Non-Exclusive Dealing with Retailer Differentiation and Market Penetration*

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October 22, 2018

Abstract

Retailer differentiation exists in most industries. It gives manufacturers an incentive to adopt non-exclusive vertical contracts which help them to penetrate the market. However, the literature usually neglects such a penetration effect and finds that manufacturers prefer exclusive dealing. We analyze the impact of the market penetration effect on exclusive dealing in a vertical oligopolistic model with differentiated retailers. We show that, when the penetration effect is strong, non-exclusive dealing implies higher profits for manufacturers. Using an example with Logit demand, we find that, when the product quality is low, non-exclusive dealing is better for manufacturers, retailers, and consumers.

Keywords: non-exclusive dealing, market penetration, retailer differentiation

*The authors would like to thank the discussant and participants at the 15th Annual International Industrial Organization Conference and UGA economics workshop for very helpful comments. All errors are our own responsibility. This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

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1 Introduction

Retailer differentiation and non-exclusive dealing are very common in business practices. Retailers can be different in the geographic locations, loyalty programs, target customer groups, and so on. Such differentiation leads to a *market penetration effect* of non-exclusive vertical contracts. It means that the demand of a manufacturer's product under the non-exclusive contracts is higher than that under the exclusive contracts when the wholesale prices are the same. This effect arises when differentiated retailers (e.g. AT&T and Verizon, differentiated in terms of services and coverage) make a *single* product (e.g. iPhone X) of a manufacturer to become *multiple* differentiated products, and as a result, the manufacturer can sell to more customers with non-exclusive dealing than with exclusive dealing. This effect gives manufacturers an incentive to adopt non-exclusive vertical contracts.

While the market penetration effect is intuitive, it is unclear when such a penetration effect exists and how it affects the vertical relationship between upstream and downstream firms. For example, the penetration effect does not exist if all consumers purchase a product or there is no outside option, as often assumed in the theoretical literature (e.g., Besanko and Perry, 1994). Even if the outside option exists, the strength of the penetration effect may depend on factors such as product quality. Overall, the literature often neglects the market penetration effect and finds that exclusive dealing leads to higher manufacturer profits.

In this paper, we analyze the impact of retailer differentiation and the market penetration effect on exclusive dealing in a vertical oligopolistic model. We consider a model of two differentiated manufacturers and two differentiated retailers with a general demand function. The manufacturers first choose the wholesale prices, then the retailers choose the retail prices. Under exclusive dealing, each manufacturer sells its product exclusively to a retailer. Under non-exclusive dealing, each manufacturer sells to both retailers. We find that, when the market penetration effect is strong, manufacturers' equilibrium profits are higher with the non-exclusive contracts than with the exclusive contracts.[1] This is the opposite to the results in Besanko and Perry (1994) and Rey and Stiglitz (1995), who do not consider the market penetration effect and find that exclusive dealing generates more profits for the manufacturers. In addition, we find that retailers' profits

[1] We show that under the symmetric setup, an asymmetric equilibrium where one manufacturer chooses the exclusive contract and the other manufacturer chooses the non-exclusive contract does not exist in Section 3.4.

and consumer surplus can be higher in non-exclusive contracts.

The market penetration effect is influenced by three individual effects. First, a manufacturer's product sold by differentiated retailers are viewed as different varieties of the product. This variety effect relies on retailer differentiation, and it helps the manufacturer to reach more customers. Consequently, this increases the market penetration effect. Second, intra-brand competition arises because the two retailers compete on the same manufacturer's product under the non-exclusive contracts. Given the wholesale prices, this effect drives down the retailers' prices of the product and reinforces the market penetration effect. Third, with the non-exclusive contracts, each retailer can internalize the inter-brand competition between the two products. This effect tends to increase the retail prices because some consumers switch within the same retailer when the product's price rises. Hence, the internalization effect lowers the sales of a product and thus reduces the market penetration effect.

The three effects in the non-exclusive contracts influence the manufacturers' profits not only through the market penetration effect but also through the consumers' demand elasticities to the wholesale prices. The variety effect and the intra-brand competition lower the wholesale price elasticities, whereas the internalization effect increases them. Therefore, the comparison of the manufacturers' profits under the two types of contracts depends on the relative strength of the three forces. When the variety effect and the intra-brand competition dominate the internalization effect, the market penetration effect appears and the wholesale price elasticities are lower in the non-exclusive contracts. Together, they imply higher manufacturer profits in equilibrium compared with exclusive contracts.

The market penetration effect relies on the existence of an outside option with a positive market share, which is very common in reality. If consumers do not have an outside option, like the Hotelling model in Besanko and Perry (1994), the penetration effect does not exist because every consumer already buys a product under the exclusive contracts and there is no room for the manufacturers to penetrate the market. Since product quality influences the market share of the outside option in exclusive contracts, it is an important factor that affects the strength of the market penetration effect. Specifically, the strength of the penetration effect decreases as the product quality increases. With high-quality products, the outside option's market share in the exclusive case is very low, so the market penetration effect from the non-exclusive contracts is small. On the contrary, as the product quality decreases, the outside option's market share in the exclusive case goes up, which implies a larger potential market for the manufacturers to capture using non-exclusive contracts. Therefore, if the product quality is low, the manufacturers can earn more profits in the non-exclusive case than in the exclusive case.

We compare the equilibrium under the two types of contracts in an example with Logit demand which incorporates both retailer differentiation and the outside option. We find that the market penetration effect exists for all the cases that we consider. The results are consistent with the theoretical predictions. The manufacturers' profits are higher under non-exclusive contracts compared with exclusive contracts when the product quality is low, and the opposite is true when the product quality is high. The retailers' profits and the consumer surplus are higher in the non-exclusive case regardless of the product quality.

This paper sheds light on how retailer differentiation and the outside option together can affect the comparison of exclusive dealing and non-exclusive dealing. Although retailer differentiation and outside options exist in most industries, the theoretical literature on exclusive dealing has only considered models with either identical retailers (e.g., Rey and Stiglitz, 1988; Besanko and Perry, 1993; Rey and Stiglitz, 1995) or differentiated retailers without the outside option (e.g., Besanko and Perry, 1994; Gabrielsen, 1996; Gabrielsen and Sørgard, 1999; Allain, 2002; Kourandi and Vettas, 2010). The findings in the literature imply that the manufacturers should adopt the exclusive contracts to get higher profits. We draw the opposite conclusion when the combination of retailer differentiation and the outside option market share generates a strong market penetration effect.

Our study also contributes to the literature that investigates manufacturers' incentives to engage in exclusive dealing. These incentives include reducing intra-brand competition and imposing the foreclosure effect (e.g., Rey and Stiglitz, 1988; Rasmusen, Ramseyer, and Wiley, 1991; Rey and Stiglitz, 1995; Segal and Whinston, 2000; Sass, 2005; Hortaçsu and Syverson, 2007; Asker and Bar-Isaac, 2014; Nurski and Verboven, 2016). Some papers study the impacts of the externality in producer investment and retailer promotional efforts on vertical contracts (e.g., Besanko and Perry, 1993; Desiraju, 2004; Murry, 2017). In contrast, we focus on the impact of retailer differentiation on the exclusivity of vertical contracts and emphasize the market penetration effect rising from non-exclusive vertical contracts.

This paper is also related to a broader literature on vertical restraints (e.g., Mathewson and Winter, 1984; Katz, 1989; Lafontaine and Slade, 1997, 2007, 2008; Mortimer, 2008; Villas-Boas, 2009; Rey and Vergé, 2010), regarding their implications on producer and consumer prices, market structure, efficiency and welfare, as well as the role of exclusive dealing in the context of various vertical relations (e.g., Bernheim and Whinston, 1998; Mycielski, Riyanto, and Wuyts, 2000; Spiegel and Yehezkel, 2003; Abito and Wright, 2008; Cachon and Kök, 2010).

We organize the remainder of this paper as follows. Section 2 sets up a general oligopolistic vertical model for exclusive and non-exclusive contracts. Section 3 compares the equilirium manufacturer profits, retailer profits, and consumer surplus in the two contracts. Section 4 presents a specific example using Logit demand. We conclude in Section 5.

2 Vertical Contracts with Differentiated Retailers

2.1 A Two-Manufacturer, Two-Retailer Framework

In this section, we describe the theoretical framework to analyze exclusive and non-exclusive dealing. Two manufacturers, A and B, produce two imperfectly substitutable products, denoted by a and b. They have constant unit costs, c_a and c_b, respectively. We assume that the two differentiated products have the same quality. There are two differentiated retailers, C and D.

We assume that the manufacturers either both sign exclusive or both sign non-exclusive contracts with the retailers.[2] With exclusive contracts, a manufacturer sells its product only to one retailer, and different manufacturers sell to different retailers. With non-exclusive contracts, each manufacturer sells its product to both retailers. The manufacturers and retailers play a two-stage pricing game. In the first stage, the manufacturers simultaneously choose the wholesale prices. We assume that the manufacturers cannot differentiate the retailers by setting different wholesale prices to the two retailers. In the second stage, the retailers simultaneously choose their retail prices after observing their own and the opponents' wholesale prices. The retailers don't have any costs other than the wholesale costs.

Under the non-exclusive contracts, a manufacturer's product becomes two differentiated products when sold by both retailers. For example, if the two retailers are in different locations, then

[2] We abstract away from any negotiation between the manufacturers and the retailers.

consumers get different utility from buying the same product at the two retailers. We denote product j at retailer r by jr for $j \in \{a, b\}$ and $r \in \{C, D\}$. An outside option exists besides the products. It means to not buy product a or b from either retailer. Denote the outside option by o. Thus, consumers face a choice set of three options, $\Omega^e = \{a, b, o\}$, when the manufacturers sign exclusive contracts and a choice set of five options, $\Omega^{ne} = \{ac, ad, bc, bd, o\}$, when they sign non-exclusive contracts. The market size is normalized to be one. We assume that each option in the choice set, including the outside option, has a strictly positive market share under each type of contracts.[3]

Our setup differs from the theoretical literature on exclusive dealing in two ways. First, the two retailers are differentiated. Second, an outside option exists and has a positive market share. These two differences together imply that the total demand of a manufacturer's product can be higher under the non-exclusive contracts than under the exclusive contracts. This gives the manufacturers an incentive to sign non-exclusive contracts to increase their market shares.

2.2 Exclusive Contracts

Without loss of generality, we assume that retailer C sells product a and D sells product b under exclusive contracts. Denote the retail prices of the two products by (p_a, p_b). The consumer demand of product j is a function of the retail prices,

$$Q_j^e(p_a, p_b), \forall j \in \{a, b\},$$

where the superscript e denotes the exclusive contracts.[4] Because the market size is one, Q_j^e is equivalent to the market share of product j.

