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博 士 論 文

平成 27 年 12 月
神戸大学大学院経済学研究科
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補完的でない商品の競争戦略としての抱き合わせ販売

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November 9, 2015

Qing Hu

Bundling of non-complementary products as a competitive strategy

Abstract

This paper discusses three questions about bundling. The first question is about the incentive of bundling for multiproduct firms in a symmetric duopoly market under consumers' product specific preference. We show that mixed bundling is the dominant strategy when consumers' reservation value is relatively low; otherwise, firms choose independent pricing. The second question is about the effect of bundling to deter entry under consumers' product specific preference. When consumers' reservation value is relatively high, we show that the incumbent has an incentive to use bundling to deter entry only if a prior commitment is applicable. However, when consumers' reservation value is low, the multiproduct firm even has no incentive to use bundling and bundling has no effect on entry deterrence. The third question is about the entry deterrence effect of bundling under consumers' firm specific preference. we show that the incumbent can deter and even block entry by bundling when consumers' reservation value is at an intermediate or relatively high level. This result holds even when the incumbent cannot commit itself to such bundling in advance.

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Chapter 1. Introduction

As the whole economy all over the world develops rapidly, the categories of items sold are increasing as well. A result of this products variety is that we can see many products sold together. They may be in a box, such as several different cosmetic items in a single box. This kind of selling way is called “pure bundling”. Pure bundling is defined as that products are sold in a certain proportion. Besides pure bundling, you may also find that buying several items together is more profitable, such as a hamburger set with a glass of cola may be cheaper than the sum of the price for each one. This kind of selling way is called “mixed bundling”. Mixed bundling represents that if you purchase several products together, you will get a certain amount of discount. Bundling can be observed in many industries, such as telecommunication, financial, cosmetic industries and so on.

Usually people think that bundling is a way of price discrimination, which is used as a selling strategy. However, bundling, especially pure bundling is always suspected as a tool for entry deterrence or market foreclosure. For example, Japan Fair Trade Commission once suggested to cease the bundling of Microsoft’s Word and Excel, since it may be a tool to foreclose the word processor market where another competitor Ichitaro existed. Therefore, surrounding the topic of bundling from the perspectives of price discrimination and entry deterrence, the previous work on bundling can be divided into these two types. One type is about bundling as a price discrimination. Many researches can tell us why this is worthy discussing. In a monopoly market, Matutes and Regibeau (1988), Matutes and Regibeau (1992), Adams and Yellen (1976) showed important models. Matutes and Regibeau (1988) showed that in a monopoly market, the multiproduct firm has a stronger incentive to cut price if it engages in a pure bundle, compared with the situation under independent pricing. Moreover, consumers have more varieties to choose under independent pricing. These lead that independent pricing is more profitable than pure bundling. Matutes and Regibeau (1992) showed that mixed bundling is more profitable than independent pricing because the demand under mixed bundling is bigger than it under independent pricing, for the more purchasing varieties under mixed bundling. These results are based on a certain level of consumers’ reservation price. Adams and Yellen (1976) showed that pure bundling may dominate independent pricing in some occasions after numerous experiments with random distributions of reservation value. In a competitive market, Matutes and Regibeau (1988), Matutes and Regibeau (1992) and Gans and King (2005) showed that bundling harms firms’ profits if both bundles, because bundling intensifies the

competition. This leads to a price competition. However, if either bundles, mostly bundles attracts more consumers, therefore the one bundles gets more profit. For these, in order to release the competition, independent pricing is always preferred. The other type of previous work is about bundling as a entry deterrence tool. Whinston (1990), Nalebuff (2004), Peitz (2008), Armstrong, M., and Vickers, J. (2010) discussed this question. Mostly these results showed that bundling can deter entry for the leverage effect from the monopoly market to the potential competitive market. And most previous researches discuss pure bundling rather than mixed bundling, since pure bundling is more likely to deter entry hence its legality is also considered.

From the previous work, we find that many previous researches assumed that products are complementary such as cameras and lenses. These products must be used together, therefore in the model a single product demand does not exist. However, in reality, bundles of non-complementary products, such as the bundle of Microsoft's Word and Excel, are very common. Consumers may prefer buying only a single product because it can be used alone or it can be paired with other products. Therefore it is necessary to talk about bundling based on non-complementary products. In this paper, we intend to discuss the two types of bundling problem. In addition, we find that Hotelling model is used very often on bundling problem. And Hotelling model can be divided into two types: consumers' product specific preference and firm specific preference. Product specific preference means that consumers consider products are different, such as a consumer may prefer Gucci's bag but Prada's clothes. Comparatively, firm specific preference means that consumers only consider the firms are different. For example, the transportation cost does not increase in proportion to the number of the items you buy from a certain supermarket. We intend to use Hotelling model in this paper.

In a summary, we discuss three questions of bundling based on the assumption of non-complementary products: first, we talk about bundling for price discrimination under consumers' product specific preference. Second, we discuss bundling for entry deterrence under consumers' product specific preference. Finally, we take a look at bundling for entry deterrence but under consumers' firm specific preference. There is a lack of the extension of Matutes and Regibeau (1988)' model on our first and second topic, we extend their model in this paper. And we build a new model to discuss the final topic.

The reminder of this paper is as follows. In chapter 2, we discuss bundling for price discrimination and product specific preference. In chapter 3, we see bundling for entry deterrence and product specific preference. In chapter 4, we talk about bundling for

entry deterrence and firm specific preference. In chapter 5, we show a summary.

Chapter 2. Bundling for price discrimination and product specific preference

2-1. Introduction

By considering bundling as a selling strategy, a multiproduct firm can sell its products in three ways: pure bundling, independent pricing, and mixed bundling. Pure bundling refers to selling products only in a bundle. independent pricing means selling products separately. Mixed bundling means selling goods by using both of these pricing methods. In this study, assuming the market is a duopoly and each firm sells the same products, we examine the incentives of firms to engage in bundling. We analyze this topic by assuming the products that a firm sells are non-complementary. In addition, we assume a firm can select among three strategies: pure bundling, independent pricing, and mixed bundling.

This question has been examined rather extensively in the relevant literature by assuming the products involved are complementary. Accordingly, previous literature assumed consumers are not allowed to purchase only a single product. For example, in previous studies, two products are complementary—for instance, like a computer and a mouse or a camera and a lens; the products must be used together because one product cannot be used without the other. Therefore, a consumer must also purchase the products together. Matutes and Regibeau (1988) examined firms' incentive to engage in pure bundling and independent pricing in a duopoly market. In their model, they assumed there were two firms, *A* and *B*, selling two complementary system components, say, products 1 and 2. A consumer purchases at most one unit of each product. Therefore, when both firms engage in independent pricing, consumers have five options to select from, namely, *AA*, *BB*, *BA*, *AB*, and purchasing nothing. For example, *AA* means buying two components together from firm *A*, whereas *AB* means buying product 1 from firm *A* and product 2 from firm *B*. When both firms bundle, consumers have three purchasing options to select from, namely, *AA*, *BB*, and purchasing nothing. When only firm *A* bundles, because consumers must buy two components, the situation is the same as the one where both firms bundle. The researchers showed that independent pricing always dominated pure bundling.

In this study, we assume products are non-complementary—for example, like coffee and sugar. We can find a bundle of coffee and sugar in supermarket stores. However, coffee and sugar are also sold separately. A consumer may purchase only coffee because

he prefers drinking coffee without sugar. A consumer may also buy the bundle for a lower price. Therefore, consumers are allowed to purchase only a single product in this situation. Based on the setup of Matutes and Regibeau (1988), with the new assumption that products are non-complementary, when both firms engage in independent pricing, there are nine purchasing options: AA , BB , $A1$, $A2$, $B1$, $B2$, AB , BA , and purchasing nothing. When only firm A bundles, consumers have AA , BB , $B1$, $B2$, and purchasing nothing to select from, which is not equal to the situation where both choose to bundle. In our study, we find that pure bundling may dominate independent pricing.

Matutes and Regibeau (1992) subsequently examined the incentives for mixed bundling and independent pricing for multiproduct firms in a duopoly market. Using a model similar to the one from 1988, they found a variety of results corresponding to the level of consumers' reservation value (C). When C is small, the equilibrium result is that both firms engage in mixed bundling. However, this situation turns out to be a prisoners' dilemma. When C is big, the equilibrium result is that both firms engage in independent pricing. If C is in between, the equilibrium result is that either firm chooses mixed bundling. Gans and King (2006) extended the model of Matutes and Regibeau (1992) for analyzing the incentives for mixed bundling and independent pricing. They found the same results, but they changed the model from two to four firms. Thus, the situation became a problem concerning integration as well.

No study has considered the relationship between pure bundling and mixed bundling based on complementary products. This is because when pure bundling and mixed bundling are considered in this setup, if one firm engages in pure bundling, it automatically means that the other firm has to engage in pure bundling as well. Matutes and Regibeau (1988) found that pure bundling was always dominated by independent pricing, and hence, there is no need to compare pure bundling and mixed bundling. However, in this study, we find that pure bundling may dominate as a selling strategy over independent pricing, and hence, we must compare mixed bundling with pure bundling.

By adding the possibility of consuming one product, Peitz (2008) analyzed the entry deterrence effect of pure bundling for a multiproduct monopoly in a two dimensional Hotelling model. This is not a symmetric market. In his model, consumers are allowed to buy a bundle from the incumbent in addition of another product from the rival if the entry has occurred. Based on this assumption, pure bundling is preferred by the incumbent if the entry has happened. This differs from the result of Whinston(1990) where bundling is never preferred if the entry has occurred. In Peitz (2008)'s model, the horizontal axis had vertical axis represent consumers' surplus from buying product 1

and 2, respectively. A consumer located further from a firm means that this consumer has higher surplus of buying this firm's product hence she is more willing to buy its product. However, in our model, a consumer located further from a firm means that she needs to pay more cost to buy the firm's product, therefore she is less willing to buy its product. Based on Peitz (2008)'s model, the market configuration does not change as consumers' reservation changes. Nalebuff (2004) also considered the similar problem by assuming the incumbent chooses prices before the entrant in a two dimensional Hotelling model similar to our model. But he did not examine the change of the level of consumers' reservation. However in our study, market configurations change as consumers' reservation changes and we assume consumers buy at most of each product.

