two distinct markets, markets 0 and 1. These markets are positioned at opposite ends of a characteristic line with a unit length. The left endpoint corresponds to products suited for general-purpose use, while the right endpoint represents products optimized for gaming purposes. To exhibit the asymmetric demand structure, we assume that there are $n_0 = \gamma$ consumers whose ideal characteristic is at the market 0, $n_1 = 1$ consumers at market 1, and no consumers along the line. Market 0 is larger than market 1, that is, $\gamma > 1$. In the PC market context illustrated earlier, this market asymmetry corresponds to the fact that the market for general computers is larger than that for gaming computers. The manufacturers can serve consumers in both markets. Manufacturer A and supplier d are located in market 0, whereas manufacturer B and supplier r are located in market 1, with the location defined by $x_A = 0$ and

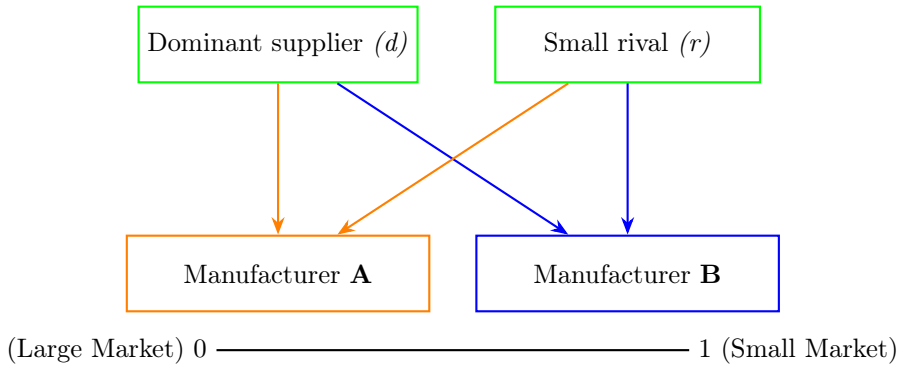


Figure 1
The Model

$x_B = 1$, respectively. [3]

As is common in horizontal differentiation models, consumers incur disutility when buying a product that deviates from their ideal products. This disutility can be measured as the transportation cost between the ideal and the available products.[4] The transport cost function is linear in distance, such that $t|x_i - x_k^l|$, where x_i is the characteristic of manufacturer i's product ($i = A, B$); x_k^l denotes the characteristic of consumer l, whose ideal product is at the site of market k ($x_0^l = 0, x_1^l = 1$); t is a per unit distance per unit output marginal disutility rate, equivalent to the transport rate in the location model. We further assume that input suppliers also incur transportation costs, which are linear in the distance to ship the intermediate input to manufacturers. Specifically, the transport cost rates for the input and the final goods are denoted by t_U and t_D, respectively.

Consumer valuation for the manufacturer A's product is normalized to 1 in both markets, while consumers value the manufacturer B's product at $1 + a$ in Market 1 and $1 - a$ in Market 0. In the microprocessor market example, this can be interpreted as all consumers having the same valuation for general computers, but some having a higher or lower valuation for gaming computers.

As we prove in Appendix D, the manufacturers always prefer to accept rather than reject an ED offer, as their profits are always higher when they accept an ED contract. The suppliers are able to provide the compensation fee above the minimum transfer required for a manufacturer to accept the ED contract.[5] Thus, we focus on the ED competition between suppliers in this model. For

[3] This spatial configuration follows Liang, Hwang, and Mai (2006) who show that when location is endogenized under the barbell model framework, firms locate at opposite endpoints.

[4] Please refer to Lederer and Hurter Jr (1986), Anderson and De Palma (1988), De Fraja and Norman (1993), Böckem (1994), Eaton and Schmitt (1994), and Shimizu (2002) for papers involving models with horizontal differentiation.

[5] When the manufacturers reject the contract, the model is reduced to the NO ED case.

the contracts, suppliers pay a compensatory payment to the manufacturers for securing exclusivity. Suppliers compete to offer ED contracts in each market, i.e., in market 0 for manufacturer A and in market 1 for manufacturer B. The suppliers price-discriminate across manufacturers and markets. A supplier aggressively lowers its input price in markets where the rival supplier's input is more attractive, while maintaining higher prices in markets where its own input is already preferred. Through this targeted price discrimination, the supplier strategically helps its downstream partner, enabling the manufacturer to compete more effectively in markets where the rival enjoys a competitive advantage. This behavior mirrors the conduct attributed to Intel during the FTC's investigation of its strategies toward AMD.[6] If a uniform wholesale price is imposed, this ability to strategically target and help a specific market to win downstream competition is eliminated.

The game structure is as follows. In Stage 1, suppliers compete simultaneously to offer ED contract packages consisting of a transfer fee (F) and an input price (w) to the manufacturer that wins the downstream competition in each market. At the end of this stage, the manufacturers decide which offer to accept. In stage 2, manufacturers compete in Bertrand fashion in the downstream market. We provide in Table 1 a summary of the notations used in the model.

Table 1
Summary of Key Notation

Notation	**Definition / Description**
Market 0	The large market
Market 1	The small market
s_i	The supplier chosen by Manufacturer i ($s_i \in \{d, r\}$)
w	Input Price
F^{si}	The fixed fee paid by Supplier s to Manufacturer i
$w_0^{s_i}$	The equilibrium wholesale price (w) offered by Supplier s to Manufacturer i in Market 0
t_U	The transportation cost for the input
t_D	The transportation cost for the downstream product
(s, u)	A Supplier Strategy Profile: Manufacturer A chooses s and B chooses u, where $s, u \in \{d, r\}$
γ	Parameter for Market Size/Demand Asymmetry
a	Relative strength of consumer preference/difference in willingness to pay

Given supplier offers and manufacturer responses, four ED configurations can arise: (d, d), (d, r), (r, d), and (r, r). Here, (d, d) denotes that both manufacturers accept ED contracts from the dominant supplier d; (d, r) indicates that manufacturer A contracts with d while B contracts with r; (r, d) the reverse; and (r, r) denotes that both contract with the rival supplier r. We can generalize

[6] During the European Commission's investigation of Intel (COMP/37.990), Intel offered conditional rebates to OEMs only in product segments where AMD posed a credible competitive threat, while keeping higher effective prices in segments in which Intel CPUs already faced little risk of substitution. Similar findings emerged in the FTC's enforcement records. Thus, the model captures the logic of strategic, market-specific price discrimination observed in the Intel–AMD rivalry. For details, refer to the European Commission. (2009). See also Federal Trade Commission. (2009). Complaint, In the Matter of Intel Corp. (Docket No. 9341). Comparable findings are also reported by the Japan Fair Trade Commission (2005).

these four configurations using (s, u) with $s \neq u; s, u = d, r$.

3 Downstream Competition

We solve the model using backward induction, beginning with the final stage of the game. Once ED contracts have been signed in the first stage, manufacturers engage in price competition à la Bertrand in the downstream market. Note that the Bertrand game in this framework exhibits a *winner-takes-all* property due to price competition with homogeneous products. Each manufacturer sets its delivered price equal to the sum of its input price, downstream transport cost, and the intrinsic valuation of the product. The firm with the lower delivered cost undercuts its rival and captures the entire market demand. The details of deriving the demands are provided in Appendix A. Assuming that manufacturer A is located in market 0, it has an advantage in driving manufacturer B out of market 0. Similarly, manufacturer B has a location advantage in market 1. This advantage is further amplified by consumer preferences. Firm A can serve consumers in market 0 at a lower delivered cost and therefore undercuts firm B's price to serve all demand in market 0. Conversely, firm B, having the same locational advantage in market 1, can set a slightly lower delivered price than firm A and capture the entire demand in market 1. Formally, this undercutting price can be represented as the rival's marginal cost plus the transportation cost, minus a positive term ϵ, where ϵ is small and is assumed to be zero throughout the paper. Recall that the willingness to pay for product A in both markets is 1, whereas that for product B in market 1 is $1 + a$ and in market 0 is $1 - a$. Given this asymmetry in consumer valuations and price undercutting behavior, each manufacturer captures the market in which it enjoys both locational and valuation advantages. Let p_k^{si} denote the price charged by manufacturer $i \in \{A, B\}$ in market $k \in \{0, 1\}$ when it sources inputs from supplier $s \in \{d, r\}$ under an ED contract.