We solve for the equilibrium conditions of the two-stage pricing game of the manufacturers and retailers using backwards induction. In the second stage, retailer C's profit-maximization problem is

$$\max_{p_a} (p_a - w_a) Q_a^e(p_a, p_b),$$

[3]This assumption holds in a model where consumers have heterogenous tastes for each option. For example, in a Logit model, each option has a strictly positive market share.

[4]The demand should also depend on the product quality. We assume that the product quality does not change with the contracts, so we omit them in the demand function.

where w_a is manufacturer A's wholesale price. Retailer C gets a markup of $(p_a - w_a)$ from product a. Then the first-order condition (FOC) for the retail price of a is

$$Q_a^e(p_a, p_b) + (p_a - w_a)\frac{\partial Q_a^e(p_a, p_b)}{\partial p_a} = 0.$$

The FOC requires that the marginal profit from product a is zero given retailer D's retail price for product b. The FOC defines retailer C's best response function against retailer D's retail price p_b. We denote it by $p_a(w_a, p_b)$. Similarly, from retailer D's profit maximization problem, the FOC of retailer D's price of product b is

$$Q_b^e(p_a, p_b) + (p_b - w_b)\frac{\partial Q_b^e(p_a, p_b)}{\partial p_b} = 0.$$

Denote retailer D's best response function to C's price by $p_b(w_b, p_a)$.

The best response functions of C and D together determine the retail prices of a and b. Let $p_a^e(w_a, w_b)$ and $p_b^e(w_a, w_b)$ be the retail prices under exclusive contracts for any given wholesale prices, (w_a, w_b). Intuitively, the retail price of each product increases with the wholesale prices both products. That is, $\frac{\partial p_j^e(w_a, w_b)}{\partial w_j} > 0$ for $j \in \{a, b\}$. Pluging the retail prices into the demand functions, we can write the demand for each product as a function of the wholesale prices, $Q_j^e(w_a, w_b) = Q_j^e(p_a^e(w_a, w_b), p_b^e(w_a, w_b)), j \in \{a, b\}$.

In the first stage, manufacturer j chooses its wholesale price w_j, knowing its impact on the retail prices. Manufacturer j's profit maximization problem is

$$\max_{w_j}(w_j - c_j)Q_j^e(w_j, w_{j'}),$$

where j' denotes the other product. The equilibrium wholesale prices, (w_a^{e*}, w_b^{e*}), should satisfy the FOCs given by

$$Q_j^e(w_a^{e*}, w_b^{e*})\left[\epsilon_{jj}^e(w_a^{e*}, w_b^{e*})(1 - \frac{c_j}{w_j^{e*}}) + 1\right] = 0, \forall j \in \{a, b\}, \tag{1}$$

where $\epsilon_{jj}^e(w_a, w_b) = \frac{\partial Q_j^e(w_a, w_b)}{\partial w_j}\frac{w_j}{Q_j^e(w_a, w_b)}$ is the own-wholesale price demand elasticity of product j.[5] Let (p_a^{e*}, p_b^{e*}) be the retail prices at the equilibrium wholesale prices (w_a^{e*}, w_b^{e*}).

[5] The wholesale prices indirectly affect consumer demand through the retail prices. The partial derivative is

2.3 Non-Exclusive Contracts

With non-exclusive contracts, each retailer sells both a and b. There are four products and the outside option in the market due to the retailer differentiation. Consumers' demand for each product depends on the retail prices of all the four products.[6] Denote the demand function of product jr by

$$Q_{jr}^{ne}(p_{ac}, p_{ad}, p_{bc}, p_{bd}), \forall j \in \{a, b\}, r \in \{c, d\}.$$

where the superscript ne denotes non-exclusive contracts.

As in the exclusive contract case, the manufacturers and retailers play a two-stage pricing game. A retailer's profit now comes from the sales of both products. In the second stage, retailer $r \in \{C, D\}$'s profit-maximization problem is

$$\max_{p_{ar}, p_{br}} \pi_r^{ne}(p_{ar}, p_{br}, p_{ar'}, p_{br'}) = (p_{ar} - w_a)Q_{ar}^{ne}(p_{ar}, p_{br}, p_{ar'}, p_{br'}) + (p_{br} - w_b)Q_{br}^{ne}(p_{ar}, p_{br}, p_{ar'}, p_{br'}),$$

where r' denotes the other retailer. The FOC with respect to p_{jr} is

$$Q_{jr}^{ne} + (p_{jr} - w_j)\frac{\partial Q_{jr}^{ne}}{\partial p_{jr}} + (p_{j'r} - w_{j'})\frac{\partial Q_{j'r}^{ne}}{\partial p_{jr}} = 0, \forall j \in \{a, b\}, j' \neq j.$$

The first two terms are the impact of p_{jr} on the retailer's profit from product j, and the third term is its impact on the retailer's profit from product j'.

From the retailers' FOCs, the retail prices are functions of the wholesale prices. For a pair of (w_a, w_b), we denote the vector of the retail prices in the non-exclusive case by $\boldsymbol{p}^{ne}(w_a, w_b) = (p_{ac}(w_a, w_b), p_{ad}(w_a, w_b), p_{bc}(w_a, w_b), p_{bd}(w_a, w_b))$. In the non-exclusive case, each manufacturer's total demand is the sum of its product sales from the two retailers. That is, consumers' total demand of product j is

$$Q_j^{ne}(w_a, w_b) = Q_{jc}^{ne}(\boldsymbol{p}^{ne}(w_a, w_b)) + Q_{jd}^{ne}(\boldsymbol{p}^{ne}(w_a, w_b)), \forall j \in \{a, b\}.$$

$\frac{\partial Q_j^{ne}(w_a,w_b)}{\partial w_j} = \sum_{j'} \frac{\partial Q_j^{ne}(w_a,w_b)}{\partial p_{j'}^{ne}} \frac{\partial p_j^{ne}}{\partial w_j}$.

[6] We again omit the product quality in the demand functions because the quality is the same across contract types.

In the first stage, the manufacturers simultaneously choose their wholesale prices to maximize profits. Manufacturer j's profit-maximization problem is

$$\max_{w_j}(w_j - c_j)Q_j^{ne}(w_j, w_{j'}).$$

Let (w_a^{ne*}, w_b^{ne*}) be the equilibrium wholesale prices. They satisfy the manufacturers' FOCs

$$Q_j^{ne}(w_a^{ne*}, w_b^{ne*})\left[\epsilon_{jj}^{ne}(w_a^{ne*}, w_b^{ne*})(1 - \frac{c_j}{w_j^{ne*}}) + 1\right] = 0, \forall j \in \{a, b\},$$

where $\epsilon_{jj}^{ne}(w_a, w_b) = \frac{\partial Q_j^{ne}(w_a,w_b)}{\partial w_j}\frac{w_j}{Q_j^{ne}(w_a,w_b)}$ is the own-wholesale price demand elasticity of product j with the non-exclusive contracts. Plug the wholesale prices into the retail price functions, we can get the equilibrium retail prices under non-exclusive contracts, $\boldsymbol{p}^{ne}(w_a^{ne*}, w_b^{ne*}) = (p_{ac}^{ne*}, p_{bc}^{ne*}, p_{ad}^{ne*}, p_{bd}^{ne*})$.

3 Equilibrium: Exclusive vs. Non-Exclusive Contracts

In this section, we compare the manufacturers' profits, the retailer profits, and the welfare between the exclusive and non-exclusive contracts. To simplify the analysis, we consider the case where the manufacturers are symmetric and the retailers are also symmetric. This means that the two products have the same unit cost and the same quality, and the retailers have the same demand when their prices are the same.[7] Compared with the exclusive contracts, three important effects rise under the non-exclusive contracts. They are the market penetration effect, the retailer internalization effect, and the intra-brand competition effect. We consider symmetric equilibrium where both manufacturers choose exclusive contracts or non-exclusive contracts, and explain how the three effects affect the comparison of profit of manufacturers and retailers under two types of contracts. We show that under the symmetric setup, an asymmetric equilibrium where one manufacturer chooses the exclusive contract and the other manufacturer chooses the non-exclusive contract does not exist in Section 3.4.

[7] We discuss the setup in which the manufacturers are asymmetric in their costs and product quality in Section 3.4.

3.1 The Market Penetration Effect of Non-Exclusive Contracts

The **market penetration effect** exists for product $j \in \{a, b\}$ if the total demand of j in the non-exclusive case is greater than that in the exclusive case when the wholesale prices are the same. That is,

$$Q_{jc}^{ne}(\boldsymbol{p}^{ne}(w_a, w_b)) + Q_{jd}^{ne}(\boldsymbol{p}^{ne}(w_a, w_b)) > Q_j^e(\boldsymbol{p}^e(w_a, w_b)), \forall (w_a, w_b). \tag{2}$$

There are three important effects of the non-exclusive contracts that determine whether the market penetration effect exists. Two of them affect the comparison of the retail prices under the two types of contracts, and the third effect influences the total demand comparison when the retail prices are the same.

The first effect of the non-exclusive contracts is the retailers' **internalization effect**. With the non-exclusive contracts, each retailer can internalize the competition between the two products because it sells both products. For example, when choosing the retail price of a, retailer r takes the impact of p_{ar} on the demand of its product b into account. This internalization effect increases the retail prices of both products because some consumers switch within a retailer when a product's price increases. Thus, the internalization effect increases the retail prices and weakens the market penetration effect.

Second, **intra-brand competition** among the two retailers also rises with the non-exclusive contracts because they directly compete on the same products. Fixing the wholesale prices, the intra-brand competition lowers the equilibrium retail prices in the non-exclusive case compared with the exclusive case. This is the opposite to the impact of the internalization effect on the retail prices. Thus, the intra-brand competition effect lowers the retail prices and increases the market penetration effect.

Finally, a **variety effect** can exist under the non-exclusive effect. The variety effect means that the total demand of $j \in \{a, b\}$ in the non-exclusive case is greater than that in the exclusive case when retail prices are the same. That is,

$$Q_{jc}^{ne}(p_a, p_a, p_b, p_b) + Q_{jd}^{ne}(p_a, p_a, p_b, p_b) > Q_j^e(p_a, p_b), \forall (p_a, p_b). \tag{3}$$

The variety effect is a result of the retailer differentiation. Both products are sold by each retailer under the non-exclusive contracts. This increases the manufacturers' sales because some consumers who choose the outside option in the exclusive contracts may buy the products under the non-exclusive contracts. Such consumers exist because the retailer differentiation limits the product availability of the retailers under the exclusive contracts. At the same time, the consumers who buy products in the exclusive case will not switch to the outside option because the retail prices are the same. Thus, the variety effect exists, and it increases the market penetration effect.