The remainder of this chapter is arranged as follows. In section 2, the model is introduced. In section 3, we analyze the equilibrium prices and profits in four cases: (1) pure bundling and independent pricing, (2) independent pricing and mixed bundling, (3) mixed bundling and pure bundling, and (4) integrating all three strategies. In section 4, we show the differences between this study and previous ones. In section 5, we present conclusions.

2-2. The model

Suppose there are two products, products 1 and 2, which can be used together or separately, such as coffee and sugar. There are two firms in the market, firms *A* and *B*, producing both products 1 and 2. Without loss of generality, all marginal costs are set to equal zero. A consumer purchases at most one unit of each product. Therefore, if both firms engage in independent pricing, nine system configurations are available for consumers to purchase, as follows: *AA*, *BB*, *A1*, *A2*, *B1*, *B2*, *AB*, and *BA*; otherwise, they purchase none. For example, *AB* means buying product 1 from firm *A* and product 2 from firm *B* and *A1* stands for buying only product 1 from firm *A*. We consider three strategies for each firm: pure bundling (*B*), independent pricing (*N*) (i.e., non-bundling), and mixed bundling (*M*). However, we analyze four cases in this study. In the first case, we consider that firms have pure bundling and independent pricing as the only two strategies. In the second case, we set the condition that both firms can select from the strategies of mixed bundling and independent pricing only. In the third case, we assume the two firms have mixed bundling and pure bundling as their choices of strategy. In the last case, we integrate all three cases.

In each case, we examine the firms' choice of pricing schemes by employing a two-stage game. In stage one, the firms decide whether to bundle. In stage two, the

firms set their prices simultaneously.

Then, we extend the basic model of Matutes and Regibeau (1988), allowing consumers to purchase only one product. Consumers are uniformly distributed on the unit square: firm A is located on the origin $(0, 0)$, while firm B is located at the point of coordinates $(1, 1)$. The horizontal axis stands for product 1, and the vertical axis stands for product 2. Generally, under an independent-pricing scheme, a consumer buying only one product has a surplus of

$$C - \lambda d_{mj} - p_{mj},$$

where $m = 1, 2$, and $j = A, B$. The term C is the reservation value common to all consumers to buy one product. Therefore, buying two products will result in $2C$. The term d_{mj} is the distance between the consumer's location and the firm j horizontally or vertically, which depends on the product m . The term p_{mj} is the price of firm j 's product m , and $\lambda > 0$ measures the degree of horizontal product differentiation. We assume $\lambda = 1$ in this study. A consumer buying two products together has a surplus of

$$2C - \lambda(d_{1i} + d_{2j}) - p_{1i} - p_{2j},$$

where $i, j = A, B$. Concerning different pricing schemes, if a consumer buys both products from firm i engaging in pure bundling, she will have a surplus of

$$2C - \lambda(d_{1i} + d_{2i}) - p_i,$$

where p_i stands for the price of pure bundling of firm i . In addition, if a consumer purchases two products together from firm i engaging in mixed bundling, she will obtain a surplus of

$$2C - \lambda(d_{1i} + d_{2i}) - (p_{1i} + p_{2i} - \delta_i),$$

where δ_i is a discount owing to mixed bundling.

2-3. Equilibrium prices and profits

In this section, we find equilibrium results, analyze the behavior of firms in three cases, and then integrate these three cases into a final case. In every case, we consider

three strategy combinations for analyzing a Nash equilibrium. We draw the market configurations of each combination in a two-dimensional Hotelling unit square by using consumer surplus formulations. Then, we can calculate the firms' profits in each combination and find out the equilibriums by comparing the profits of each combination. We will see that the market configurations and equilibriums are different, depending on the level of consumers' reservation value (C).

2-3-1. Case 1: pure bundling vs. independent pricing

In this case, we assume firms have only two strategies available: pure bundling (B) and independent pricing (N) (i.e., non-bundling). The market configurations corresponding to different dimensions of C are presented in Figure 1. The three strategy combinations possible are BB , BN (NB), and NN . BB means that both firms engage in pure bundling. BN means only one firm engages in pure bundling, and we set the condition that firm A is the one that does so. NN is the combination that both firms do not bundle goods. Concerning the situation where only firm A bundles, we demonstrate an example for the calculation in the situation where $C \leq 0.5$. The demand of AA on the horizontal and vertical axes are the same, and we denote demand as d_{mA} , $m = 1, 2$, and $2C - d_{mA} - p_A \geq 0$ (i.e., $d_{mA} \leq 2C - p_A$). Then, the area of the triangle is $(2C - p_A)^2/2$, and this is the demand for firm A . Therefore, profit is

$$\pi_A = p_A (2C - p_A)^2/2.$$

Maximizing firm A 's profit with respect to p_A gives us maximized

$$p_A^* = 2C/3$$

and

$$\pi_A^* = 16C^3/27.$$

For other calculations, please refer to the Appendix 1.

We define π^{hl} as the profit of a firm engaging in strategy h , while the rival engages in strategy l , with $h, l \in \{B, N, M\}$. The term p^{hl} is the price of one product but it is the bundle price when h stands for bundle (B). We obtain the equilibriums as follows: first, both firms choose independent pricing (NN):

When $C < 0.5$, because $\pi^{NN} = \pi^{NB} > \pi^{BB} = \pi^{BN}$, and

When $0.5 \leq C < 0.75$, because $\pi^{NN} > \pi^{NB} > \pi^{BB} > \pi^{BN}$.

We also have the results on the prices as follows:

$2p^{NN} > p^{BN} = p^{BB} > p^{NB} = p^{NN}$, when $C < 0.5$, and

$2p^{NN} > p^{BN} > p^{BB} > p^{NB} = p^{NN}$, when $0.5 < C \leq 0.75$.

Second, there are two equilibriums where both firms choose independent pricing (NN) and both choose pure bundling (BB),

When $0.75 \leq C < 1$, because $\pi^{NN} > \pi^{BB} > \pi^{NB} > \pi^{BN}$,

When $1 \leq C < 1.5^1$, because $\pi^{NN} > \pi^{BB} > \pi^{BN} > \pi^{NB}$, and

When $C \geq 1.5$, because $\pi^{NN} > \pi^{BB} = \pi^{NB} = \pi^{BN}$.

Finally, we have the results on the prices as follows:

$2p^{NB} > 2p^{NN} > p^{BN} > p^{BB} > p^{NB} > p^{NN}$ when $0.75 \leq C < 1$,

$2p^{NN} > 2p^{NB} > p^{BB} > p^{BN} > p^{NN} > p^{NB}$ when $1 \leq C < 1.5$, and

$p^{BN} = p^{BB} = p^{NN}$ when $C \geq 1.5$.

Market configuration when both firms engage in individual pricing (NN):

AB	B2	BB
A1		B1
AA	A2	BA

($C < 1$)

AB	BB
AA	BA

($C \geq 1$)

Market configuration when firm A engages in pure bundling and firm B engages in individual pricing (BN):

B2	BB
AA	B1

B2	BB
AA	B1

B2	BB
AA	B1

¹ Strictly speaking, when C approaches 1.4, say $C = 1.48$, only NN becomes the equilibrium.

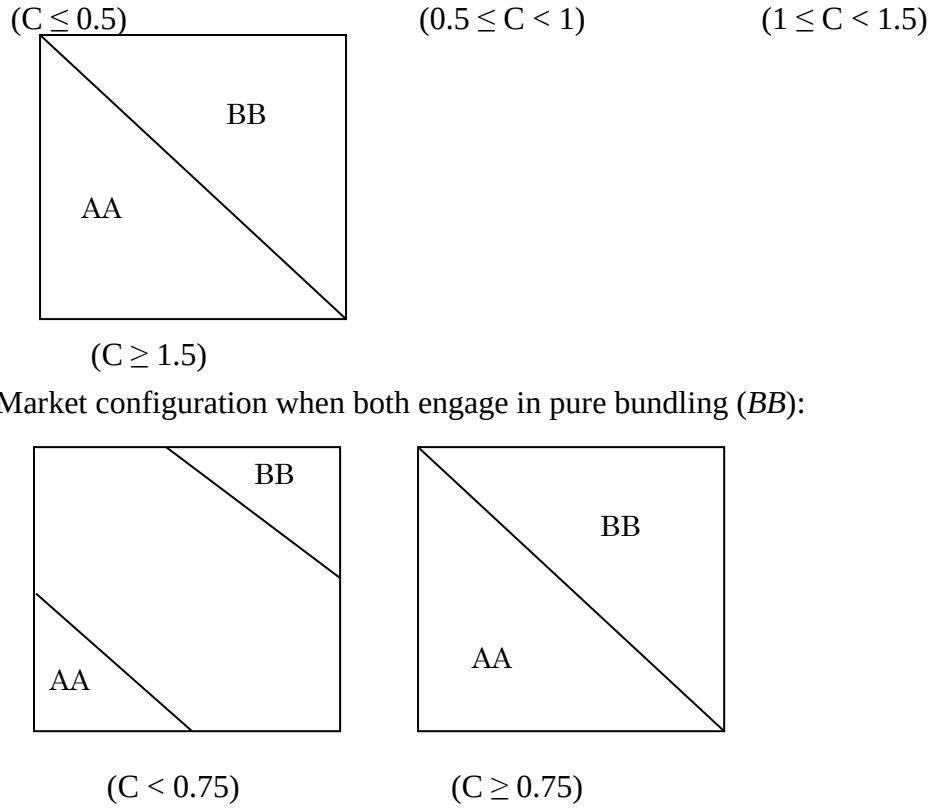


Figure 1. Market configuration. Case 1: pure bundling vs. individual pricing

On comparing our results with those of Matutes and Regibeau (1988), we find several differences. We find that the market configurations are more complicated in the presence of single-product consumption. In our study, we find the result that both firms bundle (i.e., *BB*) may appear in the equilibrium, while independent pricing always dominates as a selling strategy over pure bundling (*NN*) in Matutes and Regibeau (1988). When $0.75 < C < 1$, the market for *BB* is an adjacent market. In an adjacent market, according to Matutes and Regibeau (1992, p.52, line36), “both firms set prices for their complete systems so as to leave consumers located at the common market boundary with exactly zero surplus.” The market boundary of *AA* and just touches that of *BB*. Firms *A* and *B* do not compete directly, but all the consumers in the market are covered. Comparatively, competition among pure, bundled, and single-product systems is fierce in the market for *BN*. Therefore, we see $\pi^{BB} > \pi^{BN}$ and $\pi^{BB} > \pi^{NB}$ temporarily.

