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# STRATEGIC ASPECTS OF BUNDLING

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Cahier N° 08.03.74

25 mars 2008

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# Strategic Aspects of Bundling

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21st May 2008

**Abstract**

The increase of bundle supply has become widespread in several sectors (for instance in telecommunications and energy fields). This paper review relates strategic aspects of bundling. The main purpose of this paper is to analyze profitability of bundling strategies according to the degree of competition and the characteristics of goods. Moreover, bundling can be used as price discrimination tool, screening device or entry barriers. In monopoly case bundling strategy is efficient to sort consumers in different categories in order to capture a maximum of surplus. However, when competition increases, the profitability on bundling strategies depends on correlation of consumers' reservations values.

*JEL classification: D21, D43, L13.*

*Keywords: Product Bundling, Foreclosure, Price discrimination*

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# 1 Introduction

In France, regulation authorities impose a legal framework to sell goods and services and particularly prevent firms from offering commodity bundling through the code of consumption:

> *« Il est interdit de refuser à un consommateur la vente d'un produit ou la prestation d'un service, sauf motif légitime, et de subordonner la vente d'un produit à l'achat d'une quantité imposée ou à l'achat concomitant d'un autre produit ou d'un autre service ainsi que de subordonner la prestation d'un service à celle d'un autre service ou à l'achat d'un produit*[1]*.(...) » (Art. L. 122-1)*

Despite this strict legislative frame, the increase of bundle supply has become widespread in several sectors. For instance, in telecommunications, package offers including mobile phone, fixed phone, TV channels ("triple-play") or also Internet service ("quadruple play") appear. In addition to bundles offered by the telecommunications sector, bi-energy bundles are proposed by energy providers in the electricity and natural gas markets. Commodity bundling consists of offering two or several goods together in a single package at a unique price. The consumers' preference for bundles composed of two energies encourages regulation authorities to think about the creation of a bi-energy market. These bundles allow firms to reveal synergies due to the possibility of providing this type of supply, economies of scale for instance. These synergies allow firms to sell bundles with a lower price than the sum of independent goods prices. It is advisable to make a distinction between pure bundling and mixed bundling strategies. With pure bundling strategy, products A and B are sold only under a package form (AB). With mixed bundling strategy, goods are available under a package form and also separately (A,B or AB). At a theoretical level, many authors are interested in describing the main strategic aspects of bundling. The authors presented here, appear as initiators of this trend.

[1] *It is forbidden to refuse from a consumer the sale of a good or the provision of a service, except lawful motive, and to subordinate the sale of a good to a quantity imposed purchase or to a concomitant purchase with an other good or service, as to subordinate the provision of a service to another one or to a good purchase.*

The first aspect of both pure and mixed bundling is price discrimination based on the consumers' choice heterogeneity according to their willingness to pay. Indeed, a consumer has a willingness to pay more or less for a particular good. Price discrimination shows a way to capture this divergence of choice. In the monopoly case, the mixed bundling strategy is the most efficient strategy since consumers' reservation prices for the two goods are negatively correlated: when a consumer likes good A, he does not like good B and conversely (Adams and Yellen, 1976, McAfee et al., 1989, Schmalensee 1984). The second aspect of bundling concerns the strategic effect of short term. The use of bundling can prevent the entry of rivals into a tie-market or exclude rivals. Moreover, bundling allows firms to consolidate market power or to reduce the degree of competition on this same market. Indeed, when a firm is in a monopoly situation in one market, bundling can extend this market power in the tie-market, according to the "leverage effect" (Whinston, 1990, Nalebuff, 2004).

Competition is not an end in itself, its objectives are to provide consumers with a greater quality of goods and services at best prices. When competition increases (duopoly or oligopoly), the change of market structure harms bundling profitability. Contrary to the results in a monopolistic situation, an increase in competition entails a negative effect on firms' profit due to bundling. Indeed, when the environment becomes competitive, firms prefer to sell their goods independently. When firms commit to a pure bundling strategy, it leads to an increase in competition on the pricing of bundles. This situation is referred to as the Bertrand Paradox. In the same respect, following a mixed bundling strategy is also not efficient because firms compete on several fronts, thereby creating a situation that entails an increase in the intensity of competition.

The following section sets out a representative model of bundling in the case of a monopoly that provides two goods. Section 3 shows how bundling can be used as an entry-deterrent strategy when competition increases on only one market. Section 4 extends the bundling analysis to a more competitive environment, principally one that is duopolistic. Section 5 proposes an empirical illustration to bundling notably in the energy sector (section 5.1), and also in telecommunications (section 5.2). The final section proposes some concluding remarks.

# 2 Monopoly and Bundling

## 2.1 Adams and Yellen analysis (1976): a representative model

### Hypothesis of model

We assume the hypothesis of Adams and Yellen's model (1976). We consider a monopoly that produces two goods: $(A, B)$. The demand functions for two goods are supposed to be independent and are defined by $D_A(p_A)$ and $D_B(p_B)$.

The marginal production cost for each good is invariable and given by $(c_A, c_B)$. There are no fixed costs. The marginal utility of a second unit bought of either commodity is zero. The couple of consumers' reservation prices (or willingness to pay) is respectively $(R_A, R_B)$.

The three types of pricing strategy are available:

1. Independent pricing strategy: firm chooses two prices, $p_A$ and $p_B$, and allows no discount for the joint purchase.
2. Pure bundling strategy: firm chooses one price, $p_{AB}$ and allows only tied sales.
3. Mixed bundling strategy: firm chooses three prices: $p_A$, $p_B$ and $p_{AB}$ (with ex-post $p_{AB} < p_A + p_B$).

The reservation price for a bundle including one unit of each good $(R_{AB})$ is equal to the sum of reservation prices for the two separate goods $(R_{AB} = R_A + R_B)$. The marginal cost for a bundle is also equal to the sum of marginal costs for the two goods.

Adams and Yellen exclude both economies in the bundling process (for instance, economies of scales) and complementarity between goods, thus if results show that bundling is an optimal strategy, it cannot be explained by these phenomena. An implicit hypothesis in Adams and Yellen's model is that a bundle purchase can be conceived only in a personal consumption context, a consumer cannot buy a bundle in order to make an exchange with other consumers. If a monopoly commits to sell its goods separately then it will choose an independent pricing strategy. This strategy is presented in the following section.

## 2.2 Independent pricing strategy

When a monopoly commits to follow an independent pricing strategy, goods are only available separately. $p_A$ and $p_B$ are the respective prices for the two independent goods. $R_A$ and $R_B$ are the consumers' reservation prices for good A and good B (with $R_k > 0$ for $k = A, B$), with each consumer in the population having a reservation price for each good. Without loss of generality, marginal production costs are assumed to be zero $c_A = c_B = 0$. According to its willingness to pay, each consumer has the choice to either buy goods ($R_k \geq p_k \quad k = A, B$) or not ($R_k < p_k \quad k = A, B$) (*see Figure 1*).

In relation to the reservation price values $(R_A, R_B)$, we can define four groups corresponding to four different consumption behaviours: to buy nothing $\{\varnothing\}$, to buy only good A $\{A\}$, to consume only good B $\{B\}$ or to buy both goods $\{C\}$.

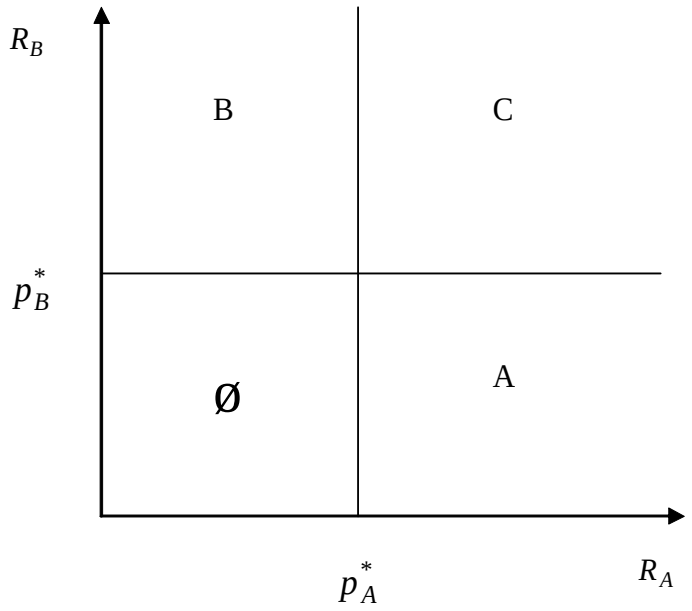


Figure 1: Independent pricing strategy

On one hand, if a consumer has a high willingness to pay for good A ($R_A > p_A^*$) and good B ($R_B > p_B^*$) s/he will be highly likely to buy both goods (*i.e* their reservation values are positively correlated). For this type of consumer, a monopoly would be well advised to sell its goods under an independent strategy because it captures a maximum

surplus for both goods. On the other hand, if a consumer has a high willingness to pay for good A ($R_A > p_A^*$) and a low willingness to pay for good B ($R_B < p_B^*$), under an independent pricing strategy, consumer buys only good A (*i.e.,* reservation values are negatively correlated). In this last case, Adams and Yellen recommend to monopoly to offer a package of both goods and thus to capture marginal consumers that is consumers for which $R_{AB} = R_A + R_B > p_{AB}^*$. In this way, monopoly has an additional tool of price discrimination, this strategy is analyzed in the following subsection.