The variety effect exists for at least one product when the retailers are differentiated and the outside option has a strictly positive market share under the exclusive contracts. Consider an example where the two retailers differ in location. Due to retailer differentiation, there exist some consumers of retailer C who choose the outside option because product b is not available at retailer C and product a is not as good as the outside option under the exclusive contracts. They will buy product b if retailer C also sells it, at the same price as in the exclusive case. Thus, the market share of the outside option is smaller if the contracts are non-exclusive, fixing the retail prices of a and b. This means that the total demand of a and b is greater under the non-exclusive contracts when the retail prices are the same. Therefore, the variety effect must exist for at least one product. In a symmetric case where the two products have the same quality and price, the variety effect exists for both products.

The market penetration effect also relies on the positive share of the outside option in the exclusive case. If all consumers purchase either a or b (the outside market share is zero) in the exclusive case, then the market penetration effect will disappear because non-exclusive contracts cannot increase the demand of either product. Thus, the market penetration effect does not exist in the frameworks that do not consider the outside option, like the standard Hotelling model where each consumer always buys a product in the exclusive case.

Because the positive share of the outside option in the exclusive case is critical, the market penetration effect's strength depends on this share. The higher the outside option share under the exclusive contracts is, the stronger the penetration effect can be. This share depends on not only the retailers' prices but also the quality of product a and b. If the products have very high quality and almost all the consumers will buy one of the products under exclusive contracts, the market penetration effect will be small. On the other hand, if the product quality is low and many consumers do not buy the products under exclusive contracts, then the demand will increase significantly in the non-exclusive contracts.

3.2 Comparing the Manufacturers' Profits

We make the following assumptions through out the paper. First, an outside option exists and has a positive share under the exclusive contracts. That is, $Q_a^e(p_a^{e*}, p_b^{e*}) + Q_b^e(p_a^{e*}, p_b^{e*}) < 1$. This is true as long as some consumers do not buy any product in the exclusive case. Second, the total demand of a product decreases with its own wholesale price and increases with the other product's. That is, $\frac{\partial Q_j^{ne}(w_a, w_b)}{\partial w_j} < 0, \forall j \in \{a, b\}$, and $\frac{\partial Q_j^{ne}(w_a, w_b)}{\partial w_{j'}} > 0$, if $j \neq j'$. Third, the demand of a product decreases to zero as its wholesale price goes to infinity, $\lim_{w_j \to \infty} Q_j^{ne}(w_a, w_b) = 0, \forall j \in \{a, b\}$.

In this section, we show that, under a few additional assumptions, the manufacturers get equilibrium higher profits with the non-exclusive contracts than with the exclusive contracts. The manufacturer of product $j \in \{a, b\}$ earns a profit of $\pi_j^e(w_j^{e*}, w_{j'}^{e*}) = (w_j^{e*} - c_j) Q_j^e(w_j^{e*}, w_{j'}^{e*})$ in the exclusive case and $\pi_j^{ne}(w_j^{ne*}, w_{j'}^{ne*}) = (w_j^{ne*} - c_j) Q_j^{ne}(w_j^{ne*}, w_{j'}^{ne*})$ in the non-exclusive case.

Assumption 1. *The market penetration effect exists for both products at the exclusive equilibrium prices. That is,* $Q_{jc}^{ne}(\boldsymbol{p}^{ne}(w_a^{e*}, w_b^{e*})) + Q_{jd}^{ne}(\boldsymbol{p}^{ne}(w_a^{e*}, w_b^{e*})) > Q_j^e(p_a^e(w_a^{e*}, w_b^{e*}), p_b^e(w_a^{e*}, w_b^{e*}))$.

The condition in Assumption 1 is imposed on the equilibrium wholesale prices for a few reasons. First, due to vertical structural and oligopoly setup, it is very challenging to derive

Lemma 1. *Under Assumption 1, the manufacturers get higher profits if they both use the exclusive equilibrium wholesale prices in the non-exclusive case,* $\pi_j^{ne}(w_j^{e*}, w_{j'}^{e*}) > \pi_j^e(w_j^{e*}, w_{j'}^{e*})$, $\forall j \in \{a, b\}$.

Lemma 1 is a direct implication of the market penetration effect. Because the total demand for each product is higher under the non-exclusive contracts when the wholesale prices are at the exclusive level, both manufacturers get more profits under the non-exclusive contracts. However, the equilibrium wholesale prices under the non-exclusive contracts will be different from those with the exclusive contracts because the wholesale price demand elasticities are different in the two types of contracts. To compare the equilibrium wholesale prices between the two types of contracts, we make the following assumption on the wholesale price elasticities.

Assumption 2. *The own-wholesale price demand elasticity in the non-exclusive case is greater than that in the exclusive case when wholesale prices are at the exclusive equilibrium levels. That* *is,*

$$0 > \epsilon_{jj}^{ne}(w_a^{e*}, w_b^{e*}) > \epsilon_{jj}^{e}(w_a^{e*}, w_b^{e*}), \forall j \in \{a, b\}, \tag{4}$$

where $\epsilon_{jj}^{ne}(w_a, w_b) = \frac{\partial Q_j^{ne}(w_a,w_b)}{\partial w_j}\frac{w_j}{Q_j^{ne}}$ is the wholesale price elasticity of product j. Fixing the wholesale prices, the non-exclusive contracts change the elasticity through three channels. First, the retailers' internalization increases the retail prices, so it makes the demand more elastic, and the total demand decreases. At the same time, when the wholesale prices increase, the retail prices increase by larger amounts in the non-exclusive case because of retailer internalization, which implies that $\frac{\partial Q_j^{ne}(w_a,w_b)}{\partial w_j}$ becomes more negative. Thus, internalization increases the wholesale price elasticity. On the contrary, the intra-brand competition makes the demand less elastic to the wholesale price because it drives down the retail prices, so consumer demand increases. That is, Q_j^{ne} increases and $\frac{\partial Q_j^{ne}(w_a,w_b)}{\partial w_j}$ becomes less negative. The intra-brand competition effect lowers the demand elasticity. Lastly, the variety effect reduces the elasticities by increasing the total demand, Q_j^{ne}. This also lowers the demand elasticity. Therefore, Assumption 2 holds when the intra-brand competition effect and the variety effect together dominate the internalization effect.

From the expression of the profits, we know that the manufacturers' marginal profits increase as the demand becomes less elastic.[8] Assumption 2 implies that the manufacturers' marginal profits in the non-exclusive case are positive at the exclusive equilibrium wholesale prices. This is because that the FOCs imply that the marginal profits are zero in equilibrium under the exclusive contracts. Since the demand is less elastic in the non-exclusive case, the marginal profits are positive. We show this result in Lemma 2.

Lemma 2. *Suppose that Assumption 2 holds, then* $\frac{\partial \pi_j^{ne}(w_a^{e*},w_b^{e*})}{\partial w_j} > 0, \forall j \in \{a, b\}$.

Proof. Take manufacturer A's profit as an example. We have

$$\begin{aligned}\frac{\partial \pi_a^{ne}(w_a^{e*}, w_b^{e*})}{\partial w_a} &= Q_a^{ne}(w_a^{e*}, w_b^{e*})\left[\epsilon_{aa}^{ne}(w_a^{e*}, w_b^{e*})(1 - \frac{c}{w_a^{e*}}) + 1\right] \\ &> Q_a^{ne}(w_a^{e*}, w_b^{e*})\left[\epsilon_{aa}^{e}(w_a^{e*}, w_b^{e*})(1 - \frac{c}{w_a^{e*}}) + 1\right] = 0.\end{aligned}$$

The inequality follows from Assumption 2, and the last equality is from the FOC in the exclusive case as in equation (1). □

[8] The marginal profit in the non-exclusive case is $\frac{\partial \pi_j^{ne}(w_a,w_b)}{\partial w_j} = Q_j^{ne}(\boldsymbol{p}^{ne}(w_a, w_b)) * (1 + \frac{w_j - c_j}{w_j}\epsilon_{jj}^{ne}(w_a, w_b))$. The marginal profit in the exclusive case is similar.

Given that the marginal profits at the exclusive equilibrium wholesale prices is positive, each manufacturer will increase its wholesale price to increase profits. As a manufacturer increases its wholesale price, the opponent will also adjust its price. Whether the opponent increases its wholesale price or not depends on the complementarity between the two prices. If the two prices are strategic complements, a manufacturer's optimal price will increase with the opponent's. We show that the two wholesale prices are strategic complements under the following assumption.

Assumption 3. *The second-order cross derivative of manufacturer $j \in \{a, b\}$'s profit function is positive. That is,* $\frac{\partial^2 \pi_j^{ne}(w_a,w_b)}{\partial w_a \partial w_b} > 0, \forall j \in \{a, b\}$.

Assumption 3 requires a manufacturer's marginal profit $\frac{\partial \pi_j^{ne}(w_a,w_b)}{\partial w_j}$ to increase with the opponent's wholesale price under the non-exclusive contracts. The marginal profit depends on the demand and the elasticity, $\frac{\partial \pi_j^{ne}(w_a,w_b)}{\partial w_j} = Q_j^{ne}(w_a, w_b)\left[\epsilon_{jj}^{ne}(w_a, w_b)(1 - \frac{c}{w_j}) + 1\right]$.As the wholesale price of $j' \neq j$ goes up, the demand of j (Q_j^{ne}) increases, and the elasticity of j ($\epsilon_{jj}^{ne}(w_a, w_b)$) will increase. Thus, the marginal profit of $\frac{\partial \pi_j^{ne}(w_a,w_b)}{\partial w_j}$ will increase with $w_{j'}$. This assumption holds for a wide range of demand models.

Lemma 3. *Suppose that Assumptions 1 - 3 hold. Then we have the following results under the non-exclusive contracts.*

1. *When the opponent's wholesale price is greater or equal to its exclusive equilibrium level, manufacturer j's optimal wholesale price is greater than its exclusive equilibrium level. That is, $w_j^{ne}(w_{j'}) > w_j^{e*}$, if $w_{j'} \geq w_{j'}^{e*}$.*

2. *Manufacturer j's best response function, $w_j^{ne}(w_{j'})$, is strictly increasing in $w_{j'}$. In other words, the wholesale prices are **strategic complements**.*

3. *When the opponent's wholesale price is greater than the exclusive equilibrium level, manufacturer j's profit is higher in the non-exclusive case than its exclusive equilibrium profit. $\pi_j^{ne}(w_j^{ne}(w_{j'}), w_{j'}) > \pi_j^{ne}(w_j^{e*}, w_{j'}^{e*})$, for all $w_{j'} \geq w_{j'}^{e*}$.*

Proof. Without loss of generality, we consider manufacturer A in this proof. We prove the three statements step by step.