2-3-2. Case 2: mixed bundling vs. independent pricing

In this case, we consider a situation where firms have only two choices as their strategy: mixed bundling (*M*) and independent pricing (*N*). The market configurations

are presented in Figure 2. There are three strategy combinations: MM , MN (NM), and NN . The term p_M^{hl} is the set price of the mixed bundle, and p^{hl} is the price of a single product. We obtain the following results.

First, both firms choose mixed bundling (MM)

When $C \leq 0.7$, because $\pi^{MM} = \pi^{MN} > \pi^{NN} = \pi^{NM}$,

When $0.7 < C < 1$, because $\pi^{MN} > \pi^{MM} > \pi^{NM} > \pi^{NN}$,

When $1 \leq C < 1.2$, because $\pi^{MM} > \pi^{MN} > \pi^{NN} > \pi^{NM}$, and

When $1.2 \leq C < 1.4$, because $\pi^{MN} > \pi^{NN} > \pi^{MM} > \pi^{NM}$.

Second, both firms choose not to bundle (NN), when $C \geq 1.4$, because $\pi^{NN} > \pi^{MN} > \pi^{NM} > \pi^{MM}$.

We also have the results on the prices as follows:

$2p^{NN} > p_M^{MM} = p_M^{MN}$, $p^{MM} = p^{MN} > p^{NM} = p^{NN}$ when $C \leq 0.7$,

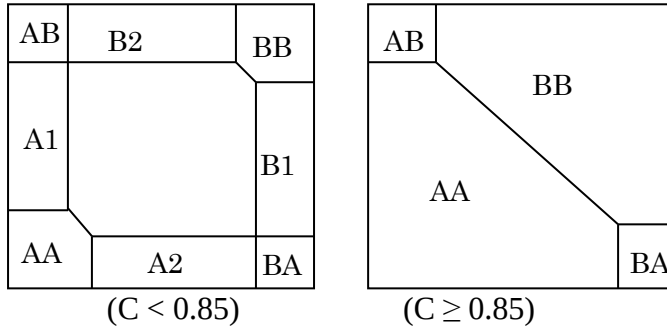
$2p^{NN} > p_M^{MM} \leq p_M^{MN}$, $p^{MM} > p^{MN} > p^{NM} > p^{NN}$ when $0.7 < C < 1.1$,

$2p^{NN} > p_M^{MM} > 2p^{NM} > p_M^{MN}$, $p^{MM} > p^{MN} > p^{NN} > p^{NM}$ when $1.1 \leq C < 1.16$,

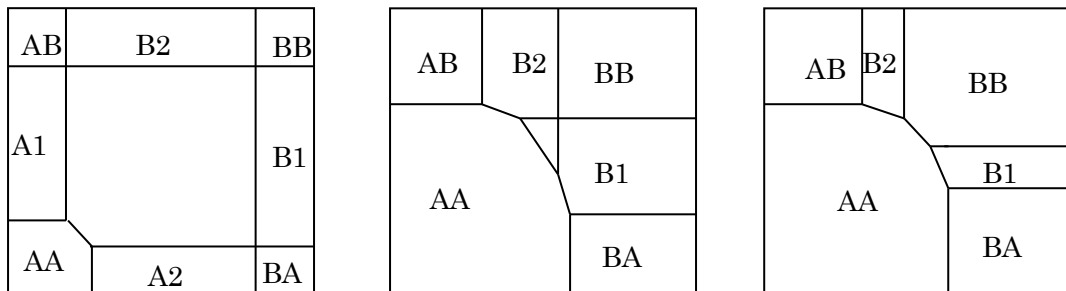
$2p^{NM} > p_M^{MN} > p_M^{MM}$, $p^{MN} > p^{MM} > p^{NM} = p^{NN}$ when $1.16 \leq C < 1.4$, and

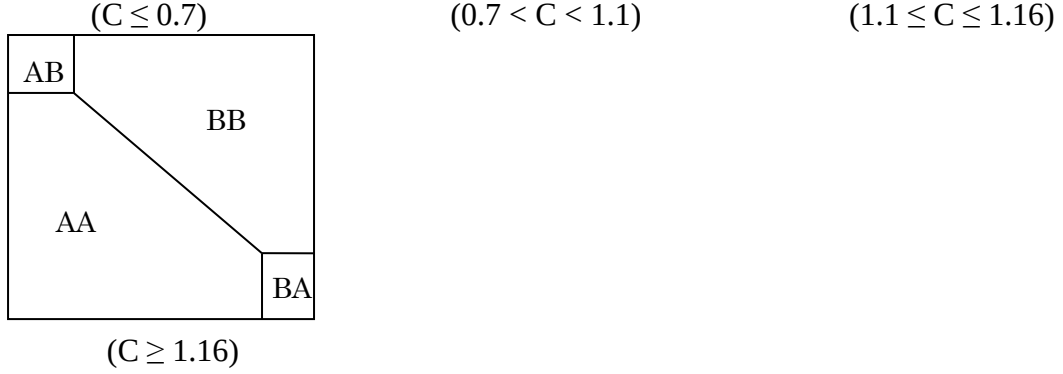
$2p^{NN} > p_M^{MN} > 2p^{NM} > p_M^{MM}$, $p^{MN} > p^{MM} > p^{NN} > p^{NM}$ when $C \geq 1.4$.

Market configuration when both firms engage in mixed bundling (MM):



Market configuration when firm A engages in mixed bundling and firm B engages in individual pricing (MN):





See figure 1 for the market configurations of “neither firm bundles.”

Figure 2. Market configuration. Case 2: mixed bundling vs. individual pricing

Let us examine the differences between our results and that of Matutes and Regibeau (1992). We find that when $C < 1.2$, the equilibrium result is that both firms bundle and it is not a prisoners’ dilemma. In comparison, the result is that both firms bundle and that it is a prisoners’ dilemma in Matutes and Regibeau (1992). When $1.2 < C < 1.4$, the equilibrium result is MM but it turns out to be a prisoners’ dilemma. At the same time, we find that there is no MN or NM in the equilibrium result, whereas these two results appear in Matutes and Regibeau (1992).

2-3-3. Case 3: mixed bundling vs. pure bundling

In this case, we consider firms that have only two choices of strategy: mixed bundling (M) and pure bundling (B). The market configurations are presented in Figure 3. There are three strategy combinations: MM , MB (BM), and BB . We obtain the following results.

First, both firms choose mixed bundling (MM),

When $C < 0.6$, because $\pi^{MM} = \pi^{MB} > \pi^{BB} = \pi^{BM}$,

When $0.6 \leq C < 0.85$, because $\pi^{MB} > \pi^{MM} > \pi^{BB} > \pi^{BM}$,

When $0.85 \leq C < 1$, because $\pi^{MM} > \pi^{MB} > \pi^{BB} > \pi^{BM}$, and

When $1 \leq C < 1.4$, because $\pi^{MM} > \pi^{BM} > \pi^{MB} > \pi^{BB}$.

Second, there are two equilibriums: both firms choose mixed bundling (MM) or pure bundling (BB), when $C \geq 1.4$, because $\pi^{MM} > \pi^{BM} = \pi^{MB} = \pi^{BB}$. We also have the following results on prices:

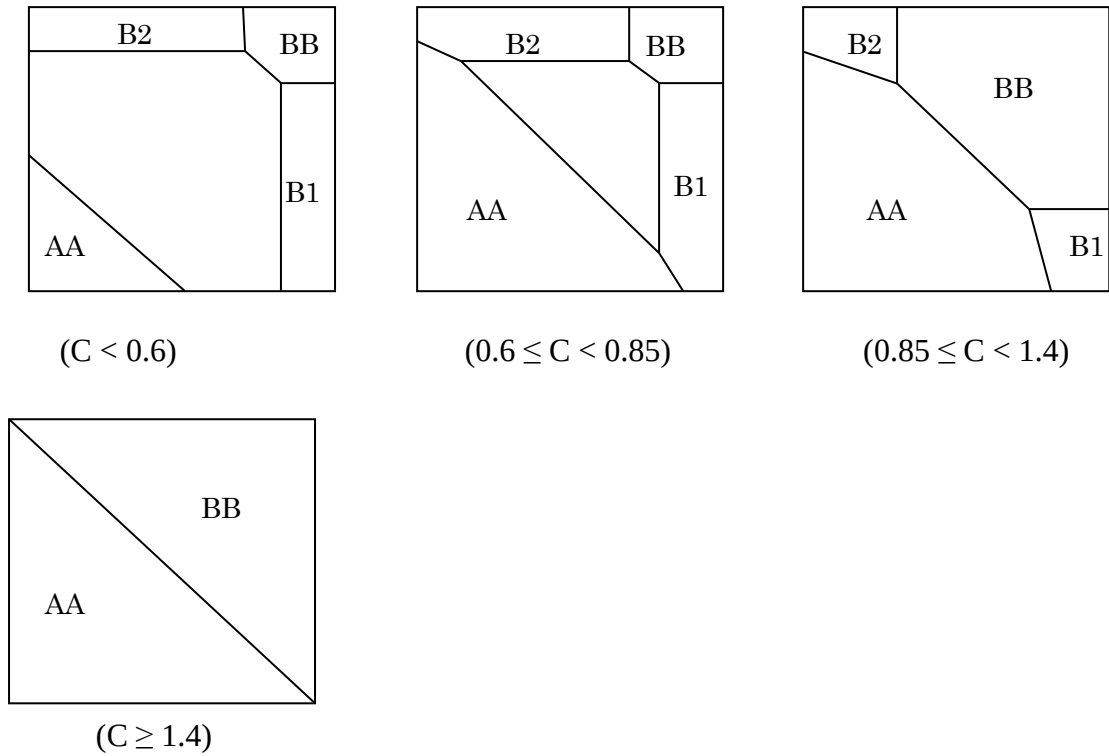
$p_M^{MM} = p_M^{MB} < p^{BB} = p^{BM}$, $p^{MM} = p^{MB}$ when $C < 0.6$,

