GCOE Discussion Paper Series

Global COE Program
Human Behavior and Socioeconomic Dynamics

Discussion Paper No.20

Exclusionary Vertical Contracts with Multiple Entrants

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December 2008

GCOE Secretariat
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December 10, 2008

Abstract

This paper constructs a model of anticompetitive exclusive dealing in the presence of multiple entrants. Unlike a single-entrant model in the extant literature, an entrant competes not only with the incumbent to deal with buyers but also with other entrants. The competition among entrants then plays the role of commitment such that low wholesale prices are offered to buyers when they deviate from exclusive contracts. We argue that this commitment effect becomes a barrier to exclusive dealing and that the results differ drastically from the predictions of the single-entrant framework.

JEL Classifications Code: L12, L41, L42.
Keywords: Vertical Relation; Exclusive Dealing; Multiple Entrants; Antitrust Policy.

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*This paper has benefited from helpful discussion and constructive comments by many interested and informed persons. The author would especially like to thank Katsuya Takii, Junichiro Ishida, Noriaki Matsushima, David Flath, Shingo Ishiguro, Toshihiro Matsumura, Keizo Mizuno, Masaki Nakabayashi, Dan Sasaki, Takashi Shimizu, and Tetsuya Shinkai, conference delegates at the Japanese Economic Association and the Japanese Association for Applied Economics, and seminar participants at Kwansei Gakuin University and Osaka University. The usual disclaimer applies.

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1 Introduction

Exclusive contracts have been a controversial issue among economists for some time. Seemingly, the exclusive contract is anticompetitive because it may deter efficient entry and thereby reduce welfare. However, the Chicago School opposes this view. They show that rational economic agents do not engage in exclusive dealing for anticompetitive reasons because exclusive dealing does not increase the joint surplus between contracting parties[1]. The Chicago School argument remains highly influential.

The key assumption of the Chicago School argument is that buyers are final consumers. Two recent papers, Simpson and Wickelgren (2007) and Abito and Wright (2008), show that if buyers are competing firms and they compete intensively, then an exclusive contract can deter efficient entry because exclusive dealing increases the joint surplus between contracting parties by extracting surplus from final consumers. More surprisingly, Abito and Wright show that with nonlinear wholesale pricing, exclusion is a unique equilibrium, regardless of the degree of downstream competition and any cost advantage of the entrant.

The aim of this paper is to reexamine recent studies on exclusive dealing in the framework of multiple entrants. Although Simpson and Wickelgren (2007) and Abito and Wright (2008) provide the mechanism for anticompetitive exclusive dealing, they only analyze the case of a single entrant. However, industries with high substitutability of production factors, products, or technologies may be composed of multiple entrants. This paper shows that the existence of multiple entrants serves as a barrier to anticompetitive exclusive dealing and that the results differ drastically from the single-entrant model.

Although our argument is applicable elsewhere, the model presented in this paper follows Abito and Wright (2008) in amalgamating most existing models of exclusive dealing. Hence, by comparing our results with Abito and Wright (2008), we clarify the importance of multiple entrants. Abito and Wright (2008) construct a model of exclusive dealing where downstream buyers compete imperfectly. Their approach allows us to analyze the relation between the likelihood of exclusive dealing and the degree of downstream competition under both linear pricing and nonlinear pricing.

[1] See Posner (1976) and Bork (1978). See Whinston (2006) for a survey.

To understand the importance of multiple entrants, consider the case of linear wholesale pricing. Under linear wholesale pricing, exclusive contracts can deter an efficient entrant when buyers compete intensively. Abito and Wright (2008) show that in the case of a single entrant, this result holds, even when the entrant has a large cost advantage. With intense downstream competition, buyers obtain almost zero profits when all buyers sign exclusive contracts. Conversely, when one of the buyers deviates from an exclusive contract, the deviant buyer obtains small profits because the efficient entrant always offers it a wholesale price slightly lower than the marginal cost of the incumbent. This allows the incumbent to deter efficient entry by offering an exclusive contract with low transfers, even when the entrant is efficient.

The key implicit assumption is that the entrant is unable to commit initially to offer sufficiently low wholesale prices when the buyer deviates from an exclusive contract. If the entrant were able to do so, then the entrant could increase the buyer's deviation profits and induce them not to sign an exclusive contract. Therefore, the problem faced by the entrant is that it cannot make the commitment to offer low wholesale prices, even when it is efficient.

This paper shows that the existence of rival entrants mitigates this commitment problem because a multiplicity of entrants increases the upstream competition between entrants. This additional competition reduces the wholesale prices offered to deviant buyers to the marginal cost of the second most efficient entrant, and serves the role of commitment to offer low wholesale prices when buyers deviate from exclusive contracts.

This finding suggests that while it is useful to express the fundamental mechanism of anticompetitive exclusive dealing in the framework of a single entrant, we need to take into account the possibility of multiple entrants when we apply the model to any real-world situation. Multiple entrants are likely to exist in industries with many alternative factor inputs, products, and technologies. For example, in industries with high technological progress, such as the information industry, a number of alternative technologies may arise. If we explore the likelihood of anticompetitive exclusive dealing in these industries, the single-entrant framework may lead to misleading predictions.

Although we mainly compare our results with Abito and Wright (2008), where anticompetitive exclusive dealing arises in the absence of scale economies, we can apply our model to the other exclusive dealing models where anticompetitive exclusive dealing arises in the presence of scale economies[2]. Rasmusen, Ramseyer, and Wiley (1991) and Segal and Whinston (2000) show that in the presence of scale economies, exclusive contracts can deter the efficient entrant. More recently, Fumagalli and Motta (2006) and Wright (forthcoming) examine the model where buyers are competing firms. If we consider the multiplicity of entrants in these models, the competition between entrants reduces the wholesale price to the deviant buyer to a level where the second most efficient entrant cannot obtain positive profits. This increases the deviation profits of buyers and becomes a barrier to anticompetitive exclusive dealing. In addition to exclusive contracts, this paper is related to the literature concerned with entry deterrence in the presence of multiple entrants (Ashiya (2000) and Ishibashi (2003)). In those works, the existence of rivals decreases the possibility of entry. In contrast, this paper obtains the opposite result: the existence of rivals increases the possibility of entry.

The remainder of this paper is organized as follows. Section 2 presents the model. Section 3 introduces the analysis under linear wholesale pricing. Section 4 analyzes the case where the incumbent and entrants compete with two-part tariffs. Section 5 provides an example where the multiplicity of entrants reduces the likelihood of exclusion with scale economies. Section 6 contains some concluding remarks. The equilibrium outcomes in the subgame following the buyers' decisions are in Appendix A. Appendix B provides the proofs of all results.

2 Model

This section presents the model. The model we present follows Abito and Wright (2008). The new dimension here is the multiplicity of entrants. This modeling strategy is designed to clarify the importance of multiple entrants. We characterize an upstream and downstream market in Section 2.1. The timing of the game is introduced in Section 2.2. Finally, we derive the conditions that exclusive contracts need to satisfy in Section 2.3.

[2] Simpson and Wickelgren (2007) argue that exclusion without scale economies is more likely to arise than exclusion with scale economies, showing that exclusion is not inefficient if buyers can breach contracts and pay expectation damages. However, exclusion without scale economies remains inefficient, even if breach is possible. This is one reason why we mainly explore exclusion without scale economies in this paper.

2.1 Upstream and downstream markets

In the upstream market, three firms exist, an incumbent (denoted I), Entrant 1 (E_1), and Entrant 2 (E_2). These firms produce an identical product but differ in terms of their cost efficiency. Both Entrant $i = 1$ and 2 are more efficient than the incumbent: they have marginal cost $c_{E_i} < c_I$. Without loss of generality, we assume that $c_{E_1} < c_{E_2}$. Entrants need to incur a fixed cost to start production, $F \geq 0$. We assume that entrants can make wholesale price offers before they incur fixed costs[3]. To simplify the analysis, we assume that $F = 0$. Note that exclusive dealing here arises in the absence of fixed entry cost, and we examine the possibility where exclusive dealing arises in the absence of scale economics. In Section 5, we provide an example where the multiplicity of entrants serves as a barrier to exclusive dealing, even in the presence of scale economies ($F > 0$). The upstream firms deal with buyers who are not final consumers but rather competing firms in the downstream market.

In the downstream market, there are two buyers associated with Buyer 1 (denoted B_1) and with Buyer 2 (B_2). They are differentiated and compete in prices. The cost of transformation or resale is assumed to be zero for simplicity. Buyers sell to final consumers whose preferences are represented by the following utility function:

$$U(q_1, q_2) = \alpha(q_1 + q_2) - \frac{\beta(q_1^2 + q_2^2 + 2\gamma q_1 q_2)}{2}, \tag{1}$$

where $0 \leq \gamma < 1$ is a parameter indicating the degree of differentiation between buyers and q_j is the amount of consumption of buyer j. Buyers become homogeneous as the value of γ increases. When $\gamma = 0$, buyers are independent monopolists. However, when $\gamma = 1$, buyers are homogeneous Bertrand competitors. The inverse demand becomes $p_j = \alpha - \beta(q_j + \gamma q_{-j})$, where $c_I < \alpha \leq 2c_I$ and $\beta > 0$. Buyer j's demand depends not only on its price but also on buyer $-j$'s price:

$$q_j = \begin{cases} \frac{\alpha - p_j}{\beta} & \text{if } 0 < p_j \leq \frac{-\alpha(1-\gamma)+p_{-j}}{\gamma}, \\ \frac{\alpha(1-\gamma)-p_j+\gamma p_{-j}}{\beta(1-\gamma^2)} & \text{if } \frac{-\alpha(1-\gamma)+p_{-j}}{\gamma} < p_j < \alpha(1-\gamma)+\gamma p_{-j}, \\ 0 & \text{if } p_j \geq \alpha(1-\gamma)+\gamma p_{-j}. \end{cases} \tag{2}$$

[3] This is an important assumption when we consider the likelihood of exclusive dealing in the presence of multiple entrants. In the single-entrant model, this assumption is not important: the result is unchanged, regardless of the timing of fixed costs. However, in the presence of multiple entrants, Entrant 2 does not join the upstream competition if entrants need to incur fixed costs before making wholesale price offers. If the buyers are a number of final consumers, then assuming that the entrants need to incur fixed costs before they make wholesale price offers may be realistic. In contrast, if the buyers are firms, then assuming that entrants can make wholesale price offers before they incur fixed costs is more realistic.

The interpretation of equation (2) is as follows. When the prices of buyers are sufficiently close, both obtain positive demand. However, when the prices of buyers are sufficiently different, the higher-priced buyer loses demand but the lower-priced buyer obtains all demand.

