Available online at www.sciencedirect.com
ScienceDirect
International Journal of Industrial Organization
26 (2008) 41 – 58
International Journal of Industrial Organization
www.elsevier.com/locate/econbase

Bundling may blockade entry ☆

Martin Peitz

International University in Germany and University of Mannheim, 76646 Bruchsal, Germany

Received 18 October 2005; received in revised form 19 September 2006; accepted 28 September 2006
Available online 21 November 2006

Abstract

I consider bundling of two products as a strategy to avoid entry in a differentiated product market. I construct a simple model in which the potential entrant can offer a differentiated product to one of the incumbent's products. I show that the incumbent optimally bundles irrespective of entry. For a given entry decision, the incumbentís gains are small compared to the entrant's loss; its gains are substantial when the bundling induces the potential entrant not to enter the market. In this case bundling blockades entry and reduces welfare.

JEL classification: L12; L41

Keywords: Tying; Entry deterrence; Predation; Bundling; Leverage theory; Horizontal foreclosure; Monopolization

1. Introduction

Product bundling is a widespread phenomenon. Advocates of bundling claim that firms and society at large often reap benefits from bundling. In particular, bundling allows firms to make a set of products more equally attractive to many buyers, whose valuations differs widely for each single product in the bundle. In this respect bundling is simply part of business strategy, which is often welfare improving as it increases the total number of units sold.[1]

The above argument essentially takes market structure as given. However, antitrust authorities have scrutinized bundling as a business practice and mergers that would lead to bundling on the

☆ This paper has benefitted from comments by an anonymous referee, Jay Pil Choi, Bruno Jullien, and Patrick Rey as well various as conference and seminar audiences.

E-mail address: Martin.Peitz@i-u.de.

[1] Concerning only consumer surplus, bundling may appear however in a less positive light because it may be used as a price discrimination device to extract more surplus from consumers.

0167-7187/$ - see front matter
doi:10.1016/j.ijindorg.2006.09.005

ground that bundling may affect market structure: bundling is accused to be an instrument to induce exit and deter or blockade entry.[2] Prominent recent cases include the Microsoft cases in the U.S. and Europe.

Suppose that several markets are dominated by a single firm, which is called the incumbent. Following the argument from above, bundling is then likely to be welfare improving under monopoly. In particular, the total number of units sold is likely to increase with bundling. This implies that bundling by a dominant firm is not a worry by itself. Therefore, the antitrust authority has to build a strong case against bundling. A strong case can be made against bundling if the following three conditions are met:

Condition 1 Bundling is the preferred business strategy of the incumbent. In other words, bundling does not require commitment.

Condition 2 Entry is unlikely under bundling but likely under independent selling. In other words, bundling significantly reduces the potential entrant's profits and entry costs are likely to fall within the critical range such that entry only takes place under independent selling. Similarly, bundling is likely to lead to exit whereas independent selling does not.

Condition 3 Monopoly bundling reduces welfare compared to competitive independent pricing (where welfare refers to total consumer and producer surplus).

Suppose independent pricing is likely to lead to entry. However, if bundling is allowed, Condition 1 implies that an incumbent will in any case use bundling. Condition 1 makes bundling credible. Condition 2 then implies that an incumbent who bundles is likely to be successful in avoiding entry. According to Condition 3 prohibiting bundling then results in a welfare gain. To summarize the argument, the availability of bundling blockades welfare-increasing entry. I propose that antitrust authorities should check whether conditions 1 to 3 are likely to be satisfied. If the answer is 'yes' the antitrust authority should intervene in the bundling practice or the proposed merger leading to such bundling, if codes of conduct are difficult to implement.

If Condition 1 is violated given entry but Condition 2 holds, an incumbent firm may have an incentive to use bundling as an entry deterrent but to do so it must have (i) the power to commit to bundling[3] and (ii) in this case have a good estimate about the potential entrant's entry costs and other factors which determine the entrant's profit. In an uncertain environment it is thus questionable whether bundling is a powerful entry deterrent even if the incumbent can commit to it. I therefore consider Condition 1 to be an important element in an antitrust analysis involving bundling.

If bundling increases the entrant's profit so that Condition 2 is violated, entry is facilitated. However, with respect to leverage of market power, market conditions may be such that a monopolist in one market may have an incentive to enter new markets using bundling and that the firms active in these market then have an incentive to withdraw from these markets. This suggest that while Condition 2 has to be satisfied to prove the danger of insufficient entry, arguments based on the leverage of market power do not rely on it.

---

[2] The antitrust authorities may want to refrain from imposing codes of conduct such as independent selling of all products and therefore prohibit a merger in the first place.

[3] Note, however, that even if bundling is not credible in a static context it may be of concern for antitrust authorities because reputation concerns may make it credible in a dynamic context.

If monopoly bundling increases welfare compared to competitive independent pricing so that Condition 3 is violated, successful monopolization is beneficial to society from a welfare-perspective. If this is the case, it seems difficult to justify the prohibition of bundling or a merger leading to bundling. Only if the antitrust authority has a different objective function, for instance that it gives a larger weight to consumer surplus, can it possibly justify the prohibition of bundling when Condition 3 is violated.