For example, consider the case (d, r), where manufacturer A contracts with supplier d and B with supplier r. Under this case, the demand faced by the manufacturers is given by:

$$q_0^{dA}(d,r) = \gamma\left(1 - p_0^{dA}(d,r)\right) \qquad \text{if } p_0^{dA}(d,r) - p_0^{rB}(d,r) < 1 - (1-a), \tag{1.1}$$

$$q_1^{rB}(d,r) = 1 + a - p_1^{rB}(d,r) \qquad \text{if } p_1^{rB}(d,r) - p_1^{dA}(d,r) < (1+a) - 1. \tag{1.2}$$

To win market 0, manufacturer A sets its price, $p_0^{dA}(d, r)$, slightly below manufacturer B's delivered cost of serving that market, i.e., B's input price, $w_0^{rB}(d, r)$, plus downstream transport cost, t_D and the valuation gap, a, minus an arbitrarily small ϵ, thereby capturing all demand. By symmetry, in market 1, manufacturer B prices at A's delivered cost minus ϵ. Thus, each firm serves its home market in which it enjoys both locational and valuation advantages. This leads to the following prices:

$$p_0^{dA}(d,r) = w_0^{rB}(d,r) + t_D + a, \tag{2.1}$$

$$p_1^{rB}(d,r) = w_1^{dA}(d,r) + t_D + a. \tag{2.2}$$

From these prices, we can determine the optimal quantities sold in each market:

$$q_0^{dA}(d,r) = \gamma(1 - w_0^{rB}(d,r) - t_D - a), \tag{3.1}$$

$$q_1^{rB}(d,r) = (1 - w_1^{dA}(d,r) - t_D). \tag{3.2}$$

Generalizing this to any supplier configuration (s,u), manufacturers' sourcing decisions are determined in the first stage, so the downstream Bertrand game takes (s,u) as given. For any combination (s,u), where s and u denote the suppliers of manufacturers A and B and can be either d or r, the equilibrium quantities directly follow as:

$$q_0^{sA}(s,u) = \gamma\left(1 - p_0^{sA}(s,u)\right) \qquad \text{if } p_0^{sA}(s,u) - p_0^{uB}(s,u) < 1 - (1-a), \tag{4.1}$$

$$q_1^{uB}(s,u) = 1 + a - p_1^{uB}(s,u) \qquad \text{if } p_1^{uB}(s,u) - p_1^{sA}(s,u) < (1+a) - 1. \tag{4.2}$$

Using the same undercutting process, the delivered price of the product charged by each manufacturer in their own location-advantage market is as follows:

$$p_0^{sA}(s,u) = w_0^{uB}(s,u) + t_D + a, \tag{5.1}$$

$$p_1^{uB}(s,u) = w_1^{sA}(s,u) + t_D + a. \tag{5.2}$$

where $w_0^{uB}(s,u)$ ($w_1^{sA}(s,u)$) denotes the input price paid by manufacturer B (A) when selling its product to market 0 (1).[7] Using the demand functions above, we analyze the equilibria in the last stage under all possible outcomes.

The optimal quantity in market 0 and market 1 is as follows:

$$q_0^{sA}(s,u) = \gamma(1 - w_0^{uB}(s,u) - t_D - a), \tag{6.1}$$

$$q_1^{uB}(s,u) = (1 - w_1^{sA}(s,u) - t_D). \tag{6.2}$$

The total profit for manufacturers A and B in this scenario includes operating profit and any transfer fee from the supplier, as given by:

$$\Pi_0^A(s,u) = \pi_0^A(s,u) + F^{sA}(s,u) = (p_0^{sA}(s,u) - w_0^{sA}(s,u))q_0^{sA}(s,u) + F^A(s,u) \tag{7.1}$$

$$\Pi_1^B(s,u) = \pi_1^B(s,u) + F^{uB}(s,u) = (p_1^{uB}(s,u) - w_1^{uB}(s,u))q_1^{uB}(s,u) + F^B(s,u) \tag{7.2}$$

where $F^{sA}(s,u)(F^{uB}(u,s))$ is the compensation fee paid by supplier $s(u)$ to

[7] Notably, as we will see more clearly in the next section, suppliers price-discriminate the inputs they sell to manufacturers, depending on where the manufacturers are located and where the final products are to be sold. As mentioned in the previous section, this targeted price-discrimination strategy aims to help their downstream partners, and is observed in the real-life case of Intel vs AMD.

manufacturer A (B) under the ED contract.

Based on the ED structure, each manufacturer has two choices depending on the rival's decision. Given that manufacturer B accepts an ED contract from supplier u, manufacturer A must choose whether to also contract with u (the same supplier) or with a different supplier s. This decision is strategic, as the profitability of manufacturer A depends not only on its own input costs but also on the choice of sourcing from a shared or an opposing supplier. To assess this decision, we compare manufacturer A's profits under both scenarios. The profit difference of manufacturer A when accepting the ED offer from the same supplier as its rival, and accepting the ED offer from a different supplier is as follows:

$$\begin{aligned}(8)\quad &\Pi_0^A(u,u) - \Pi_0^A(s,u) = \\ &[(w_0^{uB}(u,u) + t_D + a - w_0^{sA}(u,u))[\gamma(1 - w_0^{uB}(u,u) - t_D - a)] + F^{sA}(u,u)] \\ &-(w_0^{sB}(s,u) + t_D + a - w_0^{sA}(s,u))[\gamma(1 - w_0^{sB}(s,u) - t_D - a)] + F^{sA}(s,u).\end{aligned}$$

Following the same procedure as in the large market, given manufacturer A's decision, we compare profits when B accepts a contract from the same supplier as A versus from a different supplier. The resulting profit difference is given by:

$$\begin{aligned}(9)\quad &\Pi_1^B(u,u) - \Pi_1^B(u,s) = \\ &(w_1^{sA}(u,u) + t_D + a - w_1^{sB}(u,u))[1 - w_1^{sA}(u,u) - t_D] + F^{uB}(u,u) \\ &-[(w_1^{uA}(u,s) + t_D + a - w_1^{sB}(u,s))[(1 - w_1^{uA}(u,s) - t_D)] + F^{uB}(u,s)].\end{aligned}$$

4 ED Competition

In Stage 1, suppliers compete in each market by simultaneously offering ED contract packages, which consist of an input price and a transfer fee. At the end of stage 1, manufacturers evaluate offers from both suppliers. Recall (8) and (9), Manufacturer A (in Market 0) chooses to contract with Supplier d if and only if the following incentive condition holds: $\pi_0^A(d,u) + F^{dA}(d,u) \geq \pi_0^A(r,u) + F^{rA}(r,u)$ where $u = \{d,r\}$ is the anticipated choice of Manufacturer B in market 1. Similarly, Manufacturer B (in market 1) chooses Supplier d if $\pi_1^B(s,d) + F^{dB}(s,d) \geq \pi_1^B(s,r) + F^{rB}(s,r)$, where $s = \{d,r\}$ is the anticipated choice of Manufacturer A in market 0. The suppliers, anticipating the manufacturers' decision, compete in a bidding game and engage in fierce ED competition. The suppliers are willing to bid up to their total incremental gain. The winning supplier is the one with the higher ability to pay.

Since suppliers make simultaneous decisions in each market, we examine their actions in one market for a given ED competition outcome in the other market. Specifically, for a given outcome of the ED competition in market 1 (0), suppliers d and r compete to win the ED contract with manufacturer A (B) in market 0 (1). In doing so, the supplier takes into account the opportunity cost if the rival wins in market 0 (1) and the benefit and transfer fee it must pay to manufacturer

A (B) if it wins.

For example, given supplier d prevails in the ED competition in market 1, with the associated operating profit of $\pi_1^d(d,d)$, its benefit of also winning in market 0 is the additional operating profit $\pi_0^d(d,d)$, minus the transfer fee, $F^{dA}(d,d)$ paid to manufacturer A. However, if supplier d loses in market 0, it earns no profit from that market, i.e., $\pi_0^d(r,d) = 0$. Therefore, supplier d's maximum offer for the ED contract in market 0 is defined by the condition: $\pi_0^d(d,d) - F^{dA}(d,d) \geq \pi_0^d(r,d)$, implying that $F^{dA}(d,d)$ is the maximum transfer fee supplier d is willing to offer manufacturer A. Similarly for supplier r, given supplier d wins in market 1, the maximum transfer fee that r is willing to offer to manufacturer A is determined by: $\pi_0^r(r,d) - F^{rA}(r,d) \geq \pi_0^r(d,d)$. Thus, $F^{rA}(r,d)$ is the maximum offer of supplier r to manufacturer A. In equilibrium, the supplier offering the higher transfer fee in market 0 wins the ED contract.

Following the same logic for the other case, given the ED competition in market 1 is won by supplier r, we can obtain the maximum transfer fees that each supplier is willing to offer to manufacturer A for an ED contract in market 0. Note that ED competition in market 1 mirrors the ED competition in market 0; using the same logic, we can analyze suppliers' strategies symmetrically across the two markets. We leave the procedures for deriving the suppliers' profits and their input prices in four different cases in Appendix B, followed by the calculation for the transfer fees under each case in Appendix C. By the calculations, we summarize the outcomes, including the operating profits of the suppliers, in various scenarios in Table 2 containing the cases (d,d), (r,r), (d,r), and (r,d).

Making use of the calculated input price and the transfer fees in the Table 2, we obtain Firms' payoffs in the following Table 3. The strategic choice of suppliers by manufacturers is based on a fundamental trade-off between securing more favorable input prices and managing the intensity of downstream competition. By using (8), we begin by analyzing the decision of manufacturer A, given the choice of manufacturer B. Given that manufacturer B contracts with supplier r, manufacturer A compares its profits when sourcing from supplier d versus supplier r in market 0. The profit difference is given by:

$$\Pi^A(r,r) - \Pi^A(d,r) \gtrless 0 \quad \text{if} \quad t_D \lessgtr \frac{(1-2a) - \sqrt{t_U(2-t_U)}}{2} \equiv t_D^A. \tag{10}$$

However, if manufacturer B has contracted with supplier d, manufacturer A's profit comparison shows that manufacturer A strictly prefers contracting with the same supplier as its rival:

$$\Pi^A(d,d) - \Pi^A(r,d) > 0. \tag{11}$$

This analysis leads to the following lemma regarding manufacturer A's optimal strategy.