$p^{BB} < p^{BM} < p_M^{MM} < p_M^{MB}$, $p^{MM} < p^{MB}$ when $0.6 \leq C < 0.85$,

$p^{BB} = p^{BM} = p_M^{MM} = p_M^{MB}$, $p^{MM} = p^{MB}$ when $0.85 \leq C < 1$,

$p^{BM} < p^{BB} < p_M^{MB} < p_M^{MM}, p^{MB} < p^{MM}$ when $1 \leq C < 1.16$,
 $p^{BM} = p^{BB} < p_M^{MB} < p_M^{MM}, p^{MB} < p^{MM}$ when $1.16 \leq C < 1.4$, and
 $p^{BM} = p^{BB} = p_M^{MB} < p_M^{MM}$ when $C \geq 1.4$.

Market configuration when firm A engages in pure bundling and firm B engages in mixed bundling (BM):



See Figure 1 and Figure 2 for the market configurations of “both engage in pure bundling” and “both engage in mix-bundling,” respectively.

Figure 3. Market configuration. Case 3: mixed bundling vs. pure bundling

No study has considered the case where both pure bundling and mixed bundling are possible. Based on the assumption of non-complementary products, we are able to consider such cases. Furthermore, we find that BB appears in the equilibrium in case 1 and that MM is the result in case 2 in the same range of C . This requires further work to compare pure bundling and mixed bundling, which was not necessary in previous studies. Fortunately, we find that mixed bundling always dominates as a selling strategy

over pure bundling if $C < 1.4$. This allows us to integrate all three bundling strategies in the following section. We can easily understand that mixed bundling makes the competition less fierce and creates more demand than pure bundling. Therefore, mixed bundling is a better choice for firms.

2-3-4. The integration of all three cases

After analyzing all of the possible equilibriums responding to different levels of C in the three cases, a question may arise as to the strategy combinations that would appear in the equilibrium if both firms have all three strategies to consider: pure bundling, independent pricing, and mixed bundling. Hence, we consider all the results in the above three cases together to pursue the equilibrium strategy combination. First, in case 1, we can easily find when $C < 1.4$, independent pricing (NN) is mostly the dominant strategy. However, pure bundling (BB) still appears in the equilibrium. In case 2, mixed bundling dominates as a selling strategy over independent pricing. In case 3, mixed bundling dominates over pure bundling. Therefore, we can conclude that when $C < 1.4$, mixed bundling is the dominant strategy for both firms. In the dimension of $C \geq 1.4$, the game is the same as in Matutes and Regibeau (1988 and 1992) and we say that the result is the same. Thus, independent pricing is the dominant strategy for both firms.

2-4. Differences compared to previous studies

Table 1 shows the differences between this study and previous studies.

Table 1. Differences compared to previous research

	Previous studies by Matutes and Regibeau (1988 and 1992)	The present study
Assumption	Consumers must purchase two products together.	Consumers can buy a single product.
Analysis subjects	Only two cases are analyzed. The case where both mixed bundling and pure bundling are possible is not considered. The BN combination is not considered in the analysis of pure bundling and	Three cases are analyzed with two strategies for each. The analysis of pure bundling and individual pricing also has the BN combination.

	individual pricing.	
Results	1. In the case of pure bundling and individual pricing, the equilibrium is always <i>NN</i>. 2. In the case of mixed bundling and individual pricing, when $C < 1.2$, the equilibrium is <i>MM</i> and it is a prisoners' dilemma game. When $C > 1.3$, the equilibrium is <i>NN</i>. If C is between the former two levels, the equilibrium is <i>MN</i> or <i>NM</i>.	1. In the case of pure bundling and individual pricing, in addition to the equilibrium of <i>NN</i>, there is also <i>BB</i> corresponding to different C. 2. In the case of mixed bundling and individual pricing, when $C < 1.4$, the equilibrium is <i>MM</i>. However, it is not a prisoners' dilemma game when $C < 1.2$. When $C \geq 1.4$, the equilibrium is <i>NN</i>. 3. In the case of mixed bundling and pure bundling, <i>MM</i> is always the dominant strategy. 4. Finally, when we integrate all the three strategies, when $C < 1.4$, the equilibrium is that both firms engage in mixed bundling. When C is equal to or more than 1.4, the equilibrium is that both firms engage in individual pricing.

2-5. Conclusions

This study presented an extensive model to show the incentives to firms in relation to bundling strategies in a duopoly market, based on the assumption that consumers can also buy a single product (i.e., we considered non-complementary products). The single-product system changes the mechanism and structure of the game compared to that in previous research, which leads us to different results. Both firms may choose pure bundling if they only consider pure bundling and independent pricing, whereas firms always choose independent pricing in Matutes and Regibeau (1988). When considering only mixed bundling and independent pricing, both firms choose mixed bundling in a certain range of C , but it is not a prisoners' dilemma game. In contrast, it

is a prisoners' dilemma game in Matutes and Regibeau (1992). Thus, it was necessary to consider the case of pure bundling and mixed bundling in our study, which finds no place in the framework used in previous studies. Our model enables firms to compete by considering pure bundling, mixed bundling, and independent pricing simultaneously. By considering bundling, it is closer to the reality that a multiproduct firm can consider all the three selling strategies at the same time.

Chapter 3. Bundling for entry deterrence and product specific preference

3-1. Introduction

Suppose a multiproduct incumbent monopolizes one market but faces a potential entrant in another market. Whinston (1990) considered such a situation and, using a simple Hotelling model, argued that the incumbent could deter entry by bundling but only if it makes a prior commitment. Nalebuff (2004) showed that in a modified Hotelling model, if the incumbent chooses prices before the entrant, it could deter entry by bundling even without any commitment. Peitz (2008) showed that bundling may block entry in a two-dimensional Hotelling model. However, there is a lack of research on this question by considering consumers' reservation value.

In reality, consumers hold different reservation value to different products. A consumer's reservation value is the highest price she is willing to pay. A product may be very welcomed thus consumers' reservation value is very high and consumers are willing to pay high price. One example may be Apple Company's products, saying iPhone. When the firm launches a new version of iPhone, consumers rush into the store to buy in a high price. At the same time, there are goods that are not popular for consumers thus many people do not want to afford. We can say that consumers' reservation value is relatively low in this case. Therefore, it is closer to the reality if we consider the entry deterrence problem by considering consumer's reservation value. In opposite to previous work (Whinston 1990; Nalebuff, 2004, Peitz, 2008) where deterring entry by bundling (monopoly under bundling) is always more profitable than letting the entry occur, we find that when consumer's reservation value is low, the incumbent even has no incentive to use bundling to deter entry. But when consumer's reservation value is relatively high, it is not the case.

Bundling has attracted significant research attention, and most studies in this field consider symmetric competition. Matutes and Regibeau (1988) examined the incentive of pure bundling for two symmetric, multiproduct firms by building a two-dimensional

Hotelling unit square. They found that pure bundling selling strategies were always dominated by independent pricing strategy, regardless of the level of consumers' reservation value. Gans and King (2006) extended Matutes and Regibeau's (1992) model to analyze the incentives associated with mixed bundling. Thanassoulis (2007) and Armstrong and Vickers (2010) analyzed the case of mixed bundling in a fully served market.

The remainder of this chapter is arranged as follows. In section 2, the model is introduced. In section 3, we analyze equilibriums and results. In section 4, we present our conclusion.

3-2. The model

Suppose there are two products, products 1 and 2. Product 1 is only provided by firm A, while product 2 may also be provided by firm B. We assume the marginal cost of either product for both firms is zero. Firm A has two strategies to select from, that is, pure bundling and independent pricing. Consumers purchase at most one unit of each product. Therefore, consumers are able to select at most six consumption combinations if firm A does not bundle, namely AA, AB, A1, A2, B2, and purchasing nothing. AA means buying products 1 and 2 from firm A; AB means buying product 1 from firm A and product 2 from firm B; and A1, A2, and B2 mean purchasing only a single product 1 from firm A, a single product 2 from firm A, and a single product 2 from firm B, respectively. A consumer purchasing one product will have a reservation value of C . Therefore, a consumer will have $2C$ if she purchases two products. We engage in a three-stage game. At the first stage, firm B decides whether to enter. If it enters, it pays a cost of F . At the second stage, firm A decides whether to bundle. At stage three, firms simultaneously set prices. We consider four situations: (1) independent pricing by monopolist A, (2) bundling by monopolist A, (3) competitive independent pricing, and (4) competitive bundling.

Consumers should be uniformly located in a Hotelling unit square with firm A located at $(0, 0)$ and firm B located at $(1, 1)$. The horizontal interval represents product 1 and as a consumer located further away from firm A horizontally, she holds less taste preference towards firm A's product 1 and more prefers to firm B's product 1. The vertical interval represents product 2. Under an independent pricing scheme, a consumer located at (d_1, d_2) buying AB will get a surplus of $2C - \lambda d_1 - \lambda (1 - d_2) - p_{1A} - p_{2B}$, where λ is the strength parameter of differentiation. Similarly, the consumer purchasing only a single product will get a surplus $C - \lambda d_m - p_{mj}$, $m=1,2, j=A,B$. When firm A bundles, the consumer

buying the bundle will earn a surplus $2C - \lambda(d_1 + d_2) - p_A$, where p_A is the bundle price.