We measure entrant i's cost advantage by θ_{E_i}, which satisfies $c_I = \theta_{E_i} p^m(c_{E_i}) + (1 - \theta_{E_i})c_{E_i}$, where $p^m(c_{E_i})$ is the monopoly price for the industry when marginal cost is c_{E_i}: $p^m(c_{E_i}) = (\alpha + c_{E_i})/2$. $\theta_{E_i} = 0$ implies that entrant i has no cost advantage. As θ_{E_i} increases, entrant i becomes efficient. Following Abito and Wright (2008), we assume $0 < \theta_{E_i} \leq 1$[4]. From the definition of θ_{E_i}, the marginal cost of entrant i can be expressed as a function of θ_{E_i} and c_I as follows:

$$c_{E_i} = C(\theta_{E_i}, c_I) = \frac{2c_I - \alpha\theta_{E_i}}{2 - \theta_{E_i}} \text{ for } i = 1, 2. \tag{3}$$

The advantage in measuring entrant i's cost advantage with θ_{E_i} is that it simplifies the analysis. By using θ_{E_i}, we obtain results that do not depend on c_I, α, and β. We can then analyze the possibility of exclusive dealing with only three parameters θ_{E_1}, θ_{E_2}, and γ.

In our framework, the single-entrant case following Abito and Wright (2008) corresponds to the situation where Entrant 2 has no cost advantage, $\theta_{E_2} = 0$. In the following analysis, we show that the existence of Entrant 2 and its cost advantage becomes an important factor in determining the possibility of exclusive dealing.

2.2 Timing of game

The timing of the game is as follows. The model contains three stages. In stage 1, the incumbent makes simultaneous and nondiscriminatory exclusive offers to each buyer. This exclusive contract involves some fixed compensation $x \geq 0$. We assume that the incumbent is unable to offer wholesale prices[5]. Buyers simultaneously decide whether to accept this offer. To avoid an open-set problem, we assume buyers sign an exclusive contract if they are indifferent between signing and not signing

[4]This assumption implies that the entrants' monopoly price is higher than c_I. Exclusion still exists, even when the entrants are more efficient, but the analysis becomes more complicated.

[5]Rasmusen, Ramseyer, and Wiley (1991) point out that price commitment is unlikely if the nature of the product is not precisely described in advance. In addition, even if the incumbent could set a price in Stage 1, the incumbent may not have an incentive to do so because the optimal pricing is contingent on the buyers' decision outcome in Stage 1, as we show in the following analysis. The incumbent is then better off offering wholesale prices after observing the buyers' decision outcome in Stage 1.

the contract. We do not allow all players to breach once the contract is signed. We refer to the buyer signing the exclusive contract as the *signer* and the buyer not signing the contract as the *free buyer*. The free buyer is able to buy not only from the incumbent but also from entrants in the latter stage. Let $S \in \{0, 1, 2\}$ be the number of signers.

In Stage 2, upstream firms offer wholesale prices. There are three cases: $S = 2$, $S = 1$, and $S = 0$. If $S = 2$, then only the incumbent offers wholesale prices to both buyers. If $S = 0$, then all upstream firms offer wholesale prices to both buyers. If $S = 1$, then the incumbent offers wholesale prices to each buyer, but entrants offer wholesale prices only to the free buyer. We assume that the incumbent is able to discriminate between buyers that have signed exclusive contracts. To avoid open-set problems, we assume that free buyers when indifferent deal with efficient upstream firms. Furthermore, we assume that for the case of $S = 1$, each buyer is unable to observe the wholesale offer to its rival[6]. This assumption avoids the possibility of multiple equilibria in the subgame for $S = 1$[7].

In Stage 3, the upstream firm(s) start production and buyers compete in prices. Following Abito and Wright (2008), we assume that buyers do not face a small fixed cost to stay active[8]. The incumbent's profit in the case of $S = k$, where $k \in \{0, 1, 2\}$, is denoted by $\Pi_{I|S=k}$, and buyer j's profit is denoted by $\pi^{l}_{j|S=k}$ where $l = s(f)$ if buyer j is the signer (free buyer).

2.3 Requirement of exclusive contracts

Given equilibrium outcomes in the subgame following Stage 1 (provided in Appendix A), we derive the conditions that an exclusive contract needs to satisfy. The exclusive contract needs to satisfy the following three conditions. First, it has to satisfy the financial feasibility for the incumbent; that is, the

[6]For $S = 0$ and $S = 2$, both buyers deal with the same upstream firms. On the other hand, for $S = 1$, buyers deal with different upstream firms: the free buyer deals with Entrant 1, but the signer deals with the incumbent in the equilibrium. Because two groups exist for $S = 1$, the wholesale price offers that are not publicly observed are more realistic than those that are publicly observed.

[7]See footnote (15) in Appendix A1.3.

[8]The epsilon participation cost for buyers serves the role of a barrier to an exclusive contract in Fumagalli and Motta (2006). However, Simpson and Wickelgren (2007) argue that assuming that buyers are always active is more reasonable for the following reasons. First, under some differentiation, both the signer and the free buyer capture positive demand, and therefore both cover the epsilon participation cost. Second, if we expand the incumbent's contract space either by allowing exclusive contracts that are contingent on all buyers signing them or by allowing up-front payments that are contingent on being active, exclusive contracts again deter entry, even when buyers compete intensively. See the remark in Section III of Simpson and Wickelgren (2007).

incumbent cannot offer a x that is larger than half of its profits under exclusive dealing[9]; i.e.:

$$0 \leq x \leq \frac{\Pi_{I|S=2}}{2}. \tag{4}$$

Second, the exclusive contract has to satisfy individual rationality for buyers: put differently, the amount of compensation x induces each buyer to sign the exclusive contract as a best response when its rival signs the exclusive contract; i.e.:

$$x + \pi^{s}_{j|S=2} \geq \pi^{f}_{j|S=1} \text{ for all } i = 1, 2. \tag{5}$$

Finally, the exclusive contract is required to satisfy uniqueness; that is, the amount of compensation x induces each buyer to sign the exclusive contract as a best response when its rival does not sign; i.e.:

$$x + \pi^{s}_{j|S=1} \geq \pi^{f}_{j|S=0} \text{ for all } i = 1, 2. \tag{6}$$

In the following analysis, we explore the existence of a transfer x that simultaneously satisfies the above conditions. In particular, we examine whether inequalities (4) and (5) are simultaneously satisfied because these conditions are necessary conditions for the existence of anticompetitive exclusive dealing. Because inequalities (4) and (5) are simultaneously satisfied if and only if:

$$\frac{\Pi_{I|S=2}}{2} + \pi^{s}_{j|S=2} \geq \pi^{f}_{j|S=1} \text{ for all } i = 1, 2, \tag{7}$$

we mainly explore whether inequality (7) is satisfied in the following analysis. We then examine whether inequality (6) also holds.

3 Linear Wholesale Pricing

This section analyzes the possibility of exclusive dealing under linear wholesale pricing. In order to understand more easily the commitment effect of the competition between entrants, we first analyze the case where downstream firms compete intensively ($\gamma \to 1$) in Section 3.1. We then extend our analysis to the case where downstream firms compete less intensively ($0 \leq \gamma < 1$) in Section 3.2.

[9] When n buyers exist, the incumbent needs to offer x to all of the n buyers. Therefore, the financial feasibility condition becomes $0 \leq nx \leq \Pi_{I|S=2}$.

3.1 Intense downstream competition

In this subsection, we examine the possibility of exclusive dealing when buyers compete intensively ($\gamma \to 1$). We first explore the single-entrant case as the benchmark in Section 3.1.1. We then analyze the multiple-entrant case in Section 3.1.2.

3.1.1 Benchmark: the single-entrant case

Assume that Entrant 2 does not exist. This corresponds to the case where Entrant 2 has no cost efficiency, $\theta_{E_2} = 0$. Abito and Wright (2008) show that when buyers compete intensively, the incumbent can always exclude efficient entry and obtain almost monopoly profits:

Proposition 1 (Abito and Wright (2008) (Proposition 1)). *Suppose that Entrant 2 does not exist. If buyers compete intensively ($\gamma \to 1$), then under linear wholesale pricing, there is a unique exclusion equilibrium with the incumbent obtaining almost monopoly profits.*

The intuitive logic for this result is as follows. When buyers compete intensively, buyers yield almost zero profits for the same wholesale prices. Under exclusive dealing ($S = 2$), the incumbent offers buyers the same wholesale price that is almost the monopoly level. Buyers then yield almost zero profits, but the incumbent yields almost monopoly profits (See Figure 1).

When one of the buyers deviates from an exclusive contract ($S = 1$), the incumbent offers its marginal cost to the free buyer, but Entrant 1 matches this offer. The free buyer then buys from Entrant 1 at a slightly lower price than the marginal cost of the incumbent. Conversely, the signer buys from the incumbent at a wholesale price close to the marginal cost of the incumbent. Because of small cost difference, the intense downstream competition induces the free buyer to yield small deviation profits (See Figure 2). By using profits under exclusive dealing, the incumbent can easily compensate for the buyers' deviation profits with a small transfer $x > 0$. Each buyer is then better off signing an exclusive contract. As a result, the incumbent excludes efficient entry and enjoys almost monopoly profits.

More importantly, this result holds even when Entrant 1 is very efficient, $\theta_{E_1} = 1$. This follows from the determination of the wholesale price to a free buyer for $S = 1$. For $S = 1$, Entrant 1 offers the free buyer a wholesale price slightly lower than the marginal cost of the incumbent, regardless of its efficiency. At the beginning of Stage 1, each buyer expects that it will be offered this wholesale price when it deviates from the exclusive contract and that deviation is then not beneficial.

This result would not hold if Entrant 1 were able to transfer part of its profits to the free buyer for $S = 1$. By so doing, dealing with Entrant 1 becomes beneficial to the free buyer for $S = 1$. When Entrant 1 is efficient, it obtains high profits and could profitably transfer part of its profits to the free buyer. If each buyer expected this transfer at the beginning of Stage 1, it would not sign an exclusive contract. Therefore, Entrant 1 has an ex ante incentive to transfer part of its profits. However, Entrant 1 has an ex post incentive not to do so when the result in Stage 1 is $S = 1$. Because each buyer knows Entrant 1's ex post incentive, it expects a small deviation to profits and signs an exclusive contract. The problem here is that Entrant 1 cannot commit to transfer part of its profits to the free buyer for $S = 1$.

3.1.2 Multiple-entrant case

We now assume that Entrant 2 exists. In contrast to the single-entrant case, wholesale price competition now exists between entrants when free buyers exist. This additional competition makes it difficult for the incumbent to deter efficient entry:

Proposition 2. *Suppose that multiple entrants exist. If buyers compete intensively ($\gamma \to 1$), then with linear wholesale pricing, the incumbent can exclude efficient entry when Entrant 2 is less efficient ($\theta_{E_2} \leq 2/9$). However, the incumbent cannot exclude efficient entry when both Entrant 1 and Entrant 2 are sufficiently efficient ($\theta_{E_1} > \theta_{E_2} > 2/9$).*

This result lies in contrast with the result in the single-entrant case where exclusion is a unique equilibrium outcome. The critical difference arises when one of the buyers deviates from an exclusive contract ($S = 1$). Because of the competition between entrants, Entrant 1 offers the free buyer a wholesale price that does not match the marginal cost of the incumbent but rather that of Entrant 2. The reduction of the wholesale price to the free buyer then increases the profits of the free buyer (See Figure 3). Therefore, wholesale price competition between entrants serves as the role as a commitment to transfer part of the profits of Entrant 1. At the beginning of Stage 1, each buyer expects that it will deliver large deviation profits as Entrant 2 becomes efficient. Each buyer then does not sign an exclusive contract if Entrant 2 is sufficiently efficient.