Proof of Statement 1. We prove the first statement in three steps. First, manufacturer A can get a positive profit if it sets the wholesale price equal to the exclusive equilibrium level when

$w_b \geq w_b^{e*}$. That is, for a $w_b \geq w_b^{e*}$,

$$\pi_a^{ne}(w_a^{e*}, w_b) = Q_a^{ne}(w_a^{e*}, w_b)(w_a^{e*} - c_a) \geq Q_a^{ne}(w_a^{e*}, w_b^{e*})(w_a^{e*} - c_a) = \pi_a^{ne}(w_a^{e*}, w_b^{e*}) > 0,$$

where the two equalities are from the definition of profit. The first inequality follows from Assumption 3, which assumes that the demand of a product increases with the wholesale price of the other product. The second inequality follows from the fact that the equilibrium profits in the exclusive case must be positive due to the retailer differentiation.

Second, manufacturer A's marginal profit at the wholesale price w_a^{e*} is positive. That is,

$$\frac{\partial \pi_a^{ne}(w_a^{e*}, w_b)}{\partial w_a} \geq \frac{\partial \pi_a^{ne}(w_a^{e*}, w_b^{e*})}{\partial w_a} > 0, \forall w_b \geq w_b^{e*}. \tag{5}$$

The first inequality follows from Assumption 3 because $w_b \geq w_b^{e*}$. The second inequality is the result in Lemma 2. Thus, A's marginal profit is positive when its wholesale price is at the exclusive equilibrium level and w_b is greater than w_b^{e*}. Lastly, we know that as a manufacturer's wholesale price goes to infinity, the demand of its product goes to zero, and so does its profit, $\lim_{w_a \to \infty} \pi_a^{ne}(w_a, w_b) = 0$.

To summarize the three steps, we find that for any $w_b \geq w_b^{e*}$, manufacturer A should increase its wholesale price to be above w_a^{e*} to increase profits because its marginal profit is strictly positive at w_a^{e*}. However, it should not increase its wholesale price by too much. Otherwise, its demand and profit will drop to zero which is below its profits when its price is equal to w_a^{e*}. Therefore, A's best response wholesale price should be greater than w_a^{e*}. That is, $w_a^{ne}(w_b) > w_a^{e*}$ for any $w_b \geq w_b^{e*}$.

Proof of Statement 2. To show that A's optimal price increases with w_b, consider two prices of manufacturer B: $w_b^{'} > w_b^{''} \geq w_b^{e*}$. Denote A's best responses by $w_a^{ne}(w_b^{'})$ and $w_a^{ne}(w_b^{''})$. From Assumption 3, we know that A's marginal profit increases with B's wholesale price, $\frac{\partial^2 \pi_a^{ne}(w_a, w_b)}{\partial w_a \partial w_b} > 0$. We get

$$\frac{\partial \pi_a^{ne}(w_a^{ne}(w_b^{''}), w_b^{'})}{\partial w_a} > \frac{\partial \pi_a^{ne}(w_a^{ne}(w_b^{''}), w_b^{''})}{\partial w_a} = 0,$$

where the inequality is from the fact that A's marginal profit increases with w_b and $w_b^{'} > w_b^{''}$, and the equality follows the definition of best response of A. Because its marginal profit at $w_a^{ne}(w_b^{''})$

is positive when B's price is $w_b^{'}$, A should increase its wholesale price to maximize profit. That is, $w_a^{ne}(w_b^{'}) > w_a^{ne}(w_b^{''})$. Thus, A's best response function is a strictly increasing function of w_b. Similarly, B's optimal price increases with A's price. Therefore, the two manufacturers' wholesale prices are strategic complements.

Proof of Statement 3. For $w_b \geq w_b^{e*}$, we know A's profits satisfy

$$\pi_a^{ne}(w_a^{ne}(w_b), w_b)) > \pi_a^{ne}(w_a^{e*}, w_b) \geq \pi_a^{ne}(w_a^{e*}, w_b^{e*}).$$

The first inequality follows the definition of profit maximization and that $\frac{\partial \pi_a^{ne}(w_a^{e*}, w_b)}{\partial w_a} > 0$ in equation (5). The second inequality is because that the demand of A increases with the wholesale price of B. This result implies that A will get more profits if it increases its price from w_a^{e*} to its best response when B's price is greater than w_b^{e*}. $\square$

The results in Lemma 3 have two important implications. First, with non-exclusive contracts, both manufacturers's wholesale prices are higher than the exclusive equilibrium prices because their marginal profits are strictly positive at the exclusive equilibrium levels. Second, each manufacturer gets more profits when it optimally adjusts its price as the opponent's price increases. We summarize these findings in the following proposition.

Proposition 1. *Under Assumption 1-3, there exists an equilibrium with the non-exclusive contracts in which the wholesale prices are greater than the exclusive equilibrium prices. Moreover, each manufacturer's equilibrium profit in the non-exclusive case is greater than its equilibrium profit with the exclusive contracts. That is,* $(w_a^{ne*}, w_b^{ne*}) > (w_a^{e*}, w_b^{e*})$ *and* $\pi_a^{ne}(w_a^{ne*}, w_b^{ne*}) > \pi_a^{e}(w_a^{e*}, w_b^{e*})$.

Proof. Let $w^{nm} = \lim_{w_b \to \infty} w_a^{ne}(w_b)$ be the limit of A's wholesale price when B's price goes to infinity, where the superscript nm denotes that A acts like a monopoly when w_b approaches infinity in the non-exclusive case. From Assumption 3, we have that $w^{nm} < \infty$ because a manufacturer's sales would go to zero if the price is infinity. From Lemma 3, we know that $w_a^{ne}(w_b^{e*}) < w^{nm}$ because $w_a^{ne}(w_b)$ is a strictly increasing function. Thus, $w_a^{ne}(w_b)$ has an upper bound w^{nm}. Lemma 3 also implies that A's optimal price in the non-exclusive case is greater than w_a^{e*} when B's price is w_b^{e*}, $w_a^{ne}(w_b^{e*}) > w_a^{e*} = w_b^{e*}$, where the equality is due to symmetry of the two products. Similarly, $w_b^{ne}(w_a)$ is also bounded above by w^{nm} because of symmetry and $w_b^{ne}(w_a^{e*}) > w_b^{e*} = w_a^{e*}$. Thus, for $j \neq j' \in \{a, b\}$,

$$\lim_{w_{j'} \to \infty} w_j^{ne}(w_{j'}) = w^{nm}, \text{and}$$
$$\lim_{w_{j'} \to w_{j'}^{e*}} w_j^{ne}(w_{j'}) > w_j^{e*}.$$

Combining these features of the two best response functions, we know that there exists an equilibrium for the non-exclusive case, (w_a^{ne*}, w_b^{ne*}), and both manufacturers' equilibrium wholesale prices are greater than their exclusive levels, $w_j^{ne*} > w_j^{e*}$ for $j \in \{a, b\}$. To see this, denote the inverse function of A's best response function $w_a^{ne}(w_b)$ by $w_b^V(w_a)$. The best response function $w_a^{ne}(w_b)$ is invertible because it is strictly increasing as in Lemma 3. Define the difference between B's best response function and the inverse of A's best response function as $\Delta(w_a) = w_b^{ne}(w_a) - w_b^V(w_a)$. If there exists a $w_a > w_a^{e*}$ such that $\Delta(w_a) = 0$, then an intersection point of the two manufacturers' best response functions exists, and it is an equilibrium under the non-exclusive contracts. If the demand functions $Q_j^{ne}(\boldsymbol{p}^{ne})$ and $\boldsymbol{p}^{ne}(\boldsymbol{w}^{ne})$ are continuous and differentiable, then the manufacturers' best response functions are continuous in each other's wholesale price because the FOC of the manufacturers will be continuous. Then $\Delta(w_a)$ is continuous because the two best response functions are continuous. Then

$$\Delta(w_a^{e*}) = w_b^{ne}(w_a^{e*}) - w_b^V(w_a^{e*}) > 0, \text{ and} \tag{6}$$

$$\lim_{w_a \to \infty} \Delta(w_a) = \lim_{w_a \to \infty} \left[w_b^{ne}(w_a) - w_b^V(w_a) \right] < 0. \tag{7}$$

We prove the inequality (6) in two steps. First, Lemma 3 implies that $w_b^{ne}(w_a^{e*}) > w_b^{e*}$. Second, from Lemma 3, we know $w_a^{e*} < w_a^{ne}(w_b^{e*})$. Thus, $w_b^V(w_a^{e*}) \leq w_b^V(w_a^{ne}(w_b^{e*})) = w_b^{e*}$, where the inequality comes from that $w_b^V(w_a)$ is an increasing function, and the equality is from the definition of the inverse function $w_b^V(w_a)$. Thus, $\Delta(w_a^{e*}) = w_b^{ne}(w_a^{e*}) - w_b^V(w_a^{e*}) > w_b^{e*} - w_b^V(w_a^{e*}) > w_b^{e*} - w_b^{e*} = 0$.

To see the inequality (7), we know that $\lim_{w_a \to \infty} w_b^{ne}(w_a) = w^{nm}$ by definition of w^{nm} and the symmetry between the two manufacturers. We also have that $\lim_{w_a \to \infty} w_b^V(w_a) = \infty$ because A will only set an extremely high price when B's wholesale price goes to infinity. Thus, $\lim_{w_a \to \infty} \Delta(w_a) = \lim_{w_a \to \infty} w_b^{ne}(w_a) - \lim_{w_a \to \infty} w_b^V(w_a) = w^{nm} - \infty < 0$.