Lemma 1 *Given manufacturer B sources from supplier r, manufacturer A*

chooses to contract with supplier d if and only if $t_D > t_D^A$*; otherwise, it chooses supplier r. However, if manufacturer B contracts with supplier d, manufacturer A strictly prefers to also contract with supplier d.*

Table 2
Summary of the Equilibrium under various Scenarios

	Case (d,d)	
Outcomes	**Market** 0	**Market** 1
Price	$p_0^{dA} = \frac{1}{2}$	$p_1^{dB} = \frac{1}{2}(1+a+t_U)$
Output	$q_0^{dA} = \frac{\gamma}{2}$	$q_1^{dB} = \frac{1}{2}(1+a-t_U)$
Input Price	$w_0^{dB} = \frac{1}{2} - (t_D + a)$	$w_1^{dA} = \frac{1}{2}(1-2t_D-a+t_U)$
	$w_0^{dA} = p_0^{dA}$	$w_1^{dB} = p_1^{dB}$
d**'s operating profit**	$\pi_0^d = \frac{\gamma}{4}$	$\pi_1^d = \frac{1}{4}(1+a-t_U)^2$
r**'s operating profit**	$\pi_0^r = 0$	$\pi_1^r = 0$
Transfer Fee	$F^{dA}(d,d) = \frac{\gamma}{4}$	$F^{dB}(d,d) = \frac{1}{4}(1+a-t_U)^2$
	Case (r,r)	
Price	$p_0^{rA} = \frac{1+t_U}{2}$	$p_1^{rB} = \frac{1+a}{2}$
Output	$q_0^{rA} = \frac{\gamma}{2}(1-t_U)$	$q_1^{rB} = \frac{1}{2}(1+a)$
Input Price	$w_0^{rA} = p_0^{rA}$	$w_1^{rB} = p_1^{rB}$
	$w_0^{rA} = \frac{1+t_U}{2} - (t_D + a)$	$w_1^{rB} = \frac{1-a}{2} - t_D$
d**'s operating profit**	$\pi_0^d = 0$	$\pi_1^d = 0$
r**'s operating profit**	$\pi_0^r = \frac{\gamma}{4}(1-t_U)^2$	$\pi_1^r = \frac{1}{4}(1+a)^2$
Transfer Fee	$F^{rA}(r,r) = \frac{\gamma}{4}(1-t_U)^2$	$F^{rB}(r,r) = \frac{1}{4}(1+a)^2$
	Case (d,r)	
Price	$p_0^{dA} = t_D + a$	$p_1^{rB} = t_D + a$
Output	$q_0^{dA} = \gamma(1-t_D-a)$	$q_1^{rB} = (1-t_D)$
Input Price	$w_0^{dA} = t_D + a$	$w_1^{dA} = 0$
	$w_0^{rB} = 0$	$w_1^{rB} = p_1^{rB}$
d**'s operating profit**	$\pi_0^d = (t_D+a)\gamma(1-t_D-a)$	$\pi_1^d = 0$
r**'s operating profit**	$\pi_0^r = 0$	$\pi_1^r = (t_D+a)(1-t_D)$
Transfer Fee	$F^{dA}(d,r) = (t_D+a)\gamma(1-t_D-a)$	$F^{rB}(d,r) = (t_D+a)(1-t_D)$
	Case (r,d)	
Price	$p_0^{rA} = t_U + t_D + a$	$p_1^{dB} = t_U + t_D + a$
Output	$q_0^{rA} = \gamma(1-t_U-t_D-a)$	$q_1^{dB} = (1-t_U-t_D)$
Input Price	$w_0^{rA} = p_0^{rA}$	$w_1^{rA} = t_U$
	$w_0^{dB} = t_U$	$w_1^{dB} = p_1^{dB}$
d**'s operating profit**	$\pi_0^d = 0$	$\pi_1^d = (t_D+a)(1-t_U-t_D)$
r**'s operating profit**	$\pi_0^r = (t_D+a)\gamma(1-t_U-t_D-a)$	$\pi_1^r = 0$
Transfer Fee	$F^{rA}(r,d) = (t_D+a)\gamma(1-t_U-t_D-a)$	$F^{dB}(r,d) = (t_D+a)(1-t_U-t_D)$

Lemma 1 explores manufacturer A's strategic response to manufacturer B's supplier choice. In this setting, each ED contract includes a *reimbursement payment* from the supplier to the manufacturer, regardless of which supplier is chosen. However, the structure of input pricing critically depends on whether the two manufacturers contract with the same or different suppliers. When both contract with the *same supplier*, that supplier enjoys upstream monopoly power

Table 3
Payoff Matrix of Manufacturers under ED Choices

Manufacturers		B	
Suppliers		d	r
A	d	$\Pi^A(d,d) = \frac{\gamma}{4}$ $\Pi^B(d,d) = \frac{1}{4}(1+a-t_U)^2$	$\Pi^A(d,r) = (t_D+a)\gamma(1-t_D-a)$ $\Pi^B(d,r) = (t_D+a)(1-t_D)$
	r	$\Pi^A(r,d) = (t_D+a)\gamma(1-t_U-t_D-a)$ $\Pi^B(r,d) = (t_D+a)(1-t_U-t_D)$	$\Pi^A(r,r) = \frac{\gamma}{4}(1-t_U)^2$ $\Pi^B(r,r) = \frac{1}{4}(1+a)^2$

and charges a *monopoly input price* to the downstream firms. In contrast, when manufacturers are served by *different suppliers*, the suppliers offer more favorable input prices to support the competitiveness of their downstream partner, effectively mitigating double marginalization.

If manufacturer B contracts with supplier r, then manufacturer A's optimal response depends on the degree of horizontal product differentiation, as indicated by the level of transportation cost t_D. If the transportation cost is low ($t_D < t_D^A$), downstream price competition is intense, and sourcing from the same supplier as its rival (from supplier r) can mitigate competition despite the higher monopoly input price. In this environment, the strategic benefit of softening competition outweighs the drawback of paying a higher monopoly input price, so manufacturers have a strong incentive to source from the same supplier. This reasoning is also evident in the literature on outsourcing, which indicates that manufacturers often opt for shared upstream sources not solely for input efficiency, but also as a strategy to mitigate downstream rivalry.[8] However, when $t_D > t_D^A$, the products are more differentiated, and competition in the downstream market is less aggressive. In this case, manufacturer A finds it more profitable to switch to supplier d, who offers a lower input price to support the competitiveness of A. Thus, A chooses a different supplier when the market differentiation is sufficiently large. Here, the priority shifts from mitigating rivalry to securing lower input costs; hence, sourcing from different suppliers becomes the more profitable strategy.

On the other hand, when manufacturer B contracts with the dominant supplier d, manufacturer A strictly prefers to contract with d as well. The reason is that contracting with a supplier r entails both a geographic disadvantage, since the supplier r is located in market 1 while the manufacturer A is in market 0, and the loss of shared monopoly rent available through the reimbursement fee.

Next, by using (9), we analyze the symmetric decision for manufacturer B conditional on manufacturer A's choice. If manufacturer A sources from supplier d, manufacturer B compares its profits under both supplier options as follows:

$$\Pi^B(d,d) - \Pi^B(d,r) \gtrless 0 \quad \text{if} \tag{12}$$

[8]See Loertscher and Riordan (2019), Mittendorf, Arya, and Sappington (2008), Biancini and Ettinger (2017), Rey and Tirole (2007), Van Moer (2017).

$$t_D \lessgtr \frac{(1-a) - \sqrt{t_U\,(2+2a-t_U)}}{2} \equiv t_D^B.$$

If instead manufacturer A sources from supplier r, then manufacturer B strictly prefers to also contract with r, that is:

$$\Pi^B(r,r) - \Pi^B(d,r) > 0 \tag{13}$$

LEMMA 2 *Given manufacturer A sources from supplier d, manufacturer B chooses to contract with supplier r if and only if $t_D > t_D^B$; otherwise, it chooses supplier d. However, if manufacturer A contracts with supplier r, manufacturer B strictly prefers to contract with the same supplier.*

Lemma 2 mirrors Lemma 1 but focuses on manufacturer B's decision, conditional on manufacturer A's supplier choice. Together, Lemmas 1 and 2 highlight how product differentiation reflected in the transportation costs governs equilibrium outcomes under exclusive dealing. When t_D is low, both manufacturers contract with the same supplier to soften downstream competition, even at the cost of facing monopoly input prices. The upstream supplier in this case extracts higher margins but shares part of the surplus through compensation fees, consistent with the findings of DeGraba (2013). In contrast, when t_D is high, differentiation softens competition, and sourcing from different suppliers becomes more profitable due to lower input pricing.