Note that Proposition 2 also implies that the competition between entrants does not always serve as a barrier to inefficient exclusion; that is, the incumbent can profitably exclude efficient entry if Entrant 2 is inefficient. The incumbent then has an advantage to hold the almost monopoly profits under exclusive dealing. Therefore, if Entrant 2 is not efficient, the incumbent can profitably compensate buyers and can exclude efficient entry.

The result here suggests that although the mechanism of anticompetitive exclusive dealing is in the single-entrant framework, we need to take into account the existence of multiple entrants if we wish to apply the model to real-world situations. In the single-entrant framework model, Abito and Wright (2008) provide a very important implication that anticompetitive exclusive dealing is possible with intense downstream competition. However, once we consider the multiplicity of entrants, the possibility of exclusive dealing also depends on the efficiency of the second most efficient entrant. As multiple entrants are likely to exist in the industries in the presence of alternative factor inputs, products, and technologies, when we apply the model to these industries, the analysis in the single-entrant framework may provide misleading predictions.

3.2 Less intense downstream competition

In this subsection, we extend the analysis to all degrees of downstream competition ($0 \leq \gamma < 1$). The aim of this analysis is to examine the robustness of Proposition 2 under imperfect downstream competition. Abito and Wright (2008) also analyze the relation between the likelihood of an exclusion equilibrium and the degree of downstream competition. In a single-entrant framework, they show that exclusive dealing arises with intense downstream competition. We show that while their prediction is correct, it overestimates the likelihood of exclusive dealing as in Proposition 2 when we consider the possibility of multiple entrants:

Proposition 3. *Suppose that upstream firms are restricted to offer linear wholesale prices. The multi-*

plicity of entrants decreases the likelihood of a unique exclusion equilibrium for all degrees of downstream competition where exclusion equilibrium arises in the single-entrant case.

Appendix B summarizes the more precise statement of Proposition 3. Figure 4 depicts the results of Proposition 3. In order to understand easily the importance of the existence of Entrant 2, we construct Figure 5 where Entrant 2 has no cost efficiency ($\theta_{E_2} = 0$). Note that this coincides with the single-entrant model in Abito and Wright (2008).

By comparing these figures, it is easy to see that exclusion is a unique equilibrium outcome when downstream competition is not too strong ($\gamma < 0.76$). This result coincides with Abito and Wright (2008). One of the main reasons is double marginalization. The double marginalization prevents joint profit maximization among contracting parties under exclusive dealing ($S = 2$). In addition, weaker competition exacerbates the double marginalization problem. Therefore, weaker competition makes it difficult for the incumbent to compensate the buyers' deviation profits and makes exclusive dealing difficult, even in the absence of Entrant 2[10].

Conversely, as downstream competition becomes strong ($\gamma \geq 0.76$), exclusion equilibrium arises. Proposition 3 implies that with strong downstream competition, the multiplicity of entrants becomes a barrier to exclusive dealing. By comparing Figures 4 and 5, it is easy to see that the market environment of a unique exclusion decreases because of the existence of Entrant 2.

One of the significant results here is that the possibility of a unique exclusion equilibrium is most likely not when buyers compete intensively ($\gamma \to 1$) but when buyers compete slightly less intensively ($\gamma = 0.94$). This result follows from the determination of the free buyer's profits for $S = 1$. As buyers compete less intensively, both the free buyer and the signer obtain positive demands, and duopoly competition arises for $S = 1$. In the duopoly equilibrium, both buyers yield low (high) profits with intense (less intense) downstream competition. The incumbent needs to offer a large amount of compensation to buyers as they compete less intensively. Therefore, exclusive dealing becomes difficult with intense downstream competition when buyers compete less intensively.

On the other hand, as buyers compete intensively, the free buyer monopolizes the downstream

[10] In Section 4, we show that the adaptation of nonlinear wholesale pricing solves the double marginalization problem and that there exists an exclusion equilibrium, even when downstream competition is sufficiently relaxed.

market. In order to monopolize the downstream market, free buyers are required to choose a high (low) price with intense (less intense) downstream competition[11]. This implies that under monopolization by the free buyer, the free buyer's profits increase as buyers compete intensively. From the incumbent's view, the amount of compensation increases with the intensity of downstream competition. Hence, exclusion equilibrium is more likely to arise when downstream competition is slightly relaxed.

4 Two-part Tariffs

In this section, we extend the analysis to allow upstream firms to adapt two-part tariffs. Two-part tariffs consist of a linear wholesale price and an upfront fixed fee, denoted by $(w, \psi) \in \mathbb{R}_+^2$. In the single-entrant model, Abito and Wright (2008) provide the strong result that the adaptation of nonlinear wholesale pricing allows the incumbent always to exclude efficient entry. However, we show that this strongly depends on the assumption of a single entrant.

In order to understand our logic, we first review the result in Abito and Wright (2008) and explain why exclusion is a unique equilibrium outcome in the framework of a single entrant. We then show that a multiplicity of entrants does not always lead to the exclusion equilibrium. The result in Abito and Wright (2008) is summarized as follows.

Proposition 4 (Abito and Wright (2008) (Proposition 5)). *Suppose that Entrant 2 does not exist. If upstream firms can offer two-part tariffs* (w, ψ)*, then exclusion is a unique equilibrium outcome for all degrees of downstream competition and cost efficiencies of the entrant.*

Figure 6 summarizes the above proposition. There are two main reasons why nonlinear wholesale pricing allows the incumbent always to exclude efficient entry in the single-entrant case. First, nonlinear wholesale pricing solves the double marginalization problem and achieves joint profit maximization among contracting parties under exclusive dealing ($S = 2$). Therefore, compared with linear wholesale pricing, nonlinear wholesale pricing increases the joint profits between the incumbent and buyers for $S = 2$; see the left-hand side of inequality (7).

[11] See Appendix A.1.3 Case (C) and (D).

Second, another effect exists in the single-entrant case such that nonlinear wholesale pricing reduces the free buyer's profits when one of the buyers deviates from an exclusive contract ($S = 1$); see the right-hand side of inequality (7). With linear wholesale pricing, the free buyer yields high profits as Entrant 1 becomes efficient. However, with nonlinear wholesale pricing, Entrant 1 can withdraw the free buyer's profits with the fixed free $\psi > 0$. Entrant 1 then chooses a two-part tariff that induces the free buyer to yield exactly the same profits as if it dealt with the incumbent. Therefore, the free buyer's profits in the single entrant do not depend on the cost advantage of Entrant 1; rather, they are the normal duopoly profits when both buyers compete by buying from the incumbent at the marginal cost of the incumbent.

Note that the maximized joint profits of the incumbent and each buyer are always higher than the normal duopoly profits of each buyer. Therefore, Abito and Wright (2008) conclude that the incumbent can always exclude efficient entry in the case of a single entrant. However, as with linear wholesale pricing, this result would not hold if Entrant 1 offered a sufficiently low fixed fee for $S = 1$. By lowering the fixed fee, Entrant 1 could increase the deviation profits of each buyer and thereby induce each buyer not to sign an exclusive contract. Therefore, the problem here is that Entrant 1 excessively withdraws the free buyer's profits with a fixed fee and it cannot commit to offer a low fixed fee for $S = 1$. This paper shows that as with linear wholesale pricing, the multiplicity of entrants solves this commitment problem under nonlinear wholesale pricing:

Proposition 5. *Suppose that upstream firms adapt two-part tariffs (w, ψ). The multiplicity of entrants decreases the likelihood of a unique exclusion equilibrium for all degrees of downstream competition.*

Appendix B provides a precise statement of Proposition 5. Figure 7 depicts the results of Proposition 5. Proposition 5 implies that as with linear wholesale pricing, the existence of Entrant 2 serves the role of a barrier to inefficient exclusive dealing. Because of the wholesale price competition between entrants, Entrant 1 chooses a fixed fee ψ so that the free buyer yields profits so as to deal not with the incumbent but rather with Entrant 2 for $S = 1$. Therefore, the existence of Entrant 2 serves the role of a commitment to reduce the fixed fee. This makes the free buyer's profits for $S = 1$ depend on the cost advantage of Entrant 2. If Entrant 2 is sufficiently efficient, then each buyer expects that it is better off deviating from an exclusive contract at the beginning of Stage 1 and so does not sign an exclusive contract.

In addition, the comparison between linear wholesale pricing and nonlinear wholesale pricing leads to two main findings. First, compared with linear wholesale pricing, the adaptation of nonlinear wholesale pricing increases the possibility of exclusive dealing: $\Theta^{NL}(\gamma) > \Theta^{L}(\gamma)$ for all $0 \leq \gamma < 1$. This follows from the achievement of the joint profit maximization for $S = 2$. The joint profit maximization allows the incumbent to compensate buyers for a larger amount of profits than linear wholesale pricing. This increases the possibility of exclusion equilibrium.

Second, compared with linear wholesale pricing, the multiplicity of entrants serves the more important role as a barrier to anticompetitive exclusive dealing under nonlinear wholesale pricing. Under linear wholesale price, the incumbent cannot exclude efficient entry, regardless of the existence of multiple entrants if downstream competition is not too strong ($\gamma < 0.76$). In contrast, under nonlinear wholesale pricing, the incumbent can always exclude efficient entry in the absence of the multiplicity of entrants. Therefore, under nonlinear wholesale pricing, exploring the possibility of anticompetitive exclusive dealing in the single-entrant case may lead to more misleading predictions than linear wholesale pricing.

5 Scale Economies

Although we can examine exclusive dealing in the absence of scale economies in Simpson and Wickelgren (2007) and Abito and Wright (2008), our logic is applicable to exclusive dealing in the presence of scale economies. In order to show the applicability, this section provides an example of how the multiplicity of entrants reduces the likelihood of exclusive dealing with scale economies in Fumagalli and Motta (2006). To simplify the analysis, we assume that $\alpha = \beta = 1$ and $c_I = 1/2$. In order to coincide with Fumagalli and Motta (2006), we analyze the case where buyers are independent monopolists[12] $\gamma = 0$. To simplify the analysis, Entrant 1 is efficient enough that $\theta_{E_1} = 1$ ($c_{E_1} = 0$). We first

[12]When buyers are independent monopolists in Fumagalli and Motta (2006), buyers' profits depend only on the wholesale prices offered to themselves. This model structure coincides with Rasmusen, Ramseyer, and Wiley (1991), where buyers are final consumers whose surplus depends only on their own prices.

explore the single-entrant case in Section 5.1. We then examine multiple entrants in Section 5.2. We assume that upstream firms are restricted to linear wholesale prices.

5.1 Single-entrant case

Suppose now that Entrant 2 does not exist. In the absence of scale economies ($F = 0$), we have $\pi^s_{S=2} = 1/64$, $\Pi_{I|S=2} = 1/16$ and $\Pi_{E|S=2} = 0$ for $S = 2$, $\pi^f_{S=0} = 1/16$, $\Pi_{I|S=0} = 0$, and $\Pi_{E|S=0} = 1/4$ for $S = 0$, and $\pi^f_{S=1} = 1/16$, $\pi^s_{S=1} = 1/64$, $\Pi_{I|S=1} = 1/32$, and $\Pi_{E|S=1} = 1/8$ for $S = 1$.