We denote the profit of firms A and B as $\pi_A(s_A, s_B)$, $\pi_B(s_A, s_B)$, respectively. $s_A \in SA = \{N, B\}$, where N stands for independent pricing and B stands for bundling. In addition, $s_B \in SB = \{0, 1\}$, where 0 means does not enter and 1 means enter.

3-3. The equilibriums and results

We extend the model of Matutes and Regibeau (1988) by adding the single consumption. For simplicity of calculation, we set $\lambda=1$. We show the market configurations according to different levels of consumers' reservation value (C) in figure 1. Concerning the situation where firm A bundles in a competitive market (situation 4), we demonstrate an example for the calculation in the situation where $C \leq 0.55$. The demand of AA on the horizontal and vertical axes are the same, and we denote demand as d_{mA} , $m = 1, 2$, and $2C - d_{mA} - p_A \geq 0$ (i.e., $d_{mA} \leq 2C - p_A$). Then, the area of the triangle is $(2C - p_A)^2/2$, and this is the demand for firm A . Therefore, profit is

$$\pi_A = p_A (2C - p_A)^2/2.$$

Maximizing firm A 's profit with respect to p_A gives us maximized

$$p_A = 2C/3$$

and

$$\pi_A = 16C^3/27.$$

When $1 \leq C < 1.5$, the market of competitive independent pricing is an adjacent market. In an adjacent market, according to Matutes and Regibeau (1992, p.52, line36), "both firms set prices for their complete systems so as to leave consumers located at the common market boundary with exactly zero surplus." The market boundary of AA and AB just touches. And the market boundary of $A2$ and $B2$ just touches. In market 2, $A2$, $B2$ are symmetric. Therefore, for the consumer $(0, 1/2)$ located in the boundary,

$$C - 1/2 - p_{2A} = 0$$

And

$$C - 1/2 - p_{2B} = 0$$

are satisfied.

$$p_{2A} = p_{2B} = C - 1/2$$

and

$$\pi_{2A} = (C - 1/2)/2.$$

The profit in market one is still monopoly profit $C^2/4$. Then the total profit is

$$\pi_A = (C - 1/2)/2 + C^2/4.$$

When $C \geq 2$, all consumers can buy product 1 in the market of competitive independent pricing. Therefore firm A sets a price to ensure all consumers to buy product 1 thus

$$C - 1 - p_{1A} = 0,$$

and we have

$$p_{1A} = C - 1,$$

$$\pi_{1A} = C - 1.$$

And we can find the demand for product 2 of each firm by finding the critical point $(0, d_2)$ where buying AA is indifferent with buying AB:

$$2C - d_2 - p_{1A} - p_{2A} = 2C - (1 - d_2) - p_{1A} - p_{2B},$$

then we have

$$d_2 = (p_{2B} - p_{2A} + 1)/2.$$

Therefore,

$$\pi_{2A} = p_{2A} (p_{2B} - p_{2A} + 1)/2,$$

$$\pi_{2B} = p_{2B} (1 - (p_{2B} - p_{2A} + 1)/2).$$

Maximizing the profits with respect to p_{2A}, p_{2B} , we get

$$p_{2A} = p_{2B} = 1,$$

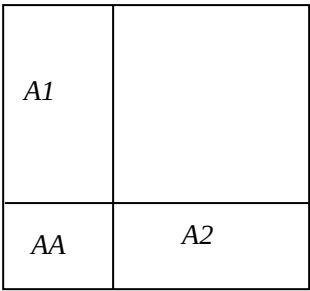
$$\pi_{2A} = 1/2,$$

so

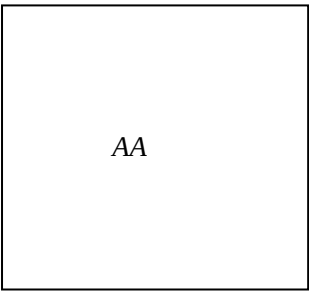
$$\pi_A = C-1/2.$$

For more calculations, please refer to Appendix 2.

Independent pricing selling by a monopolist A

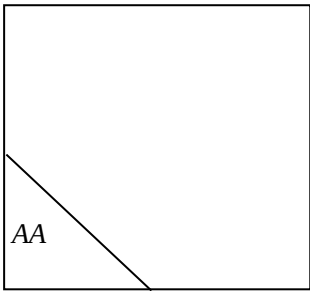


($C < 2$)

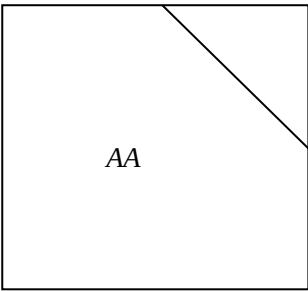


($C \geq 2$)

Bundling by a monopolist A

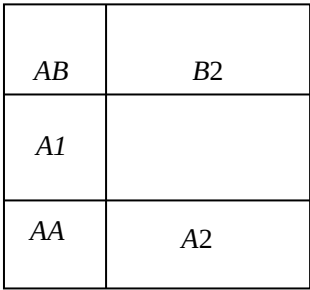


($C < 0.75$)

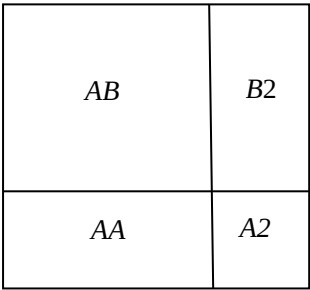


($C \geq 0.75$)

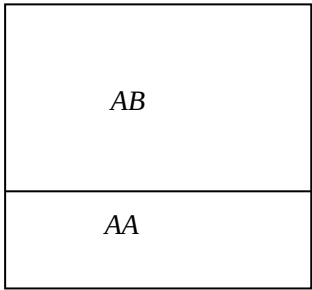
Competitive independent pricing



($C < 1$)



(when $1 \leq C < 1.5$, adjacent market.
when $1.5 \leq C < 2$, competitive market)



($C \geq 2$)

Competitive bundling

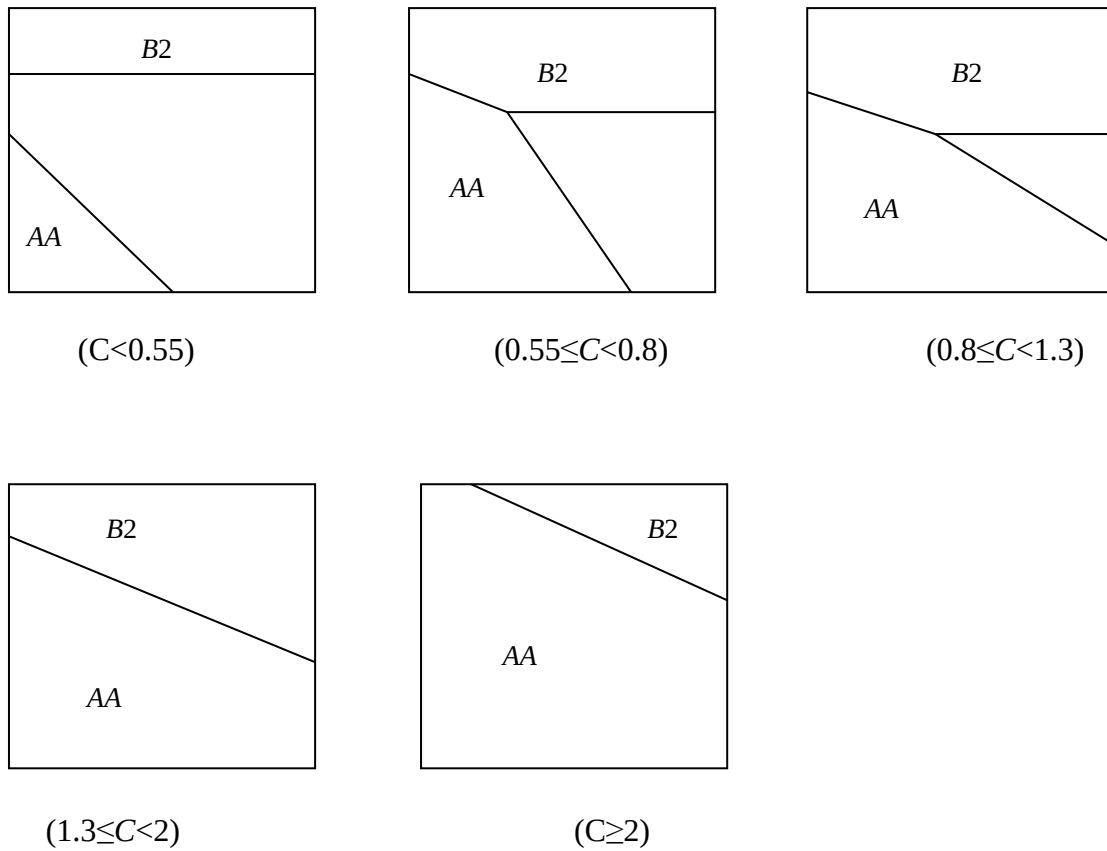


Figure 4. market configurations

We find if firm A monopolizes the market, when $C < 0.86$, $\pi_A(N,0) > \pi_A(B,0)$, otherwise $\pi_A(B,0) > \pi_A(N,0)$. In addition, $\pi_A(N,1) > \pi_A(B,1)$ always.

Therefore when $C < 0.86$, firm A never uses bundling and firm A must enter the market on a certain range of entry costs.

Table 2. Firm A and Firm B's profits when $C=0.6$

	Monopoly	Entry
Independent pricing	0.18, 0	0.18, $0.09-F$
Bundling	0.128, 0	0.127, $0.089-F$

We can easily see if $F \in (0, 0.09)$, firm B must enter the market. $\pi_A(B,0) < \pi_A(N,1)$ in this case, therefore firm A has no incentive to bundle and deter entry. And we find that

the profit of firm A has no change whatever the entry happens or not. This is because in this range of C , even entry has occurred, under independent pricing scheme, there is no competition.