To be precise, in identifying the Nash equilibria, we categorize t_D into high, moderate, and low ranges relative to two critical thresholds, t_D^A and t_D^B, where $t_D^B > t_D^A$. When t_D is high ($t_D > t_D^B$), both manufacturers have clear dominant strategies: manufacturer A consistently finds it more advantageous to source from supplier d, irrespective of manufacturer B's decision, while manufacturer B's optimal choice is always to source from supplier r. This alignment of dominant strategies leads to a singular Nash equilibrium where manufacturer A chooses d and manufacturer B chooses r, resulting in the (d, r) outcome. In this scenario, supplier r effectively wins the ED competition for manufacturer B's in market 1, while supplier d wins for manufacturer A in market 0.

As t_D falls into a moderate range ($t_D^A < t_D < t_D^B$), manufacturer A continues to favor supplier d as a dominant strategy, whereas manufacturer B's best response becomes conditional: it prefers r if A chooses r, but d if A chooses d. Given A's consistent choice of d, B's best response is also to choose d. This interdependence leads to a unique Nash equilibrium where both manufacturers opt for supplier d, resulting in the (d, d) outcome. Thus, when the transport rate is moderate, supplier d wins the ED competition in both markets.

Finally, when t_D is low ($t_D < t_D^A$), the situation becomes more complex, as neither manufacturer has a dominant strategy. Their optimal choices are mutually dependent, leading to two distinct candidate Nash equilibria: (r, r) and (d, d). The final outcome is determined by the relative magnitude of the total transfer fees offered by the suppliers. The supplier that offers the higher combined transfer payment will successfully attract both manufacturers, thereby

securing exclusive contracts across both markets.

We formalize this result in the following proposition.

PROPOSITION 1 *The structure of ED outcomes depends on the level of transportation cost t_D:*

(i) When the transportation cost is high, the manufacturers contract with different suppliers, thereby preserving upstream competition.

(ii) When the transportation costs are moderate and low, both manufacturers contract with the same supplier, resulting in an upstream monopoly.

The result that manufacturers contract with the same supplier when downstream competition is fierce (transportation cost t_D, and hence product differentiation, is low) stems from a strategic mechanism to soften downstream price competition. When manufacturers choose different suppliers, upstream competition drives input prices down aggressively. While this secures low input costs for the manufacturers, it fuels an intense and unprofitable downstream price war, as both firms have low marginal costs. By contrast, contracting with a single supplier (creating an upstream monopoly) eliminates this price-cutting mechanism. The upstream monopolist sets a higher input price w for both manufacturers. Crucially, since the rival manufacturer also faces this higher w, the rival's marginal cost increases as well. This effect allows both manufacturers to profitably raise their final prices, effectively mitigating the intensity of the downstream Bertrand competition and restoring downstream margins. The manufacturer's loss from the higher input cost w is more than offset by the resulting higher fixed transfer fee, which shares the monopolist's supra-competitive profit with the manufacturer.

This result reveals a key insight that ED contracts do not always lead to foreclosure or monopolization. Instead, under certain market conditions, specifically, when downstream differentiation is strong, exclusive dealing may promote rather than suppress input competition. This reasoning is absent in the original model of DeGraba (2013).

In what follows, we investigate the prevailing equilibrium when the transport cost is low, where (r, r) and (d, d) are the candidates. The successful supplier in this scenario is the one that offers a higher combined transfer payment to attract both manufacturers and secure exclusive contracts across both markets. This outcome depends on the two factors, market asymmetry (represented by γ) and the difference in consumers' willingness to pay for the final products (represented by a).

Denote T as the difference in the total transfer fees of the suppliers: total fees from (d, d) minus total fees from (r, r). The formula for T is given as:

$$T = \frac{t_U}{4}(\gamma(2 - t_U) + t_U - 2 - 2a) \gtrless 0 \quad \text{if} \quad \gamma \gtrless \frac{2 + 2a - t_U}{2 - t_U} \equiv \hat{\gamma} \tag{14}$$

Equation (14) implies that the dominant supplier wins ED competition in

both markets when the market asymmetry is sufficiently large relative to the difference in consumers' willingness to pay, and the reverse occurs otherwise. The intuition behind this result is as follows. We know that the dominant supplier has a location advantage in the large market. As the market becomes larger, the dominant supplier can exploit the amplified location advantage and use the rent from the large market to compensate the manufacturer in the small market, thereby winning the ED competition in both markets.

Conversely, the small rival wins the ED competition when the difference in consumers' willingness to pay is relatively high compared to market asymmetry. The condition $\gamma < \hat{\gamma}$ shows that the small rival can prevail when the market-size asymmetry (γ) is small relative to the consumer preference parameter (a). This is because the winner is determined by the supplier's overall ability to generate rent and offer the highest total compensation fee. While the dominant supplier has the advantage of a larger home market (Market 0, size γ), a sufficiently high value of a endows the small rival with a significant vertical differentiation advantage in its home market (Market 1). This higher consumer valuation in Market 1 translates into a substantially increased profit for supplier r in that segment. This increased home-market rent provides supplier r with the capability to outbid the dominant supplier for the contract in the larger Market 0, allowing the small rival to secure an ED competition across both markets. The logic is as follows. As a goes up, the final product B becomes more valuable to consumers in market 1. This higher consumer valuation leads to an increase in the monopoly input price and a higher profit for supplier r in market 1. Despite the dominant supplier's larger market presence, the increased profitability in market 1 for the small rival, driven by manufacturer B's quality and location advantage in market 1, allows supplier r to generate sufficient rents.[9] These rents can then be used to compensate manufacturer A in Market 0, enabling the small rival to win the overall ED competition. Thus, higher quality (as captured by a) can compensate for the loss due to intense competition in the product variety. In other words, the small rival wins the ED competition when horizontal differentiation is low (i.e., intense competition) and vertical differentiation is sufficiently high.

Based on the above analysis, we have:

PROPOSITION 2 *Under low transportation costs, the dominant supplier wins in both markets when the market asymmetry is sufficiently large relative to the difference in consumers' willingness to pay for the final product; otherwise, the small rival wins.*

This result is sharply different from the result in DeGraba (2013), which shows that the dominant supplier always wins the ED competition. DeGraba (2013) assumes that suppliers only compete in the small market, while manufacturers

[9] The input price in market 1 under (d,d) and (r,r), respectively, are $w_1^{dB}(d,d) = p_1^{dB}(d,d) = \frac{1}{2}[1+a+t_U]$ and $w_1^{rB}(r,r) = p_1^{rB}(r,r) = \frac{1+a}{2}$. The output under (r,r) is higher than (d,d), i.e., $q_1^{rB}(r,r) - q_1^{dB}(d,d) = \frac{1}{2}t_U > 0$.

are captive to the dominant input supplier in the large market. This enables the dominant input supplier to earn monopoly profits in both the large and small markets under ED while yielding an undercutting profit in the large market under no ED. We argue that it is unreasonable to assume that the dominant input supplier can earn a monopoly profit in the large market because, in the absence of an ED contract, it cannot exert monopoly power and force the manufacturer in that market to pay a monopoly input price. Instead, in this paper, we allow the suppliers to compete on ED in both markets, leading to a striking difference in results. Not only does relaxing the assumption improve the generalizability of the model, but it also demonstrates situations where the derived results in DeGraba (2013) may not hold.

5 Welfare Comparison

In this section, we compare the social welfare under two scenarios, with ED (the ED case) and without ED (the No ED case). For the ED case, we focus on the scenario where manufacturers contract with separate suppliers, case (d, r), where ED could potentially lead to welfare improvement. The reason is that competition is conventionally associated with more efficient outcomes.[10]

We define the total welfare as the sum of consumer surplus and producer surplus across both markets. We denote the case under ED with a superscript E, and under No ED with N. The calculations detailing the No ED outcomes are provided in Appendix D.

Under ED, the quantity in both markets is higher than under No ED. Specifically, in the large market, the difference in quantity is $q_0^{dAE} - q_0^{dAN} = \gamma t_U > 0$, and in the small market, it is $q_1^{rBE} - q_1^{rBN} = t_U > 0$. Correspondingly, prices under ED are lower: $p_0^{dAE} - p_0^{dAN} = -t_U < 0$ and $p_1^{rBE} - p_1^{rBN} = -t_U < 0$. The difference in total social welfare under ED and No ED is given by:

$$\begin{aligned} W^N - W^E = \frac{1}{2} &\left[(2\gamma(1 - t_D - a) - t_U)\,(-\gamma t_U) + (2(1 - t_D) - t_U)\,(-t_U)\right] \\ &+ \left[(t_D + t_U + a)\gamma(1 - t_D - t_U - a) - (t_D + a)\gamma(1 - t_D - a)\right] \\ &+ \left[(t_D + t_U + a)(1 - t_D - t_U) - (t_D + a)(1 - t_D)\right] < 0 \end{aligned} \tag{15}$$

The first term captures the change in consumer surplus in both markets due to higher quantities and lower prices under ED. The second and third terms represent the changes in producer surplus in the large and small markets, respectively. The inequality $W^N - W^E < 0$ implies that total welfare under ED exceeds that under No ED.

The welfare comparison between ED and No ED reveals two key mechanisms through which ED enhances efficiency in our model. First, under the (d, r)

[10] We may also examine the social welfare under the monopoly cases of (d, d) and (r, r), but since the main objective of this section is to demonstrate conditions under which welfare can be enhanced in the presence of ED, we conjecture that monopoly is unlikely to achieve such an improvement.

structure of ED, each manufacturer contracts with a different supplier. This arrangement intensifies downstream competition, as upstream suppliers strategically set input prices to enhance their downstream partners' competitiveness in their respective markets. As a result, final good prices decrease and output increases in both the large and small markets. In contrast, under No ED, upstream competition is internalized by manufacturers, leading to higher marginal costs, weaker price competition, and lower quantities sold.