The proposed test seems to be a high hurdle to take but if the antitrust authority has good reasons to believe that all three conditions are met, it has a strong case to intervene. From a theoretical perspective the question is how a market may look like such that these conditions are met. Or, put as a more skeptical question, is it possible that all three conditions are met simultaneously? The modest goal of this paper is to show that the answer to this latter question is affirmative: I construct a simple model with pure bundling in which all three conditions are met. The model has the property that the use of bundling is profit and, under no entry, total surplus-increasing in the absence of any strategic considerations because the bundle is profitably sold at a discount compared to the price that would be set under independent pricing.[4] Variations of this simple model also show, when some of the conditions fail to hold.

1.1. Related literature

Several papers have analyzed the discounting effect of bundles under pure or mixed bundling in monopoly (see Adams and Yellen, 1976; Schmalensee, 1984; McAfee et al., 1989).[5] These works can be seen as a defence of bundling as a business practice in the tradition of the Chicago Law School as it tends to increase welfare, at least if marginal costs are sufficiently low.

There are a number of papers that consider bundling and entry. Two closely related papers are Whinston (1990) and Nalebuff (2004).[6] Whinston (1990, section I) shows that in situations in which bundling is not attractive under a given market structure it may still be the preferred business strategy if the incumbent can induce exit or deter entry. Bundling here requires the commitment of the firm to bundle. If the predicted market structure does not materialize the incumbent is stuck with a privately suboptimal business strategy. In other words, Condition 1 is violated. In general, welfare effects are ambiguous.[7]

[4] This paper does not consider bundling of complements, which played an important role in another high-profile case, the proposed merger between GE and Honeywell. In this case the European Commission applied the test consisting of the three conditions stated above (see e.g. Nalebuff, 2003). In particular, the Commission found that bundling was credible and would lead to exit by rival firms. However, the welfare effect of the proposed merger was not satisfactorily addressed.

[5] As Bakos and Brynjolfsson (1999, 2000) show, bundling of *information goods* can allow a firm to better extract the surplus from consumers.

[6] Recent contributions have also looked at bundling from a dynamic perspective. Carlton and Waldman (2002) show how bundling or tying can be used to preserve market power and to extend it into adjacent markets. In particular, they consider a two-period model with complementary products. In the first period a firm enjoys monopoly power in the primary market. They show that tying and foreclosure can increase its future profits by deterring entry of efficient firms. Choi (1996, 2004) shows that tying can be a profitable strategy because of its long-term effects on competition through innovation. Further dynamic analyses include Choi and Stefanides (2001, in press).

[7] Whinston discusses the various effects of bundling on welfare in his basic model with homogeneous preferences for the monopoly good. However, in his model with heterogeneous preferences for the monopoly good, which is also the feature of my model, a welfare analysis is missing.

Nalebuff (2004) considers a model similar to the one of this paper. The main difference is that in his model the entrant's and one of the incumbent's products are perfect substitutes. His main part considers sequential price setting where the entrant is the follower. He demonstrates that the incumbent can avoid entry through bundling, in particular Conditions 1 and 2 are satisfied.[8] However, this is *not* robust to a change in the timing of the game such that both firms simultaneously set prices. In his Section III.E Nalebuff demonstrates that bundling is an instrument to control the competitor's profit while significantly extending own profit if entry does not take place. This makes it an effective instrument to leverage market power but independent selling is more effective in avoiding entry because this completely wipes out the entrant's profit. Therefore, bundling facilitates entry.[9] In other words, Condition 2 is violated. Hence, with simultaneous price setting the two papers mentioned above do not provide a theoretical foundation for the antitrust authority to rule out bundling on the grounds of Conditions 1–3.[10]

The present paper builds on the models by Whinston (1990) and Nalebuff (2004). Both consider the bundling of two products. I construct a model with the property that the outcomes under monopoly are identical to the ones by Nalebuff. I then follow Whinston (1990) assuming that the entrant offers a differentiated product. For simplicity and ease of comparison, my model is specified such that under independent pricing the incumbent's prices and profit are not affected by entry. This leaves bundling under competition as the novel case. The model is rich enough to allow for a variety of consumer patterns. In particular, in equilibrium, some consumers buy the incumbent's bundle as well as the entrant's stand-alone product. Such behavior does not occur in previous work.

My findings provide a theoretical basis for the proposed test consisting of Conditions 1–3: first, bundling is the preferred business strategy; second, entry is blockaded when bundling is allowed; and third, welfare is lower under monopoly bundling than under competitive independent selling. This shows that bundling can be anti-competitive and welfare reducing.

The plan of the paper is as follows. In Section 2 I present the model. In Section 3 I analyze the pricing, the entry decision, and the choice of selling policy in a market with potential entry. In Section 4 I provide welfare results. Section 5 discusses some variations of the model and concludes.

2. The model

2.1. The setup

Following Whinston (1990) and Nalebuff (2004) I consider a market with two products, A and B. Product A is provided by only one firm, firm 1. Product B may also be provided by firm 2. In line with Whinston (1990) but different to Nalebuff (2004) product market B is assumed to be differentiated: firm 1 offers variety B1 and firm 2 may offer variety B2. Varieties are horizontally differentiated. Consumers are interested in consuming exactly one unit of A and/or one unit of B. Products A, B1, and B2 are produced at zero marginal costs.

[8] Note that due to the nature of sequential price setting Condition 3 is violated.

[9] Similarly, in Carbajo, de Meza, and Seidman (1990) and Chen (1997) bundling is a product differentiation strategy which relaxes price competition.