## 2.3 Pure bundling strategy

Under a pure bundling strategy, the monopolist has committed to offering only tied sales and the bundle price is lower than the sum of goods sold separately, *i.e.,* $p_{AB} \leq p_A + p_B$. The monopolist prefers to abandon a higher unit margin for each good, it is the discount effect of the package and to catch on the quantities sold.

With this strategy consumers' choice is restricted at the maximum: either they buy the package $\{P\}$ or they buy nothing $\{\varnothing\}$. This strategy is depicted in Figure 2.

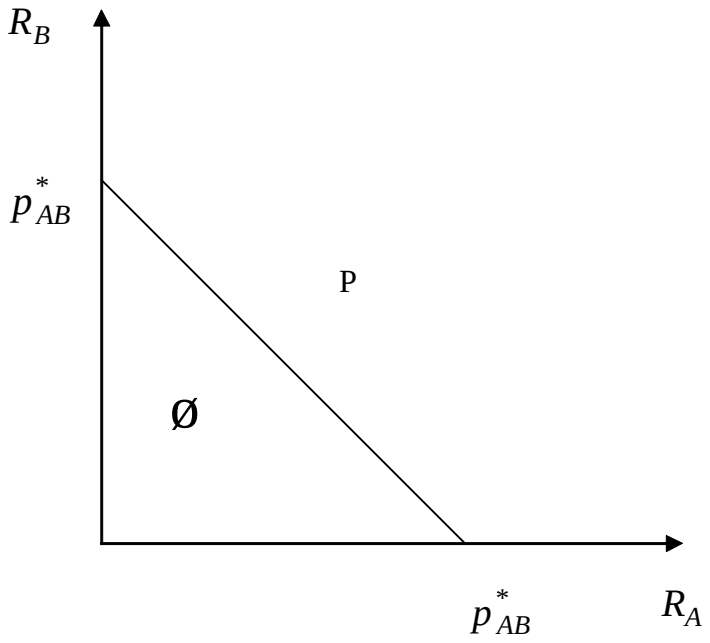


Figure 2: Pure bundling strategy

Consumers decide to buy a bundle if their willingness to pay for it is higher than the bundle price, *i.e.,* $R_{AB} = R_A + R_B \geq p^*_{AB}$. An advantage of bundling is to permit consumers who have a low reservation value for one of the goods to consume it, under the constraint that reservation prices for both goods are higher than bundle price. Indeed, if the correlation of reservation values is negative, the monopolist has an incentive to practise price discrimination by following a pure bundling strategy. By sorting consumers in different categories, bundling allows a monopolist to capture maximum surplus. However, examining a few examples of Adams and Yellen illustrates that selling goods both independently and in bundles is a dominant strategy for a monopolist. This strategy is called mixed bundling strategy and is presented in the next subsection.

## 2.4 Mixed bundling strategy

This strategy is a mix of the independent pricing strategy and the pure bundling strategy. The mixed bundling strategy enables products to be available both separately at two prices and as a bundle at a single price. We can define four consumers groups corresponding to four different behaviours: buy nothing, buy only good A, buy only good B or buy both goods as a package, respectively $\{\varnothing, A, B, P\}$. Consumers make their choices according to their reservation prices and to the surplus maximization criterion. Figure 3 represents the four consumers groups.

If the monopolist knows the reservation price of each consumer for each product, its profit-maximizing strategy is a case of Pigouvian first-degree price discrimination. If the monopolist only knows the distribution function of reservation prices in the population, however, this is a Pigouvian second-degree discrimination case. In this situation a monopolist encourages consumers to reveal their preferences by proposing a menu of tariffs for each type of consumer. Mixed bundling is similar to second-degree price discrimination in that it allows monopolist to try consumers in different categories, while an independent pricing strategy will not allow such discrimination.

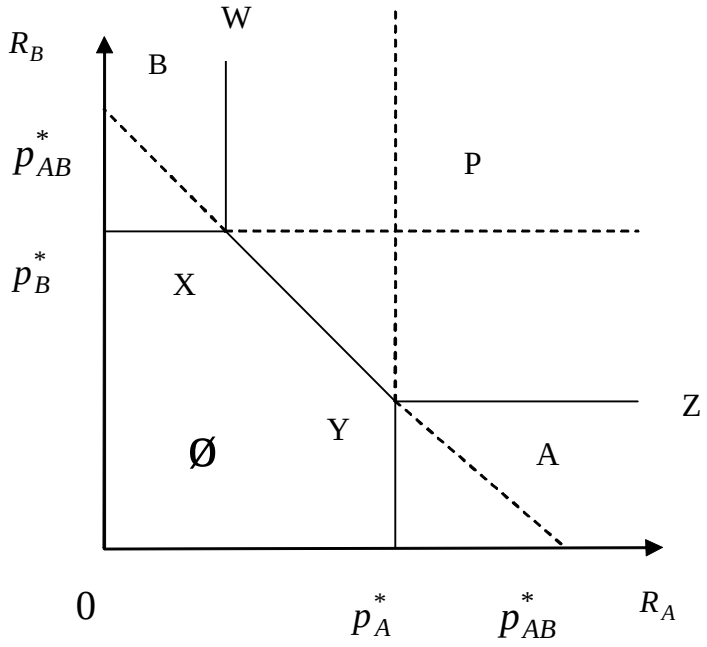


Figure 3: Mixed bundling strategy

Monopolist makes higher profits with mixed bundling strategy because such a strategy enables it to manage its price discrimination policy more efficiency. This strategy allows monopolist to divide the population into three groups instead of two with separate sales (without taking into account $\{\varnothing\}$). Consumers in area $0p^*_B XY p^*_A$ buy nothing: $\{\varnothing\}$. They have low reservation values for both goods $R_A \leq p^*_A$, $R_B \leq p^*_B$ and $R_{AB} \leq p^*_{AB}$. Consumers belonging to group $\{A\}$ southeast of $p^*_A YZ$ purchase only good A because their reservation value for good A is higher than the commodity's price and $R_B \leq p^*_{AB} - p^*_A$. Indeed, $(p^*_{AB} - p^*_A)$ is the implicit price for good B to an individual already prepared to buy good A. For similar reasons, consumers belonging to group $\{B\}$ northwest of $p^*_B XW$ consume only good B. They are characterized by $R_B > p^*_B$ and $R_A \leq (p^*_{AB} - p^*_B)$. The last consumer group $\{P\}$ to the north of $WXYZ$ consumes bundles. They have reservation values of $R_A + R_B \geq p^*_B$, $R_A \geq (p^*_{AB} - p^*_B)$ and $R_B \geq (p^*_{AB} - p^*_A)$. Those individuals derive more surplus from purchasing the bundle $(R_{AB} - p^*_{AB})$ than they would from purchasing each good separately $(R_k - p_k, k = A, B)$.

The mixed bundling strategy allows firms to extract more surplus from consumers whose willingness to pay for two goods is negatively correlated: when a consumer likes A,

he does not like B and the converse also holds true. If we compare this situation to the situation where monopolist follows a pure bundling strategy, consumers are no longer constrained to buy the bundle composed of one undesired product. To the contrary, a mixed bundling strategy allows consumers who have no marked preference for a particular good to buy the bundle under the constraint that the sum of reservation prices are high enough. With an independent pricing strategy, consumers would buy only one good. However with the supply of bundles the loss to the firm in lowering its prices is counterbalanced by the increase in quantity consumed.

**Bundling and negative correlation**

Intuitively, the profitability of bundling depends on the correlation of consumers' reservation prices for the two goods. This link can be emphasized through the following examples. There are four consumers $\{A, B, C, D\}$ who are ranked according to their reservation values as in Figure 4:

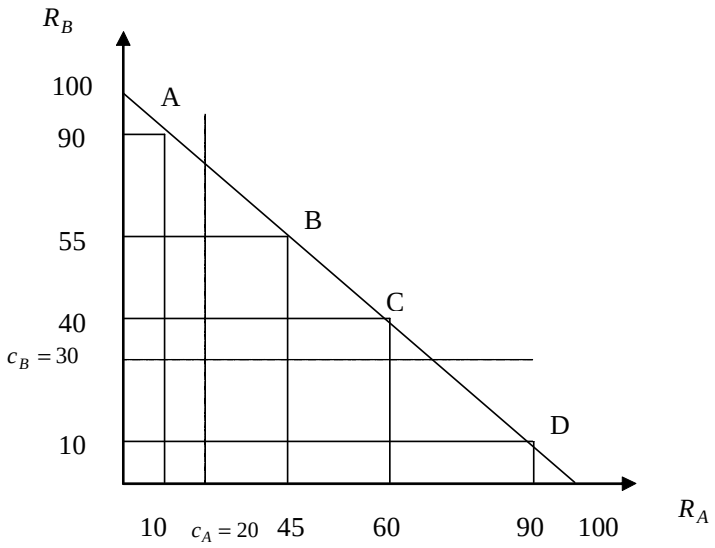


Figure 4: Negative correlation of consumers' values (demand structure 1)

Table 1 represents a monopoly's profits determined upon demand structure 1. There are four consumers who have reservation values for products A and B, and they buy these

goods only if $p_k \leq R_k$ with $k = A, B$.

| | $p_A^*$ | $p_B^*$ | $p_{AB}^*$ | Profits |
|---|---|---|---|---|
| IP | 60 | 90 | – | 140 |
| PB | – | – | 100 | 200 |
| MS | 90 | 90 | 100 | 230 |

Table 1. Prices and profits according to different strategies

If a monopoly follows an independent pricing strategy, it fixes $p_A^* = 60$ for good A (with $c_A = 20$) and $p_B^* = 90$ for good B (with $c_B = 30$). In this case, a monopoly does not allows a discount for a joint purchase of the two goods. Therefore profit fonction is given by:

$$\Pi^{IP} = (p_A - c_A)D_A(p_A) + (p_B - c_B)D_B(p_B)$$

In our example, with first demand configuration, when a monopoly follows an independent strategy, its profit is given by:

$$\begin{aligned} \Pi^{IP} &= (60 - 20).2 + (90 - 30).1 \\ &= 140 \end{aligned}$$

With separates sales, a monopoly has less of an ability to practise price discrimination. In order to satisfy consumers with a low willingness to pay for each good, the sole alternative for a monopolist is to lower the unit price of its products (at the expense of its margins). That explains why the unit product prices with independent pricing are lower than prices with mixed bundling strategy.