Second, and critically, the No ED regime suffers from *double marginalization*. Here, upstream suppliers independently choose input prices without regard to downstream pricing behavior, resulting in a double markup along the supply chain. This vertical inefficiency reduces total surplus by raising final prices and constraining output. Under ED, by contrast, each upstream supplier internalizes downstream incentives: with exclusive access to a single buyer, the supplier optimally sets input prices to align with downstream pricing, thereby eliminating or reducing the double marginalization effect.

Taken together, these effects imply that ED not only strengthens downstream competition but also improves vertical pricing harmonization. Contrary to conventional views that associate ED with foreclosure and reduced welfare, our model demonstrates that exclusive dealing can be *pro-competitive* and *welfare-enhancing* when structured across competing upstream suppliers. Based on this finding, we have the following Proposition.

PROPOSITION 3 *In the presence of upstream exclusive dealing (ED) competition and asymmetric downstream markets, ED can lead to higher total welfare than the no exclusive dealing (No ED) regime.*

Traditional models of ED emphasize its potential to facilitate upstream foreclosure and reduce welfare by excluding rival suppliers and softening downstream competition. For instance, Rasmusen, Ramseyer, and Wiley Jr (1991) and Segal and Whinston (2000) demonstrate how ED can prevent downstream buyers from benefiting from competition by creating negative externalities among them, thus enabling incumbents to deter more efficient rivals. Similarly, Abito and Wright (2008) and DeGraba (2013) argue that ED can reduce welfare by softening downstream competition, especially when the number of downstream buyers is small, or when entry barriers exist. In contrast, our model presents a different mechanism: when manufacturers contract with competing upstream suppliers in a segmented downstream environment, ED may increase total welfare.

This welfare gain emerges from two complementary forces. First, the (d, r) configuration of ED encourages aggressive price competition in downstream markets, lowering consumer prices. Second, ED eliminates double marginalization by aligning upstream pricing incentives with downstream profit maximization. These vertical efficiency effects are not present in standard foreclosure-based models, which typically assume a single upstream monopolist. This is in line with Fumagalli, Motta, and Rønde (2012), who introduces the role of

innovation, and Kitamura, Matsushima, and Sato (2018), who emphasizes the role of complementary inputs in enhancing market dynamics. Moreover, unlike DeGraba (2013), whose model restricts ED competition to a smaller market, our framework allows ED competition to occur in both markets, providing a broader perspective on the welfare effects of ED. This highlights the importance of market structure, demand conditions, and product differentiation in shaping the outcomes of ED competition.

From a policy perspective, our findings suggest that exclusive dealing should not be evaluated solely on the basis of its foreclosure potential. In contexts where upstream competition exists and downstream markets are differentiated, ED may serve as a tool for vertical pricing synchronization and pro-competitive restructuring. Regulatory approaches should therefore account for market structure, particularly the upstream ED competition.

6 Concluding Remarks

This paper develops a model of ED in vertically related markets with asymmetric market sizes and differentiated products. Allowing two upstream suppliers, one dominant and one smaller rival, to compete for ED contracts with downstream manufacturers, we characterize the equilibrium patterns of ED competition and assess their welfare implications.

Our findings depart from the conventional view that ED arrangements are uniformly anticompetitive. We demonstrate that when transportation costs are low, indicating weak horizontal product differentiation, manufacturers may prefer to contract with the same supplier to reduce downstream price competition. This leads to upstream monopoly power, albeit with rent-sharing through transfer fees. In contrast, when product differentiation increases, competition softens, and manufacturers opt for different suppliers, preserving upstream rivalry and improving input pricing.

Importantly, the dominant supplier does not always prevail. While market-size asymmetry allows it to cross-subsidize and win both contracts, the small rival can out-compete when consumer preferences in the smaller market are strong. We further demonstrate that ED contracts can enhance total welfare relative to a no-ED benchmark by reducing double marginalization and intensifying downstream competition when suppliers are differentiated.

Policy implications follow directly: exclusive dealing should not be presumed anticompetitive. In contexts with ED competition and product differentiation, ED can promote efficiency and increase welfare. Regulators should assess exclusive contracts based on market structure and the nature of upstream competition, rather than solely on supplier dominance or exclusionary concerns.

Appendices

A Demand

The utility of consumer $l \in \{n_0, n_1\}$, whose ideal product characteristic corresponds to the location of market $k \in \{0, 1\}$, is defined over a differentiated final good and a numéraire. The utility function is specified as:

(A1)

$$U_k^l = \sum_{i\in\{A,B\}} (1 + a_k^{si}) q_k^{sil} - \frac{1}{2}\left(\sum_{i\in\{A,B\}} q_k^{sil}\right)^2 - \sum_{i\in\{A,B\}} t|x_i - x_k^l| q_k^{sil} + z,$$

The term z is the numéraire good. Consumer l faces a budget constraint given by: $I = \sum_{i\in\{A,B\}} p_k^{sim} q_k^{sil} + z$, where I denotes consumer income, and p_k^{sim} is the mill price set by manufacturer i in market k under supplier s. The term $(1 + a_k^i)$ represents the willingness to pay by consumers in market k for the product of firm i. We assume:

$$a_k^A = 0, \quad a_0^B = -a, \quad a_1^B = a,$$

which implies that the willingness to pay is normalized to 1 for product A in both markets, while for product B it is $1 - a$ in market 0 and $1 + a$ in market 1. The delivered price, defined as the mill price plus transportation cost, is expressed as: $p_k^{si} = p_k^{sim} + t|x_i - x_k^l|$.

Maximizing utility subject to this budget constraint yields the following first-order condition:

(A2)
$$\sum_{i\in\{A,B\}} \left[1 + a_k^{si} - q_k^{sil} - p_k^{sim} - t|x_i - x_k^l|\right] = 0.$$

In the downstream market, manufacturer i captures the entire demand, an equal share of the demand, or zero demand in market k, depending on the difference in delivered prices and the difference in consumers' willingness to pay for products from firms i and j. Based on this, the demand for final goods in each market is determined as follows. In market 0, the demand for the product of firm i is given by:

(A3)

$$q_0^{si}(s,u) = \begin{cases} \gamma\left(1 + a_0^i - p_0^{si}(s,u)\right) & \text{if } p_0^{si}(s,u) - p_0^{uj}(s,u) < (1 + a_0^i) - (1 + a_0^j), \\ \frac{\gamma}{2}\left(1 + a_0^i - p_0^{si}(s,u)\right) & \text{if } p_0^{si}(s,u) - p_0^{uj}(s,u) = (1 + a_0^i) - (1 + a_0^j), \\ 0, & \text{if } p_0^{si}(s,u) - p_0^{uj}(s,u) > (1 + a_0^i) - (1 + a_0^j). \end{cases}$$

In market 1, the corresponding demand is:

(A4)
$$q_1^{si}(s,u) = \begin{cases} 1 + a_1^i - p_1^{si}(s,u) & \text{if } p_1^{si}(s,u) - p_1^{uj}(s,u) < (1+a_1^i) - (1+a_1^j), \\ \frac{1}{2}(1 + a_1^i - p_1^{si}(s,u)) & \text{if } p_1^{si}(s,u) - p_1^{uj}(s,u) = (1+a_1^i) - (1+a_1^j), \\ 0 & \text{if } p_1^{si}(s,u) - p_1^{uj}(s,u) > (1+a_1^i) - (1+a_1^j). \end{cases}$$

where $i, j \in \{A, B\}$ with $i \neq j$, and $s, u \in \{d, r\}$ such that $s \neq u$. Specifically, $p_k^{si}(s,u)$ denotes the price charged by manufacturer i in market $k \in \{0,1\}$ when using input $s \in \{d,r\}$, under the scenario where firm i accepts an ED contract from supplier s, and firm j accepts an ED contract from supplier u. Due to their location and valuation advantages, with the characteristic of Bertrand competition, manufacturer A dominates market 0, while manufacturer B prevails in market 1. Using the specification of the consumer's willingness to pay, the demand in market 0 and market 1 is as follows:

(A5.1) $q_0^{sA}(s,u) = \gamma\left(1 - p_0^{sA}(s,u)\right)$,if $p_0^{sA}(s,u) - p_0^{uB}(s,u) < (1) - (1-a)$

(A5.2) $q_1^{sB}(s,u) = 1 + a - p_1^{sB}(s,u)$,if $p_1^{sB}(s,u) - p_1^{uA}(s,u) < (1+a) - (1)$.

B Input Prices

In this appendix, we analyze the equilibria of input prices under the four possible cases, as well as the associated prices and quantities for the final products and the profit of each firm.