[10] This statement needs one qualification. While Whinston (1990) focuses his analysis on the case where commitment is required and entry is deterred, he points in his section II to the possibility of tying as a device to facilitate entry or to avoid entry in the absence of commitment. The present paper can therefore be seen as complementing Whinston's article on the latter issue.

There is a unit mass of consumers. Consumers are uniformly distributed on the unit square. A consumer is of type $(\alpha, \beta) \in [0, 1]^2$. If α is large she is willing to pay a high price for product A. If β is large she is willing to pay a high price for product B1 but a low price for product B2. If β is small the reverse holds. A consumer's purchasing decision for the three products is a vector $(a, b_1, b_2) \in \{0,1\}^3$. If the three products are sold at prices p_A, p_{B1}, and p_{B2} respectively, the indirect utility of consumer (α, β) is

$$v(a, b_1, b_2) = a(\alpha - p_A) + \max\{b_1[\beta - p_{B1}], b_2[(1-\beta) - p_{B2}]\}.$$

Hence, product A gives valuation α to consumers of type α. If products A and B1 are not bundled, consumers make a discrete choice between products B1 and B2. They may also decide not to consume product B. Consuming one unit of product B1 gives a valuation $1-(1-\beta)$, where $1-\beta$ is the disutility associated with not obtaining the ideal version of product B. Correspondingly for product B2. Suppose firm 1 only offers the bundle of products A and B1 at price $\bar{p}$. Consequently, $b_1 = a$ and the indirect utility of consumer (α, β) is

$$v(a, a, b_2) = a(\alpha - \bar{p}) + \max\{a\beta, b_2[(1-\beta) - p_{B2}]\}.$$

Note that in this case a consumer may purchase all three products A, B1, and B1 although one of the varieties is useless for her.

The model is specified so as to give exactly the same outcome as Nalebuff's analysis in case of monopoly. In addition, parameters are chosen such that firms are symmetric in the differentiated product market and are local monopolists for products B1 and B2 under separate selling. The analysis of this latter case is straightforward. This means that the only more involved case to be analyzed in detail is competition with a bundle.

Reduced profit by firm 1 depends on the selling policy by firm 1, s and the entry strategy of firm and 2, e. It is denoted by $\pi_1(s, e)$. Similarly, denote $\pi_2(s, e)$ firm 2′s reduced profit gross of entry costs. The selling policy is either bundling, $s = b$, or independent selling, $s = i$; the entry strategy of firm 2 is to enter, $e = 1$, or not to enter, $e = 0$.

2.2. The entry game

I will consider the following entry game:

Stage 1 Firm 2 decides whether or not to enter, $e \in \{0,1\}$. If it does enter, it pays the cost F.
Stage 2 Firm 1 decides whether or not to bundle products, $s \in \{b,i\}$.
Stage 3 Firms simultaneously set prices.

According to the timing of the game, firm 1 cannot commit to bundling or independent selling before entry can take place. This means in particular that a deterrence device, which relies on commitment, does not work under this setting.[11] I characterize the subgame perfect equilibrium of this game and compare this to the subgame perfect equilibrium of the game in which at stage 2 firm 1 is forced to sell its products independently (which is anticipated by firm 2 at stage 1).

[11] If stages 1 and 2 are reversed, firm 2 does not enter in subgame perfect equilibrium if the following holds: $\pi_1(b,0) > \pi_1(i,1)$ and $F > \pi_2(b,1)$. Note that the difference between blockaded and deterred entry is easily illustrated. Entry is deterred, in particular, if in addition $\pi_1(b,1) < \pi_1(i,1)$; it is blockaded if bundling is a dominant strategy. Under deterred entry Condition 1 is violated. Then the equilibrium outcome is not robust to reversing the order of stages 1 and 2.

2.3. Firm exit: a reinterpretation of the model

Alternatively one may want to analyze situations of firm exit. For instance, when two firms, one producing product A and the other product B1 merge, the concern of the antitrust authority is that bundling may lead to exit of the firm producing product B2 (which leads to a welfare loss). Consider the game after the merger has been cleared and suppose that at stage 1 firm 2 decides whether to exit or stay in the market. Here, if F constitutes a fixed cost the concern is that bundling reduces firm 2′s profit so that, after the merger has been cleared, it decides to exit because $\pi_2(i,1) > F > \pi_2(b, 1)$.

3. Pricing and entry

At the pricing stage (stage 3) four different subgames have to be analyzed: (1) independent selling by a monopolist, (2) monopoly bundling, (3) competitive independent selling, and (4) competitive bundling.

3.1. Independent selling by a monopolist

Suppose A and B1 are sold separately. This implies that the two goods are priced independently. Profit maximizing prices are $p^*_{\mathrm{A}}(i,0) = p^*_{\mathrm{B1}}(i,0) = 1/2$. Thus all consumers with $\alpha \geq 1/2$ buy product A and all consumers with $\beta \geq 1/2$ buy product B1. Those consumers who buy both products pay the price $\overline{p}(i,0) \equiv p_{\mathrm{A}}(i,0) + p_{\mathrm{B1}}(i,0) = 1$ for both products. Firm 1's profit is $\pi^*_1(i,0) = 1/4 + 1/4 = 1/2$.