Suppose now that the fixed cost is sufficiently high that Entrant 1 requires both buyers to be profitable: $1/8 < F < 1/4$. If the incumbent can only make simultaneous and nondiscriminatory exclusive offers to each buyer, then there exist both an exclusion equilibrium and an entry equilibrium. However, if buyers can coordinate, they prefer the entry equilibrium to the exclusion equilibrium because upstream competition raises their profits. Therefore, the entry equilibrium is more likely.

The exclusion equilibrium becomes a unique equilibrium outcome if we extend the contract space. For example, if the incumbent can make discriminatory offers where $x_1 = \pi^f_{S=0} - \pi^s_{S=2} + \epsilon$ to Buyer 1 but $x_2 = \epsilon$ to Buyer 2 for any small $\epsilon > 0$, then there is a unique exclusion equilibrium[13]. This result follows from $\pi^f_{S=0} < \pi^s_{S=2} + \Pi_{I|S=2}$.

Note that this result would not hold if Entrant 1 were able to offer low wholesale prices for $S = 0$. By so doing, each buyer's profits for $S = 0$ would increase. This might make it difficult for the incumbent to exclude Entrant 1, even if it could use discriminatory offers. For example, if Entrant 1 offered $w^f_{E_1|S=0} < (4 - \sqrt{5})/4 \cong 0.441$, then buyers would be better off not signing exclusive contracts with discriminatory or sequential offers: $\pi^f_{S=0} > \pi^s_{S=2} + \Pi_{I|S=2}$. In addition, if Entrant 1 offered $w^f_{E_1|S=0} = 2/5 < (4 - \sqrt{5})/4$, then Entrant 1 would yield $\Pi_{E_1|S=0} = 6/25$. In this case, Entrant 1 could profitably deal with each buyer for $S = 0$ if $1/8 < F < 6/25$. Therefore, if entrants were able to commit to make such wholesale prices for $S = 0$, the incumbent could not exclude Entrant 1 as a unique equilibrium outcome, even with discriminatory offers.

[13] Abito and Wright (2008) show that this result holds for all degrees of downstream competition ($0 \le \gamma < 1$) in Proposition 3.

5.2 Multiple-entrant case

Suppose now that Entrant 2 does exist. We assume that Entrant 2 is also efficient, $\theta_{E_2} = 1 - \epsilon$ for any small $\epsilon > 0$ and $F = 1/6$. The existence of Entrant 2 does not affect the equilibrium outcomes for $S = 2$ and $S = 1$. However, the existence of Entrant 2 changes the equilibrium outcomes for $S = 0$. For $S = 0$, Entrant 2 offers wholesale prices at the level where its profit is equal to fixed cost: $\Pi_{E_2|S=0} = 1/6$ and Entrant 1 profitably matches this offer $w^f_{E_1|S=0} = (3 - \sqrt{3})/6 \cong 0.211$. With this wholesale price, each buyer yields $\pi^f_{S=1} = (2 + \sqrt{3})/24 > 1/16$. Because $\pi^f_{S=0} - (\pi^s_{S=2} + \Pi_{I|S=2}) = (1 + 8\sqrt{3})/192 > 0$, the incumbent cannot profitably compensate one of the buyers, even when it uses discriminatory offers.

Note that the only difference is the existence of Entrant 2. This adds competition between entrants in the upstream competition for $S = 0$ and reduces wholesale prices to buyers, and increases buyers' profits for $S = 0$. The incumbent cannot compensate for these profits, even with discriminatory offers, if Entrant 2 is sufficiently efficient. Therefore, exploring the likelihood of exclusion with scale economies in the framework of a single entrant may also lead to misleading prediction.

6 Concluding Remarks

This paper has explored recent studies on exclusive dealing in the framework of multiple entrants. Unlike a single-entrant model, an entrant needs to compete not only with the incumbent but also with its rivals. We find that the competition between entrants serves as a barrier to exclusive dealing, and the results differ drastically from the single-entrant model.

This paper provides new implications for antitrust agencies: put simply, we need to take into account the existence of multiple entrants when we apply the model to real-world situations. The findings here imply that earlier results obtained in the single-entrant framework may depend on the assumption of a single entrant. However, multiple entrants may exist in industries in the presence of alternative factor inputs, products, or technologies. Although the fundamental mechanism of exclusive dealing is in the single-entrant framework, it may overestimate the possibility of exclusion and may lead to misleading predictions.

Our result is differently interpreted in that anticompetitive exclusive dealing is more likely to be observed in the industries with few alternative factor inputs, products, and technologies[14]. In such industries, there is less opportunity for multiple entrants to appear, and exploring the possibility of exclusion in a single-entrant framework may be more suitable. Therefore, the possibility of anticompetitive exclusive dealing increases.

Several outstanding issues require future work. First, there is concern about the generality of our results. While the analysis is in terms of a parametric example, the results may extend to settings that are more general. Second, there is a concern about the incumbent's behavior needed to achieve a market environment where exclusive dealing is possible. Previous studies have mainly explored the existence of exclusive dealing for anticompetitive reasons. However, the incumbent may be able to affect the market environment to exclude the more efficient entry. We trust this study will assist future researchers in addressing these important issues.

A Equilibria in the subgame following Stage 1

This Appendix provides the characterization of equilibria in the subgame following Stage 1. We consider each of the possible subgames for $S = 2$, $S = 0$, and $S = 1$, respectively. We first explore the case of linear wholesale pricing in Section A.1. We then examine the case of nonlinear wholesale pricing in Section A.2.

A.1 Linear wholesale pricing

A.1.1 $S = 2$

When both buyers sign exclusive contracts in Stage 1, they both deal with the incumbent. The incumbent sets wholesale prices for each buyer that maximize its profit by taking into account the buyers' pricing in Stage 4 given its wholesale price: i.e.:

$$w^s_{j|S=2} = \arg\max_{w_j \geq c_I} \sum_{j\in\{1,2\}} (w_j - c_I) q_j(p_1(w_1, w_2), p_2(w_1, w_2)), \tag{8}$$

[14]For example, MDS Nordion, which produces Molybdenum-99, a radioisotope, has a 10-year exclusive contract with two Japanese companies, Nihon Medi-Physics and Daiichi Radioisotope Laboratory. These companies produce Technetium-99m from Molybdenum-99. The key point is that Molybdenum-99 is the only factor input available to produce Technetium-99m. This may make exclusive dealing easier.

subject to:

$$p_j(w_j, w_{-j}) = \arg\max_{p_j \geq w_j} (p_j - w_j) q_j(p_j, p_{-j}), \tag{9}$$

given w_{-j} for $j = 1, 2$. In the equilibrium, the incumbent yields:

$$\Pi_{I|S=2} = \frac{(\alpha - c_I)^2}{2\beta(1+\gamma)(2-\gamma)}, \tag{10}$$

and each buyer $j = 1, 2$ yields:

$$\pi^s_{j|S=2} = \frac{(\alpha - c_I)^2(1-\gamma)}{4\beta(1+\gamma)(2-\gamma)^2}. \tag{11}$$

A.1.2 $S = 0$

When neither buyer signs an exclusive contract in Stage 1, each becomes a free buyer and deals with Entrant 1. Because of the competition between entrants, the equilibrium wholesale price decreases to the marginal cost of Entrant 2: $w^f_{j|S=0} = c_{E_2}$ for all $j = 1, 2$. Given this wholesale price, each buyer chooses the price to maximize its profits: i.e.:

$$p^f_{j|S=0} = \arg\max_{p_j \geq c_{E_2}} (p_j - c_{E_2}) q_j(p_j, p_{-j}), \tag{12}$$

for all $j = 1, 2$. In the equilibrium, the incumbent obtains zero profits: $\Pi_{I|S=0} = 0$. On the other hand, each buyer $j = 1, 2$ yields:

$$\pi^f_{j|S=0} = \frac{(\alpha - c_{E_2})^2(1-\gamma)}{\beta(1+\gamma)(2-\gamma)^2} \geq 4\pi^j_{S=2}. \tag{13}$$

A.1.3 $S = 1$

When one of buyers signs the exclusive contract but the other does not, only the signer deals with the incumbent. Without loss of generality, assume that buyer $-j$ signs the exclusive contract. Then, buyer j becomes the free buyer and deals with Entrant 1 in equilibrium. Entrant 2 offers its marginal cost to the free buyer. On the other hand, the incumbent and Entrant 1 choose the profit maximization price by taking into account the buyers' pricing in the final stage given their wholesale prices: i.e.

(*)

$$w^f_{j|S=1} = \arg\max_{w_j \geq c_{E_1}} (w_j - c_{E_1}) q_j(p_j(w_j, p_{-j}), p_{-j}), \tag{14}$$

and:

$$w^s_{-j|S=1} = \arg\max_{w_{-j}\geq c_I} (w_{-j} - c_I) q_j(p_j, p_{-j}(p_j, w_{-j})), \tag{15}$$

subject to:

$$w_j \leq c_{E_2}, \tag{16}$$

$$p_j(w_j, p_{-j}) = \arg\max_{p_j \geq w_j} (p_j - w_j) q_j(p_j, p_{-j}), \tag{17}$$

$$p_{-j}(p_j, w_{-j}) = \arg\max_{p_{-j}\geq w_{-j}} (p_{-j} - w_{-j}) q_{-j}(p_j, p_{-j}). \tag{18}$$

Let $\gamma_L(\theta_{E_1})$, $\gamma_M(\theta_{E_1})$, and $\gamma_H(\theta_{E_1})$ be defined such that:

1. for $\gamma \leq \gamma_L(\theta_{E_1})$, Entrant 1 sets its wholesale price to the free buyer at c_{E_2} regardless of the efficiency of Entrant 2;

2. for $\gamma > \gamma_M(\theta_{E_1})$, the incumbent sets its wholesale price to the signer at c_I if entrants are almost identical: $\theta_{E_1} - \theta_{E_2} \leq \epsilon$ for any $\epsilon > 0$; and

3. for $\gamma \geq \gamma_H(\theta_{E_1})$, the incumbent sets its wholesale price to the signer at c_I regardless of the efficiency of Entrant 2.

In order to derive γ_L and γ_H, we assume that no constraints are active in the problem (*). Then, we obtain the pair $(w^f_{j|S=1}, w^s_{-j|S=1})$:

$$w^f_{j|S=1} = \frac{8(\alpha + c_I) - 3\gamma^2(2\alpha + c_I) - 2\gamma(\alpha - c_{E_1})}{16 - 9\gamma^2}, \tag{19}$$

and:

$$w^s_{-j|S=1} = \frac{8(\alpha + c_{E_1}) - 3\gamma^2(2\alpha + c_{E_1}) - 2\gamma(\alpha - c_I)}{16 - 9\gamma^2}. \tag{20}$$

Because $c_{E_2} < c_I$, we have $w^f_{j|S=1} \geq c_{E_2}$ if $w^f_{j|S=1} \geq c_I$. Therefore, the critical value γ_L is derived by solving $w^f_{j|S=1} = c_I$ with respect to γ, which implies:

$$\gamma_L = \frac{\theta_{E_1} + \sqrt{196 - 340\theta_{E_1} + 145(\theta_{E_1})^2} - 2}{3(4 - \theta_{E_1})}. \tag{21}$$

For $0 \leq \gamma \leq \gamma_L$, Entrant 1 sets its wholesale price to the free buyer at c_{E_2} even when Entrant 2 has low efficiency.

