Exclusive Contracts in Durable Goods Markets*

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Abstract

This study constructs a model of exclusive contracts in durable goods markets. Like a durable goods monopolist, an incumbent supplier and a downstream firm suffer from the profit loss due to the future price reduction. When upstream entry in the future is predicted, the future price reduction becomes more serious, which reduces the current joint profit of the contracting party. Such a negative externality allows the inefficient incumbent to deter socially efficient entry through exclusive contracts. The result here provides an important implication for competition policy; the Chicago School argument, based on perishable goods markets, cannot be necessarily applied to durable goods markets.

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1 Introduction

In a number of vertical relations, firms often agree on exclusive contracts. The Federal Trade Commission (henceforth FTC) remarks that exclusive contracts are common and generally lawful. This view is supported by the economic analysis pointing out that exclusive contracts may promote the relationship-specific investment (Marvel, 1982; Segal and Whinston, 2000a). On the other hand, the FTC also remarks that exclusive contracts have anticompetitive effects to exclude rival firms, and thus these agreements are judged under a rule of reason standard, which balances any procompetitive and anticompetitive effects.

Among a number of antitrust cases in which the anticompetitive effects are dominant, exclusive contracts are often observed in the market for durable goods such as aluminum (United States of America v. Aluminum Co. of America in the U.S., 1945.), furnitures (Paramount Bed Case in Japan, 1998), artificial teeth (United States of America, v. Dentsply International, INC., in the U.S., 2005), and CPU (Intel Case in the U.S., 2005). Moreover, we commonly observe exclusive contracts, currently regarded as lawful agreements, in a number of markets for durable goods such as industrial machinery/equipment and electronic and electric equipment (Heide, Dutta, and Bergen, 1998). Despite of these observations, existing models of anticompetitive exclusive contracts are constructed by assuming perishable goods markets. Thus, the present study focuses on anticompetitive exclusive contracts

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1 See “Exclusive Dealing or Requirements Contracts” in the FTC’s competition policy guidance (link).

2 See also Besanko and Perry (1993), de Meza and Selvaggi (2007) and de Fontenay, Gans, and Groves (2010).

3 For each case, see United States of America v. Aluminum Co. of America, 148 F.2d 416 (1945, link); Blair and Sokol (2015); United States of America. v. Dentsply International, INC., 399 F.3d (2005, link); Advanced Micro Devices, INC., a Delaware corporation, and AMD International Sales & Services, LTD., a Delaware corporation, v. Intel corporation, a Delaware corporation, and Intel Kabushiki Kaisha, a Japanese corporation, Civil Action No. 05-441-JJF (2005, link), respectively.

4 See also Mollgaard and Lorentzen (2004) who explore exclusive dealing in Eastern Europe’s car component industry. Moreover, in aviation industry, the Boeing Company and Airbus sometimes award exclusivity to one or two jet engine makers over the others. See “GE Unit Lands Exclusive Boeing Pact For Developing Commercial Jet Engine” The Wall Street Journal, July 8, 1999 (link), and “Airbus selects Rolls-Royce Trent 7000 as exclusive engine for the A330neo” Rolls-Royce, July 14, 2014 (link).
in durable goods markets.

In this study, we develop a model of entry deterrence through exclusive contracts in the durable goods market. Our model is based on the Chicago School argument (Posner, 1976; Bork 1978), which is a seminal study of anticompetitive exclusive contracts; we consider the situation in which an upstream incumbent supplier offers an exclusive contract to a single downstream firm to deter entry of an entrant supplier that is more efficient than the incumbent supplier. In the perishable goods market, which is assumed in the Chicago School argument, exclusion never occurs because socially efficient entry allows the downstream firm to earn considerably high profits; the incumbent supplier cannot profitably make the exclusive offer acceptable for the downstream firm. In contrast to the Chicago School framework, we introduce the situation in which durable goods are sold for two periods and the entrant supplier appears at the second period. In this setting, we explore whether the incumbent supplier and the downstream firm sign two-period exclusive contracts at the first period to deter socially efficient entry at the second period.

By introducing non-linear wholesale pricing, we first show that exclusion can be a unique equilibrium outcome. We then show that this exclusion mechanism remains valid under linear wholesale pricing. As in the Chicago School framework, the second period entry generates the upstream competition, which allows the downstream firm to earn higher second period profits. Thus, exclusion is seemingly difficult. However, in the durable goods market, the price reduction through the upstream competition at the second period does not attract final consumers to the purchase at the first period, which leads to the low price and joint profit of a contracting party at the first period. That is, the second period upstream entry exacerbates the intertemporal downstream competition that the contracting party faces by nature. Because exclusive contracts can avoid the future competition in the upstream market, the contracting party can enjoy higher joint profits at the first period. Therefore, at the first period, the incumbent supplier can profitably makes the two-period exclusive offer to the downstream firm in the durable goods market.

We then check the robustness of the above exclusion mechanism. First, we can derive
the exclusion outcome in the case of linear wholesale pricing. The notable feature of the results under linear wholesale pricing is that the possibility of exclusion is reduced because the double marginalization problem occurs when the exclusive offer is accepted. Second, we show that the exclusion equilibrium exists in the case where suppliers’ inputs are vertically differentiated; the supplier producing low quality input can deter future entry of the supplier producing high quality input. In both cases, exclusion cannot be an equilibrium outcome in perishable goods markets. Therefore, the exclusion mechanism here plays an essential role in these extended settings.

Note that the exclusion mechanism identified in this study is based on the nature of a durable goods monopolist, initially argued by Coase (1972). Hence, the findings here can be applied to diverse real-world exclusive dealing in the durable goods market, which provide an important implication for competition policy; the Chicago School argument cannot necessarily apply to durable goods markets. In addition, exclusive contracts here are used to deter the entry of efficient entrant in the future. From this perspective, this study is suitable for the situation in which a local firm faces the entry threat of multinational firms with high efficiency. For example, Vist, a Russian personal computer maker, develops exclusive distribution agreements with several key retailers as a survival strategy toward entry of multinational firms such as Compaq, IBM, and Hewlett-Packard (Dawar and Frost, 1999). More importantly, multinational firms’ entry usually takes some time after the news of their entry (Bao and Chen, 2018). Such a news in the media allows not only every economic agent to predict the future entry but also the incumbent firm to respond to the threat of future entry, both of which are required for the exclusion mechanism in this study. Therefore, the exclusion mechanism here can be applied to such situations. In Section 4.3, we introduce the Intel case (2005) as an example of anticompetitive exclusive dealing in detail and consider the linkage with the results in this study.

This study is related to the literature on anticompetitive exclusive contracts that deter

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socially efficient entry of a potential entrant. The literature on anticompetitive exclusive contracts starts from the Chicago School argument in 1970s (Posner, 1976; Bork, 1978). By using a simple setting, they point out that rational economic agents never sign exclusive contracts for anticompetitive reasons if we consider all members' participation constraints in the contracting party. In rebuttal to the Chicago School, post Chicago economists find that rational economic agents agree with exclusive contracts for anticompetitive reasons in certain market environments. By extending the Chicago School argument’s single-buyer model to a multiple-buyer model, mainstream studies introduce scale economies, wherein the entrant needs a certain number of buyers to cover its fixed costs (Rasmusen, Ramseyer, and Wiley, 1991; Segal and Whinston, 2000b), and competition between buyers (Simpson and Wickelgren, 2007; Abito and Wright, 2008). In these studies, negative externalities exist; signing exclusive contracts reduces the possibility of entry under scale economies, and upstream entry reduces industry profits in the presence of downstream competition. Furthermore, in the framework of a single downstream firm, several studies point out that the intensity of upstream competition plays a crucial role in the Chicago School argument. They show that

6 Several studies focus on the fact that active firms may compete for exclusivity and explore the welfare effect (Mathewson and Winter, 1987; O’Brien and Shaffer, 1997; Bernheim and Whinston, 1998). Recently, Calzolari and Denicolò (2013, 2015) introduced asymmetric information in this literature.

7 For the analysis of the impact of this argument on antitrust policies, see Motta (2004), Whinston (2006), and Fumagalli, Motta, and Calcagno (2018).

8 In the literature on exclusion with downstream competition, Fumagalli and Motta (2006) show that the existence of participation fees to remain active in the downstream market plays a crucial role in exclusion if buyers are undifferentiated Bertrand competitors. See also Wright (2009), who corrects the result of Fumagalli and Motta (2006) in the case of two-part tariffs.

9 For the extended model of exclusion with scale economies, see Choi and Stefanadis (2018). By contrast, for extended models of exclusion with downstream competition, see Wright (2008), Argenton (2010), Kitamura (2010), and DeGraba (2013). Whereas these studies all show that the resulting exclusive contracts are anticompetitive, Gratz and Reisinger (2013) show potentially procompetitive effects if downstream firms compete imperfectly and contract breaches are possible.