A.1 (d, d) Case

In this sub-section, we analyze the equilibria when both manufacturers accept ED from the dominant supplier. The total profit of the dominant supplier is its operating profit in market 0 and market 1 minus the compensation fee to manufacturers A and B, which can be expressed as follows:

(A6) $\Pi^d(d,d) = \pi_0^d(d,d) - F^{dA}(d,d) + \pi_1^d(d,d) - F^{dB}(d,d)$
$= w_0^{dA}(d,d)q_0^{dA}(d,d) - F^{dA}(d,d) + [w_1^{dB}(d,d) - t_U]q_1^{dB}(d,d) - F^B(d,d).$

Note that since supplier d is located in market 0, to ship the input to market 1, it must pay transport cost t_U. Substituting quantities in (6) into the above equation, we obtain the total profit function of the dominant supplier as follows:

(A7) $\Pi^d(d,d) = w_0^{dA}(d,d)[\gamma(1 - w_0^{dB}(d,d) - t_D - a)] - F^{dA}(d,d)$
$+[w_1^{dB}(d,d) - t_U][1 - w_1^{dA}(d,d) - t_D] - F^{dB}(d,d).$

The dominant supplier maximises its profit by choosing the optimal input prices for manufacturers A and B, subject to the condition that these input prices are no less than the final good prices. The problem can be defined as

follows:

$$\begin{aligned}\underset{\{w_0^{dA},w_0^{dB},w_1^{dB},w_1^{dA}\}}{Max}\ \Pi^d(d,d) &= w_0^{dA}(d,d)[\gamma(1-w_0^{dB}(d,d)-t_D-a)]-F^{dA}(d,d)\\ &\quad+[w_1^{dB}(d,d)-t_U][1-w_1^{dA}(d,d)-t_D]-F^{dB}(d,d)\\ &\quad\textbf{\textit{subject to}}\qquad w_0^{dA}(d,d)<p_0^{dA}(d,d),\\ &\qquad\qquad\qquad\quad w_1^{dB}(d,d)<p_1^{dB}(d,d).\end{aligned}\tag{A8}$$

We can solve the equation above by using the Lagrange method and by substituting (5) into (A8), as follows:

$$\begin{aligned}L &= w_0^{dA}(d,d)[\gamma(1-w_0^{dB}(d,d)-t_D-a)]-F^{dA}(d,d)\\ &\quad+[w_1^{dB}(d,d)-t_U][1-w_1^{dA}(d,d)-t_D]-F^{dB}(d,d)\\ &\quad+\lambda_1(w_0^{dA}(d,d)-w_0^{dB}(d,d)-t_D-a)\\ &\quad+\lambda_2(w_1^{dB}(d,d)-w_1^{dA}(d,d)-t_D-a)\end{aligned}\tag{A9}$$

The first-order conditions of the Lagrangian function above are as follows:

$$\frac{\partial L}{\partial w_0^{dA}(d,d)}=\gamma(1-w_0^{dB}(d,d)-t_D-a)+\lambda_1=0\tag{A10.1}$$

$$\frac{\partial L}{\partial w_0^{dB}(d,d)}=-\gamma w_0^{dA}(d,d)-\lambda_1=0\tag{A10.2}$$

$$\frac{\partial L}{\partial w_1^{dA}(d,d)}=-w_1^{dB}(d,d)+t_U-\lambda_2=0\tag{A10.3}$$

$$\frac{\partial L}{\partial w_1^{dB}(d,d)}=[1-w_1^{dA}(d,d)-t_D]+\lambda_2=0\tag{A10.4}$$

$$\frac{\partial L}{\partial \lambda_1}=w_0^{dA}(d,d)-w_0^{dB}(d,d)-t_D-a=0\tag{A10.5}$$

$$\frac{\partial L}{\partial \lambda_2}=w_1^{dB}(d,d)-w_1^{dA}(d,d)-t_D-a=0\tag{A10.6}$$

Solving the above system of first-order conditions simultaneously yields the equilibrium input prices set by supplier d for each manufacturer under the (d,d) case as follows:

$$w_1^{dA}(d,d)=\frac{1}{2}(1-2t_D-a+t_U),\tag{A11.1}$$

$$w_0^{dB}(d,d)=\frac{1}{2}-(t_D+a),\tag{A11.2}$$

$$w_0^{dA}(d,d)=\frac{1}{2},\tag{A11.3}$$

$$w_1^{dB}(d,d)=\frac{1}{2}(1+a+t_U).\tag{A11.4}$$

Substituting (A11.2) and (A11.1) into (5), respectively, we obtain the equilibrium final good prices under the (d,d) case:

$$p_0^{dA}(d,d) = w_0^{dA}(d,d) = \frac{1}{2}, \tag{A12.1}$$

$$p_1^{dB}(d,d) = w_1^{dB}(d,d) = \frac{1}{2}(1+a+t_U). \tag{A12.2}$$

Doing the same on equations (6), we obtain the associated equilibrium quantities of final goods:

$$q_0^{dA}(d,d) = \gamma(1-\frac{1}{2}) = \frac{\gamma}{2}, \tag{A13.1}$$

$$q_1^{dB}(d,d) = 1+a-\frac{1}{2}(1+a+t_U) = \frac{1}{2}(1+a-t_U). \tag{A13.2}$$

Substituting (A11.1), (A12.1), into (7), we obtain the total profit of each manufacturer as follows:

$$\Pi^(d,d) = 0 + F^{dA}(d,d) \tag{A14.1}$$

$$\Pi^B(d,d) = 0 + F^{dB}(d,d) \tag{A14.2}$$

Since, in this case, the dominant supplier wins the ED competition in both markets, the small rival makes no profit. Substituting the input prices in (A11.1) and (A11.4) and quantities in (A13.1) and (A13.2) into (A7), we obtain the profit of the dominant supplier in each market as follows:

(A15.1)

$$\Pi_0^d(d,d) = w_0^{dA}(d,d)q_0^{dA}(d,d) - F^{dA}(d,d) = \frac{1}{2}\frac{\gamma}{2} = \frac{\gamma}{4} - F^{dA}(d,d)$$

(A15.2)

$$\Pi_1^d(d,d) = [w_1^{dB}(d,d) - t_U]q_1^{dB}(d,d) - F^{dB}(d,d) = \frac{1}{4}(1+a-t_U)^2 - F^{dB}(d,d)$$

A.2 (r, r) Case

This subsection refers to the case where the small rival wins the ED competition in both markets, resulting in the dominant supplier making zero profit. In this case, the total profit of the small rival in markets 0 and 1 is as follows:

$$\begin{aligned}\Pi^r(r,r) &= \pi_0^r(r,r) - F^{rA}(r,r) + \pi_1^r(r,r) - F^{rB}(r,r) \\ &= [w_0^{rA}(r,r) - t_U]q_0^{rA}(r,r) - F^{rA}(r,r) + w_1^{rB}(r,r)q_1^{rB}(r,r) - F^{rB}(r,r)\end{aligned}$$

Similar to the procedure for supplier d before, the objective of supplier r is defined as follows:

$$\underset{\{w_0^{rA}, w_0^{rB}, w_1^{rB}, w_1^{rA}\}}{Max} \Pi^r(r,r) = w_0^{rA}(r,r) - t_U][\gamma(1 - w_0^{rB}(r,r) - t_D - a)] - F^{rA}(r,r)$$

$$
\begin{aligned}
&+w_1^{rB}(r,r)[1-w_1^{rA}(r,r)-t_D]-F^{rB}(r,r)\\
&\textbf{\textit{subject to}}\quad w_0^{rA}(r,r)<p_0^{rA}(r,r),\\
&\qquad\qquad\qquad\quad w_1^{rB}(r,r)<p_1^{rB}(r,r).
\end{aligned}
\tag{A16}
$$

which can be solved using the Lagrange method and making use of (5) again as follows:

$$
\begin{aligned}
L=&[w_0^{rA}(r,r)-t_U][\gamma(1-w_0^{rB}(r,r)-t_D-a)]-F^{rA}(r,r)\\
&+w_1^{rB}(r,r)[1-w_1^{rA}(r,r)-t_D]-F^{rB}(r,r)\\
&+\lambda_1(w_0^{rA}(r,r)-w_0^{rB}(r,r)-t_D-a)\\
&+\lambda_2(w_1^{rB}(r,r)-w_1^{rA}(r,r)-t_D-a)
\end{aligned}
\tag{A17}
$$

with the solutions satisfying the first-order conditions:

$$\frac{\partial L}{\partial w_0^{rA}(r,r)}=\gamma(1-w_0^{rB}(r,r)-t_D-a)+\lambda_1=0 \tag{A18.1}$$

$$\frac{\partial L}{\partial w_0^{rB}(r,r)}=-\gamma[w_0^{rA}(r,r)-t_U]-\lambda_1=0 \tag{A18.2}$$

$$\frac{\partial L}{\partial w_1^{rB}(r,r)}=1-w_1^{rA}(r,r)-t_D+\lambda_2=0 \tag{A18.3}$$

$$\frac{\partial L}{\partial w_1^{rA}(r,r)}=-w_1^{rB}(r,r)-\lambda_2=0 \tag{A18.4}$$

$$\frac{\partial L}{\partial \lambda_1}=w_0^{rA}(r,r)-w_0^{rB}(r,r)-t_D-a=0 \tag{A18.5}$$

$$\frac{\partial L}{\partial \lambda_2}=w_1^{rB}(r,r)-w_1^{rA}(r,r)-t_D-a=0 \tag{A18.6}$$