However, if $C > 0.86$, firm A can use bundling to deter entry only if it commits to bundle.

Table 3. Firm A and Firm B 's profits when $C=1.4$

	Monopoly	Entry
Independent pricing	0.98, 0	0.94, $0.45-F$
Bundling	1.148, 0	0.845, $0.245-F$

We can see if $F \in (0.245, 0.45)$, firm A can use bundling to deter entry only if it commits to bundling(in the game, stage1 and stage2 are in reverse order so that firm A can commit to bundle). In this case $\pi_A(B,0) > \pi_A(N,1)$, firm A optimally engages in bundling to deter entry for a higher profit. This outcome and profit ranking are similar to the model by Whinston (1990).

In a monopoly market, the bundle price is always lower than the total price of the two products under independent pricing. However, when consumers' reservation value is small, consumers who cannot buy the bundle can buy single product under independent pricing. Independent pricing provides more selections and the demand under this situation is larger. Thus $\pi_A(N,0) > \pi_A(B,0)$ when $C < 0.86$. As consumers' reservation value increases, more and more consumers can afford two products and the lower price of the bundle attracts more demands. Therefore bundling makes more profits. Then in a competitive market, the competition under bundling is more intensified thus harms firms' profits. Independent pricing is preferred in a competitive market.

3-4. Conclusions

We sought to analyze the effect of bundling to deter entry by considering consumers' reservation value and this makes the result differ from the previous research. In Whinston (1990), bundling deter entry only if the incumbent makes a prior commit. We show that when consumers' reservation value is low, the incumbent even has no incentive to deter entry by using bundling because the profit if the entry happened under independent pricing is even higher than it in a monopoly bundling market. As

consumers' reservation value increases, we find the outcome is similar to Whinston (1990). In reality, we can imagine that consumers obtain different level of value on different goods. If we consider a multiproduct firm's products which are not that popular for consumers so that there are many consumers even do not want or just want one rather than both, we see that bundling cannot deter entry. If the products are very welcomed, bundling may deter entry only if the incumbent makes a prior commitment. Therefore, we can see that by considering consumers' reservation value in a two dimensional Hotelling model, bundling is not easy to happen because prior commitment to bundling is also difficult sometimes.

Chapter 4. Bundling for entry deterrence and firm specific preference

4-1. Introduction

Suppose a multiproduct incumbent monopolizes one market but faces a potential entrant in another market. Usually it is difficult to use bundling to deter entry for the multiproduct incumbent if the question is considered in a Hotelling model. For example, Whinston (1990) considered such a situation and, using a simple Hotelling model, argued that the incumbent could deter entry by bundling but only if it makes a prior commitment. Generally a prior commitment is not that credible. Nalebuff (2004) showed that in a modified two-dimensional Hotelling model, only if the incumbent chooses prices before the entrant.

In our model, we assume consumers have "firm-specific preferences" or firms are differentiated, and we obtain that incumbent can deter entry by bundling without any commitment device, even if the incumbent and the entrant choose prices simultaneously. The result varies according to consumers' reservation value.

According to Thanassoulis (2007, p.438, line 22), "firm-specific preferences capture situations in which the differentiation is at the firm level, between stores or shopping experiences, as opposed to at the independent product level. More formally, the taste compromise or transport/hassle cost associated with buying from a firm does not increase in proportion to the products being bought." One example is the supermarket industry. A consumer incurs different transportation costs for different supermarkets. However, the cost does not increase in proportion to the number of goods bought in a specific store.

Our study shows that the incumbent can deter and even block entry by bundling when consumers' reservation value is at an intermediate or relatively high level. Therefore

bundling is more likely to happen if the products are very popular or the consumers' reservation value is at a high level. This provides a more specific target to judge if bundling should be intervened.

The remainder of this chapter is arranged as follows. In section 2, the model is introduced. In section 3, we analyze equilibriums and results. In section 4, we present our conclusion.

4-2. The model

Suppose there are two products, products 1 and 2. Product 1 is only provided by firm *A*, while product 2 may also be provided by firm *B*. We assume the marginal cost of either product for both firms is zero. Consumers purchase at most one unit of each product. Therefore, consumers are able to select at most six consumption combinations if firm *A* does not bundle, namely *AA*, *AB*, *A1*, *A2*, *B2*, and purchasing nothing. *AA* means buying products 1 and 2 from firm *A*; *AB* means buying product 1 from firm *A* and product 2 from firm *B*; and *A1*, *A2*, and *B2* mean purchasing only a single product 1 from firm *A*, a single product 2 from firm *A*, and a single product 2 from firm *B*, respectively. A consumer purchasing one product will have a reservation value of *C*. Therefore, a consumer will have $2C$ if she purchases two products. Firm *A* has two strategies to select from, that is, pure bundling and independent pricing. We engage in a three-stage game. At the first stage, firm *B* decides whether to enter. If it enters, it pays a cost of *F*. At the second stage, firm *A* decides whether to bundle. At stage three, firms simultaneously set prices. We consider four situations: (1) independent pricing by monopolist *A*, (2) bundling by monopolist *A*, (3) competitive independent pricing, and (4) competitive bundling.

Consumers are uniformly distributed along a Hotelling unit interval with length of 1. They have firm-specific preferences, meaning that the products sold are not differentiated but the firms themselves are differentiated. Firm *A* is located on the left corner, and firm *B* is located on the right corner. Suppose there is a consumer *x* located at a certain distance *d* away from firm *A*. For the case of independent pricing, consumer *x* purchasing one product from firm *A* (i.e., *A1* or *A2*) will obtain a surplus of $C - t \times d - p_{mA}$, $m = 1, 2$, where p_{mA} is the price of a certain product of firm *A* and *t* is the strength parameter of differentiation. If this consumer buys *AB*, she will obtain a surplus of $2C - t \times 1 - p_{1A} - p_{2B}$. This consumer is *d* away from firm *A* and $1 - d$ away from firm *B*. Thus, purchasing two products from two firms induces a cost $t \times 1$. However, if she purchases *AA*, she will obtain a surplus of $2C - t_1 \times d - p_{1A} - p_{2A}$, where $t \leq t_1 \leq 2t$, meaning she

incurs a reduced cost owing to one-stop shopping. The reduced cost may stand for repeated contract cost, cost of collecting information, or transportation cost. For the case of pure bundling, consumer x purchasing the bundle from firm A will obtain a surplus of $2C - t_1 \times d - p_A$, where p_A is the bundle price.

In the entry game, we denote the profit of firms A and B as $\pi_A(s_A, s_B)$, $\pi_B(s_A, s_B)$, respectively. $s_A \in SA = \{N, B\}$, where I stands for independent pricing and B stands for bundling. In addition, $s_B \in SB = \{0, 1\}$, where 0 means does not enter and 1 means enter.

4-3. The equilibriums and results

For simplicity of calculation, we set

$$\begin{aligned} t &= 1, \\ t_1 &= 1.5.^2 \end{aligned}$$

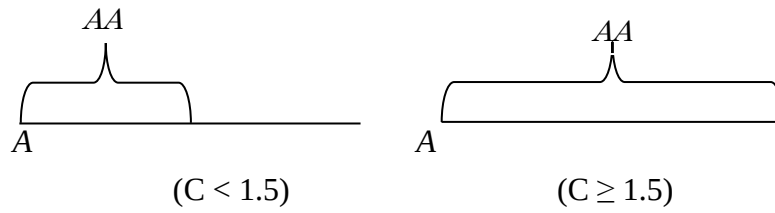
We show the market configurations corresponding to different levels of consumers' reservation value (C) in four situations in Figure 1. We use the consumer's surplus to determine the market configurations. For example, in order to determine the demand for AA , we just find the area d where the surplus of buying AA (i.e., $2C - t_1d - p_{1A} - p_{2A}$) is higher than the surplus of buying all the other possible consumption selections under a certain level of C . Then, we can ascertain demand for the other selections at the same time and thus obtain the market configurations. This process is conducted using Mathematica software.

In a monopoly market, we find that a consumer can always obtain a higher surplus by purchasing two products from firm A together (AA) because of the reduced cost of one-stop shopping, compared with purchasing a single product from firm A ($A1, A2$).³ Therefore, in a monopoly market, consumers always purchase two products, and hence, the market configuration of independent pricing and bundling are the same.

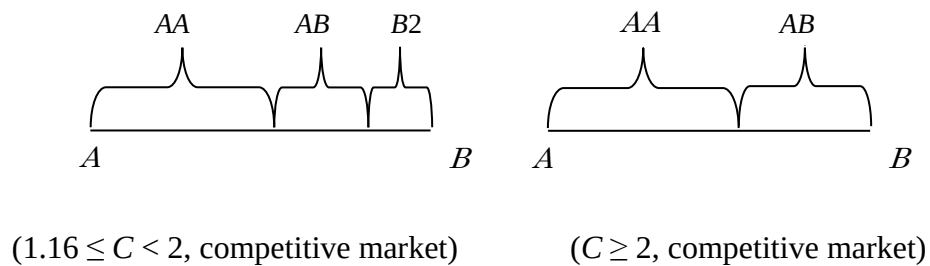
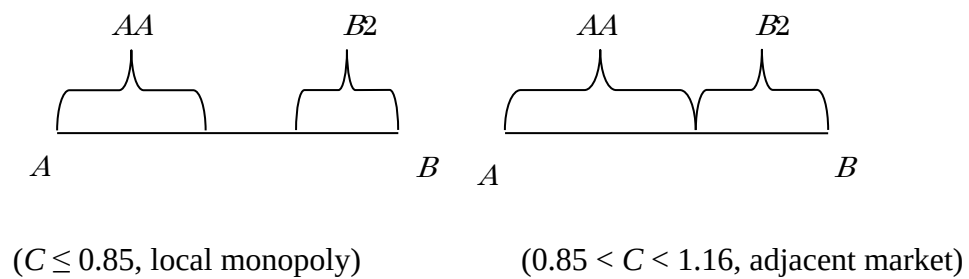
² If $t \in [0, 1]$ and $t \leq t_1 \leq 2$ are satisfied, the change of t , t_1 , only changes if the equilibriums occur in different ranges of C and there is no significant difference in outcomes.