10 For another mechanism of anticompetitive exclusive dealing, see Fumagalli, Motta, and Rønde (2012), who focus on the incumbent’s relationship-specific investments. See also Kitamura, Matsushima, and Sato (2018), who focus on the existence of a complementary input supplier with market power.
the exclusion result is obtained in the cases where the incumbent sets liquidated damages for the case of entry (Aghion and Bolton, 1987), where the entrant is capacity constrained (Yong, 1996), where upstream firms compete à la Cournot (Farrell, 2005), and where upstream firms can merge (Fumagalli, Motta, and Persson, 2009). To the best of our knowledge, existing models in this literature are constructed under the assumption of perishable goods markets. Thus, we construct the model here to clarify that the exclusion mechanism in this study depends on the nature of durable goods markets; exclusion occurs due to the negative externality that future entry reduces current industry profits.

This study is also related to the literature on entry deterrence in the durable goods market. By comparing selling with renting, Bucovetsky and Chilton (1986) show that the durable goods monopolist may choose selling to deter future entry. From a viewpoint of planned obsolescence, Bulow (1986) also shows that the durable goods monopolist has an incentive to increase durability to deter future entry. The basic idea behind these studies is reducing the demand for the future entrant. By focusing on exclusive contracts in the vertical relation, this study provides an alternative route that leads to entry deterrence in the durable goods market.

The remainder of this paper is organized as follows. Section 2 constructs the model. Section 3 analyzes the existence of exclusion outcomes under two-part tariffs. Section 4 provides the extension analysis and discusses the linkage between this study and Intel case (2005). Section 5 offers concluding remarks. Appendix A includes the equilibrium outcomes in the subgame following buyers’ decisions. Appendix B provides the proofs of the results.

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11 See also Kitamura, Matsushima, and Sato (2017a), who show that anticompetitive exclusive dealing can occur if the downstream buyer bargains with suppliers sequentially.

12 Firms’ strategies to deter future entry in the perishable goods market are analyzed in several studies, wherein entry deterrence is possible owing to cost uncertainty (Milgrom and Roberts, 1982), quality uncertainty (Schmalensee, 1982), and switching costs (Klemperer, 1987).
2 Model

This section develops the basic setting of the model. There are two periods: \( t = 1, 2 \). All players in this study have a common discount factor \( \delta \in (0, 1) \). We assume that the final good is durable; the final good produced and used at Period 1 can be used at Period 2, with no depreciation. For simplicity, there is no resale market. We assume that all firms cannot commit to future prices and that there is no possibility of renting products.\(^{13}\)

The rest of this section is organized as follows. We first explain players’ characteristics and the game’s timing in Section 2.1. Section 2.2 then introduces the design of the anticompetitive exclusive contracts.

2.1 Basic environment

Consumers There are a number of mass unit of consumers for all periods. Each consumer has a different preference for a final good. Let \( v \) be the type of consumer’s willingness to pay, which is stationary for all periods and is uniformly distributed on the interval \([0, 1]\). For simplicity, we assume that the size of consumers is 1. In the durable goods market, each consumer purchases the final good once by considering the final goods prices at both periods \( p_1 \) and \( p_2 \). At Period 2, a consumer type \( v \), who does not purchase the final good at Period 1, purchases the final good if and only if the consumer surplus is nonnegative, i.e., \( v - p_2 \geq 0 \). By rationally expecting \( p_2 \), the consumer purchases the final good at Period 1 if and only if \( v - p_1 \geq \max\{\delta(v - p_2), 0\} \). By defining the indifferent consumer’s willingness to pay as \( \overline{v} - p_1 = \delta(\overline{v} - p_2) \), we have

\[
\overline{v} = \frac{p_1 - \delta p_2}{1 - \delta}.
\]

(1)

Then, the willingness to pay of consumers who purchase the final good at Period 1 is distributed in \( v \in [\overline{v}, 1] \); thus, the demand for the final good at each period \( Q_i \) becomes

\[
Q_1 = 1 - \overline{v}, \quad Q_2 = \overline{v} - p_2.
\]

\(^{13}\) No possibility of renting can be justified by the study of Bucovetsky and Chilton (1986) who show that the durable goods monopolist choosing selling rather than renting in the presence of future entry threat.
Firms The upstream market consists of the incumbent supplier $U_I$ and the entrant supplier $U_E$. Following the Chicago School model, $U_I$ and $U_E$ produce an identical input but differ in cost efficiency; that is, $U_E$ is more efficient than $U_I$, with constant marginal cost $c_E \in [0, c_I)$, as opposed to $U_I$’s constant marginal cost $c_I < 1$. We explore the case in which suppliers’ inputs are vertically differentiated in Section 4.2. Following Abito and Wright (2008), we measure $U_E$’s cost advantage by $\eta$, where $c_I = \eta p^m(c_E) + (1 - \eta)c_E$ and $p^m(c_E)$ is the monopoly price for the industry when the marginal cost is $c_E$ and the market demand is $Q = 1 - p$: $p^m(c_E) = (1 + c_E)/2$. $\eta = 0$ implies that $U_E$ has no cost advantage. As $\eta$ increases, $U_E$ becomes efficient. We assume that $\eta \in (0, 1)$. From the definition of $\eta$, the marginal cost of $U_E$ can be expressed as a function of $\eta$ and $c_I$ as follows:

$$c_E = \frac{2c_I - \eta}{2 - \eta}.$$  

The downstream market is composed of a downstream monopolist $D$. This modeling strategy clarifies the role of durable goods; namely, the prevention of socially efficient entry occurs even in the absence of scale economies and downstream competition, both of which require more than one downstream firm. $D$ transforms one unit of the input into one unit of the final good, which is durable. To simplify the analysis, we assume that the cost of transformation is zero. Thus, given the linear input price $w_t$, the production cost of $D$ at Period $t$ when it purchases $q_t$ units of the input is given by $C_{DQ}(q_t) = w_tq_t$.

Timing Following Bucovetsky and Chilton (1986) and Bulow (1986), at Period 1, only $U_I$ exists in the upstream market. This may be because of a patent right, superior technology, efficient marketing, or an industry protection policy. Period 1 consists of three stages. At Period 1.1, $U_I$ makes a two-period exclusive offer to $D$, with fixed compensation $x \geq 0$. Following the standard literature on naked exclusion, we assume that the exclusive offer does not contain the term of wholesale prices.\footnote{Rasmusen, Ramseyer, and Wiley (1991) and Segal and Whinston (2000b) point out that price commitments are unlikely if the nature of the final good is not precisely described in advance. In the naked exclusion liter-} After observing the exclusive offer, $D$ decides...
whether to accept the offer. $D$ immediately receives $x$ if it accepts the offer. Let $\omega \in \{a, r\}$ be $D$’s decision at Period 1.1, where the superscript “$a$” (“$r$”) indicates that the exclusive offer is accepted (rejected). At Period 1.2, $U_I$ offers a two-part tariff contract to $D$. We extend the model to the case of linear wholesale pricing in Section 4.1. At Period 1.3, $D$ orders the input and sells the final good to consumers.

At the beginning of Period 2, $U_E$ appears in the upstream market. Period 2 consists of three stages. At Period 2.1, $U_E$ decides whether to enter the market. We assume that the fixed entry cost is sufficiently small that $U_E$ can earn positive profits. At Period 2.2, active suppliers offer two-part tariff contracts to $D$. For the case of $U_E$’s entry, $U_I$ and $U_E$ become homogeneous Bertrand competitors. We assume that if they charge the same input price, the efficient supplier, $U_E$, supplies its input to $D$; namely, we impose the so-called tie-breaking rule. At Period 2.3, $D$ orders the input and sells the final good to consumers.

$U_I$’s profit at Period $t$ in the case where $D$’s decision at Period 1.1 is $\omega \in \{a, r\}$ is denoted by $\pi_{I|t}^{\omega}$, where $i \in \{I, E\}$. Likewise, $D$’s profit at Period $t$ is denoted by $\pi_{D|t}^{\omega}$. We assume that $U_I$ and $D$ maximize the present discounted value of their profits $\pi_{I|1}^{\omega} + \delta \pi_{I|2}^{\omega}$ and $\pi_{D|1}^{\omega} + \delta \pi_{D|2}^{\omega}$ respectively, while $U_E$ maximizes Period 2 profits $\pi_{E|2}^{\omega}$ for the case of entry.

### 2.2 Design of exclusive contracts

For an exclusion equilibrium to exist, the equilibrium transfer $x^*$ must satisfy the following two conditions simultaneously.