3.2. Monopoly bundling

Products A and B1 are sold as a bundle. As has been shown by Nalebuff (2004) in the present context and earlier by McAfee, McMillan, and Whinston (1989) as a more general result, the monopolist prices the good at a discount compared to independent prices.

For $\overline{p} \leq 1$ the profit of the firm is

$$\pi_1(b,0) = \overline{p}(b,0)\left(1 - \frac{\overline{p}(b,0)^2}{2}\right).$$

Profit maximization leads to the first-order condition $1 - \frac{3}{2}\overline{p}^*(b,0)^2 = 0$. The maximizing price then is $\overline{p}^*(b,0) = \sqrt{2/3} \approx 0.82 < 1$. This means that the monopolist chooses a price which is lower than the combined price under separate selling. Consumers with $\alpha + \beta \geq \sqrt{2/3}$ buy both products, all other do not buy. Compared to independent selling, some consumers now buy the bundle who only bought one or none of the products under independent selling but there also exist consumers who would have bought one of the products under independent selling but refrain from buying under monopoly bundling. Note that if the bundle was sold at a price of 1 the same total number of units would be sold. Consequently, since the bundle is sold at a discount more units are sold. The monopolist's profit is $\pi^*_1(b,0) = (2/3)^{3/2} \approx 0.544 > 0.5$. This shows that bundling increases profit although the valuations for the two products are not correlated.

3.3. Competitive independent selling

Under independent selling, firms are local monopolists for products B1 and B2, respectively, where the marginal consumers who are indifferent between buying B1 and not buying are also marginal consumers who are indifferent between buying B2 and not buying. In other words, the areas of demand for B1 and demand for B2 just touch. Both firms are symmetric in market B and set prices $p^*_{B2}(i,1)=p^*_{B1}(i,1)=1/2$. Thus all consumers buy either product B1 or B2; those with $\beta>1/2$ buy product B1 and those with $\beta<1/2$ buy product B2. The price for product A and associated demand is the same as under monopoly since firm 1′s position is not contested in market A, $\pi^*_1(i,1)=\pi^*_1(i,0)=1/2$. Firm 2′s profit is $\pi^*_2(i,1)$. In this model competition does not affect the profit of firm 1 under independent selling because products B1 and B2 are sufficiently differentiated so that market areas of the firms touch. The model can thus be seen as the limit case of imperfect competition between B1 and B2, as products become more differentiated. The opposite limit case has been analyzed by Nalebuff (2004): he assumed that B1 and B2 are perfect substitutes (see Section 5).

3.4. Competitive bundling

When products A and B1 are sold as a bundle and product B2 is sold by a competitor, there are up to four different groups of consumers:

- consumers who buy only product B2, i.e., (0, 0, 1) is preferred,
- consumers who buy the bundle consisting of products A and B1, i.e., (1, 1, 0) is preferred,
- consumers who buy the bundle consisting of products A and B1 as well as product B2, i.e., (1, 1, 1) is preferred,
- consumers who do not buy, i.e., (0, 0, 0) is preferred.

I introduce the following notation: $\tilde{\alpha}\equiv\overline{p}$, $\hat{\alpha}\equiv p_{B2}-(1-\overline{p})$; $\tilde{\beta}\equiv(1-p_{B2})/2$; $\hat{\beta}\equiv 1-p_{B2}$; $\overline{\beta}\equiv\overline{p}$. Consumer choice is represented in Fig. 1. Consumers (α, β) with $0\leq\alpha\leq\tilde{\alpha}$ are indifferent

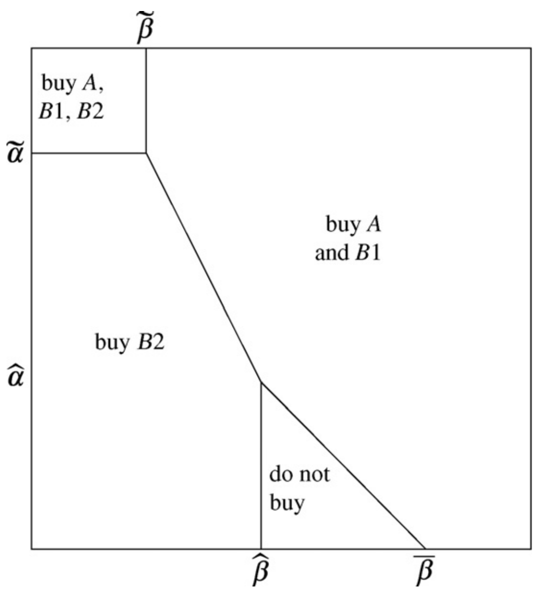

Fig. 1. Consumer choice under competitive bundling.

between (0, 0, 1) and (1, 1, 1). Consumers ($\tilde{\alpha}$, β) with $0 \leq \beta \leq \tilde{\beta}$ are indifferent between (1, 0, 0) and (1, 1, 1). Consumers (α, β) with $\alpha = \lambda\tilde{\alpha} + (1-\lambda)\hat{\alpha}$ and $\beta = \lambda\tilde{\beta} + (1-\lambda)\hat{\beta}$ where $\lambda \in [0,1]$ are indifferent between (0, 0, 1) and (1, 1, 0). Consumers (α, $\hat{\beta}$) with $\alpha \leq \hat{\alpha}$ are indifferent between (0, 0, 1) and (0, 0, 0). Finally, consumers (α, β) with $\alpha = \lambda\hat{\alpha} + (1-\lambda)\overline{\alpha}$ and $\beta = \lambda\hat{\beta}$ where $\lambda \in [0, 1]$ are indifferent and between (1, 1, 0) and (0, 0, 0). If $0 < \overline{p} < 1$, $p_{B2} < 1$ and $1 < \overline{p} + p_{B2}$ each of the four groups of consumers has positive mass. In particular, consumers with (α, β) such that $\alpha > \tilde{\alpha}$ and $\beta > \tilde{\beta}$ buy products A, B1, and B2. This means that consumers in the square in the northwest corner of Fig. 1 buy all three products. Consumers in the triangle in the south do not buy. In the remaining area in the west consumers buy product B2; in the remaining area in the east consumers buy products A and B1.