The critical value γ_H is derived by solving $w^s_{-j|S=1} = c_I$ with respect to γ, which implies:

$$\gamma_H = \frac{\sqrt{49 - 48\theta_{E_1} + 12(\theta_{E_1})^2} - 1}{3(2 - 3\theta_{E_1})}. \tag{22}$$

For $\gamma_H \le \gamma < 1$, the incumbent sets its wholesale price to the signer at c_I regardless of the efficiency of Entrant 2. The free buyer then monopolizes the downstream market in equilibrium.

In order to derive γ_M, we assume that the entrants are almost identical so that $w^f_{j|S=1} = c_{E_2}$ in problem (*). Then, we obtain:

$$w^s_{-j|S=1}(w^f_{j|S=1} = c_{E_2}) = \frac{4(\alpha + c_I) - \gamma^2(2\alpha + c_I) - 2\gamma(\alpha - c_{E_2})}{8 - 3\gamma^2}. \tag{23}$$

The critical value γ_M is derived by solving $w^s_{-j|S=1} = c_I$ with respect to γ, which implies:

$$\gamma_M = \frac{\sqrt{9 - 8\theta_{E_1} + 2(\theta_{E_1})^2} - 1}{2 - \theta_{E_1}}. \tag{24}$$

For $\gamma \le \gamma_M$, the incumbent sets its wholesale price to the signer at $w^s_{-j|S=1} > c_I$ even if the entrants are almost identical. On the other hand, for $\gamma > \gamma_M$, the incumbent sets its wholesale price to the signer at $w^s_{-j|S=1} = c_I$ if Entrant 2 is sufficiently efficient: $\gamma > \gamma_M(\theta_{E_2})$.

Note that $\gamma_L < \gamma_M < \gamma_H$ and all critical values are strictly decreasing in $\theta_{E_1} \in [0, 1]$. We define four cases as follows: (A) $0 \le \gamma \le \gamma_L$, (B) $\gamma_L < \gamma \le \gamma_M$, (C) $\gamma_M < \gamma < \gamma_H$, and (D) $\gamma_H \le \gamma < 1$. We explore each case as follows.

Case (A)

In case (A), $w^{f(A)}_{j|S=1} = c_{E_2}$ but the other constraints are not active in problem (*). In the equilibrium, the incumbent yields:

$$\Pi^{(A)}_{I|S=1} = \frac{2((\alpha - c_I)(2 - \gamma^2) - \gamma(\alpha - c_{E_2}))^2}{\beta(1 - \gamma^2)(8 - 3\gamma^2)^2}, \tag{25}$$

and the signer yields $\pi^{s(A)}_{-j|S=1} = \Pi^{(A)}_{I|S=1}/2$. On the other hand, Entrant 1 yields:

$$\Pi^{(A)}_{E_1|S=1} = \frac{(c_{E_2} - c_{E_1})((\alpha - c_{E_2})(4 - 3\gamma^2) - \gamma(\alpha - c_I))}{\beta(1 - \gamma^2)(8 - 3\gamma^2)}, \tag{26}$$

and the free buyer yields:

$$\pi^{f(A)}_{j|S=1} = \frac{((\alpha - c_{E_2})(4 - 3\gamma^2) - \gamma(\alpha - c_I))^2}{\beta(1 - \gamma^2)(8 - 3\gamma^2)^2}. \tag{27}$$

Case (B)

In case (B), $w^{s(B)}_{-j|S=1} > c_I$ but $w^{f(B)}_{j|S=1}$ is not always restricted by the marginal cost of Entrant 2. $w^{f(B)}_{j|S=1}$ is not restricted by the marginal cost of Entrant 2 if the entrant is not efficient. More precisely, $w^{f(B)}_{j|S=1} < c_{E_2}$ if and only if $\theta_{E_2} < \Theta^{iw}$ where:

$$\Theta^{iw}(\gamma, \theta_{E_1}) = \frac{\theta_{E_1}(16-\gamma(2+9\gamma)) - 4(1-\gamma)(4+3\gamma)}{(2-\gamma)(4+3\gamma) - \gamma\theta_{E_1}}. \tag{28}$$

In the equilibrium, the incumbent yields:

$$\Pi^{(B)}_{I|S=1} = \begin{cases} \frac{2((4-3\gamma^2)(\alpha-c_I)-\gamma(\alpha-c_{E_1}))^2}{\beta(1-\gamma^2)(16-9\gamma^2)^2} & \text{if } 0 \leq \theta_{E_2} < \Theta^{iw} \\ \Pi^{(A)}_{I|S=1} & \text{if } \Theta^{iw} \leq \theta_{E_2} < \theta_{E_1}, \end{cases} \tag{29}$$

and the signer yields $\pi^{s(B)}_{-j|S=1} = \Pi^{(B)}_{I|S=1}/2$. On the other hand, Entrant 1 yields:

$$\Pi^{(B)}_{E_1|S=1} = \begin{cases} \frac{2((4-3\gamma^2)(\alpha-c_{E_1})-\gamma(\alpha-c_I))^2}{\beta(1-\gamma^2)(16-9\gamma^2)^2} & \text{if } 0 \leq \theta_{E_2} < \Theta^{iw} \\ \Pi^{(A)}_{E_1|S=1} & \text{if } \Theta^{iw} \leq \theta_{E_2} < \theta_{E_1}, \end{cases} \tag{30}$$

and the free buyer yields:

$$\pi^{f(B)}_{j|S=1} = \begin{cases} \Pi^{(B)}_{E_1|S=1}(0 \leq \theta_{E_2} < \Theta^{iw})/2 & \text{if } 0 \leq \theta_{E_2} < \Theta^{iw} \\ \pi^{f(A)}_{j|S=1} & \text{if } \Theta^{iw} \leq \theta_{E_2} < \theta_{E_1}. \end{cases} \tag{31}$$

Case (C)

In case (C), the incumbent and signer do not always obtain positive demands. The incumbent and the signer yield positive demands if Entrant 2 is not efficient. More precisely, $w^{s(C)}_{-j|S=1} > c_I$ if $0 \leq \theta_{E_2} < \Theta^{-1}_M(\gamma)$ where:

$$\Theta^{-1}_M(\gamma) = \frac{2(2+\gamma)(1-\gamma)}{2-\gamma^2}, \tag{32}$$

and where $\Theta^{-1}_M(\gamma)$ is an inverse function of $\gamma_M(\theta)$. In contrast, if Entrant 2 is sufficiently efficient, $\Theta^{-1}_M(\gamma) \leq \theta_{E_2} < \theta_{E_1}$, then the incumbent and the signer yield zero demands $w^{s(C)}_{-j|S=1} = c_I$[15]. Note that

[15] Fumagalli and Motta (2006) point out in their Section 3 that multiple equilibria exist when the free buyer monopolizes the downstream market $S = 1$. When the free buyer monopolizes the downstream market, the signer does not capture any demand and profits in the subgame for $S = 1$. From the viewpoint of the incumbent, regardless of the price the incumbent sets for the signer, the signer obtains no demand and the incumbent yields zero profits. Therefore, there exists a multiplicity of equilibria in the subgame for $S = 1$. Fumagalli and Motta (2006) then show that both entry and exclusion equilibriums exist. However, this depends on the assumption that the wholesale price to the signer is publicly observable and that the

$\Theta_M^{-1} > \Theta^{iw}$ if and only if $\gamma < \gamma_H$. Therefore, in case (C), we have $\Theta_M^{-1} > \Theta^{iw}$. When the free buyer monopolizes the downstream market, it sets its price at $p_{-j|S=1}^{f(C)} = (c_I - \alpha(1-\gamma))/\gamma$, which is sufficient for monopolization. Entrant 1 sets its wholesale price to the free buyer at $w_{j|S=1}^{f(C)} < c_{E_2}$ if and only if $\theta_{E_2} < \Theta^{iw}$ as in case (B). In the equilibrium, the incumbent yields:

$$\Pi_{I|S=1}^{(C)} = \begin{cases} \Pi_{I|S=1}^{(B)}(0 \le \theta_{E_2} < \Theta^{iw}) & \text{if } 0 \le \theta_{E_2} < \Theta^{iw} \\ \Pi_{I|S=1}^{(A)} & \text{if } \Theta^{iw} \le \theta_{E_2} < \Theta_M^{-1} \\ 0 & \text{if } \Theta_M^{-1} \le \theta_{E_2} < \theta_{E_1}, \end{cases} \tag{33}$$

and the signer yields $\pi_{-j|S=1}^{s(C)} = \Pi_{I|S=1}^{(C)}/2$. On the other hand, Entrant 1 yields:

$$\Pi_{E_1|S=1}^{(C)} = \begin{cases} \Pi_{E_1|S=1}^{(B)}(0 \le \theta_{E_2} < \Theta^{iw}) & \text{if } 0 \le \theta_{E_2} < \Theta^{iw} \\ \Pi_{E_1|S=1}^{(A)} & \text{if } \Theta^{iw} \le \theta_{E_2} < \Theta_M^{-1} \\ \frac{(c_{E_2}-c_{E_1})(\alpha-c_I)}{\beta\gamma} & \text{if } \Theta_M^{-1} \le \theta_{E_2} < \theta_{E_1}, \end{cases} \tag{34}$$

and the free buyer yields:

$$\pi_{j|S=1}^{f(C)} = \begin{cases} \Pi_{E_1|S=1}^{(B)}(0 \le \theta_{E_2} < \Theta^{iw})/2 & \text{if } 0 \le \theta_{E_2} < \Theta^{iw} \\ \pi_{j|S=1}^{f(A)} & \text{if } \Theta^{iw} \le \theta_{E_2} < \Theta_M^{-1} \\ \frac{(\alpha-c_I)^2(\gamma(\alpha-c_{E_2})-(\alpha-c_I))}{\beta\gamma^2} & \text{if } \Theta_M^{-1} \le \theta_{E_2} < \theta_{E_1}. \end{cases} \tag{35}$$

Case (D)