First, the exclusive contract must satisfy individual rationality for $D$; that is, the amount of compensation $x^*$ induces $D$ to accept the exclusive offer:

$$\pi_{D|1}^{a} + x^* + \delta \pi_{D|2}^{a} \geq \pi_{D|1}^{r} + \delta \pi_{D|2}^{r} \quad \text{or} \quad x^* \geq \pi_{D|1}^{r} + \delta \pi_{D|2}^{r} - (\pi_{D|1}^{a} + \delta \pi_{D|2}^{a}).$$


16 The result does not change if we consider the possibility that $U_I$ makes exclusive offers at Period 2 if its exclusive offer at Period 1 is rejected. In such a case, the Chicago School argument can be applied; $U_I$ cannot make exclusive offers to profitably compensate $D$ at Period 2.
Second, the exclusive contract must satisfy individual rationality for $U_I$; that is, $U_I$ earns higher profits under exclusive dealing:

$$\pi_{I1}^a + \delta \pi_{I2}^a - x^* \geq \pi_{I1}^r + \delta \pi_{I2}^r \text{ or } x^* \leq \pi_{I1}^a + \delta \pi_{I2}^a - (\pi_{I1}^r + \delta \pi_{I2}^r). \quad (3)$$

From the above conditions, it is evident that an exclusion equilibrium exists if and only if inequalities (2) and (3) simultaneously hold. This is equivalent to the following condition:

$$\pi_{I1}^a + \delta \pi_{I2}^a + \pi_{D1}^a + \delta \pi_{D2}^a \geq \pi_{I1}^r + \delta \pi_{I2}^r + \pi_{D1}^r + \delta \pi_{D2}^r. \quad (4)$$

Condition (4) implies that anticompetitive exclusive contracts are attained if exclusive contracts increase the two-period joint profits of $U_I$ and $D$. Thus, in the rest of this study, we focus on the two-period joint profits of the contracting party.

### 3 Two-part tariffs

This section analyzes the existence of anticompetitive exclusive contracts under two-part tariffs, which consist of a linear wholesale price $w$ and an upfront fixed fee $F$. Two-part tariff offered by $U_i$ at Period $t$ when $D$’s decision is $\omega \in \{a, r\}$ is denoted by $(w_{Ii}^\omega, F_{Ii}^\omega)$.

To guarantee that at least some consumers purchase the final goods at Period 1, we assume the following condition;

**Assumption 1.** $\overline{\nu} < 1$ holds for the case in which the exclusive offer is rejected at Period 1.1; i.e.,

$$0 < \delta \leq \hat{\delta}(\eta) \equiv \frac{2(2 - \eta)}{4 - \eta}, \quad (5)$$

where $\hat{\delta}(\eta) < 0 \text{ for all } \eta \in (0, 1)$ and where as $\eta \to 0$, $\hat{\delta}(\eta) \to 1$ and $\eta \to 2$, $\hat{\delta}(\eta) \to 0$.

If condition (5) does not hold, all consumers are attracted to the purchase at Period 2 when entry of $U_E$ is expected.

In the rest of this section, we solve the game using backward induction, starting from Period 2.3. In Section 3.1 we first explore the equilibrium outcomes in the subgame following
Section 3.2 then explores the contractual decision at Period 1.1 to examine the existence of anticompetitive exclusive contracts. Finally, Section 3.3 explores the case in which condition (5) does not hold.

3.1 Equilibrium outcomes after Period 1.1

We characterize the properties of subgame perfect Nash equilibria after the subgame at Period 1.1 from the perspective of joint profit maximization between each supplier and $D$. This approach simplifies the analysis. In the last part of this subsection, we show that two-period joint profit maximization is achieved under two-part tariff contracts in the equilibrium, derived in Appendix A.1.

We first consider the game at Period 2. For notational convenience, we define $p^*_2(z,v)$ and $\Pi^*_2(z,v)$ as follows:

$$p^*_2(z,v) \equiv \arg\max_{p_2 \geq z} (p_2 - z)(v - p_2),$$

$$\Pi^*_2(z,v) \equiv (p^*_2(z,v) - z)(v - p^*_2(z,v)).$$

By solving joint profit maximization problem (6), we have

$$p^*_2(z,v) = \frac{v + z}{2}, \quad \Pi^*_2(z,v) = \frac{(v - z)^2}{4}$$

Note that $\Pi^*_2(z,v)$ is the jointly maximized profit of $U_I$ and $D$ at Period 2 when the supplier whose marginal cost is $z \geq 0$. When the exclusive offer is accepted at Period 1.1, $U_I$ becomes the equilibrium supplier at Period 2; that is, the joint profit of $U_I$ and $D$ becomes $\Pi^*_2(c_I,v)$ and the equilibrium final goods price is $p^*_2(c_I,v)$ under exclusive dealing. By contrast, when the exclusive offer is rejected, $U_I$ and $U_E$ compete at Period 2. $U_I$ makes its best offer $(c_I,0)$ to $D$. $U_E$ offers $(c_E, \Pi^*_2(c_E,v) - \Pi^*_2(c_I,v))$ and it becomes the equilibrium supplier at Period 2. In the equilibrium, $D$ chooses $p^*_2(c_E,v)$. As a result, $D$ earns $\Pi^*_2(c_I,v)$ and $U_I$ earns nothing, which implies that the joint profit of $U_I$ and $D$ becomes $\Pi^*_2(c_I,v)$ for the case of entry. Therefore, the joint profit of $U_I$ and $D$ at Period 2 can be expressed by $\Pi^*_2(c_I,v)$ regardless of $D$’s decision at Period 1.1. However, the value of indifferent consumer’s willingness to pay $v$ depends on
D’s decision at Period 1.1 because equilibrium final goods prices depend on the efficiency of the equilibrium supplier. By substituting the equilibrium price at Period 2 into equation (1), we have
\[ v(p_1, z) = \frac{2p_1 - \delta z}{2 - \delta}, \] (7)
where \( z = c_I (c_E) \) when D accepts (rejects) the exclusive offer at Period 1.1. Equation (7) shows that in the durable goods market, the equilibrium outcome at Period 2 intertemporally affects the indifferent consumer’s willingness to pay, which cannot be observed in the perishable goods market. Equation (7) implies that the price reduction due to entry at Period 2 increases \( v(p_1, z) \), Therefore, the contracting party needs to reduce the final goods price to maintain the same output level at Period 1 when entry at Period 2 is predicted; namely, in the durable goods market, the future entry shrinks the current consumer demand.

We next consider the game at Period 1. By using equation (7), we define \( p^*_1(z) \), \( \Pi^*_1(z) \), and \( \Pi^*_J(z) \) as follows:
\[ p^*_1(z) \equiv \arg\max_{p_1} (p_1 - c_I)(1 - v(p_1, z)) + \delta \Pi^*_2(c_I, v(p_1, z)), \] (8)
\[ \Pi^*_1(z) \equiv (p^*_1(z) - c_I)(1 - v(p^*_1(z), z)), \quad \Pi^*_J(z) \equiv \Pi^*_1(z) + \delta \Pi^*_2(c_I, v(p^*_1(z), z)). \]

Note that \( \Pi^*_J(z) \) is the jointly maximized two-period profit of D and U, when the marginal cost of an equilibrium supplier at Period 2 is \( z \). By solving the joint profit maximization problem (8), we have the joint profit maximizing prices in the equilibrium:
\[ p^*_1(z) = \frac{(2 - \delta)^2(1 + c_I) + 2\delta(1 - \delta)z}{2(4 - 3\delta)}, \quad p^*_2(z, v(p^*_1(z), z)) = \frac{(2 - \delta)(1 + c_I) + 4(1 - \delta)z}{2(4 - 3\delta)}. \] (9)

Under these prices, the equilibrium joint profit of U, and D becomes
\[ \Pi^*_1(z) = \frac{(2 - \delta)^2(1 + c_I^2) + 2\delta(1 - \delta)z}{2(4 - 3\delta)} \left\{ (2 - \delta)(1 - c_I) - \delta(1 - z) \right\}, \]
\[ \Pi^*_2(c_I, v(p^*_1(z), z)) = \frac{((2 - \delta)(1 - c_I) + \delta(c_I - z))^2}{4(4 - 3\delta)^2}, \]
\[ \Pi^*_J(z) = \frac{(2 - \delta)^2(1 - c_I^2) - \delta(c_I - z)(4(1 - \delta)(1 - c_I) - \delta(c_I - z))}{4(4 - 3\delta)}. \] (10)
The following lemma shows that joint profit maximization prices (9) are obtained as the subgame perfect Nash equilibrium outcomes:

**Lemma 1.** Suppose that suppliers adopt two-part tariffs and condition (5) holds. In the subgames after Period 1.1, the pair of final goods prices becomes \((p^*_1(c_I), p^*_2(c_I, \bar{v}(p^*_1(c_I), c_I)))\) when \(D\) accepts the exclusive offer and \((p^*_1(c_E), p^*_2(c_E, \bar{v}(p^*_1(c_E), c_E)))\) when \(D\) rejects the exclusive offer.