The use of a pure bundling strategy allows firms to reduce consumers' taste heterogeneity, while the use of an independent pricing strategy allows firm to fix high prices for each product to consumers who have a low reservation value for one good. When a monopolist follows a pure bundling strategy with a bundle price fixed at $p_{AB}^* = 100$ with $(c_A + c_B = 50)$ its profit is given by the following:

$$\begin{aligned} \Pi^{PB} &= (p_{AB} - c_A - c_B)D_{AB}(p_{AB}) \\ &= 200 \end{aligned}$$

This illustration shows that a pure bundling strategy is more profitable than separate sales. However, a comparison of profits gained from a pure bundling strategy should

be compared with profits gained from a mixed bundling strategy in order to know the dominant strategy. Assuming that a monopolist fixes $p_A^* = 90$, $p_B^* = 90$ and sets its bundle price at $p_{AB}^* = 100$, its profit will be as follows:

$$\begin{aligned}\Pi^{MS} &= (p_A - c_A)D_A(p_A) + (p_B - c_B)D_B(p_B) \\ &\quad +(p_{AB} - c_A - c_B)D_{AB}(p_{AB}) \\ &= 230\end{aligned}$$

The mixed bundling strategy combines the advantages of the independent pricing and the pure bundling strategies by allowing a monopoly to reduce the heterogeneity of consumers' preferences and by simultaneously fixing a high price for consumers that are within the boundaries of the reservation price distribution (who buy only one good).

**Separate sales and positive correlation**

A second example focuses on a positive correlation of reservation values between the two goods. There are many consumers who like both goods A and B. Figure 5 illustrates this positive correlation and Table 2 gives products prices and profits according to different strategies.

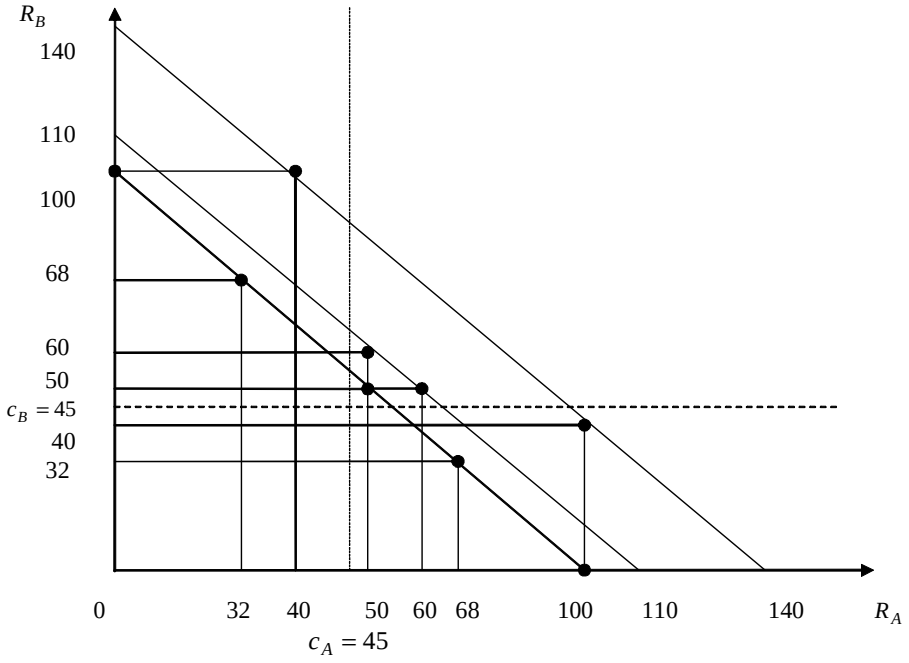


Figure 5: Positive correlation of consumers' values (demand structure 2)

| | $p_A^*$ | $p_B^*$ | $p_{AB}^*$ | Profits |
|---|---|---|---|---|
| IP | 100 | 100 | – | 220 |
| PB | – | – | 140 | 100 |
| MS | 100 | 100 | 110 | 190 |

Table 2. Prices and profits according to different strategies

Monopoly profits in relation to the three types of strategies are computed in the same manner as in the previous example. This example will show that an independent pricing strategy is always more advantageous if the correlation of consumers' reservation values is positive.

**Proposition 1** *The mixed bundling strategy is an optimal strategy for a monopoly if the correlation of consumers' reservation values between the two goods is negative. However, if the correlation of consumers' reservation values is positive, the independent pricing strategy proves to be more efficient because it leads to higher profits.*

Bundling works as a price-discrimination mechanism and resultingly reduces the consumers' taste heterogeneity. Thus firms can try consumers in several categories according to their goods' reservation values and extract a maximum surplus. This effect is called "the sorting effect". In addition to the sorting effect, bundling entails another effect called "the bundling discount effect". Firms implement the bundling discount effect by reducing the price of a package and selling it at a discount relative to the original component prices, thereby making the package more attractive. This discount reduces monopoly profit, but price reduction entails a quantity effect which is positive from the firm's point of view. By reducing the price of a bundle compared to the sum of its independent products prices, firms attract consumers who previously purchased only one component due to their reservation values.

Despite their intuitions, Adams and Yellen did not find any general conditions under which bundling raises either monopoly profit, or social welfare. Therefore, the mixed bundling strategy is an effective tool for price discrimination in Adams's and Yellen's model. They note that if one pricing strategy generates more profits than another strategy, it depends to the level cost over the considered period and to the distribution of consumers' reservation values. Schmalensee (1984) extends these results by minimizing restrictions.

## 2.5 Limits and reach of the results

Adams's and Yellen's results (1976) must be limited as these results seem to depend on the distribution of consumers' tastes and general conditions, under which mixed bundling strategy dominates separate sales strategy, are not provided. Intuitively, their findings show that the profitable use of bundling is linked to negative correlation between goods' reservation values across the population of consumers.

When the monopolist follows a mixed bundling strategy we suppose, for the package is attractive in comparison with separate sales, that $p^*_{AB} = p_A + p_B - 2\phi$ where $\phi > 0$ (this is essentially the bundle discount effect the sale of bundles with lower prices in comparison with independent pricing strategy entails the opportunity to raise monopoly profits).

The model of Schmalensee (1984) supplements Adams's and Yellen's hypothesis by providing that consumers' reservation prices follow a bivariate normal distribution. The bivariate normal distribution has a small number of easily interpreted parameters. Moreover, the attraction behind the Gaussian case is that the distribution of reservation prices for each individual good and for the bundle (composed of one unit of each good) are all normal. This assumption facilitates a comparison of separate sales and pure bundling strategies. Thus Schmalensee shows that, in the case of bivariate normal distribution, he finds the same intuitions that exist in Adams's and Yellen's model. In a monopolistic situation, a mixed bundling strategy is always more profitable than any other strategy. These results have been proven through analytical methods. However, Schmalensee does not show the superiority of bundling in a definite way when the correlation between the reservation values of goods is negative.

In Schmalensee's framework, he first compares pure bundling strategy and separate sales. Afterwards, he compares mixed bundling strategy with separate sales one.

**Pure bundling strategy versus separate sales**

Without solving Schmalensee's model, we give the main conclusions. Schmalensee explicitly shows that pure bundling reduces the effective dispersion in consumers' tastes. This happens simply because reservation prices are not perfectly correlated (correlation coefficient is not equal to 1) and the standard deviation of reservation prices for the bundle

is less than the sum of standard deviations for the two independent goods.

Thus, the comparison between independent pricing and pure bundling strategies in the symmetric case (where the weight of the standard deviations for the two goods which composed the bundle is the same) is easy. When the correlation of reservation values is perfectly positive, pure bundling and separate sales strategies are equivalent. In Adams's and Yellen's model, the profitability of pure bundling strategy requires a perfect negative correlation between two products. In Schmalensee case it is not necessarily the case.

It is important to note that the pure bundling strategy is always more efficient than separate sales in the Gaussian symmetric case for a positive correlation coefficient. For buyers, the pure bundling strategy always entails a decrease of consumers' surplus as the correlation of reservation values is not perfectly positive.

When the correlation is perfectly negative, following a pure bundling strategy allows a monopoly to capture all consumers' surplus. As a result, welfare value is equal to the value of the profit gained.

**Mixed bundling strategy versus separate sales**

Because mixed bundling is a much more complex strategy than either independent pricing or pure bundling, the analysis of mixed bundling yields fewer results than those obtained for pure bundling strategy. In the symmetrical case, a mixed bundling strategy is always more efficient than an independent pricing strategy if the correlation of consumers' reservation values is negative or equal to zero. A mixed bundling strategy permits a seller to have more efficient extraction of surplus by reducing buyer heterogeneity among consumers who have a high valuation for both goods. It also allows a monopolist to sell to consumers who have a high willingness to pay for only one good.