Profits can then be written as

$$\pi_1 = \left[(1-\hat{\beta}) - \frac{1}{2}\hat{\alpha}(\overline{\beta} - \hat{\beta}) + \hat{\beta}(1-\tilde{\alpha}) + \frac{1}{2}(\hat{\beta} - \tilde{\beta})(\tilde{\alpha} - \hat{\alpha})\right]\overline{p} \tag{1}$$

$$\pi_2 = \left[\tilde{\beta}(1-\hat{\alpha}) + \hat{\beta}\hat{\alpha} + \frac{1}{2}(\hat{\beta} - \tilde{\beta})(\tilde{\alpha} - \hat{\alpha})\right]p_{B2},$$

where the terms in the square brackets are the mass of consumers buying the bundle or product B2, respectively. These terms depend on both prices, $\overline{p}$ and p_{B2}. First-order conditions of profit maximization can be written as

$$\frac{1}{4}(3 - 6\overline{p}^2 + 2p_{B2} - p_{B2}^2) = 0$$

$$\frac{1}{4}(1 + 2\overline{p} - 4\overline{p}p_{B2} - 3p_{B2}^2) = 0$$

Note that firm 2's best response is decreasing in the price of the bundle. Note also that firm 1's profit-maximizing price lies below the equilibrium price (which is the same as the monopoly price) under independent selling. The reason behind the first observation is that as firm 1 lowers its price, firm 2 faces more difficulties in counteracting and therefore settles for a higher price giving up demand. The incentives for firm 1 are different: Its best response is increasing in firm 2's price. Its price is below the monopoly price under bundling. The reason for the second observation then is that a higher price for variety B2 allows firm 1 to price less aggressively settling for a price closer to the monopoly price under bundling.

In equilibrium, prices are $\overline{p}^*(b,1) \approx 0.795$ and $\overline{p}_{B2}^*(b,1) \approx 0.540$. Equilibrium profits are $\pi_1^*(b,1) \approx 0.502$ and $\pi_2^*(b,1) \approx 0.194 - F$. Consumer choice in equilibrium is represented by Fig. 1.

3.5. Comparison of different regimes

Bundling commits the incumbent to price more aggressively under competitive than under monopoly bundling. For the effect to hold, it is sufficient to show that firm 1's profit given by Eq. (1) satisfies

$$\left.\frac{\partial \pi_1(\overline{p}, p_{B2})}{\partial \overline{p}}\right|_{\overline{p} = \overline{p}(b,0)} < 0$$

for any price p_{B2} which affects firm 1's profit. This expression is equivalent to $(1 - p_{B2})^2 > 0$, which is always satisfied. Note that since $\overline{p}(b,0) < p_A(i,1) + p_{B1}(i,1) = \overline{p}(i,1)$, firm 1 also prices more aggressively under bundling than under independent selling (with or without entry).

Table 1
Firm 1 and firm 2's profit

	Monopoly	Entry
Independent selling	0.50, 0	0.500, 0.250 − F
Bundling	0.54, 0	0.502, 0.194 − F

Concerning profits, Table 1 reports equilibrium profits in the four different pricing subgames. A number of observations can be made. First, competition (weakly) reduces firm 1's profit. In other words, firm 1 is interested in avoiding entry. Second, since bundling reduces firm 2's profit after entry, firm 2 would enter under independent selling but not under bundling on a certain range of entry costs. Hence, Condition 2 is satisfied to the extent that entry costs are likely to fall within this range. Third, firm 1 is better off under bundling than under independent selling independent of the entry decision. This means that bundling is a dominant strategy and Condition 1 is satisfied. Hence, bundling does not suffer from the commitment problem which arises in the model by Whinston (1990); for a discussion see Rey and Tirole (in press). Fourth, the gain from bundling in the event of entry is miniscule for firm 1 while imposing a significant reduction in profit on firm 2. More precisely, firm 1's gain from bundling corresponds to half a percent given entry (and 8% given no entry). The effect of bundling on firm 2's profit is more pronounced: Firm 2's profit decreases by around 25% when firm 1 adopts bundling instead of independent pricing. This makes bundling an effective strategy to "blockade" entry. I can now state the following proposition.