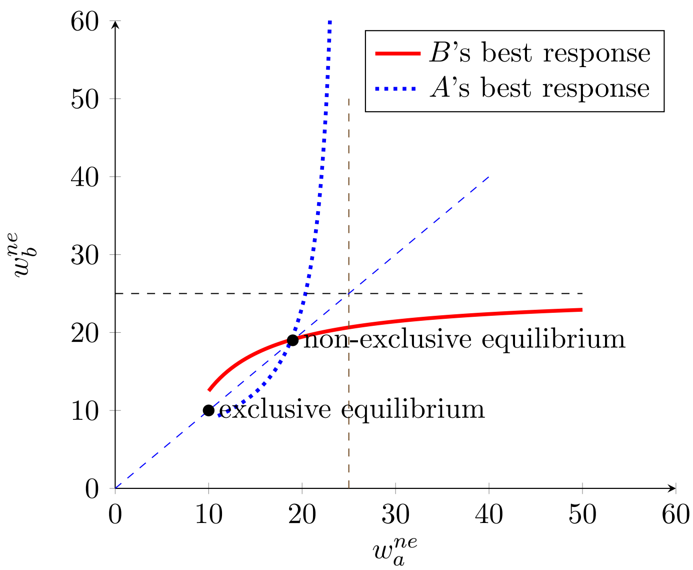
Because $\Delta(w_a)$ is continuous, the inequalities in (6) and (7) imply that a $w_a \in (w_a^{e*}, \infty)$ exists such that $\Delta(w_a) = 0$. This intersection point of the two best response functions is an equilibrium with the non-exclusive contracts. Denote the equilibrium prices by (w_a^{ne*}, w_b^{ne*}). By the symmetry of the two manufacturers, we know $w_a^{ne*} = w_b^{ne*} > 0$. In addition, their equilibrium profits are greater than the exclusive equilibrium profits because

$$\pi_a^{ne*}(w_a^{ne*}, w_b^{ne*})) = \pi_a^{ne*}(w_a^{ne}(w_b^{ne*}), w_b^{ne*})) > \pi_a(w_a^{e*}, w_b^{e*}),$$

where the equality is from the definition of equilibrium, and the second inequality follows from the last statement in Lemma 3. □

Figure 1 illustrates the best response wholesale price functions of the two manufacturers in the non-exclusive contracts. The red sold curve is manufacturer B's best response function, and the blue dotted curve is A's. In this figure, manufacturer A's best response curve starts from the point $(w_a^{ne}(w_b^{e*}), w_b^{e*})$. From Lemma 3, we know that this point is below the 45 degree line, $w_a^{ne}(w_b^{e*}) > w_a^{e*} = w_b^{e*}$. Similarly, B's best response curve starts from the point $(w_a^{e*}, w_b^{ne}(w_a^{e*}))$ and this point is above the 45 degree line because $w_b^{e*} = w_a^{e*} < w_b^{ne}(w_a^{e*})$. Both best response functions are bounded by w^{nm}, which is the value of the horizontal and vertical dashed lines. As a result, the non-exclusive equilibrium wholesale prices are greater than the exclusive equilibrium prices.

Figure 1: Best Response Functions with Non-Exclusive Contracts



3.3 Comparing the Retailers' Profits

The retailers' total profits depend on their total demand and markups. The total demand is the same as the total demand of the manufacturers. The retailers' markups in the non-exclusive contract case depend on the demand elasticities with respect to the retail prices. We find that the retailers sell more products and can earn higher markups in the non-exclusive case.

Proposition 2. *The retailers get higher markups and more profits with the non-exclusive contracts than with the exclusive contracts if the following conditions hold.*

1. *The total equilibrium demand of the two products is higher in the non-exclusive case than in the exclusive case.*

$$Q_a^{ne}(w_a^{ne*}, w_b^{ne*}) + Q_b^{ne}(w_a^{ne*}, w_b^{ne*}) > Q_a^e(w_a^{e*}, w_b^{e*}) + Q_b^e(w_a^{e*}, w_b^{e*}). \tag{8}$$

2. *The marginal demand of each product in the non-exclusive case is greater than that in the exclusive case. That is,*

$$\frac{\partial Q_j^e(\boldsymbol{p}^{e*})}{\partial p_j^e} < \frac{\partial Q_{ac}^{ne}(\boldsymbol{p}^{ne*})}{\partial p_j^{ne}} + \frac{\partial Q_{ad}^{ne}(\boldsymbol{p}^{ne*})}{\partial p_j^{ne}} + \frac{\partial Q_{bc}^{ne}(\boldsymbol{p}^{ne*})}{\partial p_j^{ne}} + \frac{\partial Q_{bd}^{ne}(\boldsymbol{p}^{ne*})}{\partial p_j^{ne}} < 0, \forall j \in \{a, b\}. \tag{9}$$

Proof. Recall that in the exclusive equilibrium, retailer C's FOC is

$$Q_a^e(p_a^{e*}, p_b^{e*}) + (p_a^{e*} - w_a^{e*})\frac{\partial Q_a^e(p_a^{e*}, p_b^{e*})}{\partial p_a^e} = 0. \tag{10}$$

With the non-exclusive contracts, retailer r's price p_{ar}^{ne*} affects its sales of both products under the non-exclusive contracts. Its FOC for product a's retail price is

$$Q_{ar}^{ne}(\boldsymbol{p}^{ne*}) + (p_a^{ne*} - w_a^{ne*})\frac{\partial Q_{ar}^{ne}(\boldsymbol{p}^{ne*})}{\partial p_a^{ne}} + (p_b^{ne*} - w_b^{ne*})\frac{\partial Q_{br}^{ne}(\boldsymbol{p}^{ne*})}{\partial p_a^{ne}} = 0, \forall r \in \{C, D\}.$$

From (8), we know that the total demand in the non-exclusive case is greater than that in the exclusive case as in equation (8). Because the demand of the two products are the same in the symmetric equilibrium, each product's total demand in the non-exclusive case is also higher than that in the exclusive case. Due to symmetry, the two retailers' markups on a and b are also the same, $p_a^{ne*} - w_a^{ne*} = p_b^{ne*} - w_b^{ne*}$. Adding the two retailers' FOCs for product a in the non-exclusive case, we have

$$Q_a^{ne}(\boldsymbol{p}^{ne*}) + (p_a^{ne*} - w_a^{ne*}) \left[\frac{\partial Q_{ac}^{ne}(\boldsymbol{p}^{ne*})}{\partial p_a^{ne}} + \frac{\partial Q_{ad}^{ne}(\boldsymbol{p}^{ne*})}{\partial p_a^{ne}} + \frac{\partial Q_{bc}^{ne}(\boldsymbol{p}^{ne*})}{\partial p_a^{ne}} + \frac{\partial Q_{bd}^{ne}(\boldsymbol{p}^{ne*})}{\partial p_a^{ne}} \right] = 0. \quad (11)$$

Comparing equation (10) with (11), we get $p_a^{ne*} - w_a^{ne*} > p_a^{e*} - w_a^{e*}$ because the demand in the non-exclusive case is higher ($Q_a^{ne}(\boldsymbol{p}^{ne*}) > Q_a^e(p_a^{e*}, p_b^{e*})$) and the marginal impact of retail price is smaller as in (9). Thus, the retailers get higher markups in the non-exclusive case. Similarly, the retailers' markups on product b is also higher in the non-exclusive case, $p_b^{ne*} - w_b^{ne*} > p_b^{e*} - w_b^{e*}$. The higher demand and markup imply that each retailer's profit is also higher in the non-exclusive case than that in the exclusive case, $\pi_r^{ne*} > \pi_r^{e*}$, $r \in \{c, d\}$.

□

The condition in inequality (8) means that the outside option's equilibrium market share in the non-exclusive case is lower than that in the exclusive case. It holds if the market penetration effect exists and the manufacturers do not over-adjust the wholesale prices in response to the market penetration effect. The left-hand-side of inequality (9) is the marginal demand of product j against its retail price in the exclusive case. The four terms in the middle are the impacts of the retail price of j on the aggregate demand of all products. Two of them are negative own-derivatives, and the other two are positive cross-derivatives. The second inequality in (9) requires that the own-derivatives dominate the cross-derivatives so that the overall impact of a price increase is negative. It is equivalent to assuming that the outside option market share increases with p_j^{ne}. We show that the two inequalities (8) and (9) hold in the Logit demand model in Section 4.4.

3.4 Discussion

The consumer surplus is also different under the two types of contracts. The three effects of the non-exclusive contracts that determine the market penetration effect also affect the consumer surplus through retail prices and consumer demand. Specifically, the internalization effect lowers the consumer surplus because it increases the retail prices and thus reduces the total demand. The intra-brand competition effect increases with the consumer surplus because it lowers the retail prices and thus increases the demand. The variety effect increases the total demand for given retail prices. In the next section, we show that consumer surplus is a strictly increasing function of the aggregate demand of the products when the demand follows the Logit model.

We have considered a symmetric case where the two manufacturers produce the same quality products and have the same cost. If the manufacturers are different in either the product quality or the costs, they may prefer different regimes of contracts. Given the same cost, if product a has a very high quality, and b has a very low quality, then manufacturer A will prefer both manufacturers using the non-exclusive contracts, and manufacturer B will prefer the exclusive contracts, because the market penetration effect for product a is strong when product b has a low quality or a low market share. When the products have the same quality, if product a has a low cost, and b has a high cost, manufacturer A will also prefer both manufacturers using the non-exclusive contracts while B prefers the exclusive contracts because A can set a lower price and have more consumers with the non-exclusive contracts due to its cost advantage. We show numerical examples for these two asymmetric cases in Appendix A.

Under the symmetric setup, the equilibrium under the consideration is also symmetric. That is, both manufacturers choose exclusive contracts or non-exclusive contracts. An asymmetric equilibrium where one manufacturer (e.g., A) chooses the exclusive contract and the other manufacturer (e.g., B) chooses the non-exclusive contract does not exist. This is intuitive. If the market penetration effect exists, then manufacturer A using the exclusive contract has incentive to switch to the non-exclusive contract in order to expand its market share and increase profit. In the contrast, if the market penetration effect does not exist, then the manufacturer (B) has incentive to switch to the exclusive contract to avoid internalization and consequently increases profit.

We use a general demand function and make weak assumptions on it to show the impact of the market penetration. Using a specific demand model to compare the two types of contracts has a few challenges. An appropriate candidate demand model for our framework has to incorporate the retailer differentiation, the outside option, and the competition among all the products in each contract type. In addition, it should be suitable to present the variety effect of non-exclusive contracts. The commonly used models are the linear demand model, the Hotelling model, and the Logit model. There are two main challenges with using the first two in this paper. First, it's hard to have a systematic way to expand the choice set when the contract type changes.

Second, the equilibrium prices can be corner solutions, and their expressions depend on the parameter ranges. The problem with using a Logit model is that, while it easily incorporates the choice set difference and competition, comparing the manufacturers' equilibrium profits under the two types of contracts analytically is very difficult because of the two-stage pricing game of the manufacturers and the retailers. Therefore, instead of using a specific demand model, we assume a general demand function and impose assumptions on it. In the next section, we use the Logit model to demonstrate the assumptions and results in the general set up.

4 An Example: Vertical Contracts with Logit Demand

In this section, we compare the exclusive and non-exclusive contracts with a Logit demand model, following the discrete-choice literature started by McFadden et al. (1973). The Logit demand model provides us an ideal framework to illustrate the impacts of the market penetration effect. It incorporates the retailer differentiation and the outside option. The quality difference between the products and the outside good determines the strength of the market penetration effect.