³ Suppose a consumer is located d away from firm A . The consumer will obtain a surplus of $2C - t_1d - p_{1A} - p_{2A}$ if she buys AA . She will obtain a surplus of $C - td - p_{1A}$ if she buys a single product $A1$. $(2C - t_1d - p_{1A} - p_{2A}) - (C - td - p_{1A}) = C - (t - t_1)d - p_{2A} \geq C - td - p_{1A}$, for $t \leq t_1 \leq 2t$, $p_{1A} = p_{2A}$.

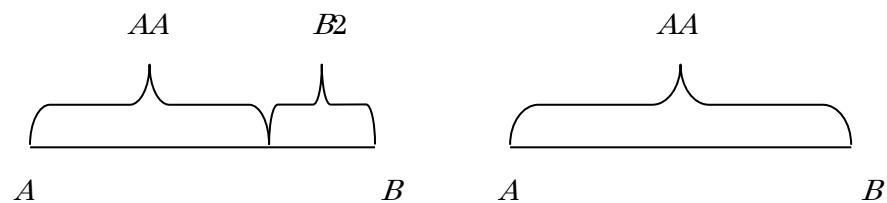
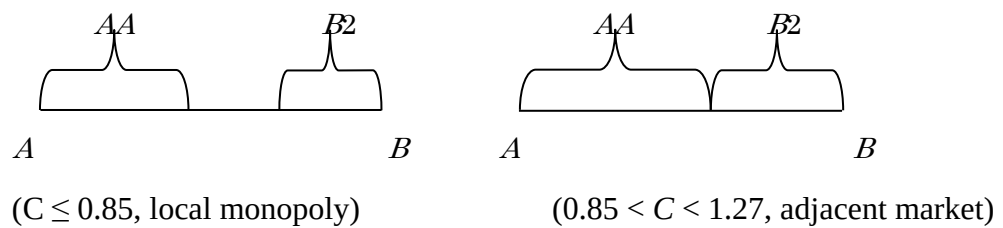
Independent pricing (bundling) by monopolist A



Competitive independent pricing



Competitive bundling



($4 > C \geq 1.27$, competitive market)

($C \geq 4$, monopoly)

Figure 5. Market configurations

4-3-1. Independent pricing and bundling by monopolist A

4.3.1.1. $C < 1.5$

Firm A serves all consumers such that $2C - 1.5 \times d - p_{1A} - p_{2A} \geq 0$ under the case of independent pricing. The situation is the same under bundling for

$$p_{1A} + p_{2A} = p_A.$$

Then, we have $d \leq 2(2C - p_A)/3$ and the profit of firm A is

$$\pi_A(N, 0) = \pi_A(B, 0) = (4C - 2p_A) p_A/3.$$

When maximizing firm A's profit with respect to p_A , we obtain

$$\pi_A(N, 0) = \pi_A(B, 0) = 2C^2/3.$$

4.3.1.2. $C \geq 1.5$

Firm A serves all the consumers in the market. Therefore, firm A sets a price to ensure that all the consumers buy the bundle so that

$$2C - 1.5 \times 1 - p_A = 0;$$

then

$$\begin{aligned} p_A &= 2C - 1.5, \\ \pi_A(N, 0) &= \pi_A(B, 0) = 2C - 1.5. \end{aligned}$$

4-3-2. Competitive independent pricing

4.3.2.1. $C \leq 0.85$

Both firms A and B are local monopolists. Assume g_A is the demand for AA and g_B is the demand for B2. Therefore, $2C - 1.5 \times g_A - p_{1A} - p_{2A} \geq 0$, $C - p_{2B} - g_B \geq 0$, p_{1A} is equal to p_{2A} , and hence, $g_A \leq 2(2C - 2p_{1A})/3$, $g_B \leq C - p_{2B}$. Then, we have

$$\pi_A(N, 1) = 4p_{1A}(2C - 2p_{1A})/3 \tag{1}$$

$$\pi_B(N, 1) = (C - p_{2B})p_{2B} \quad (2)$$

We maximize profit with respect to p_{1A} and p_{2B} , respectively. We obtain the maximized results,

$$\begin{aligned} p_{1A} &= p_{2A} = p_{2B} = C/2, \\ g_A &= 2C/3, g_B = C/2, \end{aligned}$$

and

$$\pi_A(N, 1) = 2C^2/3, \pi_B(N, 1) = C^2/4.$$

4.3.2.2. $0.85 < C < 1.16$

The market changes from a monopoly to an adjacent market. In an adjacent market, according to Matutes and Regibeau (1992, p.52, line 36), “both firms set prices for their complete systems so as to leave consumers located at the common market boundary with exactly zero surplus.” Therefore, in an adjacent market, the market boundary of AA and just touches that of $B2$ and do not change. The market configuration changes from a monopoly; hence, we have

$$2C/3 + C/2 = 1,$$

and then, we know the constant demand for firms A and B are

$$g_A = 2C/3 = 4/7$$

and

$$g_B = C/2 = 3/7$$

respectively. According to the definition of an adjacent market, the consumer on the common market boundary will have a zero surplus. Therefore, we have

$$2C - p_{1A} - p_{2A} - 1.5 \times g_A = 0$$

and

$$C - p_{2B} - g_B = 0,$$

and then, we have

$$\begin{aligned} p_{1A} &= p_{2A} = (2C - 6/7)/2, \\ p_{2B} &= C - 3/7. \end{aligned}$$

The profit of each firm is shown below:

$$\pi_A(N, 1) = 4(2C - 6/7)/7. \quad (3)$$

$$\pi_B(N, 1) = 3(C - 3/7)/7. \quad (4)$$

4.3.2.3. $1.16 \leq C < 2$

The market of product 2 is competitive. We can calculate the critical point g to be indifferent between buying AB and AA , where

$$2C - p_{1A} - p_{2A} - 1.5 \times g = 2C - p_{1A} - p_{2B} - 1,$$

and we obtain

$$g = (2 - 2p_{2A} + 2p_{2B})/3;$$

product 1 is not in this profit function. Then, we can calculate the profits from product 2 for each firm as follows:

$$\pi_{2A} = (2 - 2p_{2A} + 2p_{2B})p_{2A}/3. \quad (5)$$

$$\pi_{2B} = (1 - (2 - 2p_{2A} + 2p_{2B})/3)p_{2B}. \quad (6)$$

We maximize firm A 's profit with respect to p_{2A} and firm B 's profit with respect to p_{2B} , and we obtain

$$\begin{aligned} p_{2A} &= 5/6, \\ p_{2B} &= 2/3, \\ \pi_{2A}(N, 1) &= 25/54, \\ \pi_{2B}(N, 1) &= 8/27. \end{aligned}$$

Then, we can calculate the critical point between buying AB and $B2$,

$$2C - p_{1A} - p_{2B} - 1 = C - p_{2B} - x,$$

where x is the demand for $B2$. We obtain

$$x = p_{1A} + 1 - C.$$

From the market configuration, we know the demand for firm A 's product 1 is

$$1 - x = C - p_{1A}.$$

Then, the profit of firm A 's product 1 is

$$\pi_{1A} = (C - p_{1A})p_{1A} \quad (7)$$

Product 2 is not in this profit function. We maximize firm A 's profit with respect to p_{1A} , and then, we obtain

$$p_{1A} = C/2$$

and

$$\pi_{1A}(N, 1) = C^2/4.$$

The total profit of firm A is

$$\pi_A(N, 1) = 25/54 + C^2/4.$$

4.3.2.4. $C \geq 2$

All consumers can afford to buy $A1$, and therefore, firm A sets the highest price for product 1 to ensure that all consumers buy $A1$, so that

$$C - p_{1A} - 1 = 0,$$

and then,

$$\begin{aligned} p_{1A} &= C - 1, \\ \pi_{1A}(N, 1) &= C - 1. \end{aligned}$$

The profit of firm A from product 2 and the profit of firm B do not change. Therefore, the total profit

$$\pi_A(N, 1) = 25/54 + C - 1.$$

4-3-3. Competitive bundling

When $C < 1.27$, the ways of calculating profits are the same as in the situation of independent pricing in a local monopoly and adjacent market. We consider the following cases when $C \geq 1.27$.

4.3.3.1. $1.27 \leq C < 2$

This is a competitive market. We can calculate the critical point g to be indifferent between buying AA and $B2$:

$$2C - p_A - 1.5 \times g = 2C - p_{2B} - (1 - g).$$

By using a method similar to independent pricing, we obtain

$$\begin{aligned} p_A &= (7 + 2C)/6, \\ p_{2B} &= (4 - C)/3, \\ \pi_A(B, 1) &= 49/90 + 14C/45 + 2C^2/45, \\ \pi_B(B, 1) &= (32 - 16C + 2C^2)/45. \end{aligned}$$

4.3.3.2. $C \geq 4$

In this case, in order to compete with firm A , which has the advantage of one-stop shopping, firm B has to set its price low enough and close to zero. Therefore, in this case, firm B cannot enter the market if firm A bundles. In addition, all consumers buy two products and firm A sets its prices as a monopolist:

$$\begin{aligned} p_A &= 2C - 1.5, \\ \pi_A &= 2C - 1.5. \end{aligned}$$

4-3-4. Results

We find that when $1.16 \leq C \leq 1.74$, $\pi_A(B, 0) = \pi_A(N, 0)$ and $\pi_A(B, 1) > \pi_A(N, 1)$. Thus, bundling is a weakly dominant strategy for firm A . Therefore, in this range of C , if $\pi_B(B, 1) < F < \pi_B(N, 1)$, firm B 's entry is effectively blocked if firm A is allowed to bundle. If bundling is not allowed, firm B must enter. In addition, when $C \geq 4$, bundling ensures that firm B cannot enter the market. We show two examples as follows:

Table 4. Firm A's and Firm B's profits when $C = 1.6$

	Monopoly	Entry	
Independent pricing	1.7, 0	1.103,	0.296- F
Bundling	1.7, 0	1.156,	0.256- F

We can easily see that when $F \in (0.256, 0.296)$, firm B 's entry is effectively blocked if

firm *A* is allowed to bundle. However, if $1.74 < C < 4$, firm *A* can use bundling to deter entry only if it makes a prior commitment to bundle.