Thus results of Adams and Yellen are still valid under the normal case, but any result is given with definite way. Then, the more general formulation is presented in the following section through the model of McAfee, McMillan and Whinston (1989).

## 2.6 Generalization of the Adams and Yellen model

McAfee, McMillan and Whinston (1989) establish a general sufficient condition under which bundling dominates independent pricing. We note $R_k$ reservation value for the good $k$ (with $k = A, B$). The preference distribution is given by $g_k(p_k \mid s)$, it is continuous in $p_k$ to $p_k^*$ for all values of $s$, where $p_k^*$ is the optimal price of independent good.

**Proposition 2** *Mixed bundling strategy dominates separate sales if:*

$$\int_0^{p_A^*} \{[1 - G_B(p_B^* \mid s)] - g_B(p_B^* \mid s)(p_B^* - c_B)\} h_A(s)ds + (p_A^* - c_A)\,[1 - G_B(p_B^* \mid p_A^*)]\, h_A(p_A^*) > 0 \tag{1}$$

*where* $(p_A^*, p_B^*)$ are optimal prices in an independent strategy, $g_k(R_k/R_n)$ *is conditional density,* $h_k(R_k)$ is marginal density and $G_k(R_k/R_n)$ *is conditional distribution (where* $k, n = A, B$*).*

McAfee, McMillan and Whinston show that a mixed bundling strategy is more profitable than an independent pricing strategy when the valuation of goods is independently distributed. With proposition 2, McAfee, McMillan and Whinston extend Adams's and Yellen's results (1976) by showing that bundling is an optimal strategy in a variety of cases and not only with independent distribution. The first term of inequality (1) is either positive or negative and in the case of independent distribution it is equal to zero. McAfee, McMillan and Whinston establish an intuitive sufficient condition under which this term is non-negative. They suppose that monopolists can observe $R_k$ but not $R_n$, and let $p_k^*(R_n)$ be the optimal price of monopoly for good $k$ conditionally to the fact that consumers' valuation for a good $n$ is $R_n$. Thus, if $p_B^*(R_A)$ is decreasing in $R_A$ the first term of inequality (1) must be positive and in this case bundling dominates separate sales.

The findings of McAfee, McMillan and Whinston are more general than those of Schmalensee (1984) and show that if purchases can be monitored, a mixed bundling strategy dominates independent pricing for almost all distributions of reservation values. They show that in general, bundling dominates independent pricing if and only if the inequality (1) is not equal to zero. By providing an additonnal tool to monopolies to sort consumers into different groups, bundling strategy always increases monopoly profits.

## 2.7 Extensions: Bundling as a screening device

Bundling as a screening device was first developed by Maskin and Riley (1984) when they focused on the problem of asymmetric information in a principal-agent relationship. In general, the problem of asymmetric information does allow principals to efficiently distribute ressources in comparison to a perfect information context. Thus, the principal (monopoly) must propose a contract to reveal the consumers' private information. For compensation, the consumer may get an informational rent, which is generally costly for the principal.

In their model, Maskin and Riley (1984) consider a monopoly situation in the case of adverse selection. The principal proposes a set of different contracts to agents who choose its contract in relation to their private information.

Since a consumer's willingness to pay is private information, a firm must offer a contract based upon observable variables. It is most often assumed that a firm can observe only one variable. It is also common to assume that the observed variable is one-dimensional. For instance, Maskin and Riley (1984) believe the sole observed variable is quantity while in Mussa and Rosen (1978) believe it is quality.

However, when Maskin and Riley focus on bundling strategy they find that the one-dimensional parameter is quality. When bundling is considered, the optimal pricing for a monopoly that produces goods with different levels of quality is to propose a set of tariffs such as $\{q, z^{**}(q), T^{**}(q)\}$, where $q$ is the quality parameter, $z^{**}(q)$ is the number of goods that composed the bundle and $T^{**}(q)$ is the total expenditure paid by the consumer with a quality level of $q$. It is of interest that monopolies even make any profits to report a menu of tariff with a discount for each level of quality. Indeed, under the model's assumptions, with a one-dimensional parameter which represents consumers' preferences, quantity parameter raises with quality parameter. Therefore, unit price and the number of goods that composed the package can be directly written as a function of the quality of goods.

Martimort (1992) also focuses on the problem of asymmetrical information in principal-agent relationships. He introduces the possibility for a common agent to contract with multiple principals and compares the cooperative situation with the noncooperative situ-

ation under the hypothesis of nonlinear pricing. The cooperative situation is one that where firms can offer packages and the noncooperative situation is one that is similar to the independent pricing strategy. The results depend on the complementarity or the substitutability between activities controlled by each principal. If the goods are complements, the bundling strategy proves to be more optimal for principals and consumers. However, if the goods are substitutes, a consumer's utility is higher than the situation where there is not any cooperation between principals. However, the principal's profits are lower when substitutes are involved. Each principal anticipates that an agent may want to undervalue his report to his rival since his marginal incentives to overvalue his report are higher. With respect to consumers' surplus, for complementary and substitutable goods, the bundling strategy (cooperation) is optimal as it entails a higher level of surplus due to consumers' informational rent. When there is non-cooperation, a principal's welfare is reduced due to the effects of increased competition. Therefore, from a principal's point of view, for both complementary and substitute goods, the cooperative situation is prefered since welfare will be higher. Martimort (1996) adds the hypothesis of multiple consumers and he concludes with the same results.

Rochet and Stole (2001) consider the advantage for a multi-products monopoly to sell its goods under a bundle with a model similar to that of Mussa and Rosen (1978) under multi-dimensionnal environment. In the one-dimensional case where there is one good, there are two economic effects due to bundling. First, there is a sorting effect which distorts consumption downwards in order to decrease the rent of the "high" consumer type. The second effect appears when the demand parameters are independently distributed. The law of large numbers shows that the offering of multiple goods entails a "homogeneity effect" over consumers' heterogeneity. However in a multi-products case, these results are less significant because the homogeneity effect tends to decrease as the number of goods that compose a package increases.

The strategic aspects of bundling are multiple, particularly in its use as a tool of price discrimination. The following section focuses on bundling as an effective entry-deterrent strategy.

# 3 Monopoly in only one market: bundling as an entry barrier

The price discrimination effect due to bundling is quoted in a number of literature pieces. However, very few articles deal with bundling as an entry-deterrent strategy. Whinston (1989) was the first to examine bundling as an entry deterrent strategy for a monopoly in one market. According to Whinston, bundling may lead to the exclusion of a rival in a tie market. Whinston analyzes three cases. The first case is an independent game where bundling is forbidden. The second is a game without commitment but where bundling is introduced. In the last case, he analyzes a game with commitment for a bundling strategy or an independent pricing strategy. The following section sets out his model. In general, Whinston finds that the use of bundling allows firms to remove competitors under constraint to commit to offering only sales in bundle (leverage theory). Nalebuff (2004) allows to extend Whinston results by showing that bundling is an effective entry-deterrent strategy without any control or commitment. A firm in a monopolistic situation in one market and in competition in another market can, by bundling their goods together, foreclose a competitor in tie market. Bundling can be used as entry-deterrent strategy when a firm has large-scale market power with one product.

## 3.1 Bundling and foreclosure of rivals: Whinston (1989)

Whinston considers a model with two firms that produce independent goods. There are two markets noted—A and B. Market A is monopolized by firm 1 (it has a patent) and all consumers buy this product. Market B is dominated by two firms that provide differentiated goods—firm 1 and firm 2.

In market B, there are fixed costs $F_i$ and variable costs $c_{Bi}$ for each unit produced by firm $i$ (with $i = 1, 2$). The unit costs for good A are $c_A$. For expositional simplicity, Whinston ignores the possibility that there are fixed costs for good A.

Consumers, who are indexed by $d \in (0, 1)$ have total mass 1. At the most, each consumer desires one unit of good A and one unit of good B. All consumers have a reservation value of $R_A > c_A$ for good A, while a consumer of type $d$ has a valuation of

$R_{Bi}(d)$ for a unit of good B.

The resale of products by consumers is assumed to be prohibitively costly. Without bundling, firms set independent prices for each product $(p_A, p_B^1, p_B^2)$. A firm's sales of good $Bi$ (with $i = 1, 2$) are given by a function $D_i(p_B^1, p_B^2) \leq 1$, which Whinston assumes to be everywhere differentiable and to satisfy $D_j(p_B^1, p_B^2) \geq 0$ if $j \neq i$ and $D_j(p_B^1, p_B^2) \leq 0$ if $j = i$, with strict inequalities if $D_i(.,.) \in (0, 1)$. That is, goods $B1$ and $B2$ compete with each other for consumer purchases. The demand functions are given by $D_1$ and $D_2$ for products $B1$ and $B2$ respectively.

The timing of the game is as follows:

1. First, both firms choose simultaneously to enter or not enter in market B. If firm $i$ decides to be active, it occurs the cost $F_i$.

2. Then, firms set prices (simultaneously if both firms are active).

Whinston analyzes three cases which can be regrouped into the following two subsections: In section 3.1.1, the game without commitment is analyzed (with independent pricing and bundling strategies). In section 3.1.2 , the possibility of committing to a particular strategy is discussed.

### 3.1.1 Game without commitment

**Separate sales**

We will begin by considering an independent pricing strategy without commitment. In this case firms 1 and 2 simultaneously choose whether they will be active in market B. We analyze the game without commitment when bundling is prohibited.