**Proof.** See Appendix B.1. □

### 3.2 Existence of an exclusion equilibrium

By using above results, we now consider the game at Period 1.1. By definition, we have

\[
\Pi^*_J(c_I) = \pi^a_{I1} + \delta \pi^a_{I2} + \pi^a_{D1} + \delta \pi^a_{D2} \quad \text{and} \quad \Pi^*_J(c_E) = \pi^r_{I1} + \delta \pi^r_{I2} + \pi^r_{D1} + \delta \pi^r_{D2}.
\]

Thus, for the existence of an exclusion equilibrium, we examine whether \(\Pi^*_J(c_I) \geq \Pi^*_J(c_E)\) holds. From equation (10), this condition is equivalent to \(4(1 - \delta)(1 - c_I) \geq \delta (c_I - c_E)\). By solving this condition with respect to \(\delta\), we have

\[
0 < \delta \leq \delta(c_E) \equiv \frac{4(1 - c_I)}{4 - 3c_I - c_E},
\]

where \(\delta(c_E) \in (0, 1)\), \(\delta(c_E) > 0\), and \(\delta(c_E) \to 1\) as \(c_E \to c_I\). Therefore, exclusion becomes an equilibrium outcome for the sufficiently small discount factor. The following proposition shows that we always obtain exclusion results as long as condition (5) holds:

**Proposition 1.** Suppose that suppliers adopt two-part tariffs and condition (5) holds. If the good is durable, exclusion becomes a unique equilibrium outcome for all \((\eta, \delta) \in (0, 2) \times (0, \hat{\delta}(\eta))\).

**Proof.** See Appendix B.2. □

Proposition 1 implies that if the upstream market at Period 2 becomes duopoly for the case of entry, anticompetitive exclusion always occurs in the durable goods market. This
result can be explained by the intertemporal-negative externality in the durable goods market. In the durable goods market, future entry intertemporally affects the current market outcome in the durable goods market. Socially efficient entry at Period 2 discourages final consumers from purchasing durable goods at Period 1, which prevents the contracting party from choosing the optimal pair of prices to maximize two-period joint profits. Therefore, although consumers benefit from future entry, such entry is harmful to the contracting party; namely, in the durable goods market, rational economic agents sign exclusive contracts for an anticompetitive reason.

From the perspective of a price commitment problem, the result here can be explained as follows. If there were no threat of entry and the contracting party were able to commit to the final goods price at Period 2, the joint profit becomes \((1 - c_I)^2/4 > \Pi^*_J(c_I)\) by setting \(p_1 = p_2 = (1 + c_I)/2\). Without price commitment, the contracting party sets low prices to obtain additional sales at Period 2, which induces the contracting party to earn low two-period profits because the price reduction at Period 2 leads to the price reduction at Period 1 in the durable goods market. Thus, the possibility of socially efficient entry in the future makes the price commitment problem more severe. Since exclusive contracts mitigate the price commitment problem, exclusive contracts partially play a role of price-commitment device in the durable goods market.

### 3.3 Highly efficient entrant

Thus far, we explore the case in which at least some consumers purchase final goods by assuming condition (5) holds. However, if all players are sufficiently patient and \(U_E\) is sufficiently efficient, condition (5) does not hold; \(U_I\) cannot earn positive profits when the exclusive offer is rejected at Period 1.1. Although such a situation seemingly prevents \(U_I\) from yielding exclusion outcomes, the following proposition shows that \(U_I\) can deter socially efficient entry by using exclusive contracts:

**Proposition 2.** Suppose that suppliers adopt two-part tariffs and condition (5) does not hold. If the good is durable, exclusion becomes a unique equilibrium outcome for all \((\eta, \delta) \in (0, 2) \times \ldots\)
By combining the results in Propositions 1 and 2, we can conclude that when firms adopt two-part tariffs, the inefficient incumbent supplier can always deter socially efficient upstream entry in the future by using exclusive contracts. The result in Proposition 2 depends on two key assumptions. First, if firms adopt linear wholesale pricing instead of two-part tariffs, exclusion cannot be always observed. The detailed discussion is provided in the following section. Second, the result here highly depends on the assumption of the single entrant supplier. As in Kitamura (2010), if we assume multiple entrants, the competition between entrants induces $D$ to earn higher profits, which is increasing in the efficiency level of the second most efficient entrant. Hence, the exclusion outcome is not always observed if multiple entrants are sufficiently efficient.

4 Discussion

This section briefly discusses the wholesale pricing, vertical product differentiation, and the linkage between anticompetitive exclusive dealing in this study and the Intel case (2005). Section 4.1 extends the analysis to the case of linear wholesale pricing. Section 4.2 extends the analysis to the case in which suppliers’ inputs are vertically differentiated. Section 4.3 introduces the linkage between exclusion in this study and the Intel case (2005).

4.1 Linear wholesale pricing

In this section, we extend the case of two-part tariff to that of linear wholesale pricing; $U_i$ offers $(w_{b,t}, 0)$ at Period $t$ when $D$’s decision is $\omega \in \{a, r\}$. In this subsection, we assume that $\eta \in (0, 1)$ under which the equilibrium wholesale price at Period 2 always becomes the marginal cost of $U_i$ for the case of entry; that is, $w_{E|2}^O = w_{E|2}^F = c_I$. The equilibrium outcomes

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17 This assumption implies that $U_E$’s monopoly price is higher than $c_I$. Exclusion can still exist even when $U_E$ is more efficient, while the analysis becomes more complicated.
in the subgame after $D$’s decision at Period 1.1 are provided in Appendix A.2. The following proposition shows that in the case of linear wholesale pricing, an exclusion equilibrium exists under some conditions.

**Proposition 3.** Suppose that suppliers offer linear wholesale pricing and $\eta \in (0, 1)$. In the durable goods market, exclusion becomes a unique equilibrium outcome for $\delta \leq \bar{\delta} \simeq 0.79537$.

*Proof.* See Appendix B.4. □

In contrast to the case of two-part tariffs, linear wholesale pricing does not lead to exclusion outcomes for a high discount factor. The major difference between two types of wholesale pricing is the existence of double marginalization problems, which is observed only for the case of linear wholesale pricing. When the exclusive offer is accepted, the double marginalization problem occurs for both periods, which reduces the joint profit of $U_I$ and $D$ under exclusive dealing. By contrast, when the exclusive offer is rejected, socially efficient entry at Period 2 can mitigate such a problem; $D$ can earn considerably high profits at Period 2. If the discount factor is high, this effect becomes dominant and thus, the exclusion equilibrium does not exist.

### 4.2 Vertically differentiated inputs

In this subsection, we extend Section 3’s analysis to the case in which input suppliers produce vertically differentiated inputs. The basic model structure here follows Argenton (2010), who examines the existence of anticompetitive exclusive contracts when upstream suppliers’ products are vertically differentiated. Although Argenton (2010) explores the case in which two downstream firms exist in the perishable goods market, we explore the case in which a single downstream firm exists in the durable goods market.

The quality of the final product with the input supplied by $U_i$ is denoted by $\mu_i$, where $i \in \{I, E\}$. Following Argenton (2010), we assume that $U_E$ produces a higher quality input, $\mu_E > \mu_I$, and that for simplicity all firms’ marginal costs are zero; that is, $c_I = c_E = c_D = 0$. Consumer preferences follow the standard in the literature on vertical product differentiation.
There are a unit mass of consumers, indexed by $\theta$, which is uniformly distributed on the interval $[0, 1]$. Consumers decide whether to purchase one unit of final goods. To purchase one unit of the final good with quality $\mu_i$ at Period $t$, a consumer of type $\theta$ pays $p_{it}$ and enjoys consumer surplus $\theta\mu_i - p_{it}$. Like previous section, each consumer purchases the final good once by considering the prices of available final goods at both periods $p_{i1}$ and $p_{i2}$. At Period 2, a consumer type $\theta$, who does not purchase the final good at Period 1, purchases the final good if and only if $\max\{\theta\mu_i - p_{i1}, \theta\mu_E - p_{E1}\} \geq 0$. By rationally expecting $p_{i2}$, the consumer purchases the final good with the input supplied by $U_i$ at Period 1 if and only if $\theta\mu_i - p_{a1} \geq \max\{\theta\mu_i - p_{i2}, 0\} \geq \max\{\theta\mu_i - p_{i2}, \theta\mu_E - p_{E1}, 0\}$ when the exclusive offer is accepted (rejected). We define the indifferent consumer's type $\theta^*$ as $\theta^* \mu_i - p_{i1}^* = \max\{\theta^* \mu_i - p_{i2}^*, 0\}$ and $\theta^* \mu_i - p_{a1}^* = \max\{\theta^* \mu_i - p_{i2}^*, \theta^* \mu_E - p_{E1}^*, 0\}$, respectively.

To obtain interior solutions, we assume the following condition:

**Assumption 2.**

$$\frac{\mu_E}{\mu_i} < \psi(\delta) \equiv \frac{2 - \delta}{\delta},$$  \hspace{1cm}(11)

where $\psi'(\delta) < 0$ for all $\delta \in (0, 1)$ and where as $\delta \to 0$, $\psi(\delta) \to \infty$ and as $\delta \to 1$, $\psi(\delta) \to 1$.