Solving the system of equations simultaneously yields the equilibrium input prices under the (r,r) case as follows:

$$w_0^{rB}(r,r)=\frac{1+t_U}{2}-(t_D+a), \tag{A19.1}$$

$$w_1^{rA}(r,r)=\frac{1-a}{2}-t_D, \tag{A19.2}$$

$$w_0^{rA}(r,r)=\frac{1+t_U}{2}, \tag{A19.3}$$

$$w_1^{rB}(r,r)=\frac{1+a}{2}. \tag{A19.4}$$

Using the input prices, we obtain associated equilibrium prices and quantities for the final goods:

$$p_0^{rA}(r,r)=\frac{1+t_U}{2}, \tag{A20.1}$$

(A20.2) $$p_1^{rB}(r,r) = \frac{1+a}{2},$$

(A20.3) $$q_0^{rA}(r,r) = \gamma(1 - \frac{1+t_U}{2}) = \frac{\gamma}{2}(1-t_U),$$

(A20.4) $$q_1^{rB}(r,r) = 1 + a - \frac{1+a}{2} = \frac{1}{2}(1+a).$$

The profit of each manufacturer is given by:

(A21.1) $$\Pi^A(r,r) = 0 + F^{rA}(r,r),$$

(A21.2) $$\Pi^B(r,r) = 0 + F^{rB}(r,r).$$

The profit of the small rival supplier in market 0 and market 1 when it wins the ED competition in both markets is, therefore:

(A22.1)

$$\Pi_0^r(r,r) = [w_0^{rA}(r,r) - t_U]q_0^{rB}(r,r) - F^{rA}(r,r) = \frac{\gamma}{4}(1-t_U)^2 - F^{rA}(r,r),$$

(A22.2)

$$\Pi_1^r(r,r) = w_1^{rB}(r,r)q_1^{rB}(r,r) - F^{rB}(r,r) = \frac{1}{4}(1+a)^2 - F^{rB}(r,r).$$

A.3 (d, r) Case

This case corresponds to that when supplier d wins in market 0, and supplier r wins in market 1. The profit of the dominant supplier is its operating profit in market 0 minus the transfer fee to manufacturer A, whereas supplier r's profit is its operating profit in market 1 minus the transfer fee to manufacturer B. In particular, we can express the profit functions of the suppliers as follows:

(A23.1) $$\begin{aligned}\Pi^d(d,r) &= w_0^{dA}(d,r)q_0^{dA}(d,r) - F^{dA}(d,r)\\ &= w_0^{dA}(d,r)[\gamma(1 - w_0^{rB}(d,r) - t_D - a)] - F^{dA}(d,r),\end{aligned}$$

(A23.2) $$\begin{aligned}\Pi^r(d,r) &= w_1^{rB}(d,r)q_1^{rB}(d,r) - F^{rB}(d,r)\\ &= w_1^{rB}(d,r)[1 - w_1^{dA}(d,r) - t_D] - F^{rB}(d,r).\end{aligned}$$

We obtain the optimal input prices by taking the first derivative of each of the suppliers' profits with respect to their respective input prices as follows:

$$\frac{\partial \Pi^d(d,r)}{\partial w_0^{dA}(d,r)} = [\gamma(1 - w_0^{rB}(d,r) - t_D - a)] > 0$$

$$\frac{\partial \Pi^r(d,r)}{\partial w_1^r B(d,r)} = [1 - w_1^{dA}(d,r) - t_D] > 0$$

Since both of the derivatives above are positive, each supplier should be able to charge as high an input price as possible; however, the highest they can charge is the final good price set by their manufacturers. Therefore, the dom-

inant supplier charges $w_0^{dA}(d,r) = p_0^{dA}(d,r)$, whereas the small rival charges $w_1^{rB}(d,r) = p_1^{rB}(d,r)$.

In this case, supplier d offers ED to manufacturer A, and supplier r offers ED to manufacturer B. The suppliers can help their downstream manufacturers in each market by charging discriminatory input prices, thereby increasing the competitiveness of their downstream manufacturers. In particular, each supplier charges their input prices equal to the final good's price in its location-advantage market and its marginal cost in the location-disadvantage market as follows:

$$w_0^{dA}(d,r) = p_0^{dA}(d,r) \tag{A24.1}$$

$$w_1^{dA}(d,r) = 0 \tag{A24.2}$$

$$w_1^{rB}(d,r) = p_1^{rB}(d,r) \tag{A24.3}$$

$$w_0^{rB}(d,r) = 0 \tag{A24.4}$$

Using the equilibrium input prices, we obtain the equilibrium final good prices and quantities as follows:

$$p_0^{dA}(d,r) = w_0^{dA}(d,r) = t_D + a \tag{A25.1}$$

$$p_1^{rB}(d,r) = w_1^{rB}(d,r) = t_D + a \tag{A25.2}$$

$$q_0^{dA}(d,r) = \gamma(1 - t_D - a) \tag{A25.3}$$

$$q_1^{rB}(d,r) = (1 - t_D) \tag{A25.4}$$

and the profit of each manufacturer:

$$\Pi^{A*}(d,r) = 0 + F^{dA}(d,r) \tag{A26.1}$$

$$\Pi^{B*}(d,r) = 0 + F^{rB}(d,r) \tag{A26.2}$$

By substituting (A25.1), (A25.3) into (A23.1) and (A25.2), (A25.4) into (A23.2), we obtain the profits of each supplier as follows:

(A27.1)
$$\Pi_0^d(d,r) = w_0^{dA}(d,r)q_0^{dA}(d,r) - F^{dA}(d,r) = (t_D + a)\gamma(1 - t_D - a) - F^{dA}(d,r)$$

(A27.2)
$$\Pi_1^r(d,r) = w_1^{rB}(d,r)q_1^{rB}(d,r) - F^{rB}(d,r) = (t_D + a)(1 - t_D) - F^{rB}(d,r)$$

A.4 (r, d) Case

This case is the opposite of the previous case, that is, when supplier d wins in market 1 and supplier r wins in market 0. In this case, the profit of each of the suppliers is given by:

$$\begin{aligned}\Pi^d(r,d) &= \pi^d(r,d) - F^{dB}(r,d) \\ &= [w_1^{dB}(r,d) - t_U].[\gamma(1 - w_0^{dB}(r,d) - t_D - a)] - F^{dB}(r,d)\end{aligned} \tag{A28.1}$$

$$\Pi^r(r,d) = \pi^r(r,d) - F^{rA}(d,r)$$

$$= [w_0^{rA}(r,d) - t_U](1 - w_1^{rA}(r,d) - t_D) - F^{rA}(d,r) \tag{A28.2}$$

with the associated first derivative of each profit function:

$$\frac{\partial \Pi^d(r,d)}{\partial w_1^{dB}(r,d)} = [\gamma(1 - w_0^{dB}(r,d) - t_D - a)] > 0 \tag{A29.1}$$

$$\frac{\partial \Pi^r(r,d)}{\partial w_0^{rA}(r,d)} = (1 - w_1^{rA}(r,d) - t_D) > 0 \tag{A29.2}$$

As before, both of the first derivatives are, again, increasing and continuous in the respective input price, implying that each supplier is able to charge as high an input price as possible, but instead charges just equal to the final good's prices of their own manufacturers.

In particular, the dominant supplier charges its input price equal to the final good price of manufacturer B when B sells the product in market 1, and equals d's own marginal cost plus transport cost when B sells the product in market 0. Recall that the marginal cost of the suppliers is zero. Moreover, since supplier d (r) is located in market 0 (1) and manufacturer B (A) is located in market 1 (0), supplier d (r) must pay transportation costs to ship the product to manufacturer B (A). In the same way, for supplier r, it charges input price in market 0 equal to A's final good's price, and in market 1, it equals its marginal cost plus input transport cost. In summary, suppliers can only charge their manufacturer partner in the market where the partner is disadvantaged an input price equal to the input transportation cost, i.e., t_U. In equilibrium, the suppliers charge prices as follows:

$$w_0^{rA}(r,d) = p_0^{rA}(r,d) \tag{A30.1}$$

$$w_1^{rA}(r,d) = t_U \tag{A30.2}$$

$$w_1^{dB}(r,d) = p_1^{dB}(r,d) \tag{A30.3}$$

$$w_0^{dB}(r,d) = t_U \tag{A30.4}$$

These equilibrium input prices allow us to obtain the equilibrium final good prices and quantities under the (r,d) case:

$$w_0^{rA}(r,d) = p_0^{rA}(r,d) = t_U + t_D + a \tag{A31.1}$$

$$w_1^{dB}(r,d) = p_1^{dB}(r,d) = t_U + t_D + a \tag{A31.2}$$

$$q_0^{rA}(r,d) = \gamma(1 - t_U - t_D - a) \tag{A31.3}$$

$$q_1^{dB}(r,d) = (1 - t_U - t_D) \tag{A31.4}$$

as well as the profit of each manufacturer, as follows:

$$\Pi^{A*}(r,d) = 0 + F^{rA}(r,d) \tag{A32.1}$$

$$\Pi^{B*}(r,d) = 0 + F^{dB}(r,d) \tag{A32.2}$$

The profit of each supplier under the (r,d) case is as follows:

$$\Pi_0^r(r,d) = (t_D + a)\gamma(1 - t_U - t_D - a) - F^{rA}(r,d) \tag{A33.1}$$

$$\Pi_1^d(r,d) = (t_D + a)(1 - t_U - t_D) - F^{dB}(r,d) \tag{A33.2}$$

C Transfer Fees

Precisely, the conditions defining the profitability of each scenario to each supplier in each market are given by:
Market 0

$$\pi_0^d(d,d) - F^{dA}(d,d) \geq \pi_0^d(r,d), \tag{A34.1}$$

$$\pi_0^d(d,r) - F^{dA}(d,r) \geq \pi_0^d(r,r), \tag{A34.2}$$

$$\pi_0^r(r,r) - F^{rA}(r,r) \geq \pi_0^r(d,r), \tag{A34.3}$$

$$\pi_0^r(r,d) - F^{rA}(r,d) \geq \pi_0^r(d,d), \tag{A34.4}$$

Market 1

$$\pi_1^d(d,d) - F^{dB}(d,d) \geq \pi_1^d(d,r), \tag{A35.1}$$

$$\pi_1^d(r,d) - F^{dB}(r,d) \geq \pi_1^d(r,r), \tag{A35.2}$$

$$\pi_1^r(r,r) - F^{rB}(r,r) \geq \pi_1^r(r,d), \tag{A35.3}$$

$$\pi_1^r(d,r) - F^{rB}(d,r) \geq \pi_1^r(d,d), \tag{A35.4}$$

By substituting the corresponding equilibrium profit of the suppliers in Table 2 into (A34), we obtain the maximum compensation fees the suppliers are willing to offer to manufacturer A in market 0, for a given outcome of ED competition in market 1, as follows:

$$F^{dA}(d,d) = \frac{\gamma}{4}, \tag{A36.1}$$

$$F^{dA}(d,r) = (t_D + a)\gamma(1 - t_D - a), \tag{A36.2}$$

$$F^{rA}(r,r) = \frac{\gamma}{4}(1 - t_U)^2, \tag{A36.3}$$

$$F^{rA}(r,d) = (t_D + a)\gamma(1 - t_U - t_D - a). \tag{A36.4}$$

Similarly, for a given outcome of ED competition in market 0, by substituting the equilibrium profit of suppliers in Table 2 into (A35), we obtain the maximum compensation fees that the suppliers are willing to offer manufacturer B as follows:

$$F^{dB}(d,d) = \frac{1}{4}(1 + a - t_U)^2, \tag{A37.1}$$

$$F^{dB}(r,d) = (t_D + a)(1 - t_U - t_D), \tag{A37.2}$$

$$F^{rB}(r,r) = \frac{1}{4}(1+a)^2, \tag{A37.3}$$

$$F^{rB}(d,r) = (t_D + a)(1 - t_D). \tag{A37.4}$$

D No Exclusive Dealing (N) Case

In this case, we analyse the situation where manufacturers reject exclusive dealing from suppliers, allowing them to purchase input from either supplier d or r. Each manufacturer can capture the entire market in its location advantage under Bertrand competition with homogeneous products, due to price undercutting. This means that the firm with a lower cost (marginal cost plus transportation cost) undercuts its rival's price and captures the whole market. As we assume that manufacturer A is located in market 0, it has an advantage to force out manufacturer B from market 0; similarly, manufacturer B has a location advantage in market 1. Therefore, the demand functions are as follows:

$$q_0^{dAN} = \gamma(1 - p_0^{dAN}) \text{if } p_0^{dAN} - p_0^{rBN} < 1 - (1 - a), \tag{A38.1}$$

$$q_1^{rBN} = 1 + a - p_1^{rBN} \text{if } p_1^{rBN} - p_1^{dAN} < (1 + a) - 1. \tag{A38.2}$$

where superscript 'N' denotes variables associated with the case of no exclusive dealing. q_k^{si} and p_k^{si} are the quantity demanded and delivered price in market $i = \{0, 1\}$ for products produced by manufacturer $i = \{A, B\}$ using input $s = \{d, r\}$.

In stage three, manufacturers may engage in price undercutting in each market. The winner's price can be defined as the rival's cost in the winner's advantage market plus the difference in consumers' willingness to pay. In particular, the price charged by manufacturer A (B) in market 0 (1) is the difference in consumers' willingness to pay for the products of A and B plus the transportation cost and the rival's marginal cost as follows:

$$p_0^{dAN} = p_0^{rBN} + a = t_D + w^{rBN} + a, \tag{A39.1}$$

$$p_1^{rBN} = p_1^{dAN} + a = t_D + w^{dAN} + a, \tag{A39.2}$$

where w^{siN} is the input price charged by supplier s to manufacturer i for products sold in either market 0 or market 1 under no exclusive dealing. [11]

In the second stage, the input suppliers maximize their profit by determining their respective input prices. However, since the input suppliers compete in Bertrand fashion in determining the input price, the highest input price that suppliers can charge is the undercutting input price. Supplier d (r) is the winner in market 0 (1), therefore it sets the delivered input price in its advantageous

[11] Under this case, the suppliers charge a single input price to each manufacturer, regardless of whether the product is sold in market 0 or market 1, hence, the absence of subscript k in the input prices under no ED.

market, i.e., w^{dAN} (w^{rBN}), equal to the rival's marginal cost plus transportation cost. However, in its disadvantageous market, supplier d (r) charges a delivered input price, i.e., w^{dBN} (w^{rAN}), equal to its own marginal cost plus transportation cost. In equilibrium, suppliers charge prices as follows:

$$w^{dAN} = w^{rAN} = t_U, \tag{A40.1}$$

$$w^{rBN} = w^{dBN} = t_U. \tag{A40.2}$$

Substituting the equations above, we can rewrite delivered prices as:

$$p_0^{dAN} = t_D + t_U + a, \tag{A41.1}$$

$$p_1^{rBN} = t_D + t_U + a. \tag{A41.2}$$

It follows that the outputs in markets 0 and 1 are as follows:

$$q_0^{dAN} = \gamma(1 - t_D - t_U - a), \tag{A42.1}$$

$$q_1^{rBN} = 1 - t_D - t_U. \tag{A42.2}$$

The reduced profits of the input suppliers are subsequently given by:

$$\pi^{dN*} = w^{dAN} q_0^{dAN} = t_U \gamma(1 - t_D - t_U - a), \tag{A43.1}$$

$$\pi^{rN*} = w^{rBN} q_1^{rBN} = t_U(1 - t_D - t_U). \tag{A43.2}$$

Manufacturers' profit functions are as follows:

$$\pi^{AN*} = (p_0^{dAN} - w^{dAN}) q_0^{dA} = (t_D + a)\gamma(1 - t_D - t_U - a), \tag{A44.1}$$

$$\pi^{BN*} = (p_1^{rBN} - w^{rBN}) q_1^{rBN} = (t_D + a)(1 - t_D - t_U). \tag{A44.2}$$

The welfare function can be defined as consumer surplus plus producer surplus:

$$W^N = \frac{1}{2}(q_0^{dAN})^2 + \frac{1}{2}(q_1^{rBN})^2 + \pi^{AN*} + \pi^{BN*} + \pi^{dN*} + \pi^{rN*} \tag{A45}$$

Profit Under ED versus No ED

The profits of the manufacturers under No ED are as follows. $\pi_0^{AN} = (t_D + a)\gamma(1 - t_U - t_D - a)$ and $\pi_1^{BN} = (t_D + a)(1 - t_U - t_D)$. A manufacturer accepts an ED contract only if its profit under ED is no lower than under No-ED. For Manufacturer A, the minimum compensation that satisfies this participation condition is: $\pi^{sA}(s, u) + F^{sA} > \pi_0^{AN}$. Similarly for B, $\pi^{uB}(u, s) + F^{uB} > \pi_0^{BN}$, is the minimum payment for accepting the ED contract. We then compare those profits with the compensation fee from suppliers. For Manufacturer A, the comparison is as follows:

$$F^{dA}(d, d) - \Pi_0^{dAN} = \frac{\gamma}{4}(1 + 4(t_D + a)(t_U + t_D + a) - 4(t_D + a)) > 0, \tag{A46.1}$$

(A46.2)
$$F^{dA}(d,r) - \Pi_0^{AN} = (t_D + a)\gamma(1 - t_D - a) + (t_D + a)\gamma(t_U + t_D + a) - \gamma > 0,$$

(A46.3)
$$F^{rA}(r,r) - \Pi_0^{AN} = \frac{\gamma}{4}(1 - t_U)^2 + (t_D + a)\gamma(t_U + t_D + a) - \gamma(t_D + a) > 0.$$

For Manufacturer B, the comparison is as follows:

(A47.1)
$$F^{rB}(r,r) - \Pi_0^{BN} = \frac{1}{4}[(1 + a)^2 + 4(t_D + a)(t_U + t_D) - 4(t_D + a)] > 0,$$

(A47.2)
$$F^{dB}(d,d) - \Pi_0^{BN} = \frac{1}{4}(1 + a - t_U)^2 + (t_D + a)(t_U + t_D) - (t_D + a) > 0,$$

(A47.3)
$$F^{rB}(d,r) - \Pi_0^{BN} = t_U > 0.$$

Therefore, it is rational for manufacturers always to accept an ED offer, which motivates the assumption that ED contracts always take place in both markets.

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