In case (D), the incumbent and the signer never obtain positive demand. They set $w_{-j|S=1}^{s(D)} = p_{-j|S=1}^{s(D)} = c_I$. In order to induce the free buyer to monopolize the downstream market, Entrant 1 needs to set its wholesale price at $w_{j|S=1}^{f(D)} = \min\{c_{E_2}, ((2-\gamma^2)c_I - \alpha(1-\gamma)(2+\gamma))/\gamma\}$. $w_{j|S=1}^{f(D)}$ is restricted by the marginal cost of Entrant 2 if and only if $\theta_{E_2} \ge \Theta_M^{-1}$. The free buyer sets its price at $p_{j|S=1}^{f(D)} = (c_I - \alpha(1-\gamma))/\gamma$. In the equilibrium, both the incumbent and the buyers yield zero profits. However, Entrant 1 yields:

$$\Pi_{E_1|S=1}^{(D)} = \begin{cases} \frac{(\alpha-c_I)(\gamma(\alpha-c_{E_1})-(2-\gamma^2)(\alpha-c_I))}{\beta\gamma^2} & \text{if } 0 \le \theta_{E_2} < \Theta_M^{-1} \\ \Pi_{E_1|S=1}^{(C)}(\Theta_M^{-1} \le \theta_{E_2} < \theta_{E_1}) & \text{if } \Theta_M^{-1} \le \theta_{E_2} < \theta_{E_1}, \end{cases} \tag{36}$$

and the free buyer yields:

$$\pi_{j|S=1}^{f(D)} = \begin{cases} \frac{(\alpha-c_I)^2(1-\gamma^2)}{\beta\gamma^2} & \text{if } 0 \le \theta_{E_2} < \Theta_M^{-1} \\ \pi_{j|S=1}^{f(C)}(\Theta_M^{-1} \le \theta_{E_2} < \theta_{E_1}) & \text{if } \Theta_M^{-1} \le \theta_{E_2} < \theta_{E_1}. \end{cases} \tag{37}$$

incumbent can commit not to change the wholesale price to the signer. Note that when the incumbent offers a high wholesale price to the signer, the free buyer chooses a price slightly lower than the wholesale price or its monopoly price. Therefore, the incumbent can yield positive profits by charging a wholesale price lower than the free buyer's price. Our assumption of unobservable wholesale prices implies that the incumbent cannot solve this commitment problem. Under the unobservable wholesale price case, the unique equilibrium outcome in the subgame for $S = 1$ is that the incumbent offers c_I to the signer.

A.2 Two-part tariffs

A.2.1 S=2

When both buyers sign exclusive contracts in Stage 1, each deals with the incumbent. The incumbent maximizes its profit by setting its wholesale price so that each of buyers chooses the joint profit maximizing price $p^s_{S=2} = (\alpha + c_I)/2$. This wholesale price is $w^s_{S=2} = c_I + \gamma(\alpha - c_I)/2$. The incumbent extracts all of the buyers' profits by using a fixed fee and yields all profits:

$$\Pi_{I|S=2} = \frac{(\alpha - c_I)^2}{2\beta(1+\gamma)}. \tag{38}$$

On the other hand, each of the buyers yields zero profits: $\pi^s_{j|S=2} = 0$ for $j = 1, 2$.

A.2.2 S=0

When neither buyer signs an exclusive contract in Stage 2, all upstream firms compete to deal with each buyer. Because Entrant 1 is the most efficient firm, it attracts both buyers in the equilibrium. The incumbent offers its best terms $(c_I, 0)$ to both buyers. Entrant 2 offers its best terms $(c_{E_2}, 0)$ to both buyers. Entrant 1 only has to match Entrant 2's offer to attract both buyers. In the equilibrium, both buyers yield the duopoly profit:

$$\pi^f_{j|S=0} = \frac{(\alpha - c_{E_2})^2(1-\gamma)}{\beta(1+\gamma)(2-\gamma)^2} \geq 4\pi^j_{S=2}(\gamma). \tag{39}$$

for $j = 1, 2$. On the other hand, the incumbent yields zero profits: $\Pi_{I|S=0} = 0$. These equilibrium outcomes are identical to linear wholesale pricing.

A.2.3 S=1

When one of the buyers signs the exclusive contract but the other does not, only the signer deals with the incumbent. Without loss of generality, assume that buyer $-j$ signs the exclusive contract. Then, buyer j becomes the free buyer. In the equilibrium, the free buyer j deals with Entrant 1. Entrant 2 then offers its best terms $(c_{E_2}, 0)$ to the free buyer, and Entrant 1 matches this to attract the free buyer j. Therefore, the free buyer j's profit is determined by the profit off the equilibrium path where it accepts offers from Entrant 2. The incumbent offers the wholesale price $w^s_{-j|S=1} = c_I$ and extracts all of signer $-j$'s profits. Downstream firms compete in prices given $w^f_{j|S=1} = c_{E_2}$ and $w^s_{-j|S=1} = c_I$:

$$\max_{p_j \geq c_{E_2}} (p_j - c_{E_2}) q_j(p_j, p_{-j}), \tag{40}$$

$$\max_{p_{-j} \geq c_I} (p_{-j} - c_I) q_{-j}(p_j, p_{-j}). \tag{41}$$

Note that $p^s_{-j|S=1} > c_I$ if and only if $\gamma < \gamma_M$. We define two cases as follows: (a) $0 \leq \gamma < \gamma_M$ and (b) $\gamma_M \leq \gamma < 1$. We explore each case as follows.

Case (a)

For $\gamma < \gamma_M$, the incumbent yields:

$$\Pi^{(a)}_{I|S=1} = \frac{((2-\gamma^2)(\alpha - c_I) - \gamma(\alpha - c_{E_2}))^2}{\beta(1-\gamma^2)(4-\gamma^2)^2}. \tag{42}$$

In contrast, free buyer j yields:

$$\pi^{f(a)}_{j|S=1} = \frac{((2-\gamma^2)(\alpha - c_{E_2}) - \gamma(\alpha - c_I))^2}{\beta(1-\gamma^2)(4-\gamma^2)^2}. \tag{43}$$

Case (b)

For $\gamma \geq \gamma_M$, free buyer j monopolizes the downstream market and chooses the monopoly price. In the monopoly equilibrium, the incumbent and signer $-j$ yield zero profits: $\Pi^{(b)}_{I|S=1} = \pi^{s(b)}_{-j|S=1} = 0$. In contrast, the free buyer yields:

$$\pi^{f(b)}_{j|S=1} = \frac{(\alpha - c_I)^2(\gamma(\alpha - c_{E_2}) - \gamma(\alpha - c_{E_2}))}{\beta\gamma^2}. \tag{44}$$

B Proofs of all results

Proof of Proposition 2

See Proof of Proposition 3.

Q.E.D.

Precise statement of Proposition 3

Suppose that upstream firms are restricted to offer linear wholesale prices. The possibility of exclusive dealing is determined by the degree of downstream competition and the cost efficiency of entrants $(\gamma, \theta_{E_1}, \theta_{E_2})$ *as follows.*

1. *If downstream competition is not too strong* ($\gamma < 0.76$)*, then the incumbent cannot exclude efficient entry regardless of the cost efficiency of entrants.*

2. *For sufficiently strong downstream competition* ($\gamma > 0.94$)*:*

   (a) *the incumbent cannot exclude efficient entry if both Entrant 1 and Entrant 2 are sufficiently efficient* ($\theta_{E_1} > \theta_{E_2} > \Theta^L(\gamma)$)*; or*

   (b) *the incumbent can exclude efficient entry if Entrant 2 is less efficient* ($\theta_{E_2} \leq \Theta^L(\gamma)$)*.*

3. *For an intermediate level of downstream competition:*

   (a) *the incumbent cannot exclude efficient entry if either Entrant 1 is sufficiently efficient* ($\theta_{E_1} > \Theta^s(\gamma)$ *and* $\theta_{E_1} > 0.65$ *is sufficient) or if Entrant 2 is sufficiently efficient* ($\theta_{E_2} > \Theta^L(\gamma)$ *and* $\theta_{E_2} > 0.32$ *is sufficient); or*

   (b) *the incumbent can exclude efficient entry either if Entrant 1 is not efficient* ($\theta_{E_1} \leq \Theta^L(\gamma)$) *or if Entrant 1 is not too efficient and Entrant 2 is not efficient* ($\Theta^s(\gamma) \geq \theta_{E_1} > \Theta^L(\gamma) \geq \theta_{E_2}$)*, where*

$$\Theta^s(\gamma) = \frac{2(4+3\gamma)((4-3\gamma)\sqrt{(1-\gamma)(3-2\gamma)} + 2(1-\gamma)(2-\gamma))}{(16-9\gamma^2)\sqrt{(1-\gamma)(3-2\gamma)} - 2\gamma(2-\gamma)}, \tag{45}$$

$$\Theta^L(\gamma) = \begin{cases} \frac{2((1-\gamma)(192+\gamma(64+160\gamma-64\gamma^2-39\gamma^3+18\gamma^4))-2(2-\gamma)(8-3\gamma^2)(4-3\gamma^2))\sqrt{(1-\gamma)(3-2\gamma)})}{192-\gamma(320+32\gamma-256\gamma^2+73\gamma^3+45\gamma^4-18\gamma^5)} & \textit{for } 0 \leq \gamma < 0.94, \\ \frac{2(16(1-\gamma)-\gamma^2(4\gamma^2-14\gamma+9))}{(4-\gamma)(4+\gamma-2\gamma^2)} & \textit{for } 0.94 \leq \gamma < 1. \end{cases} \tag{46}$$

Proof of Proposition 3

We first explore the existence of an exclusion equilibrium when the wholesale price to the free buyer is not restricted by the marginal cost of Entrant 2 ($\theta_{E_2} < \Theta^{iw}$). For $\gamma < 0.94$, inequality (7) holds for all $\theta_{E_1} \in [0, 1]$. For $\gamma < 0.76$, inequality (7) never holds. For an intermediate level of downstream competition, inequality (7) holds if and only if $\theta_{E_1} \leq \Theta^s(\gamma)$.

Second, we explore the existence of exclusion equilibrium when the wholesale price to the free buyer is restricted by the marginal cost of Entrant 2 ($\theta_{E_2} \geq \Theta^{iw}$). For $\gamma < 0.76$, inequality (7) never holds. For $\gamma \geq 0.76$, inequality (7) holds if and only if $\theta_{E_2} \leq \Theta^L(\gamma)$. When exclusion is possible, the incumbent offers $x \geq \pi^f_{S=1} - \pi^s_{S=2}$.

Finally, we prove that the incumbent excludes Entrant 1 and Entrant 2 as a unique equilibrium outcome by offering $x = \pi^f_{S=1} - \pi^s_{S=2}$. To do this, we show that for all for all $(\theta_{E_1}, \theta_{E_2}, \gamma) \in [0, 1] \times [0, \theta_{E_1}] \times [0, 1]$, $\pi^f_{S=1} + \pi^s_{S=1} \geq \pi^f_{S=0} + \pi^s_{S=2}$. Let $H = \pi^f_{S=1} + \pi^s_{S=1} - (\pi^f_{S=0} + \pi^s_{S=2})$. Note that:

$$\pi^f_{S=0}(\gamma, \theta_{E_2}) + \pi^s_{S=2}(\gamma) = \frac{(\alpha - c_I)^2(1-\gamma)(20 - 4\theta_{E_2} + (\theta_{E_2})^2)}{4\beta(1+\gamma)(2-\gamma)^2(2-\theta_{E_2})^2}, \text{ for all } (\theta_{E_2}, \gamma) \in [0, 1] \times [0, 1]. \quad (47)$$

On the other hand, $\pi^f_{S=1} + \pi^s_{S=1}$ depends on γ. There are four cases, as shown in Appendix A.1.3.