If condition (11) holds, the second order condition and $0 < \theta^* < 1$ simultaneously hold.\(^{19}\)

The equilibrium outcomes in the subgame after $D$’s decision at Period 1.1 are provided in Appendix A.3. The following proposition shows that exclusion always occurs.

**Proposition 4.** Suppose that suppliers adopt two-part tariffs and condition (11) holds. In the durable goods market, the incumbent supplier with the low quality input can exclude the future entrant supplier with the high quality input by using exclusive contracts.

**Proof.** See Appendix B.5 \(\Box\)

Proposition 4 confirms the robustness of the exclusion mechanism in this study. Like the case in which the entrant supplier is efficient in terms of cost efficiency, the existence

\(^{18}\) Consumer preferences here coincide with those in previous section for $\mu_i = \mu_E = 1$.

\(^{19}\) This condition is derived from $\theta^* < 1$. The other conditions always hold if this condition holds. More importantly, as in Proposition 2 we can obtain exclusion results even when condition (11) does not hold.
of the future entrant supplier, which is efficient in terms of input quality, discourages final consumers from purchasing the durable good with $U_i$’s input at Period 1, which reduces two-period joint profits of $U_i$ and $D$.

### 4.3 Linkage with Intel case (2005)

In this subsection, we briefly consider the linkage between anticompetitive exclusive dealing in this study and Intel case (2005). In the CPU market, Intel’s rival firms sometimes develop competitive products such as “Crusoe” developed by Transmeta in early 2000s and “Ryzen” developed by AMD recently. Hence, although Intel keeps a dominant position in the CPU market, it commonly faces the threat of competitive products developed by rival firms.

In the Intel case (2005), a competitive product also exists. Intel had a dominant position in the market for 32-bit version of x86 microprocessors to run on the Microsoft Windows and Linux families of operating systems. However, in 2003, AMD achieved technological leadership for 64-bit version of x86 microprocessors, which are expected to become the next-generation standard. The U.S. Court pointed out that “Bested in a technology duel over which it long claimed leadership, Intel increased exploitation of its market power to pressure customers to refrain from migrating to AMD’s superior, lower-cost microprocessors.” As one of countermeasures against AMD, “Intel had forced major customers into exclusive-or near exclusive deals.” Hence, Intel’s exclusive dealing can be interpreted as aiming to protect its dominant position in the CPU market in the future, which corresponds to this study’s assumption in which the incumbent supplier, a currently dominant firm, becomes inferior to the entrant supplier in terms of cost efficiency and quality in the future.

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20 See also “Intel and AMD: A long history in court” CNET, July 8, 2005. (link)

21 Actually 64-bit microprocessors started to be mainstream in CPU markets after Intel launched Core 2 professors, its first 64-bit microprocessors for general consumers, on July 27, 2006. (link)

22 See page 3 of the report on Advanced Micro Devices, INC., a Delaware corporation, and AMD International Sales & Services, LTD., a Delaware corporation, v. Intel corporation, a Delaware corporation, and Intel Kabushiki Kaisha, a Japanese corporation, Civil Action No. 05-441-JJF (2005). (link)

23 See page 2 of the report.
This study has explored anticompetitive exclusive contracts in durable goods markets. Although existing studies consider exclusive contracts in perishable goods markets, exclusive contracts are often observed in durable goods markets in the real-business situations. Therefore, we need to consider how the durability of final goods in downstream markets affects the possibility of anticompetitive exclusive contracts in upstream markets.

By simply extending the framework of Chicago School argument to a two-period model without price commitment, we show that the durability of final goods plays an essential role in anticompetitive exclusive contracts; namely, in durable goods markets, exclusive contracts can be signed to deter socially efficient future entry. We also show that this result does not depend on the wholesale pricing or homogeneity of inputs; we obtain exclusion results under both linear wholesale pricing and vertically differentiated inputs. Since the exclusion mechanism in this study is based on the durable goods monopolist’s price commitment problem, the result here can be applied to real-world vertical-relationships in durable goods markets.

The finding here provides new implications for antitrust agencies; the Chicago School argument cannot be necessarily applied to durable goods markets. When we discuss the anticompetitiveness of exclusive contracts, we need to consider the durability of final goods in the market where exclusion occurs. Otherwise, we may overestimate the Chicago School argument and may lead to misleading predictions.

Despite these contributions, there remain several outstanding issues requiring future research. First, there is concern about the generality of our results. Although the analysis is presented in terms of a parametric example, the exclusion result may remain valid in more general setting because the exclusion mechanism is based on durable-goods monopolist’s price commitment problem. Second, there is concern about the relation with other studies in the literature of anticompetitive exclusive dealing. To clarify the role of durable goods, this study provides a simple model that extends the framework of the Chicago School argument to durable goods markets. We predict that when we introduce the possibility of durable
goods in other models of anticompetitive exclusive dealing, exclusion results are more likely to be observed. Thus, extensions and applications of our model can help researchers and policy-makers address similar real-world issues.
## A Equilibrium outcomes in subgames after Period 1.1

We derive the equilibrium outcomes after the game at Period 1.1 by using backward induction. Appendix A.1 introduces the equilibrium outcomes under two-part tariffs. Appendix A.2 provides the equilibrium outcomes under linear wholesale pricing. Finally, Appendix A.3 derives the equilibrium outcomes when inputs are vertically differentiated.

### A.1 Two-part tariffs

We first consider the case where the exclusive offer is accepted in Period 1.1. In this case, $U_I$ becomes an upstream monopolist at both periods. As discussed in Section 3, at Period 2.2, $U_I$ offers $(c_I, \Pi^*_2(c_I, \overline{v}))$ to $D$. At Period 2.3, $D$ chooses $p^*_2(c_I, \overline{v})$. $U_I$ earns $\Pi^*_2(c_I, \overline{v})$ and $D$ earns nothing. By substituting $z = c_I$ into (7), we have $\overline{v}(p_1, c_I)$. By anticipating these reaction functions and given $(w^1, F^1)$, at Period 1.3, $D$ chooses the final goods price to maximize its two-period profits:

$$p^a_1(w^1) = \arg\max_{p_1 \geq w^1} (p_1 - w^1)(1 - \overline{v}(p_1, c_I)) - F^1.$$  

Because $U_I$ can extract all of $D$’s profit by setting $F^1_a = (p^a_1(w^1) - w^1)(1 - \overline{v}(p^a_1(w^1), c_I))$, $U_I$’s profit maximization problem at Period 1.2 becomes

$$w^a_{\Pi^1} = \arg\max_{w^1} (p^a_1(w^1) - c_I)(1 - \overline{v}(p^a_1(w^1), c_I)) + \delta \Pi^*_2(c_I, \overline{v}(p^a_1(w^1), c_I)).$$

In the equilibrium, we have

$$w^a_{\Pi^1} = \frac{\delta(2 - \delta) + (8 - 8\delta + \delta^2)c_I}{2(4 - 3\delta)} > c_I,$$

which leads to (9) with $z = c_I$. The firms’ equilibrium profits, excluding the fixed compensation $x$, are

$$\pi^a_{\Pi^1} + \delta\pi^a_{\Pi^2} = \frac{(2 - \delta)(1 - c_I)^2}{4(4 - 3\delta)}, \quad \pi^a_{\Pi^2} = 0, \quad \pi^a_{D^1} + \delta\pi^a_{D^2} = 0. \tag{12}$$

Second, we consider the case where $D$ rejects the exclusive offer at Period 1.1. In this case, $U_I$ is an upstream monopolist at Period 1 but it needs to compete with $U_E$ at Period
2 because socially efficient entry occurs. Given $\bar{v}$, at Period 2.2, $U_I$ makes its best offer $(c_I, 0)$ and earns nothing. In contrast, $U_E$ offers $(c_E, \Pi^*_2(c_E, \bar{v}) - \Pi^*_1(c_I, \bar{v}))$, which induces $D$ to earn $\Pi^*_2(c_I, \bar{v})$ at Period 2. Because $U_E$ is the equilibrium supplier, the indifferent consumer’s willingness to pay becomes $\bar{v}(p_I, c_E)$. By anticipating these reaction functions and given $(w_{f1}, F_{f1})$, at Period 1.3, $D$ chooses the final goods price to maximize its two-period profits:

$$p_{f1}^r(w_{f1}) = \arg\max_{p_1} (p_1 - w_{f1})(1 - \bar{v}(p_1, c_E)) + \delta \Pi^*_2(c_I, \bar{v}(p_1, c_E)) - F_{f1}.$$ 