- Both firms are active. Firm 1 sells goods $(A, B1)$ at prices $(\hat{p}_A, \hat{p}_B^1)$ and firm 2 sells good $B2$ at a price $(p_B^2)$.

- Firm 1 is active and firm 2 is not active. Goods $(A, B1)$ are available at prices $(\hat{p}_A, \hat{p}_B^1)$.

- Firm 1 is inactive in market B while firm 2 is active. Available goods $(A, B2)$ are at prices $(\hat{p}_A, p_B^2)$.

- If both firms decide to be inactive in market B. Firm 1 offers only good $(A)$ at price $(\hat{p}_A)$.

When bundling is prohibited, firm 1 could do better by setting $p_A = R_A$ (where $R_A$ is the consumers' reservation value for good A). In order to calculate the best-response functions of firm $i$ in market B with $p_B^{i*}(p_B^j)$, first we solve the following program:

$$\underset{P_B^i}{Max}(p_B^i - c_{Bi})D_i(p_B^1, p_B^2)$$

In this case, the Nash equilibrium is defined by: $((\hat{p}_A, \hat{p}_B^1); \hat{p}_B^2)$ with $p_B^2 = \hat{p}_B^2$.

Firm 1 has an incentive to bundle its goods when its pricing is not identical (or, economically equivalent) to its pricing in the case of an independent pricing game.

The profit of firm 1 is given by the following:

$$\Pi_1 = (\hat{p}_A - c_A) + (\hat{p}_B^1 - c_{B1})\hat{D}_1(\hat{p}_B^1, p_B^2)$$

The profit of firm 2 is represented by the following:

$$\Pi_2 = (p_B^2 - c_{B2})\hat{D}_2(\hat{p}_B^1, p_B^2)$$

We can deduce best-response functions for both firms as follows:

$$\begin{aligned} \hat{p}_B^{1*}(p_B^2) &= \frac{1}{\hat{D}_1^1}(c_{B1} - \hat{D}_1(\hat{p}_B^1, p_B^2)) \text{ and} \\ p_B^{2*}(\hat{p}_B^1) &= \frac{1}{\hat{D}_2^1}(c_{B2} - \hat{D}_2(\hat{p}_B^1, p_B^2)). \end{aligned}$$

where $\hat{D}_1^1$ is the first-derivative of the demand function for good B from firm 2. To compare these results, we interest at the case where bundling is allowed. So, firm 1 has the possibility to bundle goods in a package.

**Bundling without commitment**

In the circumstance where there is bundling without commitment, the timing of the game is the same as it is when there is independent pricing. Each firm has the option to be active in market B, and they choose their prices simultaneously. In this game, if firm

1 decides to be active, it has the choice to bundle its products. When the firm 1 opts to bundle, it proposes to consumers a bundle composed of one unit of good $A$ and one unit of good $B1$. The bundle of firm 1 is noted $(AB1)$ and its price is $p_{AB}$.

- Both firms are active and firm 1 follows a mixed bundling strategy. Firm 1 proposes its goods separately and also in a bundle $(A, B1, AB1)$. It chooses three prices $(\mathring{p}_A, \mathring{p}_B^1, \mathring{p}_{AB})$. Firm 2 sells good $B2$ at price $(\mathring{p}_B^2)$.

- Firm 1 is active and firm 2 is inactive. Each consumer has the choice between a set of goods $(A, B1, AB1)$ offered by firm 1 available at prices $(\mathring{p}_A, \mathring{p}_B^1, \mathring{p}_{AB})$.

- Firm 1 is inactive in market B while firm 2 is active. Consumers only have the choice between $(A, B2)$ at prices $(\mathring{p}_A, \mathring{p}_B^2)$.

- If both firms decide to be inactive in market B, firm 1 proposes only product $(A)$ at price $(\mathring{p}_A)$.

An additional hypothesis of the model is that firm 1 cannot control consumers' purchases. This assumption excludes use of obligatory contracts (that is when a consumer buys good A, he is not constrainted to also buy good $B2$). This implies that bundles are bought if and only if $\mathring{p}_{AB} \leq p_A + p_B^1$. In order for consumers to buy the bundle, they must have a higher utility than in the case when they consume goods separately. Thus we must compare $U_{AB1} = R_A + R_{B1}(d) - \mathring{p}_{AB}$ (when consumers choose the bundle) with $U_A + U_{B1} = R_A - p_A + R_{B1}(d) - p_B^1$ (when consumers choose the separate goods). Accordingly, it is necessary that: $U_{AB1} > U_A + U_{B1}$, that is $\mathring{p}_{AB} < p_A + p_B^1$. In order for a bundle to be preferred by consumers it is also necessary that $U_{AB1} > U_A + U_{B2}$. In fact, consumers must have a higher utility to consume bundles than to consume goods separately $(A, B2)$. Thus it is necessary that $\mathring{p}_{AB} < p_A + p_B^2$,which means that $\mathring{p}_{AB} < p_A + \frac{1}{2}(p_B^1 + p_B^2)$.

**Proposition 3** *Any subgame-perfect equilibrium outcome of the game without commitment is economically equivalent to a subgame-perfect equilibrium outcome of an independent pricing game.*

The intuition is as follows. When $\mathring{p}_{AB} \leq p_A + p_B^1$, there are two cases. First, Whinston assumes that $\mathring{p}_A > R_A$. If it is the best-response function of firm 1, all consumers will buy a bundle. Otherwise firm 1 can be more efficient by setting the price of good $A$ to

be equivalent to the consumers' reservation price for good $A$, $p_A = R_A$. Moreover, since all consumers buy bundles (and it is for this reason that anyone buy either $A$ alone, or $B1$ alone), it cannot be that $\mathring{p}_{AB} < R_A$. If that were the case, firm 1 would do better by offering only the bundle with a price $R_A$. Then, setting $(\hat{p}_A = R_A, \hat{p}_B^1 = \mathring{p}_{AB} - R_A)$ leads to the same sales and profits for both firms with $\mathring{p}_B^2$ given and for firm 2 for all $p_B^2$.

Second, Whinston assumes instead that $R_A \geq \mathring{p}_A$. Equilibrium is such as $\mathring{p}_{AB} \geq \mathring{p}_A$. Otherwise all consumers would buy the bundle of firm 1 since they are prepared to buy good A individually and it is sold at a lower price in the bundle than it is individually. Firm 1 increases its profits by only offering the bundle at price $R_A$. However, if $R_A \geq \mathring{p}_A$ and $\mathring{p}_{AB} \geq \mathring{p}_A$, each consumer will buy either good $A$ alone, or firm 1's bundle. In this instance, fixing $(\hat{p}_A = \mathring{p}_A, \hat{p}_B^1 = \mathring{p}_{AB} - \mathring{p}_A)$ yields the same sales and profits for both firms for all $p_B^2$.

The basic premise behind the principal result of Whinston's research is simply. First, it is always beneficial for firms to ensure that all consumers buy good $A$, either separately or in a bundle. If all consumers buy good $A$ and if firm 1 commits to a bundling strategy, consumers choose between buying only good $A$ or the bundle. Consumers make this choice by imputing an effective price of $(p_{AB} - p_A)$ (with $(p_{AB} - R_A)$ if $p_A > R_A$) for the good $B$ as a bundle component, thereby equating bundling to an independent pricing strategy. In this scheme, following a bundling strategy is not a dominant strategy for firm 1.

### 3.1.2 Bundling strategy and commitment

In this case, the difference between the two previous games is that here this game has three-stages. In the first-stage, firm 1 commits to propose three sets of product—good $A$, good $B1$ and bundle $AB1$. Firm 1 can elect to commit to a pure bundling strategy, thereby making the products available only in a package. The second and the third stages are respectively identical to the previous game.

The negative result of proposition 3 is radically different if firm 1 can commit to a bundling strategy. In the three-stages game previously described, if firm 1 is active in market $B$, it can choose to produce sets of goods in a variety of ways: goods individually, separate goods along with the bundle, bundle exclusively, bundle and product $A$, bundle

and product $B1$, product $A$ only or product $B1$ only. The argument in proposition 3 implies that the two first options yield results equivalent to those under an independent pricing strategy. They are strictly more beneficial to firm 1 than the two latter options (which yield lower profits for firm 1 than any other subgame when firm 1 is active and higher profits for firm 2 when it is active). In fact, the two following results show that firm 1's options are to essentially choose between producing separate goods or only the bundle.

Indeed, if:

- Firm 1 can commit to sell good $A$ independently and to also sell the bundle, the equilibrium outcome of this subgame with commitment is equivalent to the equilibrium outcome of a subgame in an independent pricing game.

- Firm 1 can commit to sell the bundle and good $B1$, the equilibrium outcome of this subgame with commitment is equivalent to the equilibrium outcome of a subgame where firm 1 commits to sell only the bundle. In this case, firm 2 earns lower profits than in an independent pricing game.

Given these results, firm 1 can limit its choice to two pricing strategies: it can either sell its products $A$ and $B1$ separately, which will yield the same result as in an independent pricing game. Alternatively, firm 1 can commit to supply only the bundle. The analysis of competitive effects due to a pure bundling strategy entails the following results. In a subgame with commitment when both firms are active and firm 1 products only the bundle, firm 2 will earn lower profits than it would in an independent pricing strategy.