4.1 Setup

Assume that consumer i's utility from purchasing product $j \in \{a, b\}$ is

$$u_{ij} = \delta_j - \alpha p_j + \epsilon_{ij}, \tag{12}$$

where δ_j is consumers' mean utility of product j which represents the product quality, and p_j is the retail price of product j. The parameter α is the price coefficient. We assume that the two products have the same quality $\delta_a = \delta_b = \delta$. The individual idiosyncratic utility shock, ϵ_{ij}, follows the Type-I extreme value distribution. The mean utility of the outside option is zero, $\delta_0 = 0$. Assume that the market size is one, so the demand of each product is the same as its market share. The demand of product j is

$$Q_j(\boldsymbol{p}) = \frac{e^{\bar{\delta}_j}}{1 + \sum_{j \in \{a,b\}} e^{\bar{\delta}_j}}, \tag{13}$$

where $\bar{\delta}_j = \delta - \alpha p_j$ and $\boldsymbol{p}$ is the vector of retail prices for all products.

4.2 Exclusive Vertical Contracts

Suppose that both manufacturers adopt the exclusive contracts. We again assume that retailer C sells product a and retailer D sells product b under the exclusive contracts. The consumers face a choice set of the two products and the outside option, $\Omega^e = \{a, b, o\}$. The manufacturers choose their wholesale prices (w_a^e, w_b^e) first, then the retailers choose their retail prices after observing the wholesale prices. The retailers pay the wholesale prices to the manufacturers. Let retailer C's price of product a be p_a^e and retailer D's price of product b be p_b^e. Denote the mean utility $\bar{\delta} - \alpha p_j^e$ by δ_j^e. Then the demand of product $j \in \{a, b\}$ is

$$Q_j^e(p_a^e, p_b^e) = \frac{e^{\delta_j^e}}{1 + \sum_{k=a,b} e^{\delta_k^e}}. \tag{14}$$

The retailers play a simultaneous-move pricing game. Retailer $r \in \{C, D\}$'s profit-maximization problem is to choose its optimal retail price of product $j \in \{a, b\}$

$$\max_{p_j} (p_j - w_j) Q_j^e(p_j, p_{-j}).$$

The FOCs of the two retailers imply that the retail prices are functions of the wholesale prices. Let $p_j^e(w_a^e, w_b^e)$ be the retail price of product j when the wholesale prices are (w_a^e, w_b^e).

Each manufacturer takes the retailers' prices into account when choosing the wholesale price. The two manufacturers' wholesale prices affect each other's retail price and demand. Manufacturer j's profit maximization problem is

$$\max_{w_j} (w_j - c_j) Q_j^e(p_j^e(w_j, w_{-j}), p_{-j}^e(w_j, w_{-j})).$$

Denote the equilibrium wholesale prices by (w_a^{e*}, w_b^{e*}) and the retail prices by (p_a^{e*}, p_b^{e*}).

Consumer surplus in the Logit model is a function of the mean utility of each product. From Train (2003) and the Type-I extreme value distribution assumption, we have that the consumer surplus in the exclusive contracts case is

$$CS^e = \frac{1}{\alpha} \ln(e^{\delta_a^e} + e^{\delta_b^e}) = \frac{1}{\alpha} \ln \left[\frac{Q_a^e + Q_b^e}{1 - (Q_a^e + Q_b^e)} \right].$$

The second equality is because that the total demand is $Q_a^e + Q_b^e = \frac{e^{\delta_a^e}+e^{\delta_b^e}}{1+e^{\delta_b^e}+e^{\delta_b^e}}$, which implies that the sum of exponential utility is $e^{\delta_a^e} + e^{\delta_b^e} = \frac{Q_a^e+Q_b^e}{1-(Q_a^e+Q_b^e)}$. Therefore, the consumer surplus is a strictly increasing function of the total demand of the two products.

4.3 Non-Exclusive Vertical Contracts

With non-exclusive contracts, each retailer sells both products. Due to retailer differentiation, we denote retailer C's products by ac and bc and D's products by ad and bd. Consumers face a choice set of five products, $\Omega^{ne} = \{ac, bc, ad, bd, o\}$. The retail prices are $(p_{ac}^{ne}, p_{bc}^{ne})$ for retailer C and $(p_{ad}^{ne}, p_{bd}^{ne})$ for retailer D. Denote the vector of prices by $\boldsymbol{p}^{ne} = (p_{ac}^{ne}, p_{bc}^{ne}, p_{ad}^{ne}, p_{bd}^{ne})$. The mean utility of product $j \in \{a, b\}$ from retailer $r \in \{C, D\}$ is $\delta_{jr}^{ne} = \bar{\delta} - \alpha p_{jr}^{ne}$. The demand of product jr is

$$Q_{jr}(\boldsymbol{p}^{ne}) = \frac{e^{\delta_{jr}^{ne}}}{1 + \sum_{k=a,b}\sum_{l=c,d} e^{\delta_{kl}^{ne}}}. \tag{15}$$

Retailer r's problem is to maximize its profit from the two products

$$\max_{p_{ar}^{ne}, p_{br}^{ne}} \left[(p_{ar}^{ne} - w_a^{ne})Q_{ar}(\boldsymbol{p}^{ne}) + (p_{br}^{ne} - w_b^{ne})Q_{br}(\boldsymbol{p}^{ne})\right].$$

We derive the FOCs for the two retail prices for each retailer. Each retailer internalizes the competition effect between the two products. The FOCs of the two retailers imply that the retail prices are functions of the wholesale prices, denoted by $p_j^{ne}(w_j, w_{-j})$.

Each manufacturer chooses its wholesale price to maximize its profit. The total demand of each product comes from both retailers, $Q_j^{ne} = Q_{jc} + Q_{jd}$, $j \in \{a, b\}$. Manufacturer j's profit-maximization problem is

$$\max_{w_j}(w_j - c_j)Q_j^{ne}(p_j^{ne}(w_j, w_{-j}), p_{-j}^{ne}(w_j, w_{-j})).$$

Using the two manufacturers' FOCs, we solve for the equilibrium wholesale prices. Let the equilibrium wholesale prices be (w_a^{ne*}, w_b^{ne*}) and the retail prices be $(p_{ac}^{ne*}, p_{bc}^{ne*}, p_{ad}^{ne*}, p_{bd}^{ne*})$.

Under the non-exclusive contracts, the consumer surplus is

$$CS^{ne} = \frac{1}{\alpha}\ln(e^{\delta_{ac}^{ne}} + e^{\delta_{bc}^{ne}} + e^{\delta_{ad}^{ne}} + e^{\delta_{bd}^{ne}}) = \frac{1}{\alpha}\ln\left[\frac{Q_{ac}^{ne} + Q_{bc}^{ne} + Q_{ad}^{ne} + Q_{bd}^{ne}}{1 - (Q_{ac}^{ne} + Q_{bc}^{ne} + Q_{ad}^{ne} + Q_{bd}^{ne})}\right],$$

Similar to the exclusive case, the consumer surplus increases with the total demand of the products. Comparing the consumer surplus under the two types of contracts, one can see that the total demand of all products determines the consumer surplus. When the total demand is higher in the non-exclusive case than that in the exclusive case, the consumers are better off in the non-exclusive case, and vice versa.

4.4 Comparison: A Numerical Example

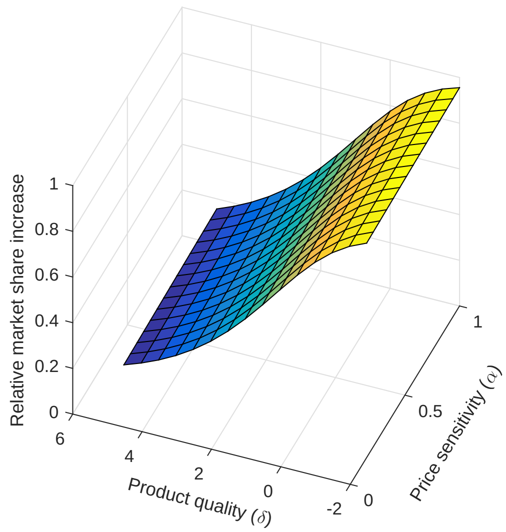
In this section, we illustrate the theoretical results in Section 2 in a numerical example of the Logit model. We first check whether the assumptions in Section 3 hold in this example and then present and explain the differences in manufacturer profits, retailer profits, and consumer surplus between the two types of contracts. Two key model parameters are the price sensitivity of consumers (α) and the product quality (δ). We consider wide ranges of the two parameters and discretize them. We discretize the ranges for the two coefficients. For each (α, δ), we solve for the symmetric equilibrium in each combination of these parameter values under both exclusive and non-exclusive contracts.

Assumption 1 requires that the market penetration effect exists for both products. Figure 2 shows the relative difference in total demand of product a for different values of (α, δ).[9] For each (α, δ), we first compute the exclusive equilibrium, then we use the exclusive equilibrium wholesale prices to compute the corresponding retail prices and demand in the non-exclusive case. The vertical axis shows the ratio $\frac{Q_a^{ne}(w_a^{e*}, w_b^{e*}) - Q_a^{e}(w_a^{e*}, w_b^{e*})}{Q_a^{e}(w_a^{e*}, w_b^{e*})}$ which represents the strength of the penetration effect. This ratio is always positive in all the parameter values we considered, which means that Assumption 1 holds in our example. As the product quality goes up, this ratio declines because the market penetration effect weakens. Intuitively, the outside option share is small, so the non-exclusive contracts do not significantly change the demand of either product when both products' quality is high. However, the total demand for each product is still higher

[9] We fix the unit cost of the two products to be $c_a = c_b = 0.42$. The results are robust to the value of the cost parameter.

in the non-exclusive case.

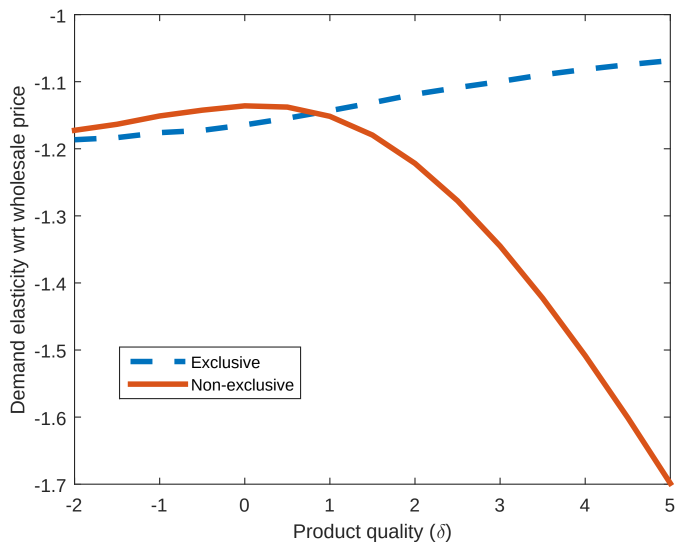
Figure 2: Differences in Demand between Non-Exclusive and Exclusive Contracts



Assumption 2 requires that the wholesale price demand elasticities are greater under the non-exclusive contracts than under the exclusive contracts at the exclusive equilibrium wholesale prices. We fix the price coefficient.[10] Figure 3 shows the elasticities in the two types of contracts.The dashed curve shows the elasticities in the exclusive case, and the solid curve shows the non-exclusive case. We find that the demand is more inelastic with non-exclusive contracts when the quality is low, but the relationship is reversed when the quality is high. This is because that when the product quality is low, the total demand is low under the exclusive contracts. In this case, the variety effect and the intra-brand competition dominate the internalization effect, and the market penetration effect is strong. As a result, the demand is less elastic in the non-exclusive case than the exclusive case. When the product quality is high, the market penetration effect is weak because the variety effect and the intra-brand competition effect are weak, and the internalization effect dominates. In this case, the retailers pass more of the wholesale price to the retail price, and demand becomes more sensitive to the wholesale price than in the exclusive case. Therefore, Assumption 2 holds when the product quality is low. Assumption 3 requires a manufacturer's marginal profit to increase with the opponent's wholesale price under the non-exclusive contracts. We verified that this assumption holds for the parameter values in our example.