Proposition 1. *For entry costs $F \in (0.194, 0.25)$ firm 2 enters if firm 1′s products have to be sold independently but does not enter if bundling is possible.*

Proof. It has to be shown that for $F \in (0.194, 0.25)$ bundling "blockades" entry, i.e. $e=0$ in subgame perfect Nash equilibrium, whereas $e=1$ if firm 1 is constrained to sell its products independently. As reported in Table 1, $\pi_2(i,1)=0.25$. Hence, for $F<0.25$ firm 2 enters in a market environment in which independent selling prevails. With bundling firm 2′s profit (if it enters) is $\pi_2(b,1) \approx 0.194$. Hence, for $F \in (0.194, 0.25)$ firm 2 enters if it expects independent selling whereas it does not enter if it expects bundling by firm 1. As reported in Table 1, bundling is a dominant strategy in the game in which profits at the third stage are replaced by the equilibrium values in each subgame. In particular, if firm 2 enters firm 1's profit satisfies $\pi_1(b,1) > \pi_1(i,1)$. Hence, if firm 2 enters firm 1 will bundle. Since in subgame perfect equilibrium firm 2 rationally anticipates this action, it is profit-maximizing for firm 2 not to enter if $F>0.194$. □

3.6. Uncertain entry costs and the prohibition of bundling

Consider the case that entry costs are uncertain. If entry costs fall within the range [0.25, 0.5] entry is never worthwhile. If entry costs are on the other hand sufficiently low, that is $F \leq 0.194$ entry will always take place. In the intermediate interval it depends on whether firm 1 sells a bundle or independently. For illustration, suppose that entry costs are uniformly distributed on [0.15, 0.35] and are therefore symmetric around 0.25. Then, if bundling is forbidden, entry takes place when $F \leq 0.25$. Hence, with probability 50% entry does take place. If bundling is allowed firm 1 will always use it. Then only with probability 22% will entry take place. This illustrates that from an ex ante point of view (where entry costs are uncertain) the legality of bundling can drastically affect market outcomes: Bundling makes entry much less likely.[12]

4. Welfare analysis

Bundling in a market with potential entry should only raise antitrust concerns if bundling reduces welfare compared to independent selling. In general, one source of inefficiency from bundling stems from the purchase of products for which a consumer derives little or no value but are costly to produce; in particular, in our model it would be socially costly for a consumer to purchase all three products since either B1 or B2 does not contribute to her surplus.[13] Clearly, in the present context with zero marginal costs this source of inefficiency has been effectively eliminated so that there is never an overconsumption of the bundled products: consumers derive a (weakly) positive value for each product so that it is socially desirable that each consumer consumes products A and B. In addition, for a welfare analysis, where welfare is equal to total surplus, it is irrelevant whether consumers purchase both products B1 and B2 or only the one which is preferred.

Denote welfare by $W(s,e)$. I will show that $W(i,1) > W(b,1) > W(b,0) > W(i,0)$. This means that, given entry, independent selling is socially desirable. As I have shown in the previous section, entry is more likely if bundling is not an available option for firm 1. In such case the relevant welfare comparison is $W(i,1) > W(b,0)$, which makes independent selling even more attractive from a welfare perspective. This reverses the monopoly finding that bundling increases welfare. It confirms the view that the defense of bundling in the Chicago tradition is fragile: welfare effects arise mainly from fewer competitors, the non-strategic effect of bundling on welfare is less pronounced.

4.1. Welfare in the first-best

The first-best allocation has the property that all consumers purchase. In the first-best, welfare is max $\{1, 5/4 - F\}$, that is, if the fixed costs are sufficiently low ($F \leq 1/4$) it is socially optimal to serve all consumers with product A and their preferred variety of product B. For higher entry costs it is socially optimal that firm 1 serves all consumers with products A and B1. Clearly, neither monopoly nor duopoly can implement the first-best in the present model.

4.2. Welfare under monopoly

Under monopoly with separate selling, firm 1 sets prices $p_A = 1/2$ and $p_{B1} = 1/2$. Social welfare is therefore equal to

$$W(i,0) = \int_{1/2}^{1} \alpha \mathrm{d}\alpha + \int_{1/2}^{1} \beta \mathrm{d}\beta = 3/4 = 0.75.$$

[12] Note that if we reverse stages 1 and 2, and if the level of the entry cost F is realized after the bundling decision, firm 1 has to cope with uncertain entry costs. Since we have shown that bundling is a dominant strategy (so that Condition 1 holds), however, firm 1's profit maximizing decision does not depend on prevailing entry costs. This provides a rationale to require Condition 1 even when firm 1 has commitment power.

[13] It is also socially costly if consumers buy the bundle but have a valuation below costs for one of the products in the bundle.

Under monopoly with bundling, the monopolist sets the price for the bundle $\overline{p} = \sqrt{2/3}$. Note that the density is γ for consumers with a total gross surplus between 0 and 1 whereas it is $2-\gamma$ for consumers with a total gross surplus between 1 and 2. Social welfare is therefore equal to

$$W(b,0) = \int_{\sqrt{2/3}}^{1} \gamma^2 \mathrm{d}\gamma + \int_{1}^{2} \gamma(2-\gamma)\mathrm{d}\gamma = 1 - \frac{2\sqrt{2/3}}{9} \approx 0.819.$$