**Proposition 4** *When firm 1 commits to a bundling strategy it may make it unattractive for firm 2 to be active in market B.*

One might at first think that bundling in this context would have no effect at all: if firm 1 sets the prices of independent goods at $p_A = R_A$ and $p_B^1$, a switch to bundling at a total price of $R_A + p_B^1$ would not change the demand for good $B1$ at all. However, in an independent pricing game, firm 1's best-response satisfies the following requirement:

$$\left[p_B^{1*}(p_B^2) - c_{B1}\right] D_1^1(p_B^{1*}(p_B^2), p_B^2) + D_1(p_B^{1*}(p_B^2), p_B^2) = 0$$

To the contrary, when firm 1 follows a bundling strategy and sets a price $p_{AB}$, the bundle demand is given by $D_1(p_{AB} - R_A, p_B^2)$ and firm 2's best-response at price $p_B^2$ for $p_{AB}^*(p_B^2)$ is as follows:

$$\left[p_{AB}^*(p_B^2) - c_A - c_{B1}\right] D_1^1(p_{AB}^*(p_B^2) - R_A, p_B^2) + D_1(p_{AB}^*(p_B^2) - R_A, p_B^2) = 0 \qquad (2)$$

If $R_A = c_A$, thus $p_{AB}^*(p_B^2) = p_B^{1*}(p_B^2) + R_A$. However, if $R_A > c_A$, thus with $p_{AB} = p_B^{1*}(p_B^2) + R_A$ the left side of equation (2) is strictly negative. Thus, it must have $p_{AB}^*(p_B^2) < p_B^{1*}(p_B^2) + R_A$. Firm 1's equilibrium price for good $B1$ is lower with bundling than it is with an independent pricing strategy. The intuition is as follows. When firm 1 commits to a bundling strategy in order to earn profitable sales of its monopolized product, good $A$, it must also make sales of good $B1$. This necessity leads firm 1 to decrease prices in order to catch firm 2's sales. This effect is called "strategic foreclosure". When equilibrium prices for goods $B1$ and $B2$ decrease simultaneously due to firm 1's bundling strategy, this leads to a decrease in firm 2's profits. Therefore, if firm 1 commits to following a pure bundling strategy, it can lower its bundle price in such a way that its rival's profits decrease once again.

It is important to note that if both firms are active, then firm 1's profits would be lower under a bundling strategy in comparison with an independent pricing strategy. Firm 1 should exclude its competitor from the market in order to obtain higher profits. Indeed, bundling entails lost profits on the sales of good $A$ but also makes the product of firm 2 more attractive due to its lowered price. Thus firm 1 should never commit to a bundling strategy unless it can drive firm 2 out of the market.

The advantage of bundling is the gain from converting market B from a duopoly into a monopoly. However, the potential loss comes from the fact that firm 1 becomes a monopoly which can offer only the bundle. As a result, many consumers who do not have a liking for good $B1$ make committing to a bundling strategy not very profitable for firm 1, even when it leads to the exclusion of firm 2.

Bundling profitability depends on the correlation of consumers reservation values. When there are heterogeneous preferences for bundles:

1. Bundling does not necessarily entail a strategic foreclosure and a decrease in rival

profits.

2. Bundling can also be a profitable strategy even without any commitment.

Finally, for complementary goods in fixed proportion in a bundle, it is never efficient for a monopolistic firm in one market and in competition in another to bundle its products in order to decrease competition level in the competitive market. The reason leads to the fact that when a monopolist's product is essential to the use of two goods, a monopoly can always take advantage of an increase in competition in the other market through monopoly product sales. Indeed, the effects of competition tend to decrease prices in market B, but the quantity effect due to this fall tends to increase sales in market A. In the complementary good case, it is not necessary for a firm that produces good A to bundle its goods in order to increase its profit. Nevertheless, in both model's extensions, when use of product A is not essential for use of product B, bundling once again becomes a profitable technique for foreclosure.

Whinston shows that bundling can be an efficient entry-deterrent strategy for a rival under the condition of making a credible commitment to become aggressive enough. In the following subsection, Nalebuff (2004) considers the same analysis case as Whinston. However, he extends Whinston's conclusions by showing that bundling also allows a firm to exclude rivals without commitment.

## 3.2 Extensions of Whinston's results: Nalebuff (2004)

In this model, the only preoccupation for the monopolist is to prepare against a possible entry in either market A or B without knowing which market the entrant will attack. The monopolist has the possibility to sell its goods separately or together in a bundle.

The timing of the game is as follows:

1. The incumbent sets prices before the rival's entry decision is made and these prices are fixed until the end of game. This approach is generally in the entrant's favour. If the incumbent can deter the rival's entry without being able to lower its prices post-entry, then even a myopic entrant would be deterred from entry into the market.

2. The entrant decides whether it should enter the market. The rival's entry decision is based on the premise that its expected profits will cover its entry costs. The entry costs are determined by the environment and known by all players.

When products A and B are sold separately and if a rival enters the market, a monopoly's profit will likely be reduced by half. However, if the incumbent follows a pure bundling strategy, then that technique would prove to be more efficient in deterring a rival's potential entry. Even if entry cannot be deterred, it is nonetheless still more efficient for a monopoly to sell its products in bundles.

By bundling its products together, a monopolist considerably decreases its rival's profit. When goods are sold separately, the entrant earns exactly the same profit as the incumbent. However, if a monopoly follows a bundling strategy then an entrant's profit considerably decreases. Bundling can be use to deter rival's potential entry.

It is surprising to note how an entrant's expected profit decreases without any resulting price ajustment. Profit is low for a mono-product entrant because it will have difficulty gaining a market share advantage over the lower cost of the incumbent's bundle, even when the entrant charges half the price of the bundle. As an entrant considers the monopoly's potential response, it makes you wonder if the incumbent will continue to bundle in response to entry.

Nalebuff shows that it is not a feasible option for entrants to fix an individual price for each of its goods, particularly when a monopoly is selling its goods jointly. An entrant should therefore expect a monopoly to bundle absent entry and to continue bundling post-entry. Contrary to Whinston's results (1989), Nalebuff shows that bundling is an effective entry deterrent strategy against a mono-product rival even without any commitment.

The last strategic aspect of bundling is analyzed in the next section and it discusses how a firm can propose bundling in order to differentiate its products in a competitive situation.

# 4 Bundling as products differentiation in a competitive situation

The final characteristic of bundling to be discussed in this paper is product differentiation. A firm can differentiate its products from those of its competitors by bundle supply. Anderson and Leruth (1993) take an interest in bundling as a tool of product differentiation. They consider a duopoly that produces complementary goods and use a discret choice model which is presented in the following subsection. Anderson and Leruth show that contrary to the monopoly case, in a duopolistic context a mixed bundling strategy is not preferred. Indeed, to sell products both separately and together in a package is not efficient for firms given that the result is an increase in competition. In their model, if firms can commit the independent pricing strategy will prove to be a dominant one.

Economides (1993) also considers bundling as tool of product differentiation and like Anderson and Leruth, he also analyzes bundling in a duopolistic situation with complementary goods. Contrary to Anderson and Leruth, Economides finds that duopolists have an incentive to follow a mixed bundling strategy but that they are in a prisoner's dilemma situation. In other words, the firms are in a worse position than if both their respective dominant strategies are not available. The following subsection goes into further detail discussing the Anderson and Leruth model (1993) and then contrasts their results with those of Economides (1993).

## 4.1 Bundling and complementary products: Anderson and Leruth model (1993)

Anderson and Leruth (1993) consider two multi-product firms that commit to follow either a bundling strategy or an independent pricing. In their model, the duopoly equilibrium entails both firms following an independent pricing strategy given that it leads to higher profits. However, if there is no commitment to follow a particular pricing strategy, the duopoly equilibrium entails both firms following a mixed bundling strategy.

### 4.1.1 Hypothesis

Anderson's and Leruth's model hypothesizes that there are two complementary products, A and B. Thses products can either be provided by firm 1 or firm 2. Each firm has a constant marginal cost $c_A$ and $c_B$, which is assumed to be the same for both firms and there are no economies of scale or scope.

There is a population of consumers T whose size has been normalized to 1. Each consumer wishes to buy one and only one unit of each good. We note $h = (Ai, Bj)$ the consumption option where a consumer buys product A from firm $i$ and B from firm $j$ (with $i, j = 1, 2$). There are four consumption options $h$ into $H$. The first option for consumer is to buy both goods from firm 1 *i.e* $(A1B1)$. The next option is to buy good A from firm 1 and good B from firm 2 *i.e* $(A1B2)$. Third, a consumer can purchase good A from firm 2 and good B from firm 1 *i.e* $(A2B1)$, and finally a consumer can purchase both goods from firm 2 *i.e* $(A2B2)$.

An individual consumer $t$ into $T$ who chooses one option $h$ into $H$ has an indirect utility function as follows:

$$U_{th} = -p_h + \mu\varepsilon_{th} \tag{3}$$

where $\varepsilon_{th}$ are independent and identical double exponential variables [2] with a mean of zero and a variance equal to 1. The price paid for the consumption option $h$ into $H$ is noted $p_h$. Finally, the parameter $\mu > 0$ expresses the degree of heterogeneity of consumers' tastes. For instance, for low values of $\mu$, the weight assigned to individual differences in tastes is small. If $\mu = 0$, all consumption options are perfect substitutes and consumers will choose the one with a lower price.

The demand functions resulting from this system are provided by the LOGIT multinomial model (Manski and McFadden, 1981) and have the form:

$$D_h = \frac{\exp(-p_h/\mu)}{\sum_{g \in H} \exp(-p_g/\mu)} \tag{4}$$

for all $h$ into $H$. We note $p_g$ the price paid for all other consumption options.