If $D$ rejects $U_I$’s two-part tariffs at Period 1.2, $D$ earns nothing at Period 1 but $(1 - c_I)^2/4$ at Period 2 due to the competition between $U_I$ and $U_E$. By anticipating this outside profit, at Period 1.2, $U_I$ sets two-part tariffs that induce $D$ to earn $\delta(1 - c_I)^2/4$ by setting $F_{f1}^r = (p_{f1}^r(w_{f1}) - w_{f1})(1 - \bar{v}(p_{f1}^r(w_{f1}), c_I)) + \delta \Pi^*_2(c_I, \bar{v}(p_{f1}^r(w_{f1}), c_I)) - \delta (1 - c_I)^2/4$. $U_I$’s profit maximization problem at Period 1.2 becomes

$$w_{f1}^r = \arg\max_{w_{f1}} (p_{f1}^r(w_{f1}) - c_I)(1 - \bar{v}(p_{f1}^r(w_{f1}), c_E)) + \delta \Pi^*_2(c_I, \bar{v}(p_{f1}^r(w_{f1}), c_E)) - \frac{\delta(1 - c_I)^2}{4}.$$ 

In the equilibrium, we have $w_{f1}^r = c_I$, which leads to (9) with $z = c_E$. The resulting firms’ profits are

$$\pi_{f1}^r + \delta \pi_{f2}^r = \frac{(4 - 2\eta - 4\delta + \eta \delta)(1 - c_I)^2}{4(2 - \eta)^2(4 - 3\delta)}, \ \pi_{f2}^r = \frac{\eta (8 + \eta \delta - 4\delta)(1 - c_I)^2}{4(2 - \eta)^2(4 - 3\delta)},$$

$$\pi_{D1}^r + \delta \pi_{D2}^r = \frac{\delta(1 - c_I)^2}{4}. \ \ \ \ \ (13)$$

### A.2 Linear wholesale pricing

We first consider the case where the exclusive offer is accepted in Period 1.1. In this case, $U_I$ becomes an upstream monopolist at both periods. At Period 2.3, $D$’s profit maximization problem given $w_{f2}$ and $\bar{v}$ is given by

$$p_{f2}^r(w_{f2}, \bar{v}) = \arg\max_{p_2} (p_2 - w_{f2})(\bar{v} - p_2).$$
By solving this problem, we have \( p_{x2}^I(w_{\|2}, \overline{v}) = (w_{\|2} + \overline{v})/2 \). By anticipating \( D \)'s reaction function, \( U_I \)'s profit maximization problem at Period 2 becomes

\[
\begin{align*}
\pi_d^2(w_{\|2}, \overline{v}) = & \arg\max_{w_{\|2} \geq c_I} (w_{\|2} - c_I)(\overline{v} - p_{x2}^I(w_{\|2}, \overline{v})).
\end{align*}
\]

By solving this problem, we have \( \pi_d^2(w_{\|2}, \overline{v}) = (\overline{v} + c_I)/2 \). The final goods price given \( \overline{v} \) at Period 2 becomes

\[
\begin{align*}
p_{x2}^I(\overline{v}) = \frac{3\overline{v} + c_I}{4}.
\end{align*}
\]

Period 2 profits given \( \overline{v} \) are given by \( \pi_d^2(\overline{v}) = (\overline{v} - c_I)^2/8 \) and \( \pi_d^2(\overline{v}) = (\overline{v} - c_I)^2/16 \). By substituting (14) into (1), we have

\[
\begin{align*}
\overline{v}'(p_1) = \frac{4p_1 - \delta c_I}{4 - \delta}.
\end{align*}
\]

By anticipating these reaction functions and given \( w_{\|1} \), at Period 1.3, \( D \) chooses the final goods price to maximize its two-period profits:

\[
\begin{align*}
p_{x1}^I(w_{\|1}) = & \arg\max_{p_1 \geq w_{\|1}} (p_1 - w_{\|1})(1 - \overline{v}'(p_1)) + \delta \frac{(\overline{v}'(p_1) - c_I)^2}{16}.
\end{align*}
\]

By anticipating this reaction, at Period 1.2, \( U_I \) chooses the input price:

\[
\begin{align*}
w_{\|1}^* = & \arg\max_{w_{\|1} \geq c_I} (w_{\|1} - c_I)(1 - \overline{v}'(p_{x1}^I(w_{\|1}))) + \delta \frac{(\overline{v}'(p_{x1}^I(w_{\|1})) - c_I)^2}{8}.
\end{align*}
\]

The equilibrium prices and indifferent consumer’s willingness to pay are

\[
\begin{align*}
w_{\|1}^d = & \frac{128 - 72\delta + 11\delta^2 + (128 - 24\delta - 11\delta^2)c_I}{32(8 - 3\delta)}, & w_{\|2}^d = & \frac{24 - 7\delta - (40 - 17\delta)c_I}{8(8 - 3\delta)},
\end{align*}
\]

\[
\begin{align*}
p_1^d = & \frac{(4 - \delta)(24 - 7\delta) + (32 + 4\delta - 7\delta^2)c_I}{16(8 - 3\delta)}, & p_2^d = & \frac{3(24 - 7\delta) + (56 - 27\delta)c_I}{16(8 - 3\delta)},
\end{align*}
\]

\[
\begin{align*}
\overline{v}^d = & \frac{24 - 7\delta + (8 - 5\delta)c_I}{4(8 - 3\delta)}.
\end{align*}
\]

The firms’ equilibrium profits, excluding the fixed compensation \( x \), are

\[
\begin{align*}
\pi_{\|1}^d + \delta \pi_{\|2}^d = & \frac{(8 - \delta)(1 - c_I)^2}{64(8 - 3\delta)}, & \pi_{E2}^d = & 0,
\end{align*}
\]

\[
\begin{align*}
\pi_{D\|1}^d + \delta \pi_{D\|2}^d = & \frac{(1024 - 576\delta + 32\delta^2 + 19\delta^3)(1 - c_I)^2}{256(8 - 3\delta)^2}.
\end{align*}
\]
Second, we consider the case where $D$ rejects the exclusive offer at Period 1.1. In this case, $U_I$ is an upstream monopolist at Period 1 but it needs to compete with $U_E$ at Period 2. Given $\bar{v}$, the competition between $U_I$ and $U_E$ at Period 2.2 leads to $w_{E|2}^r = c_I$. Given this input pricing, $D$’s maximization problem at Period 2.3 becomes

$$p_{2r}^r(\bar{v}) = \text{argmax}_{p_2 \geq c_I} (p_2 - c_I)(\bar{v} - p_2).$$

The solution of this problem is

$$p_{2r}^r(\bar{v}) = \frac{\bar{v} + c_I}{2}. \quad (16)$$

Period 2 profits given $\bar{v}$ are given by $\pi^r_{I|2}(\bar{v}) = 0$ and $\pi^r_{E|2}(\bar{v}) = (\bar{v} - c_I)^2/4$. By substituting (16), into (1), we have

$$v_{r}(p_1) = 2p_1 - \delta c_I.$$

By anticipating these reaction functions and given $w_{I|1}$, at Period 1.3, $D$ chooses the final goods price to maximize its two-period profits:

$$p_{r1}^r(w_{I|1}) = \text{argmax}_{p_1 \geq w_{I|1}} (p_1 - w_{I|1})(1 - \bar{v}(p_1)) + \delta \frac{(\bar{v}(p_1) - c_I)^2}{4}.$$

By anticipating $p_{r1}^r(w_{I|1})$, at Period 1.2, $U_I$ optimally chooses the input price:

$$w_{I|1}^r = \text{argmax}_{w_{I|1} \geq c_I} (w_{I|1} - c_I)(1 - \bar{v}(p_{r1}^r(w_{I|1}))).$$

By solving these problems, the equilibrium prices and indifferent consumer’s willingness to pay are

$$w_{I|1}^r = \frac{1 - \delta + (1 + \delta)c_I}{2}, \quad w_{E|2}^r = c_I, \quad p_{r1}^r = \frac{(2 - \delta)(3 - 2\delta) + (2 + \delta - 2\delta^2)c_I}{2(4 - 3\delta)},$$

$$p_{r2}^r = \frac{3 - 2\delta + (5 - 4\delta)c_I}{2(4 - 3\delta)}, \quad \bar{v} = \frac{3 - 2\delta + (1 - \delta)c_I}{4 - 3\delta}.$$

The firms’ equilibrium profits are

$$\pi^r_{I|1} + \delta \pi^r_{I|2} = \frac{(1 - \delta)^2(1 - c_I)^2}{2(4 - 3\delta)}, \quad \pi^r_{E|2} = \frac{(1 - \delta)(c_I - c_E)(1 - c_I)}{2(4 - 3\delta)},$$

$$\pi^r_{D|1} + \delta \pi^r_{D|2} = \frac{(1 + 2\delta - 2\delta^2)(1 - c_I)^2}{4(4 - 3\delta)}. \quad (17)$$
A.3 Vertical product differentiation