Case (A)

When $0 \leq \gamma \leq \gamma_L$, $\pi^{f(A)}_{S=1} + \pi^{s(A)}_{S=1}$ depends on γ and θ_{E_2}. By differentiating $H^{(A)}(\theta_{E_2}, \gamma)$ with respect to θ_{E_2}, we have $\partial H^{(A)}(\theta_{E_2}, \gamma)/\partial \theta_{E_2} \geq 0$ for all $(\theta_{E_2}, \gamma) \in [0, 1] \times [0, 1]$. Because:

$$H^{(A)}(0, \gamma) = \frac{(\alpha - c_I)^2 \gamma(1-\gamma)(128 + \gamma(32 - 48\gamma - 5\gamma^2))}{\beta(1+\gamma)(2-\gamma)^2(8-3\gamma^2)^2} \geq 0 \text{ for all } 0 \leq \gamma \leq 1, \quad (48)$$

we always have $H^{(A)}(\theta_{E_2}, \gamma) \geq 0$ in case (A).

Case (B)

For $\gamma_L < \gamma \leq \gamma_M$, there are two possibilities: $\theta_{E_2} \geq \Theta^{iw}$ and $\theta_{E_2} < \Theta^{iw}$. Because inequality (48) holds for all $0 \leq \gamma \leq 1$, we have $H^{(B)}(\theta_{E_2}, \gamma) > 0$ for $\theta_{E_2} \geq \Theta^{iw}$. On the other hand, for $\theta_{E_2} < \Theta^{iw}$, $\pi^{f(B)}_{S=1} + \pi^{s(B)}_{S=1}$ depends on γ and θ_{E_1}. Therefore, $H^{(B)}$ is a function of γ, θ_{E_1}, and θ_{E_2}. Because $\pi^f_{S=0}(\theta_{E_2}, \gamma)$ is strictly increasing in θ_{E_2}, we examine the case $\theta_{E_2} = \Theta^{iw}(\theta_{E_1}, \gamma)$ where obtaining $H^{(B)}(\theta_{E_1}, \theta_{E_2}, \gamma) \geq 0$ is most difficult in $\theta_{E_2} \leq \Theta^{iw}$. By differentiating $H^{(B)}(\theta_{E_1}, \Theta^{iw}(\theta_{E_1}, \gamma), \gamma)$ with respect to θ_{E_1} , we have $\partial H^{(B)}(\theta_{E_1}, \Theta^{iw}(\theta_{E_1}, \gamma), \gamma)/\partial\theta_{E_1} \geq 0$ for all $(\theta_{E_2}, \gamma) \in [0,1] \times [0, \gamma_H]$. Because:

$$H^{(B)}(\Theta_L^{-1}, \Theta^{iw}(\Theta_L^{-1}(\gamma), \gamma), \gamma) = \frac{(\alpha - c_I)^2\gamma(1-\gamma)(128+\gamma(32-48\gamma+5\gamma^2))}{4\beta(1+\gamma)(2-\gamma)^2(8-3\gamma^2)^2} \geq 0 \text{ for all } 0 \leq \gamma \leq 1, \tag{49}$$

we have $H^{(B)}(\theta_{E_1}, \theta_{E_2}, \gamma) \geq 0$ for $\theta_{E_2} < \Theta^{iw}$. Therefore, we always have $H^{(B)}(\theta_{E_1}, \theta_{E_2}, \gamma) \geq 0$ in case (B).

Case (C)

For $\gamma_M < \gamma \leq \gamma_H$, there are three possibilities: $0 \leq \theta_{E_2} < \Theta^{iw}$, $\Theta^{iw} \leq \theta_{E_2} < \Theta_M^{-1}$, and $\Theta_M^{-1} \leq \theta_{E_2}$. Because inequalities (48) and (49) hold for all $0 \leq \gamma \leq 1$, we have $H^{(C)}(\theta_{E_1}, \theta_{E_2}, \gamma) > 0$ for $0 \leq \theta_{E_2} < \Theta_M^{-1}$. On the other hand, for $\Theta_M^{-1} \leq \theta_{E_2}$, $\pi_{S=1}^{s(C)} = 0$ and $\pi_{S=1}^{f(C)}$ depends on θ_{E_2} and γ. Hence, $H^{(C)}$ is a function of γ, θ_{E_1}, and θ_{E_2}. Because $\pi_{S=0}^{f(C)}(\theta_{E_2}, \gamma)$ is strictly increasing in $\Theta_M^{-1} \leq \theta_{E_2} < \theta_{E_1}$, we examine the case $\theta_{E_2} = \theta_{E_1}$ where obtaining $H^{(C)}(\theta_{E_1}, \theta_{E_2}, \gamma) \geq 0$ is most difficult in $\Theta_M^{-1} \leq \theta_{E_2} \leq \theta_{E_1}$. By differentiating $H^{(C)}(\theta_{E_1}, \theta_{E_1}, \gamma)$ with respect to θ_{E_1}, we have $\partial H^{(C)}(\theta_{E_1}, \theta_{E_1}, \gamma)/\partial\theta_{E_1} \geq 0$ for all $(\theta_{E_1}, \gamma) \in [\Theta_M^{-1}, 1] \times [\gamma_M, 1]$. Because:

$$H^{(C)}(\Theta_M^{-1}(\gamma), \Theta_M^{-1}(\gamma), \gamma) = \frac{(\alpha - c_I)^2\gamma(1-\gamma)(16+\gamma(3-8\gamma))}{4\beta(1+\gamma)(2-\gamma)^2} \geq 0 \text{ for all } \gamma_M \leq \gamma \leq 1, \tag{50}$$

we have $H^{(C)}(\theta_{E_1}, \theta_{E_2}, \gamma) \geq 0$ for $\Theta_M^{-1} \leq \theta_{E_2} \leq \theta_{E_1}$. Therefore, we always have $H^{(C)}(\theta_{E_1}, \theta_{E_2}, \gamma) \geq 0$ in case (C).

Case (D)

For $\gamma_H \leq \gamma < 1$, there are two possibilities: $\theta_{E_2} \geq \Theta_M^{-1}$ and $\theta_{E_2} < \Theta_M^{-1}$. Because inequality (50) holds for $\gamma_H \leq \gamma \leq 1$, we have $H^{(D)}(\theta_{E_1}, \theta_{E_2}, \gamma) \geq 0$ for $\theta_{E_2} \geq \Theta_M^{-1}$. On the other hand, for $\theta_{E_2} < \Theta_M^{-1}$, $\pi_{S=1}^{s(D)} = 0$ and $\pi_{S=1}^{f(D)}$ depends only on γ. Hence, $H^{(D)}$ is a function of θ_{E_2} and γ. Because $\pi_{S=0}^{f(D)}(\gamma)$ is strictly increasing in $\theta_{E_2} < \Theta_M^{-1}$, we examine the case $\theta_{E_2} = \Theta_M^{-1}$ where obtaining $H^{(D)}(\Theta_M^{-1}, \gamma) \geq 0$ is most difficult in $\theta_{E_2} \leq \Theta_M^{-1}$. Because $H^{(D)}(\Theta_M^{-1}, \gamma) = H^{(C)}(\Theta_M^{-1}, \Theta_M^{-1}, \gamma)$, inequality (50) implies that we have $H^{(D)}(\theta_{E_1}, \theta_{E_2}, \gamma) \geq 0$ for $\theta_{E_2} < \Theta_M^{-1}$. Therefore, we always have $H^{(D)}(\theta_{E_1}, \theta_{E_2}, \gamma) \geq 0$ in case (D).

From cases (A), (B), (C), and (D), for all $(\theta_{E_1}, \theta_{E_2}, \gamma) \in [0,1] \times [0, \theta_{E_1}] \times [0,1]$, we have $\pi^f_{S=1} + \pi^s_{S=1} \geq \pi^f_{S=0} + \pi^s_{S=2}$. Therefore, the incumbent excludes Entrant 1 and 2 as a unique equilibrium outcome by offering $x = \pi^f_{S=1} - \pi^s_{S=2}$.

Q.E.D.

Precise statement of Proposition 5

Suppose that upstream firms adapt two-part tariffs (w, ψ). The incumbent can exclude efficient entry either if Entrant 1 is not efficient ($\theta_{E_1} \leq \Theta^{NL}(\gamma)$) or if Entrant 2 is not efficient ($\theta_{E_2} \leq \Theta^{NL}(\gamma) < \theta_{E_1}$). The incumbent cannot exclude efficient entry if Entrant 2 is sufficiently efficient ($\theta_{E_2} > \Theta^{NL}(\gamma)$ and $\theta_{E_2} > 0.32$ is sufficient), where:

$$\Theta^{NL}(\gamma) = \begin{cases} \frac{(1-\gamma)(\gamma^3+2(4-\gamma^2)-2(\gamma^3+2(1+\gamma)(2-\gamma))}{16(1-\gamma)-\gamma^2(2-\gamma)^2(3+\gamma)} & \textit{for } 0 \leq \gamma < 0.94, \\ \frac{2(4-3\gamma^2)}{(2+\gamma)^2} & \textit{for } 0.94 \leq \gamma < 1. \end{cases} \tag{51}$$

Proof of Proposition 5

We first explore the existence of exclusion equilibrium. Inequality (7) hold if and only if $\theta_{E_2} \leq \Theta^{NL}(\gamma)$. Because $\theta_{E_1} > \theta_{E_2}$, exclusion exists if $\theta_{E_1} \leq \Theta^{NL}(\gamma)$. On the other hand, when $\theta_{E_1} > \Theta^{NL}(\gamma)$, exclusion exists if $\theta_{E_2} \leq \Theta^{NL}(\gamma)$. When exclusion is possible, the incumbent offers $x \geq \pi^f_{S=1}$.

Next, we prove that the incumbent can exclude Entrants 1 and 2 as a unique equilibrium outcome by offering $x = \pi^f_{S=1}$. We show that for all $(\theta_{E_2}, \gamma) \in [0,1] \times [0,1]$, $\pi^f_{S=1} \geq \pi^f_{S=0}$. We examine case (a) and case (b) respectively.

Case (a)

For $S = 0$, the free buyer yields duopoly profits where its and its rival's wholesale price is the marginal cost of Entrant 2. However, for $S = 1$, the free buyer yields duopoly profits where its wholesale price is the marginal cost of Entrant 2 but its rival's wholesale price is the marginal cost of the incumbent. Because the buyer's profit is strictly increasing in its rival's wholesale price, the free buyer yields higher profits for $S = 1$. Hence, $\pi^{f(a)}_{S=1} \geq \pi^f_{S=0}$ for all $(\theta_{E_2}, \gamma) \in [0,1] \times [0, \gamma_M]$.

Case (b)

Note that $\pi^{f(b)}_{S=1}(\gamma) \geq \pi^{f(b)}_{S=1}(\gamma_M)$ and $\pi^{f}_{S=0}(\gamma) \leq \pi^{f}_{S=0}(\gamma_M)$ for all $\gamma \geq \gamma_M$. Because $\pi^{f(b)}_{S=1}(\gamma_M) = \pi^{f(a)}_{S=1}(\gamma_M) \geq \pi^{f}_{S=0}(\gamma_M)$, we have $\pi^{f(b)}_{S=1} \geq \pi^{f}_{S=0}$ for all $(\theta_{E_2}, \gamma) \in [0, 1] \times [\gamma_M, 1]$. Therefore, for all $(\theta_{E_2}, \gamma) \in [0, 1] \times [0, 1]$, $\pi^{f}_{S=1} \geq \pi^{f}_{S=0}$.