[10] The price sensitivity is $\alpha = 0.45$. For each δ, we compute the exclusive equilibrium wholesale prices and calculate the demand elasticities at these prices in both types of contracts. The unit cost of the two products are $c_a = c_b = 0.42$.

Figure 3: Wholesale Price Demand Elasticities at the Exclusive Equilibrium Wholesale Prices



Given that Assumptions 1-3 hold in the Logit demand model, we now compare the equilibrium prices, demand, and profits under the two types of contracts. Figure 4 shows the differences in the wholesale prices between the two types of contracts, $w_a^{ne*} - w_a^{e*}$. We find that $w_a^{ne*} - w_a^{e*} < 0$ when the product quality is low, and it becomes positive as the quality goes up for a given price sensitivity α. We can explain this result using the findings in Figure 3. From Figure 3, we find that, when the product quality is low, demand is less elastic in the non-exclusive case if the wholesale prices are the same in the two types of contract, so the manufacturers will choose higher wholesale prices in the non-exclusive case. As the product quality goes up, demand becomes more elastic in the non-exclusive case, and the manufacturers will choose relatively lower wholesale prices.

Figure 4: Differences in the Wholesale Prices between Non-Exclusive and Exclusive Contracts

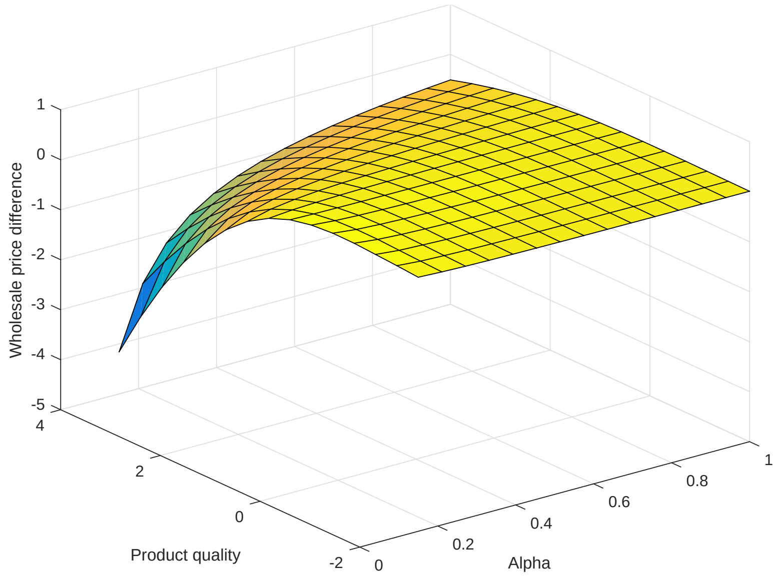
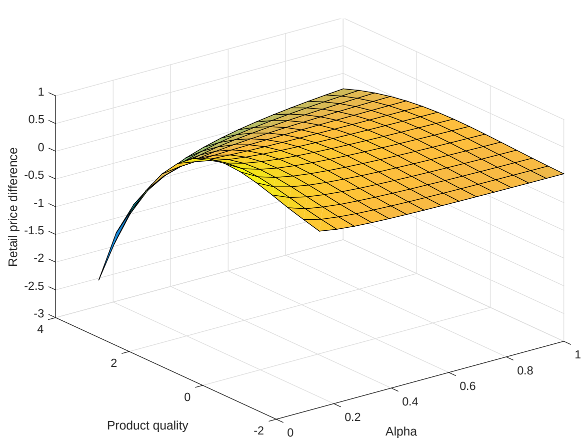


Figure 5a shows the differences in the equilibrium retail prices, $p_a^{ne*} - p_a^{e*}$. The differences in the retail prices reflect the wholesale price differences in Figure 4. For a given α, $p_a^{ne*} - p_a^{e*} < 0$ when the product quality is high and $p_a^{ne*} - p_a^{e*} > 0$ when the product quality is low. Figure 5b shows the changes in the retailers' markups. Although the retail prices can be lower, the retailers' markups always go up in the non-exclusive contracts. This is because that there are two effects that lower the consumers' retail price demand elasticities. First, the internalization effect reduces the marginal impact of an increase in the retail price because some consumers switch to the other product of the same retail. Second, the variety effect increases the total sales of each retailer. Thus, each retailer can charge a higher markup without losing consumers in the non-exclusive case.

Figure 5: Differences in the Retailer Prices and Markups

(a) Differences in the Retailer Price

(b) Differences in the Retailer Markup



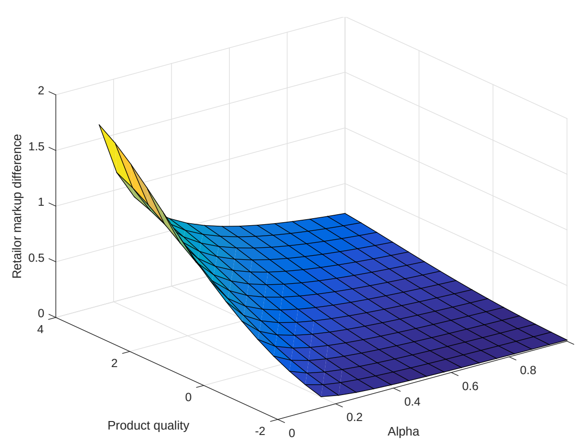


Figure 6 shows the differences in the equilibrium demand of each product between the non-exclusive contracts and the exclusive contracts, $Q_j^{ne*} - Q_j^{e*}$ for $j \in \{a, b\}$. The equilibrium demand is always higher in the non-exclusive case. For a fixed α, the difference increases with quality, implying that more consumers purchase under the non-exclusive contracts as the product quality improves. Two reasons lead to this monotonicity. First, as shown in Figure 5a, the retail prices are lower in the non-exclusive case when the quality is high. Second, the total demand of a product increases with the quality in both types of contracts. The differences are also larger as the quality goes up.

Figure 6: Differences in Demand between Non-Exclusive and Exclusive Contracts

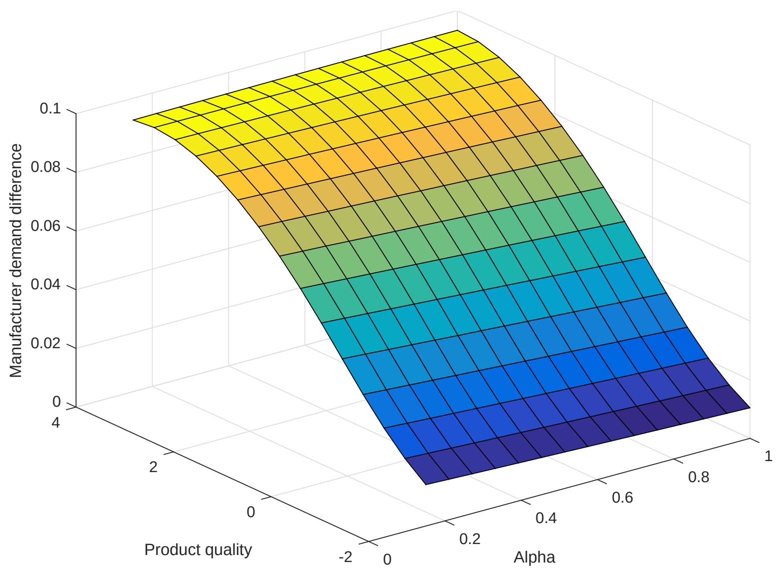


Figure 7 shows the differences in the manufacturers' profits, $\pi^{ne*} - \pi^{e*}$. We find that the differences in profits depend on the product quality. When δ is small and α is large, $\pi^{ne*} - \pi^{e*} > 0$, and when δ is large and α is small, $\pi^{ne*} - \pi^{e*} < 0$. When the product quality is high, each manufacturer's wholesale price is lower in the non-exclusive case than that in the exclusive equilibrium because demand becomes more elastic as in Figure 3. Meanwhile, the demand does not increase much in the non-exclusive case as in Figure 2 because each product already has a high market share in the exclusive case due to the high quality. Therefore, manufacturers' profits are lower in the non-exclusive case. When the product quality is low, each manufacturer increases the wholesale price, and the demand also increases as in Figure 6. Thus, each manufacturer gets a higher profit in the non-exclusive case when the product quality is low.

Figure 7: Differences in the Manufacturers' Profits between Non-Exclusive and Exclusive Contracts

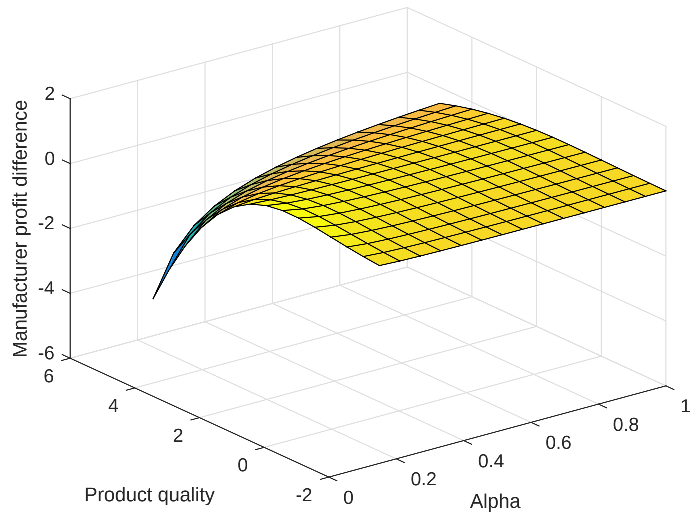


Figure 8 shows the differences in the retailer's profits, $\pi_c^{ne*} - \pi_c^{e*}$. We find that each retailer always gets a higher profit in the non-exclusive case for all (α, δ) combinations. This is because that both the markups and the sales of the retailers are higher in the non-exclusive contracts. The total demand of each product is higher in the non-exclusive case as in Figure 6, thus the total sales of each retailer is also higher. The retailers' markups on the two products are also higher as in Figure 5b. Therefore, each retailer not only sells more of the products but also charges higher markups, so the profits are higher under the non-exclusive contracts. Figure 8 also shows that the difference in the retailer profits increases with the product quality and decreases with the price sensitivity.