Each firm $i = 1, 2$ has the choice between three pricing strategies:

[2] The consumers' utility is composed of two parts: $U_i = u_i + \varepsilon_i$. If $\varepsilon_i$ follow a normal distribution, the model is called PROBIT whereas if $\varepsilon_i$ follow a double exponential distribution, then the model is called LOGIT.

1. Pure bundling strategy: firms choose one price $p^i_{AB}$ and sell their goods only under a package form.

2. Independent pricing strategy: firms choose two prices, $p^i_A$ and $p^i_B$, and allow no discount for the joint purchase.

3. Mixed bundling strategy: firms choose three prices with a discount for the joint purchase at the same firm ($i.e\ p^i_{AB} < p^i_A + p^i_B$).

If firms cannot commit to a particular strategy, then by definition they follow a mixed bundling strategy: they sell their products both independently and in a bundle. However, in a duopolistic environment, price discrimination that occurs with the supply of bundles increases competition. Therefore, mixed bundling is not an efficient strategy.

If we note $D_{ij} = D_{(i,j)}$ to equation (4), the part of the population that wishes to buy good A from firm $i$ and good B from firm $j$, with $i, j = 1, 2$, profits according to the three types of strategy are given by:

$$\begin{aligned}
\Pi^{PB}_i &= (p^i_{AB} - c_A - c_B).(D_{ii} + D_{ij} + D_{ji}) \\
\Pi^{IP}_i &= (p^i_A - c_A).(D_{ii} + D_{ij}) + (p^i_B - c_B).(D_{ii} + D_{ji}) \\
\Pi^{MS}_i &= (p^i_A - c_A).D_{ij} + (p^i_B - c_B).D_{ji} + (p^i_{AB} - c_A - c_B).D_{ii}
\end{aligned}$$

where $i, j = 1, 2$ and $i \neq j$. Note that if firm 1 follows a pure bundling strategy and if a consumer wishes to buy consumption option $h = (1, 2)$, that is good A from firm 1 and good B from firm 2, then the consumer must buy a superfluous amount of good B.

### 4.1.2 Price equilibrium

Each duopoly pricing strategy constitutes a different form of price discrimination. Each strategy also leads to a different distribution of consumers. The pure bundling strategy restricts consumers choice to a maximum and serves as an efficient tool of price discrimination. Indeed, in a duopolistic context the pure bundling strategy is used to sort consumers into two distinct categories: those who have a preference for the bundle of one firm and those who have a preference for the bundle of another firm.

Table 3 illustrates duopoly profits based on the type of strategy utilized when $c_A = c_B = 0$ (note that the profits are given by pairs $(\Pi_1, \Pi_2)$):

| | | Firm 2 | | |
|---|---|---|---|---|
| | | PB | IP | MS |
| Firm 1 | PB | $(1.218\mu\ ;\ 1.218\mu)$ | $(1.557\mu\ ;\ 1.278\mu)$ | $(1.218\mu\ ;\ 1.218\mu)$ |
| | IP | $(1.278\mu\ ;\ 1.557\mu)$ | $(2\mu\ ;\ 2\mu)$ | $(1.278\mu\ ;\ 1.557\mu)$ |
| | MS | $(1.218\mu\ ;\ 1.218\mu)$ | $(1.557\mu\ ;\ 1.278\mu)$ | $(1.218\mu\ ;\ 1.218\mu)$ |

Table 3: equilibrium profits

The equilibrium profits when both firms follow a pure bundling strategy are given by:

$$\Pi(PB, PB) = 1.218\mu$$

when $c_A = c_B = 0$. The equilibrium profits when firms follow an independent pricing and a mixed bundling strategy are represented respectively by:

$$\begin{aligned} \Pi(IP, IP) &= 2\mu \\ \Pi(MS, MS) &= 1.218\mu \end{aligned}$$

Note that if $\mu$ is equal to 0 (when all options are perfect substitutes), profits will be at a minimum level or become zero. This is a standard result of competition "à la" Bertrand and prices will be driven to marginal cost when products are homogeneous. Otherwise, prices exceed costs and profits follow the relation:

$$\Pi(IP, IP) > \Pi(MS, MS) \geqq \Pi(PB, PB); \qquad \text{for } \mu > 0$$

where the last equality holds only for $c_A = c_B = 0$.

**Proposition 5** *If each firm can commit to a particular strategy, then duopoly equilibrium entails both firms following an independent pricing strategy and equilibrium profits are* $2\mu$ *for each firm. However, if no firm can commit to a particular strategy, then by definition both firms follow a mixed bundling strategy and equilibrium profits for each firm are* $1.218\mu$.

Contrary to the monopolistic case, it is surprising to see how the introduction of competition leads to perfect discrimination, that is the utilization of a mixed bundling strategy, and to less attractive profit levels. Indeed, the use of a mixed bundling strategy

generates lower profits than in an independent pricing situation. Although the mixed strategy allows subtle price discrimination, it also entails a high level of competition because firms compete both with separate goods and with the package. According to table 3, the independent pricing strategy dominates since it results in higher profits. Indeed, the use of an independent pricing strategy lowers the intensity of competition and therefore increases profits.

The independent pricing strategy is a Pareto dominating Nash equilibrium since neither firm wishes to deviate unilaterally from this strategy since other strategies, particularly a pure bundling strategy , would result in higher levels of aggression from rivals. In fact, with a pure bundling strategy, firms compete with bundles whereas with an independent pricing strategy, competition is relaxed. If firms do not commit to a particular strategy, by definition they follow a mixed bundling strategy and supply both products separately and a bundle.

The results of Anderson and Leruth can be compared to those of Matutes and Rigibeau (1988) and Economides (1989) where these authors focus on the incentives of firms to make their products compatible with each other. A situation with full compatibility corresponds to the independent pricing strategy here as consumers can buy one good or the other from each firm. Conversely, a situation where there is incompatibility corresponds to a pure bundling strategy in this model since each firm sets a single price for bundles and cross-purchases are forbidden.

In this model, there is no prisoner's dilemma as there is in the models of Thisse and Vives (1988), Economides (1993) and Reisinger (2006). Indeed, those authors show that, in the second-stage, firms use price discrimination via bundle supply although it may be more efficient to choose uniform prices. Contrary to the model of Anderson and Leruth that shows that price discrimination leads to fierce competition, these models predict that firms choose price discrimination even without commitment. In Anderson's and Leruth's model (1993), the results depend on the nature of the strategic interaction between firms. The following subsection presents the model of Economides (1993).

## 4.2 Bundling and vertical differentiation: Economides (1993)

Similar to Anderson and Leruth, Economides (1993) also considers bundling as a tool for product differentiation and he presents a model where firms in a duopoly produce complementary goods and practice mixed bundling strategies. It is a two-stages game: in the first-stage, firms choose between a bundling strategy or a non-bundling strategy. In the second-stage, firms set prices. In Economides's model, he shows that bundling is a dominant strategy. However, firms are in a prisoner's dilemma situation and are in a more beneficial position if they follow an independent pricing strategy.

Suppose there are two complementary products, A and B, which can be provided by either firm 1 or firm 2. The demand functions are linear and the demand systems for each firm are symmetric. Economides considers three possible outcomes for this setup.

- Both firms follow a mixed bundling strategy and choose three prices for each product $(p^i_A, p^i_B, p^i_{AB})$ allowing a discount for the bundle (with $p^i_{AB} < p^i_A + p^i_B$).

- One firm follows a mixed bundling strategy, and it chooses three prices. The other firm does not and chooses two independent prices.

- Both firms follow an independent pricing strategy by choosing two independent prices $(p^i_A, p^i_B)$ and allowing no discount for the joint purchase.

At first, Economides considers these three cases and compares prices and profits. In the case where both firms follow a mixed bundling strategy, he finds that there is a dominant Nash equilibrium because if firm 1 follows a mixed bundling strategy, firm 2 has always an incentive to follow a mixed bundling strategy as well. Thus, the outcome that result in one firm following a mixed bundling strategy and the other not doing the same is not prevalent. Economides shows that each firm has an incentive to follow a mixed bundling strategy if one already practices this strategy.

However, comparison of profits shows that profits under a mixed bundling strategy are lower than they are under an independent pricing strategy. As a result, firms would be better off not bundling.

**Proposition 6** *If goods are not close substitutes, the use of mixed bundling is a dominant strategy, but profits are lower than they would be under an independent pricing strategy.*

*Firms are in prisoner's dilemma situation.*

The same results are also advanced by Reisinger (2006)[3] but with a model of horizontal differentiation. Based on the assumption that independent goods (goods are not compements and not subtitutes) is used, Reisinger concludes that the profitability of bundling depends on the correlation of consumers' reservation values. Bundling strategies are used in various economic sectors. As an illustration for this variety, the following section focuses on empirical studies particularly in energy and in telecommunications sectors.

# 5 Empirical studies

Several empirical studies focus on bundling but this paper will review focus specifically on bundling in the energy market and in telecommunications. In the energy market, we are particularly interested in energy necessary for space heating. Research by Bernard, Bolduc and Bélanger (1996) focuses on residential demand for electricity in Quebec through a microeconometric approach. In telecommunications, it is not uncommon to notice the offers of "double play", "triple-play" and "quadruple play" packages to customers. Telecommunications firms propose bundles that combine internet, landlines and mobile phone and television. Economides, Seim and Viard (2005) evaluate the impact of a new entrant in the local residential phone market in New York city on consumers' surplus. Thus, this study aims to show the entry effects of the two most important firms (AT&T and MCI) in competition into the telecommunications market.