Q.E.D.

References

Abito, J.M., and Wright, J., 2008. Exclusive Dealing with Imperfect Downstream Competition. *International Journal of Industrial Organization* 26(1), 227–246.

Ashiya, M., 2000. Weak Entrants Are Welcome. *International Journal of Industrial Organization* 18(6), 975–984.

Bork, R.H., 1978. *The antitrust paradox: A policy at war with itself.* New York: Basic Books.

Fumagalli, C., and Motta, M., 2006. Exclusive Dealing and Entry, when Buyers Compete. *American Economic Review* 96(3), 785–795.

Ishibashi, I., 2003. A Note on Credible Spatial Entry Deterrence. *International Journal of Industrial Organization* 21(2), 283–289.

Posner, R.A., 1976. *Antitrust law: An economic perspective.* Chicago: University of Chicago Press.

Rasmusen, E.B., Ramseyer, J.M., and Wiley, John, S. Jr., 1991. Naked Exclusion. *American Economic Review* 81(5), 1137–1145.

Segal, I.R., and Whinston, M.D., 2000. Naked Exclusion: Comment. *American Economic Review* 90(1), 296–309.

Simpson, J., and Wickelgren, A.L., 2007. Naked Exclusion, Efficient Breach, and Downstream Competition. *American Economic Review* 97(4), 1305–1320.

Whinston, M.D., 2006. *Lectures on Antitrust Economics*. Cambridge, MA: MIT Press.

Wright, J., forthcoming. Exclusive Dealing and Entry, when Buyers Compete: Comment. *American Economic Review*.

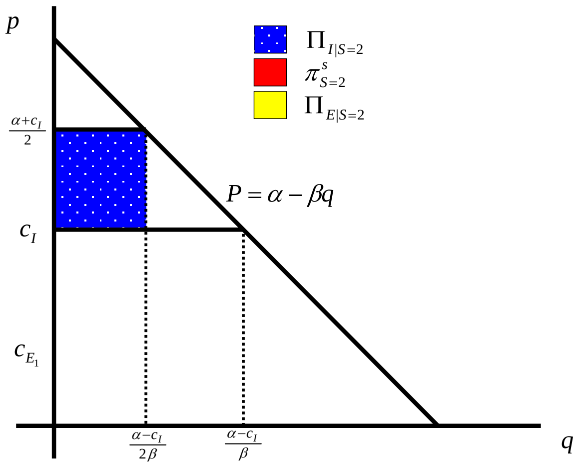

Figure 1: S=2

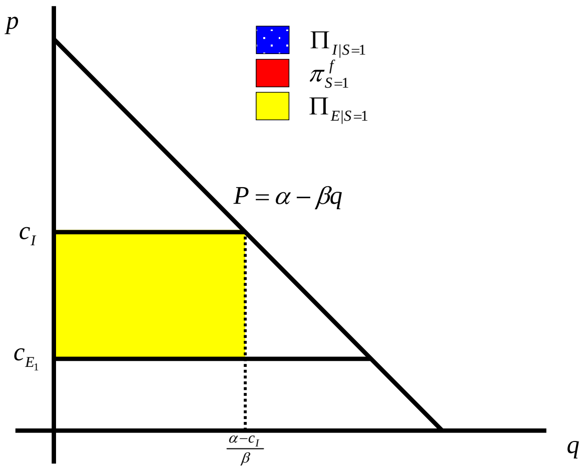

Figure 2: S=1 (Single entrant case)

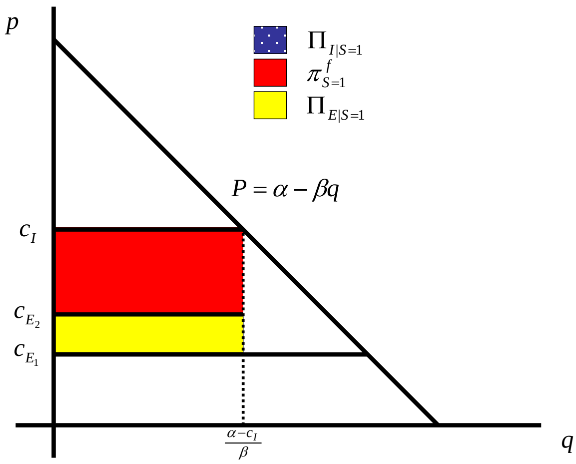

Figure 3: S=1 (Multiple entrant case)

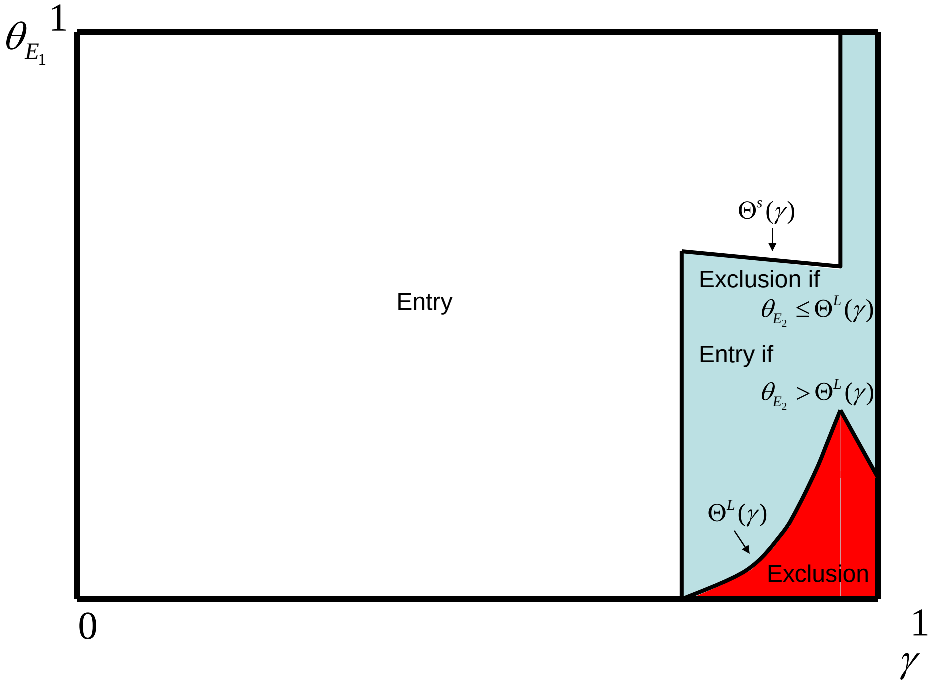

Figure 4: Linear wholesale pricing (Multiple entrant case)

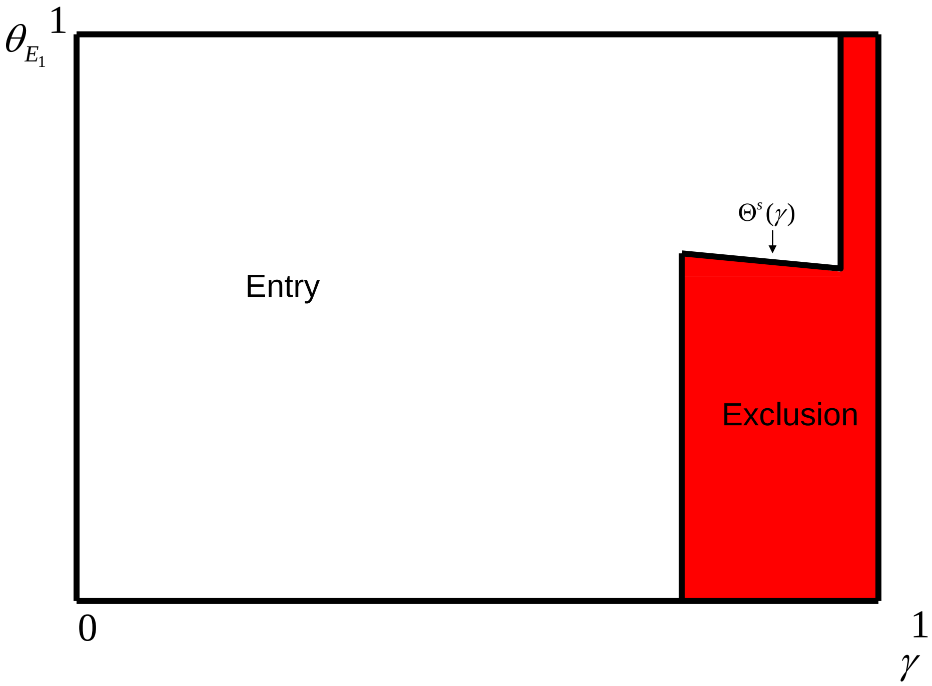

Figure 5: Linear wholesale pricing (Single entrant case)

Figure 6: Non-linear wholesale price (Single entrant case)

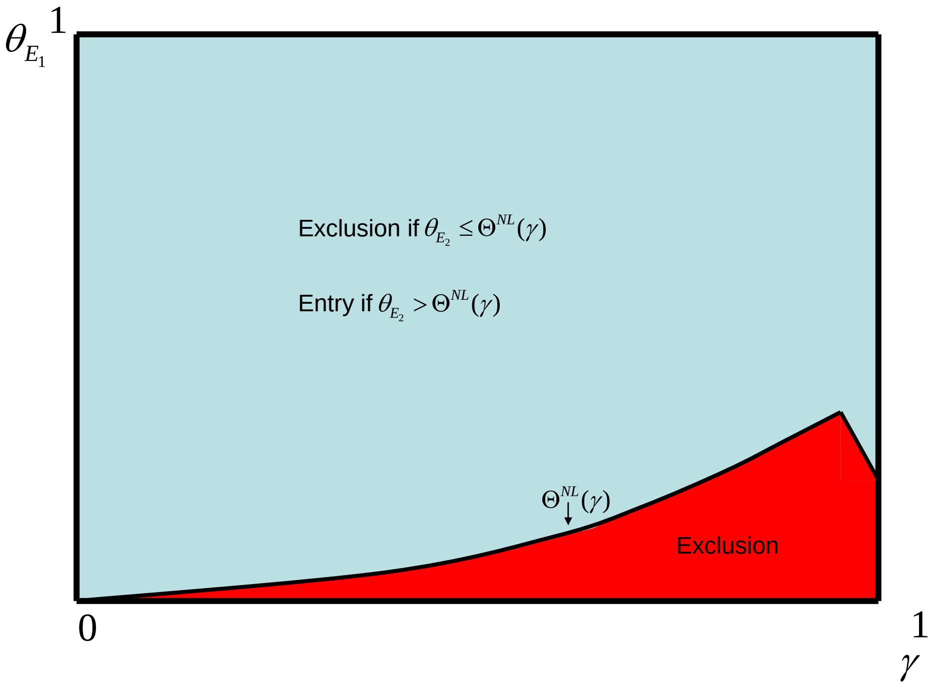

Figure 7: Non-linear wholesale price (Multiple entrant case)