Figure 8: Differences in the Retailers' Profits between Non-Exclusive and Exclusive Contracts

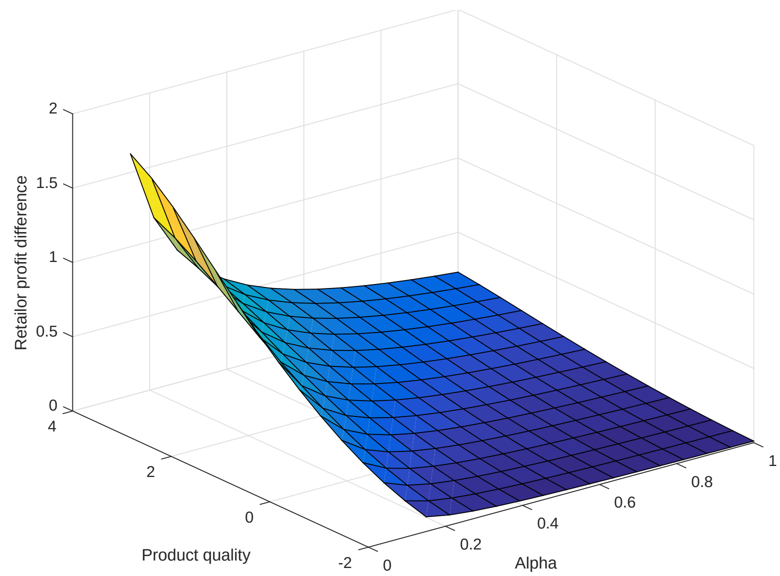


Figure 9 presents the differences in consumer surplus, $CS^{ne*} - CS^{e*}$. We find that the consumer surplus is always higher in the non-exclusive case. As shown in Section 4.2, the consumer surplus is an increasing function of the total market share of the products in the Logit demand model, so the higher total demand in the non-exclusive case means that the consumers are better off with the non-exclusive contracts.

Figure 9: Differences in the Consumer Surplus between Non-Exclusive and Exclusive Contracts

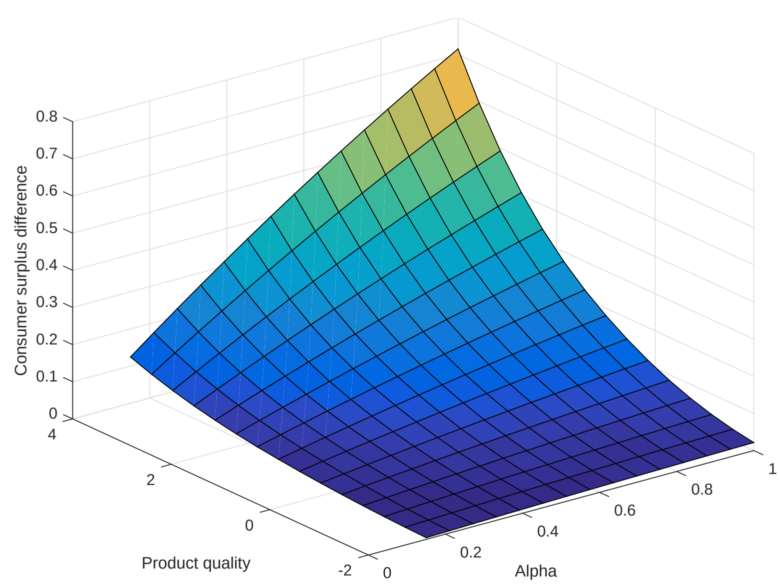
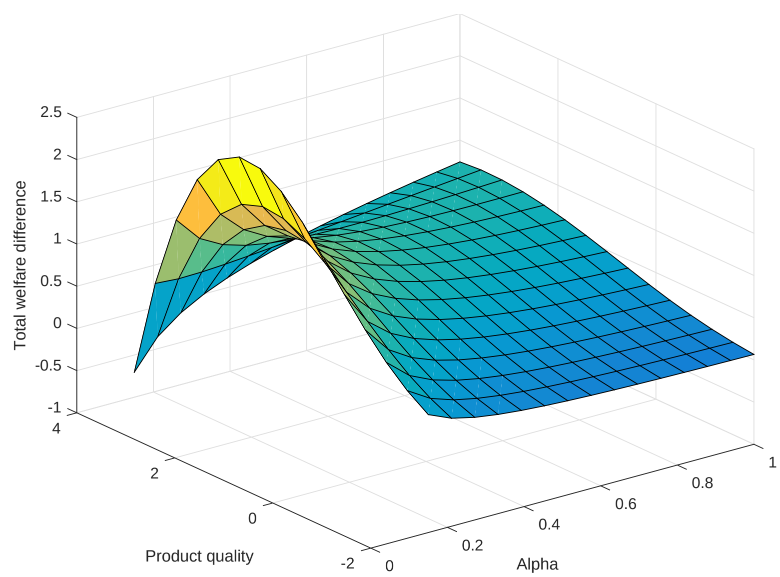


Figure 10 presents the differences in the equilibrium total welfare between non-exclusive and exclusive contracts. The social welfare is the sum of the manufacturers' profits, the retailers' profits, and the consumer surplus. We find that the changes are all positive except when the quality is very high and price sensitivity is very low. Because the retailer profits and the consumer surplus are always higher under the non-exclusive contracts, the social welfare will always be higher too if the manufacturers' profits increase. If the manufacturers' profits decrease, then the change in the social welfare depends on whether the loss in the manufacturer profits is greater than the gain in the retailer profits and consumer surplus. Since the manufacturers' profit loss is the largest when the quality is high and the price sensitivity is small, the difference in the social welfare is also the lowest in such cases and can even be negative.

Figure 10: Differences in the Social Welfare between Non-Exclusive and Exclusive Contracts



5 Conclusion

Retailer differentiation and outside goods are ubiquitous in almost every industry. Together they imply a market penetration effect of the non-exclusive contracts, which can substantially affect the manufacturers' profits, the retailer profits, and the consumer surplus. However, the theoretical literature on exclusive dealing has not considered retailer differentiation and the outside goods simultaneously. In this paper, we consider both and emphasize the role of the market penetration effect in comparing the exclusive and the non-exclusive contracts in a vertical oligopolistic model.

Without considering the retailer differentiation and the outside option together, the studies in the literature find that manufacturers can get more profits under exclusive dealing. For example, Rey and Stiglitz (1995) assume identical retailers and find that the manufacturers get higher profits under exclusive dealing. Besanko and Perry (1994) assume that the outside option does not exist and find that exclusive dealing generates higher profits for the manufacturers. However, when we consider both the retailer differentiation and the outside option, the results on the comparison of exclusive and non-exclusive contracts can be the opposite. In particular, we find that when the market penetration effect is strong, the manufacturers' equilibrium profits are higher with the non-exclusive contracts than with the exclusive contracts.

We illustrate our theoretical findings in an example of the Logit demand model which considers both the retailer differentiation and the outside option. We find that the manufacturers' profits are higher under non-exclusive contracts when the product quality is low and the price sensitivity is high. The strength of the market penetration effect decreases as the product quality increases because the outside option share decreases as the product quality goes up. We also find that the retailers charge higher markups and more consumers buy the products under the non-exclusive contracts. Thus, the retailers's profits and consumer surplus are higher under the non-exclusive contracts.

This paper sheds light on understanding the impacts of retailer differentiation on exclusive dealing, including the wholesale prices, the retail prices, the profits of the manufacturers and retailers, and the consumer surplus. Retailer differentiation can exist in many dimensions in the real world, including geographic locations, customer experiences, rewards programs, and so on. We consider the retailer differentiation through the market penetration effect, which is a very general representation. To empirically analyze the impacts of the retailer differentiation on the manufacturers' choices of exclusive dealing can be very interesting future research topics.

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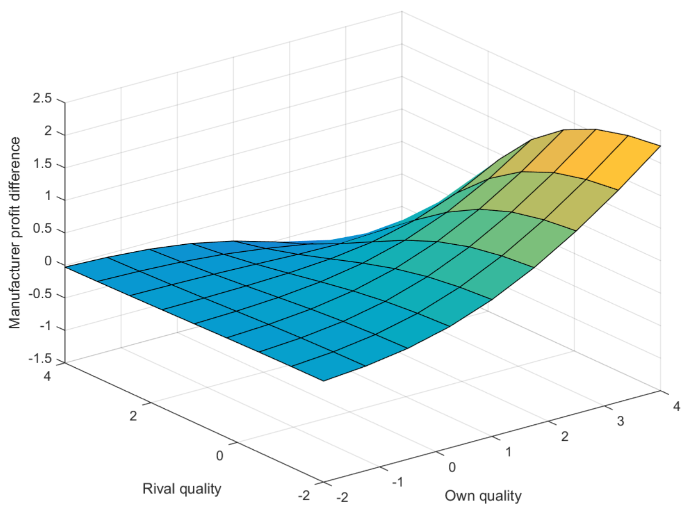
Appendix

A Asymmetric Manufacturers

This appendix section describes the results of asymmetric manufacturers in the Logit model in Section 4.4. In Figure A.1, we show the profit differences of a manufacturer between the two types of contracts when the manufacturers have products with different quality. We find that, when one manufacturer's product quality is high and the other's is low, then the manufacturer with a high quality product prefers the non-exclusive contracts because the market penetration effect dominates the inter-brand competition, and the manufacturer with a low quality product prefers the exclusive-contracts because the inter-brand competition reduces its total demand substantitally.

Figure A.1: Differences in Manufacturers' Profits with Asymmetric Product Quality



In Figure A.2, we show the differences in manufacturer profits between the two types of contracts when the manufacturers have different production costs. We find that, when a manufacturer has a low cost while the other firm has a high cost, the manufacturer with the low cost prefers the non-exclusive contracts because its lower equilibrium retail price can capture most of the market demand with non-exclusive contracts. The market penetration effect is strong for the low cost product. The manufacturer with the high cost prefers the exclusive contracts because the market penetration effect is weak.

Figure A.2: Differences in Manufacturers' Profits with Asymmetric Production Costs