## 5.1 Bundling in energy sector

Empirical studies such as that of Bernard, Bolduc and Bélanger (1996) focus on energy necessary for space heating. Bernard, Bolduc and Bélanger (1996) study residential

[3] Reinsinger (2006) shows that duopolists have an incentive to follow a mixed bundling strategy but that the consequences of such a choice on profits are ambiguous. In a duopolistic situation, for heterogeneous consumers (*i.e* if those whose reservation values are negatively correlated) bundling reduces consumer heterogeneity. Contrary to a monopolistic situation, there is an increase in competition which results in lower prices and profits. In this case, firms are in a prisoner's dilemma and they can earn higher profits by following an independent pricing strategy. On the other hand, if consumers are homogeneous (*i.e* if reservation values are positively correlated), the optimal strategy is a bundling one.

demand for electricity in Quebec through a microeconometric approach[4]. They show that households have moved towards bi-energy offer in order to satisfy space heating needs. Therefore, it seems relevant that firms provide bundles including more than one energy source. The Bernard, Bolduc and Bélanger model mixes a discret-continuous decision framework which allows interrelationships between decisions on electricity-related durable holdings and those on usage. The model is a two-stage game as Dublin and McFadden (1984). At the first stage, decisions about space and water heating system are modelled on a multinomial probit framework (MNP). In the second stage, ordinary least squares are used to estimate the electricity demand depending on the heating system chosen. From the sub-sample analyzed, it emerges that 96% of households choose electric water heating and 80% made electricity their unique heating source. If dual energy (energy that relies mostly on electricity and to a lesser extent on oil) is added to electricity, some 90% of the households within the sample used mostly electricity for space heating.

Bernard, Bolduc and Bélanger study decision variables for the different options offered. Notably, they conclude that the greater the age of the head of the household, the more the consumers' choice will move towards bi-energy consumption. Contrary to this fact, the lower the age of the head of the household, the more likely it is that wood will be chosen. Population density is also an explicative variable in consumers' choice. Indeed without surprise, an increasing population density improves the incentive to choose the gas option. Similarly, the more urban an area, the more likely it is that the wood option will be preferred.

In order to understand the time effects over heating system choices, we must know that electric heating systems have a low investment cost and a high operating cost. On the other hand, gas heating systems have a high investment cost and a low operating cost. For this reason, in cold climate electric heating systems are less attractive. In this model, Bernard, Bolduc and Bélanger find interest in switching costs for a new source of energy rather than electricity. It appears that for a recent date of switching, the choice of a gas heating system is less probable and a wood option is preferred. These results conform to what is expected.

[4]The study carried on Hydro-Québec in 1990.

To conclude, as the number of persons per home, the number of rooms, and the size of a residence increases, more electricity is used. So an increasing of population density increases electricity consumption. Electricity consumption is positively correlated with the age of the household head. Homeowners use less electricity than renters. Finally, electricity consumption has a small but significant relation with income. Overall, the price and income elasticity estimates are low, as is expected when the focus is on short-term use.

After having shown that consumers use more than one source of energy to satisfy their heating needs, and consequently the profitability of bundling in energy sector, the following subsection discusses the use of bundling in the telecommunications sector.

## 5.2 Nonlinear pricing and bundling in telecommunications sector

Similar to the energy sector, bundling is also widespread in the telecommunications sector. More and more telecommunications companies offer bundles which include, but is not limited to the following services: "Triple play" packages which offer internet, telephone and multi-channel services and the "Quadruple play" packages which offer mobile phone service in addition to the triple play components. The local residential phone service proposes to consumers a menu of binomial tariffs, that is with a fixed fee which represents the rental plus a variable part based to uniform price and depending on quantity purchased. Recent studies show that, with greater acceptance of competition in the telecommunications sector, there is an increase in competition, but also a greater variety of the products offered. Firms choose to sell several goods together in a single package and set tariffs that differ among bundles.

Economides, Seim and Viard (2005) evaluate the impact of new entrants in the New York residential phone market on consumers' surplus. Their study aims to develop a method that allows them to estimate a discret-continuous model based on data only concerning households. The competition among firms for local residential phone service is an important focus of the Telecom Act (1996), and this study aims to show the entry effects of the two most strongest firms in competition in this market. The results apply

to the third quarter of 1999 through the first quarter of 2003.

Economides, Seim and Viard (2005) develop a model that considers both tariff choice decision (discret choice) and choice of consumers' consumption level (continuous choice). To allow for differentiation between providers, they introduce an unobservable quality variable for each firm. Basing their research on optimal levels of household consumption, they compare indirect utility in order to determine tariff choice (discret) for calls. In their study, the potential entrants of interest in the telecom market are *AT&T* and *MCI*. These two companies jointly provided 85% of the residential telephone service provided by entrants at the end of 2001. Economides, Seim and Viard also focus on incumbent firms such as Verizon, Citizens Telecommunication and Rochester Telephone because these firms represent a 97% share of the residential service providers.

Economides, Seim and Viard consider four relative effects due to the entry of rivals in the market on consumers' surplus. First, there is a "price effect" that is a transfer to firms on consumers. With the entry of new competitors, the first observed effect is a fall in the prices of goods. The second effect is a "quantity effect" due to a difference in prices between incumbents and new entrants. Thus, this switch entails a demand quantity response. Moreover, firms can offer specialized services. This third effect termed the "quality effect" is positive from the consumers point of view because it increases the diversity of products. This effect has a positive influence on consumers' surplus. Lastly, households can have an incentive to purchase bundles with separate services charged to a single bill, if they will swich to an entrant that also serves as their long-distance provider. This "convenience effect" constitutes the last category of effects in relation to consumers' surplus. This effect has a positive influence on consumers' surplus but also on firms' profit. The estimation of utility function allows us to evaluate the importance of price effect, quantity, quality and convenience ones in relation to rival entry on local phone market.

The results of Economides, Seim and Viard show that on average, consumers receive a price discount due to the introduction of firms that provide local phone service, most notably entrants such as *AT&T* and *MCI*. Their results also show that if we only consider price effect, households that switch to *AT&T* save on average 4.3% in comparison with

those that remain customers of Verizon, the incumbent provider (this excludes the quantity effect). However, with the observed and unobserved quality effect, the average saving is only 1.9% for households that choose *MCI*. Focusing only on the changing behaviour of individual households, they conclude that obvious that the observed and unobserved firms' quality plays an important role on firms' decision choice (discret). However, they did not find relevant evidence for consumers' demand uncertainty or that consumers make mistakes by choosing their providers. The authors quantify gains of quality welfare and global welfare gains to entry at 10.2% and 19.3% respectively.

The bundling of services together (notably local and long-distance telephone service) by the same provider is relevant for two reasons. First, entrants offer discounts to consumers that choose two services from the same firm. During the considered period, this discount amounts to 1$ for *AT&T* and 4.95$ for *MCI.* This discount is included in price effect. Then, households attach importance to having a single bill for both services rather than two separate bills.

In general, households have better perceptions of the quality of service provided by entrants in comparison to service provided by incumbents. Households that have switched during the last year are more likely to switch to *AT&*T or *MCI*, whereas those who already received a single bill from Verizon are less likely to switch to one of the entrants. This pattern is consistent with some households who have a high valuation for single bills for local and long-distance service. Households that have *AT&T* as their long-distance provider are significantly more likely to switch to *AT&T* for local service and not to *MCI*. Households that have *MCI* as their long-distance provider are significantly more likely to switch to *MCI* for local service but not to *AT&T*. The advantage of having a bundle via a single bill is that consumers have an incentive to choose the same local and long-distance service provider. As a result, bundling can ultimately increase firms' profit.

The analysis of Economides, Seim and Viard shows that an incumbent's pricing strategies are not influenced by potential rival entry. Thus, this assumes that the regulatory authorities would not switch an incumbent's pricing absent the introduction of entrants as local telephone service providers.

# 6 Conclusion

Bundling strategies are present in several markets and serve as useful tools for increasing firms' profits. However, studies have shown that increased profits are dependent on the correlation of consumers' reservation values. This paper shows that in a monopolistic environment, bundling reduces consumers' heterogeneity in order to capture the maximum surplus amount. This effect is called "the sorting effect". Accordingly, the dominant strategy for a monopolist is to sell its goods under a mixed bundling strategy and to capture more consumers' surplus if the correlation of consumers' values is negatively correlated. However, if the correlation of consumers' reservation values is positive, a monopoly would do well to sell its products under an independent pricing strategy because prices are higher and greater profits will therefore be earned.

When competition increases in only one market, it has been proven that bundling serves as an effective entry-deterrent strategy. Indeed, as illustrated by the Whinston and Nalebuff model, a firm in monopoly situation in one market and in competition in another market can exclude the mono-product rival to the competitive market by bundling its goods together. Nevertheless, when competition is increased in both market, there is an additional effect that goes against the sorting effect from the firms point of view: it is the competitive one. When duopolists commit to a pure bundling strategy, this commitment leads to fierce competition as goods are available only under a package form. Since firms compete in prices, the exclusive sale of bundles results in a higher level of competitive intensity. This situation leads to a decrease in duopolistic profits. Anderson and Leruth (1993) show that an independent pricing strategy is a dominant one for duopolies that provide complementary goods. However, Economides (1993) finds that bundling strategy is a Nash equilibrium and for firms that are in a prisoner's dilemma situation, they would do well to abandon a bundling strategy and to sell their goods separately. Reisinger (2006) show that if correlation of consumers' reservation values is negative firms have an incentive to use a bundling strategy but there is a prisoner's dilemma situation. However if the correlation of consumers' reservation values is positive then firms follow a bundling strategy and profits are higher.

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