4.3. Welfare under competitive independent selling

Under entry with separate selling, firm 1 sets prices $p_{\mathrm{A}}=1/2$ and $p_{\mathrm{B1}}=1/2$ and firm 2 sets price $p_{\mathrm{B2}}=1/2$. Welfare in the market for product B is maximized because all consumers either buy variety B1 or variety B2 and the market splits evenly so that total "transport costs" are minimized. Hence, for $F \le 1/4$ the difference between $W(i,1)$ and the first-best is the fact that some consumers with relatively low willingness to pay for product A do not buy this product. Social welfare is equal to

$$W(i,1) = \int_{1/2}^{1} \alpha \mathrm{d}\alpha + \int_{1/2}^{1} \beta \mathrm{d}\beta + \int_{0}^{1/2} (1-\beta)\mathrm{d}\beta - F = 9/8 - F = 1.125 - F$$

4.4. Welfare under competitive bundling

Social welfare takes the following expression under entry with bundling

$$\begin{aligned} W(b,1) = & \left\{ \int_0^{\tilde{\beta}} (1-\beta)\mathrm{d}\beta + \hat{\alpha} \int_{\tilde{\beta}}^{\hat{\beta}} (1-\beta)\mathrm{d}\beta + \int_{\tilde{\beta}}^{\hat{\beta}} \left[(1-\beta)(\tilde{\alpha}-\hat{\alpha}) \frac{\hat{\beta}-\beta}{\hat{\beta}-\tilde{\beta}} \right] \mathrm{d}\beta \right\} \\ & + \left\{ \tilde{\beta} \int_{\tilde{\alpha}}^{1} \alpha \mathrm{d}\alpha + (1-\tilde{\beta}) \int_{\tilde{\alpha}}^{1} \alpha \mathrm{d}\alpha + (1-\hat{\beta}) \int_{\hat{\alpha}}^{\tilde{\alpha}} \alpha \mathrm{d}\alpha + (1-\overline{\beta}) \int_{0}^{\hat{\alpha}} \alpha \mathrm{d}\alpha \right. \\ & \left. + \int_0^{\hat{\alpha}} \left[\alpha(\overline{\beta}-\hat{\beta}) \frac{\alpha}{\hat{\alpha}} \right] \mathrm{d}\alpha + \int_{\hat{\alpha}}^{\tilde{\alpha}} \left[\alpha(\hat{\beta}-\tilde{\beta}) \frac{\alpha-\hat{\alpha}}{\tilde{\alpha}-\hat{\alpha}} \right] \mathrm{d}\alpha \right\} \\ & + \left\{ (1-\tilde{\alpha}) \int_{\tilde{\beta}}^{\hat{\beta}} \beta \mathrm{d}\beta + (1-\hat{\alpha}) \int_{\hat{\beta}}^{\overline{\beta}} \beta \mathrm{d}\beta + \int_{\overline{\beta}}^{1} \beta \mathrm{d}\beta \right. \\ & \left. + \int_{\tilde{\beta}}^{\hat{\beta}} \left[\beta(\tilde{\alpha}-\hat{\alpha}) \frac{\beta-\tilde{\beta}}{\hat{\beta}-\tilde{\beta}} \right] \mathrm{d}\beta + \int_{\hat{\beta}}^{\overline{\beta}} \left[\beta \hat{\alpha} \frac{\beta-\hat{\beta}}{\overline{\beta}-\hat{\beta}} \right] d\beta \right\} - F \end{aligned}$$

The term in the first curly brackets is the total surplus associated with product $B2$, the term in the second curly brackets is the total surplus associated with product A, and the term in the third curly brackets is the total surplus associated with product $B1$. In equilibrium, one obtains

$$W(b,1) \approx 1.072 - F.$$

4.5. Welfare comparison

The values for social welfare are reported in Table 2. Hence, the welfare ranking is $W(i,1) > W(b,1) > W(b,0) > W(i,0)$ for entry costs sufficiently small, to be precise $F < 0.253$. In particular,

Table 2
Social welfare

	Monopoly	Entry
Independent selling	0.750	$1.125-F$
Bundling	0.819	$1.072-F$

since $W(i,1) > W(b,0)$ Condition 3 is satisfied. If firm 1 successfully avoids entry through bundling, the welfare loss (compared to an environment in which bundling is not possible) is substantial in my simple model. Recall that entry takes place under independent selling if $F \leq 0.25$. Hence, if $F \leq 0.25$, welfare under independent selling is at least 0.875 whereas it is 0.819 under monopoly bundling. This implies a welfare loss from bundling compared to independent selling of at least 11% of first-best welfare.

The main finding of this section can be stated as follows.

Proposition 2. *When the decision whether or not to bundling affects the rival's entry decision (i.e., $F \in (0.194, 0.25)$), bundling is welfare reducing.*

Proof. (i) As reported in Table 2, the condition that monopoly bundling leads to lower welfare than competitive independent selling, $W(b, 0) > W(i, 0)$, is equivalent to $F < 0.306$. (ii) As has been shown in proposition 1, the possibility to use bundling leads to $e=0$ for $F > 0.194$, whereas entry would have resulted for $F < 0.25$ if only independent selling was available to firm 1. Thus for $F \in (0.194, 0.25)$ monopoly bundling will be the outcome in the unique subgame perfect Nash equilibrium of the game, whereas competitive independent selling would have prevailed if bundling was not allowed. It thus follows from (i) and (ii) that bundling is welfare reducing. □

In other words, if the antitrust authority does not allow bundling, entry takes place and welfare is increased. In the face of uncertainty public policy, however, faces a trade-off: in the absence of entry, that is, for high entry costs, bundling is the socially preferred outcome while, if entry occurs under independent selling bundling necessarily reduces welfare. If, in addition, entry does not take place when bundling is allowed, this welfare loss is aggravated.