For the sake of convenience, we derive the outcomes when $U_i$ monopolizes the upstream market at Period 2 and $D$’s decision at Period 1.1 is $\omega \in \{a, r\}$. The type of a consumer who is indifferent between purchasing the final good with $U_i$’s input and not at Period 2 satisfies $\bar{\theta} \mu_i - p_{I2} = 0$. From this condition, the demand for the final good with $U_i$’s input at Period 2 given $\bar{\theta}$ becomes

$$Q_{I2}^\omega(p_{I2}, \bar{\theta}) = \bar{\theta} - \frac{p_{I2}}{\mu_i}.$$  

At Period 2.3, $D$’s profit maximization problem given $(w_{I2}, F_{I2})$ is given by

$$p_{I2}^\omega(w_{I2}, \bar{\theta}) = \arg\max\limits_{p_{I2} \geq w_{I2}} (p_{I2} - w_{I2})Q_{I2}^\omega(p_{I2}, \bar{\theta}) - F_{I2}. \quad (18)$$

By solving this problem, we have $p_{I2}^\omega(w_{I2}, \bar{\theta}) = (w_{I2} + \bar{\theta} \mu_i)/2$. At Period 2.2, $U_i$ extracts $D$’s profits by setting $F_{I2}^\omega = (p_{I2}(w_{I2}, \bar{\theta}) - w_{I2})Q_{I2}^\omega(p_{I2}(w_{I2}, \bar{\theta}), \bar{\theta}) - k_{I2}^\omega$, where $k_{I2}^\omega$ is $D$’s outside profits. Then, $U_i$’s profit maximization problem at Period 2.2 becomes

$$w_{I2}^\omega(\bar{\theta}) = \arg\max\limits_{w_{I2}} p_{I2}^\omega(w_{I2}, \bar{\theta})Q_{I2}^\omega(p_{I2}(w_{I2}, \bar{\theta}), \bar{\theta}) - k_{I2}^\omega. \quad (19)$$

In the equilibrium, $w_{I2}^\omega(\bar{\theta}) = 0$, which leads to the following final goods price with $U_i$’s input given $\bar{\theta}$ at Period 2:

$$p_{I2}^\omega(\bar{\theta}) = \frac{\bar{\theta} \mu_i}{2}. \quad (20)$$

The rest of this appendix is organized as follows. Appendix A.3.1 explores the case where the exclusive offer is accepted at Period 1.1. Appendix A.3.2 introduces the case where the exclusive offer is rejected at Period 1.1.

A.3.1 When the exclusive offer is accepted

When the exclusive offer is accepted at Period 1.1, $U_i$ becomes an upstream monopolist at both periods. We first consider Period 2. $D$ and $U_i$’s profit maximization problem is given by (18) and (19) with $i = I$, $\omega = a$, and $k_{I2}^\omega = 0$. Period 2 profits given $\bar{\theta}$ are

$$\pi_{I2}^a(\bar{\theta}) = \frac{\bar{\theta}^2 \mu_i}{4}, \quad \pi_{D2}^a(\bar{\theta}) = 0.$$
We next consider Period 1. By substituting (20) into \( \bar{\theta} \mu_I - p_{I1} = \delta(\bar{\theta} \mu_I - p_{I2}^a) \), we have

\[
\bar{\theta}(p_{I1}) = \frac{2p_{I1}}{(2 - \delta)\mu_I}.
\]

Then, the demand for the final good at Period 1 becomes

\[
Q_{I1}^a(p_{I1}) = 1 - \frac{2p_{I1}}{(2 - \delta)\mu_I}.
\]

Given \((w_{I1}, F_{I1})\), at Period 1.3, \(D\) chooses the final goods price to maximize its two-period profits:

\[
p_{I1}^a(w_{I1}) = \arg\max_{p_{I1}\geq w_{I1}} (p_{I1} - w_{I1})Q_{I1}^a(p_{I1}) - F_{I1}.
\]

By solving this problem, we have

\[
p_{I1}^a(w_{I1}) = \frac{(2 - \delta)\mu_I}{2(4 - 3\delta)}.
\]

The equilibrium prices are

\[
w_{I1}^a = \frac{\delta(2 - \delta)\mu_I}{2(4 - 3\delta)}, \quad w_{I2}^a = 0, \quad p_{I1}^a = \frac{(2 - \delta)\mu_I}{2(4 - 3\delta)}, \quad p_{I2}^a = \frac{(2 - \delta)\mu_I}{2(4 - 3\delta)}.
\]

The firms’ equilibrium profits, excluding the fixed compensation \(x\), are

\[
\pi_{I1}^a + \delta\pi_{I2}^a = \frac{(2 - \delta)^2\mu_I}{4(4 - 3\delta)}, \quad \pi_{E1}^a = 0, \quad \pi_{D1}^a + \delta\pi_{D2}^a = 0.
\] (21)

A.3.2 When the exclusive offer is rejected

When \(D\) rejects the exclusive offer at Period 1.1, \(U_I\) is an upstream monopolist at Period 1, while it needs to compete with \(U_E\) at Period 2.

We first consider Period 2. By considering the possibility of upstream monopoly and duopoly, we derive the equilibrium outcomes at Period 2. Assuming the monopoly outcome at Period 2, we consider the case where \(D\) purchases only \(U_E\)’s input. \(D\) and \(U_E\)’s profit
maximization problem is given by (18) and (19) with \( i = E \) and \( \omega = r \). In this case, \( U_E \) offers \( w^{(m)}_{E|2} = 0 \). The joint profits between \( U_E \) and \( D \) under upstream monopoly become

\[
\pi^{(m)}_E(\bar{\theta}) + \pi^{(m)}_D(\bar{\theta}) = \frac{(\bar{\theta})^2 \mu_E}{4}.
\]  

(22)

By contrast, assuming the duopoly outcome at Period 2, we can derive the following demand for the final good with each supplier. The type of a consumer who is indifferent between purchasing the final good with \( U_I \)'s input and purchasing nothing at Period 2, denoted by \( \tilde{\theta}^r \), satisfies \( \tilde{\theta}^r \mu_I = p_{E|2} \). In addition, the type of a consumer who is indifferent between purchasing the final good with \( U_E \)'s input and purchasing the final good with \( U_I \)'s input, denoted by \( \tilde{\theta}^r \), satisfies \( \tilde{\theta}^r \mu_E = p_{E|2} = \tilde{\theta}^r \mu_I - p_{E|2} \). By solving these equations, we have \( \tilde{\theta}^r = p_{E|2}/\mu_I \) and \( \tilde{\theta}^r = (p_{E|2} - p_{E|2})/(\mu_E - \mu_I) \). Assuming \( \tilde{\theta}^r \leq \tilde{\theta}^r \leq \bar{\theta} \), the demand for the final good with \( U_I \)'s input is given by

\[
Q^{(d)}_{E|2}(p_{E|2}, p_{E|2}, \tilde{\theta}) = \frac{p_{E|2} - p_{E|2}}{\mu_E - \mu_I}, \quad Q^{(d)}_{E|2}(p_{E|2}, p_{E|2}, \tilde{\theta}) = \frac{p_{E|2} - p_{E|2}}{\mu_E - \mu_I}.
\]

At Period 2.3, given \((w_{E|2}, F_{E|2})\), \( D \) optimally chooses the prices of final goods:

\[
(p^{(d)}_{E|2}(w_{E|2}, w_{E|2}, \bar{\theta}), p^{(d)}_{E|2}(w_{E|2}, w_{E|2}, \bar{\theta})) = \arg\max_{p_{E|2}} \sum_{i \in \{I, E\}} \{(p_{E|2} - w_{E|2})Q^{(d)}_{E|2}(p_{E|2}, p_{E|2}, \bar{\theta}) - F_{E|2}\}.
\]

By solving this problem, we have

\[
p^{(d)}_{E|2}(w_{E|2}, w_{E|2}, \bar{\theta}) = \frac{w_{E|2} + \bar{\theta} \mu_I}{2}, \quad p^{(d)}_{E|2}(w_{E|2}, w_{E|2}, \bar{\theta}) = \frac{w_{E|2} + \bar{\theta} \mu_E}{2},
\]  

(23)

which leads to the following demand for each input:

\[
q^{(d)}_{I}(w_{E|2}, w_{E|2}, \bar{\theta}) = \frac{\mu_I w_{E|2} - \mu E w_{E|2}}{2(\mu_E - \mu_I)}, \quad q^{(d)}_{E}(w_{E|2}, w_{E|2}, \bar{\theta}) = \frac{w_{E|2} - w_{E|2} + \bar{\theta} (\mu_E - \mu_I)}{2(\mu_E - \mu_I)}.
\]  

(24)

By comparing upstream monopoly and duopoly, we now show that \( D \) never purchases \( U_I \)'s input. When \( U_E \) offers \( w^{r}_{E|2} = 0 \), the first equation in (24) implies that \( U_I \)'s input is never purchased for \( w_I > 0 \). By contrast, when \( U_I \) offers \( w^{r}_{E|2} \leq 0 \), the joint profits between \( U_I \) and \( D \) when \( D \) purchases both \( U_E \)'s and \( U_I \)'s inputs by substituting (23) and (24) become

\[
\pi^{(d)}_{I}(w_{E|2}, w_{E|2}, F_{E|2}, \bar{\theta}) + \pi^{(d)}_{I}(w_{E|2}, w_{E|2}, F_{E|2}, \bar{\theta}) = \frac{(\bar{\theta})^2 \mu_E}{4} - \frac{\mu E w_{E|2}^2}{4 \mu_I (\mu_E - \mu_I)} - F_{E|2},
\]
for \( w_{EI2} = 0 \). The joint profits between \( U_I \) and \( D \) are maximized at \( w_{EI2} = 0 \), under which \( D \)'s demand for \( U_I \)'s input is zero. The comparison with (22) implies that \( U_I \) cannot increase the industry profits; namely, \( D \) never purchases \( U_I \)'s input on the equilibrium path.