Table 5. Firm *A*'s and Firm *B*'s profits when $C = 1.8$

	Monopoly	Entry
Independent pricing	2.1, 0	1.27, 0.296- F
Bundling	2.1, 0	1.248, 0.215- F

We can see that if $F \in (0.215, 0.296)$, firm *A* can use bundling to deter entry only if it commits to bundling. In the game, stages 1 and 2 are in reverse order so that firm *A* can commit to bundle.⁴ In this case of $\pi_A(B, 0) > \pi_A(N, 1)$, firm *A* optimally engages in bundling to deter entry for a higher profit. This outcome is similar to the result in Whinston (1990).

Table 6. The entry deterrence effect according to consumers' reservation value

Entry deterrence effect	Level of C
Bundling has no effect	$C < 1.16$
Bundling blocks entry	$1.16 \leq C \leq 1.74$ $C \geq 4$
Bundling deters entry with commitment	$1.74 < C < 4$

4-4. Conclusion

Our results show that when C is relatively small so that two firms do not directly compete, pure bundling and independent pricing are the same. Therefore, bundling has

⁴ Prior commitment to bundling is difficult sometimes. Therefore, a possibility of failure to do this exists, and in such a case, entry still occurs.

no effect on entry deterrence in this situation. As C becomes bigger, bundling is preferred and it blocks entry. However, as C increases, the competition under bundling intensifies. Thus, independent pricing becomes more profitable. However, monopoly profit is always the biggest. Thus, firm A is willing to make a prior commitment to bundle and gains a monopoly profit. When C is high enough, all consumers are able to buy two products. If firm A bundles, in order to compete with firm A that has the advantage of one-stop shopping, firm B has to set its price low enough and close to zero. At this time, firm B is unable to enter the market. Bundling blocks entry again here and ensures firm A 's monopoly position. The reduced cost incurred by customers in one-stop shopping plays a significant role in these outcomes. Note that we discuss the effect of entry deterrence based on a certain range of entry cost. For the case where entry cost is very small, bundling never has any effect on deterring entry.

We aim to show a case where bundling can deter entry. In reality, if consumers hold firm-specific preferences, bundling may be a strong tool to deter entry thus it should be considered to be intervened in this situation. In addition, its effectiveness varies according to consumers' reservation value, therefore for the products which are very popular (consumers' reservation value is very high), the monopoly is more willing to use bundling to deter entry. This point can be considered to judge the incentive to bundle for the monopoly to deter entry.

Chapter 5. Summary

We sought to discuss bundling for price discrimination and product specific preference, bundling for entry deterrence and product specific preference, bundling for entry deterrence and firm specific preference. We find in the first question, it shows that mixed bundling is the dominant strategy when consumers' reservation value is relatively low; otherwise, firms choose independent pricing. In the second question, we find that when consumers' reservation value is relatively high, we show that the incumbent has an incentive to use bundling to deter entry only if a prior commitment is applicable. However, when consumers' reservation value is low, the multiproduct firm even has no incentive to use bundling and bundling has no effect on entry deterrence. In the third question, the incumbent can deter and even block entry by bundling when consumers' reservation value is at an intermediate or relatively high level. This result holds even when the incumbent cannot commit itself to such bundling in advance. In a brief summary, bundling may happen in duopoly market under product specific

preference, based on non-complementary products. This is different from the previous work. In addition, bundling is more like to happen and deter entry under firm specific preference, compared with the case under product specific preference.

Appendix 1

The derivations of “both engage in pure bundling” can be found in Matutes and Regibeau (1988), the fully served markets of “only firm A engages in mixed bundling” and the fully served market of “both engage in mixed bundling” can be found in Matutes and Regibeau (1992). Because there are a great number of market configurations and the ways of calculations are similar, we show two examples of how we derived the outcomes. For more calculations, please contact with me for the calculation paper.

- (1) When $1 \leq C < 1.5$, it is an adjacent market of NN in case 1, where the market boundary of AA and AB just touches, and the market boundary of AA and BA just touches. Since the market 1 is separated from market 2, therefore the market boundary of $A1$ and $B1$ just touches, $A2$ and $B2$ just touches. In an adjacent market, both firms set prices for their complete systems so as to leave consumers located at the common market boundary with exactly zero surplus. The markets of a certain product are symmetric, thus we have:

$$C - 1/2 - p_{1A} = 0,$$

$$C - 1/2 - p_{1B} = 0,$$

$$C - 1/2 - p_{2A} = 0,$$

$$C - 1/2 - p_{2B} = 0,$$

so we have

$$p_{1A} = p_{1B} = p_{2A} = p_{2B} = C - 1/2.$$

$$\pi_A = p_{1A}/2 + p_{2A}/2 = C - 1/2,$$

$$\pi_B = p_{1B}/2 + p_{2B}/2 = C - 1/2.$$

- (2) When $0.5 \leq C < 1$, we consider the market where only firm A engages in pure bundling in case 1. First, we can find the critical point where buying AA is indifferent from buying $B2$ for the consumer $(0, g_2)$:

$$2C - p_A - g_2 = C - p_{2B} - (1 - g_2),$$

so

$$g_2 = (C + p_{2B} + 1 - p_A)/2.$$

Similarly we can find other critical points located on the axis. In addition, we can find the line where AA is indifferent from B2, where

$$2C - p_A - g_1 - g_2 = C - (1 - g_2) - p_{2B},$$

so

$$g_1 = (1 + C + p_{2B} - p_A - 2g_2).$$

g_1, g_2 stand for the consumers located on the line in the unit square horizontally and vertically, respectively. We find the demand for each firm by using the critical points and indifference lines. The first order conditions are:

$$(A) \quad (-9C^2 - 3p_{1B}^2 - (1 + p_A)^2 - 4p_{1B}(3 + p_A) + 2C(5 + 6p_{1B} + 3p_A))/4$$

$$(B) \quad (-9C^2 - 3p_{2B}^2 - (1 + p_A)^2 - 4p_{2B}(3 + p_A) + 2C(5 + 6p_{2B} + 3p_A))/4$$

$$(C) \quad (-2 - 10C^2 - p_{1B}^2 - 2p_{2B} - p_{2B}^2 - 8p_A - 4p_{2B}p_A - 2p_{1B}(1 + p_A) + 2C(6 + 3p_{1B} + 3p_{2B} + 4p_A))/4$$

The equations of (A) (B) and (C) can be solved by computer for several values of C .

Appendix 2

Because there are a great number of market configurations and the ways of calculations are similar, we show one example of how we derived the outcomes. For more calculations, please contact with the author for the calculation paper.

When $0.8 \leq C < 1.3$, we consider a competitive bundling market. First, we can find the critical point where buying AA is indifferent from buying B2 for the consumer $(0, g_2)$:

$$2C - p_A - g_2 = C - p_{2B} - (1 - g_2),$$

so

$$g_2 = (C + p_{2B} + 1 - p_A)/2.$$

Then we can find the line where AA is indifferent from B2, where

$$2C - p_A - g_1 - g_2 = C - (1 - g_2) - p_{2B},$$

so

$$g_1 = (1 + C + p_{2B} - p_A - 2g_2).$$

g_1 , g_2 stand for the consumers located on the line in the unit square horizontally and vertically, respectively. We find the demand for each firm by using the critical points and indifference lines. The first order conditions are:

$$(A) \quad (-9C^2 - 3p_{2B}^2 - (1 + p_A)^2 - 4p_{2B}(3 + p_A) + 2C(5 + 6p_{2B} + 3p_A))/4$$

$$(B) \quad (-9C^2 - p_{2B}^2 - 2p_{2B}(1 + 2p_A) + 2C(7 + 3p_{2B} + 6p_A) - 3(1 + 4p_A + p_A^2))/4$$

The equations of (A) and (B) can be solved by computer for several values of C .

References

Armstrong, M., and Vickers, J. (2010): “Competitive Nonlinear Pricing and Bundling,” *The Review of Economic Studies*, 77(1), 30–60.

Gans, J., and S. King, 2005, “Paying for Loyalty: Product Bundling in Oligopoly,” *Journal of Industrial Economics*, LIV (1), 43–62.

Matutes, C., and P. Regibeau, 1988, “Mix and Match: Product Compatibility Without Network Externalities,” *Rand Journal of Economics*, 19, 221–234.

Matutes, C., and P. Regibeau, 1992, “Compatibility and Bundling of Complementary Goods in a Duopoly,” *Journal of Industrial Economics*, 40(1), 37–54.

Nalebuff, B. (2003): *Bundling and the GE-Honeywell Merger*. In: Kwoka, John, White, Lawrence (Eds.), *The Antitrust Revolution*, 4th edition. Oxford University Press.

Nalebuff, B. (2004): “Bundling as an Entry Barrier,” *Quarterly Journal of Economics*, Vol. 119, No. 1, 159–187.

Peitz., M. (2008): “Bundling May Blockade Entry,” *International Journal of Industrial Organization*, 26, 41–58.

Peitz, M., and P. Belleflamme, 2010, *Industrial Organization: Markets and Strategies*. Cambridge: Cambridge University Press.

Thanassoulis, J., 2007, “Competitive Mixed Bundling and Consumer Surplus,” *Journal of Economics & Management Strategy*, 16, 437–467.

Whinston, M. (1990): “Tying, Foreclosure, and Exclusion,” *American Economic Review*, 80(4), 837–860.