The equilibrium outcomes at Period 2 are summarized as follows. At Stage 2.2, \( U_I \) offers \((w^r_{I2}, F^r_{I2}) = (0, 0)\) and earns nothing. In contrast, \( U_E \) offers \((0, F^r_{EI2})\), which induces \( D \) to earn the outside profit when it sells the final good with \( U_I \)'s input; that is, \( k^r_{EI2} = (\bar{\theta})^2 \mu_E / 4 \). This leads to \( F^r_{EI2} = (\bar{\theta})^2(\mu_E - \mu_I) / 4 \). Under these offers, the equilibrium price of the final good with \( U_E \)'s input becomes

\[
p^r_{E2}(\bar{\theta}) = \frac{\bar{\theta} \mu_E}{2}.
\] (25)

As a result, Period 2 profits given \( \bar{\theta} \) are

\[
\pi^r_{I2}(\bar{\theta}) = 0, \quad \pi^r_{E2}(\bar{\theta}) = \frac{(\bar{\theta})^2(\mu_E - \mu_I)}{4}, \quad \pi^r_{D2}(\bar{\theta}) = \frac{(\bar{\theta})^2 \mu_I}{4}.
\]

We next consider Period 1. By substituting (25) into \( \bar{\theta} \mu_I - p^r_{I1} = \delta(\bar{\theta} \mu_E - p^r_{EI2}) \), we have

\[
\bar{\theta}(p_{I1}) = \frac{2p_{I1}}{2\mu_I - \delta \mu_E}.
\]

Then, the demand for the final good with \( U_I \)'s input at Period 1 becomes

\[
Q^r_{I1}(p_{I1}) = 1 - \frac{2p_{I1}}{2\mu_I - \delta \mu_E}.
\]

Given \((w^r_{I1}, F^r_{I1})\), at Period 1.3, \( D \) optimally chooses the price of final good with \( U_I \)'s input to maximize its two-period profits:

\[
p^r_{I1}(w_{I1}) = \underset{p_{I1}}{\text{argmax}}(p_{I1} - w_{I1})Q^r_{I1}(p_{I1}) + \delta \pi^r_{D2}(\bar{\theta}(p_{I1})) - F^r_{I1}.
\]

By solving this problem, we have

\[
p^r_{I1}(w_{I1}) = \frac{(2\mu_I - \delta \mu_E)(2(w_{I1} + \mu_I) - \delta \mu_E)}{2((4 - \delta)\mu_I - 2\delta \mu_E)}.
\]

\footnote{The profit maximization problem of \( D \) in such a case corresponds with the maximization problem (13) by substituting \((w_{I2}, F_{I2}) = (0, 0)\) and \( \bar{\theta}' = 1 \).}
If $D$ rejects $U_I$’s two-part tariffs at Period 1.2, $D$ earns nothing at Period 1 but $\mu_I/4$ at Period 2 due to the competition between $U_I$ and $U_E$. By anticipating this outside profit, at Period 1.2, $U_I$ sets two-part tariffs that induce $D$ to earn $\delta\mu_I/4$ by setting $F_{rI}^r = (p_{rI}(w_{rI}) - w_{rI})Q_{rI}(p_{rI}(w_{rI})) + \delta(\theta_{rI}(p_{rI}(w_{rI})))^2\mu_I/4 - \delta\mu_I/4$. Then, $U_I$’s profit maximization problem at Period 1.2 becomes

$$w_{rI} = \arg\max_{w_{rI}} p_{rI}(w_{rI})Q_{rI}(p_{rI}(w_{rI})) + \frac{\delta\theta_{rI}(p_{rI}(w_{rI}))^2}{4}\mu_I - \frac{\delta\mu_I}{4}.$$ 

In the equilibrium, we have $w_{rI} = 0$. The firms’ two-period profits in the equilibrium are

$$\pi_{rI}^* + \delta\pi_{rI}^* = \frac{(2 - \delta)\mu_I - \delta\mu_E}{4((4 - \delta)\mu_I - 2\delta\mu_E)^2}, \quad \pi_{rE}^* = \frac{\delta(\mu_E - \mu_I)(2\mu_E - \delta\mu_I)^2}{4((4 - \delta)\mu_I - 2\delta\mu_E)^2}, \quad \pi_{rD}^* + \delta\pi_{rD}^* = \frac{\delta\mu_I}{4}. \quad (26)$$

**B Proofs of the results**

**B.1 Proof of Lemma 1**

See the results in Appendix A.1. Q.E.D.

**B.2 Proof of Proposition 1**

Substituting $z(\eta) = (2c_I - \eta)/(2 - \eta)$ into $\Pi_f(z)$, we have

$$\Pi_f(z(\eta)) = \frac{(8 - \eta^2\delta^2 + 2\eta^2 + 2\eta\delta^2 + 4\eta\delta - 8\eta + 2\delta^2 - 8\delta)(1 - c_I)^2}{2(2 - \eta)^2(4 - 3\delta)}. $$

By differentiating $\Pi_f(\eta)$ with respect to $\eta$, we have

$$\frac{\partial\Pi_f(z(\eta))}{\partial\eta} = -\frac{\delta(2(2 - \eta) - (4 - \eta)\delta)(1 - c_I)^2}{(2 - \eta)^3(4 - 3\delta)} < 0,$$

for all $(\eta, \delta) \in (0, 2) \times (0, \hat{\delta}(\eta))$. Hence, $\Pi_f(c_I) > \Pi_f(c_E)$ holds for $c_E < c_I$, which implies that condition (4) holds.

Q.E.D.
B.3 Proof of Proposition 2

If condition (5) does not hold, $U_I$ and $D$ cannot earn positive profits at Period 1 for the case in which the exclusive offer is rejected at Period 1.1; that is, $\pi_{r|1} = \pi_{r|2} = 0$. At Period 2, $U_I$ and $D$ earn $\pi_{r|2} = (1 - c_I)^2/4$. By substituting these equations and (12), we find that

$$\pi_{I|1} + \delta \pi_{I|2} + \pi_{D|1} + \delta \pi_{D|2} - (\pi_{r|1} + \delta \pi_{r|2} + \pi_{r|1} + \delta \pi_{r|2}) = \frac{(1 - \delta)^2(1 - c_I)^2}{4 - 3\delta} > 0,$$

which implies that condition (4) always holds.

Q.E.D.

B.4 Proof of Proposition 3

By substituting (15) and (17), we find that

$$\pi_{I|1} + \delta \pi_{I|2} + \pi_{D|1} + \delta \pi_{D|2} - (\pi_{r|1} + \delta \pi_{r|2} + \pi_{r|1} + \delta \pi_{r|2}) = \frac{\delta(768 - 1280\delta + 412\delta^2 - 21\delta^3)(1 - c_I)^2}{256(4 - 3\delta)(8 - 3\delta)^2}.$$

Condition (4) holds for $\delta \leq \tilde{\delta}$.

Q.E.D.

B.5 Proof of Proposition 4

By substituting (21) and (26), we find that

$$\pi_{I|1} + \delta \pi_{I|2} + \pi_{D|1} + \delta \pi_{D|2} - (\pi_{r|1} + \delta \pi_{r|2} + \pi_{r|1} + \delta \pi_{r|2}) = \frac{\delta(\mu_E - \mu_I)((8(1 - \delta) + \delta^2)\mu_E + \delta(4 - 3\delta)\mu_I)}{4(4 - 3\delta)(4 - \delta)\mu_I - 2\delta \mu_E}.$$

Condition (4) holds if and only if $\mu_E/\mu_I \leq \hat{\psi}(\delta) \equiv (8(1 - \delta) + \delta^2)/\delta(4 - 3\delta)$. Since $\hat{\psi}(\delta) - \psi(\delta) = 2(1 - \delta)/(4 - 3\delta) > 0$ for all $\delta \in (0, 1)$, exclusion always becomes a unique equilibrium outcome as long as condition (11) holds.
References


99(5), 1850–1877.