My welfare findings are illustrated in a particular example in which the policy maker faces uncertainty with respect to firm 2's entry cost. In particular, assume that F is uniformly distributed on [0.15, 0.35] (hence, the distribution is symmetric around 0.25).

Suppose first that bundling is prohibited. Then with probability 0.5 entry takes place and the expected entry cost conditional on entry taking place is 0.2. Hence, expected welfare in the restricted game in which the incumbent is forced to sell independently at stage 1 is $EW|i = 0.5 \cdot 0.75 + 0.5(1.125 - 0.2) = 0.8375$.

Compare this to the situation that bundling is allowed which implies that firm 1 will always bundle products A and B1. Then with probability 0.313 entry takes place and the expected entry cost conditional on entry taking place is 0.172. Hence, expected welfare is $EW = 0.687 \cdot 0.819 + 0.313(1.072 - 0.172) = 0.8368$. This means that in this example the policy maker should not allow bundling. In this example, welfare is lower under bundling only due to the exclusion of the entrant, that is due to the entrant taking a different entry decision when bundling is allowed. To see this, I compare welfare under the assumption that bundling does not affect the probability of entry. In this case bundling would lead to a gain in welfare of 0.008.

If it is sufficiently more likely that entry does not take place under independent selling, welfare gains from bundling under monopoly dominate the welfare loss that arises from bundling otherwise. In this case the policy conclusion is reversed. Hence, the optimal public policy depends on the priors of the policy maker whether bundling was used as a strategy by an unchallenged monopolist or whether it was used with the result of monopolization.

4.6. Comparison of the welfare result to previous work

Whinston (1990) provides a welfare analysis only in the model in which consumers have homogeneous valuations for good A, Nalebuff (2004) does not provide a welfare analysis for his model. However, it can easily be shown that in his setting with simultaneous pricing, welfare under competition with independent pricing is higher than under monopoly with bundling, $W(i,1) > W(b,0)$, so that Condition 3 is satisfied.[14] In the Appendix, I present a simple model in the spirit of Whinston (1990), which is a modification of the model considered in the main text, and I show that monopoly bundling reduces welfare compared to independent selling irrespective of the market structure under independent selling, so that Condition 3 is satisfied.

4.7. Multiple periods

The above analysis was placed in an atemporal setting. However, a major concern of antitrust authorities are the long-run consequences of bundling. While the analysis of dynamic issues of bundling is beyond the scope of the paper a simple extension of the model allows me to provide some interpretations.[15] Suppose that firms compete in the market for two periods, that there is no discounting, and that consumers face the same decision problem in each period (possibly with different prices). We can focus on the bundling issue in period 1. Suppose that F constitutes an entry cost that is sunk after entry. Firm 2 would enter with independent selling but does not enter with bundling if $\bar{F}=F/2\in[\pi_2(b,1),\ \pi_2(i,1)]$. On this range of entry costs prohibiting bundling increases total surplus if

$$\pi_1(i,1) + \pi_2(i,1) - \bar{F} + \mathrm{CS}(i,1) > \pi_1(b,0) + \mathrm{CS}(b,0),$$

where CS denotes consumer surplus. Thus the problem has the same structure as in the atemporal model. The only modification is that the entry cost F is spread over two periods. Suppose alternatively that F constitutes a fixed cost that has to be paid in every period in which the firm is active. Then the analysis of this paper directly carries over. Hence, in a particular market it is important to explore the time dimension and the nature of the fixed cost to determine whether bundling is likely to have effects on firm entry.

4.8. Consumer surplus standard

Often antitrust authorities use consumer surplus instead of total surplus as the welfare criterion. My main insight is robust to using this alternative standard although the consumer surplus ranking does not coincide with the total surplus ranking, $\mathrm{CS}(b,1) > \mathrm{CS}(i,1) > \mathrm{CS}(b,0) > \mathrm{CS}(i,0)$. The

[14] Since Nalebuff's monopoly setup is equivalent to my setup welfare with monopoly bundling is around 0.819 (see above). This is less than welfare under entry with independent pricing, which gives 0.875 in Nalebuff's model.

[15] However, important dynamic issues are ignored. These include the long-run effects of bundling on investment incentives and of bundling as a defensive measure to avoid entry in market A.

respective values are CS(b,1) ≈ 0.376, CS(i,1) = 0.375, CS(b,0) ≈ 0.274, CS(i,0) = 0.25. The ranking implies that for a given entry decision consumer surplus is always higher under bundling than under independent selling. Therefore, ignoring strategic effects the wrong conclusion is reached, namely that bundling is in the interest of consumers. As I have shown above (see Proposition 1), for $F \in (0.194, 0.25)$ entry only takes place with independent selling but not with bundling. In this case the relevant comparison is CS(i, 1) > CS(b, 0). I conclude that also with respect to consumer surplus, if entry costs fall within this range the possibility of bundling drastically reduces consumer surplus, whereas if F is outside the range (so that the possibility of bundling does not affect the entry decision) the increase in consumer surplus due to bundling is rather modest.

5. Discussion and conclusion

In this paper, I have proposed a demanding sufficient test for antitrust authorities to become active in case of bundling, namely that the following three conditions must be satisfied:

1. Bundling is the preferred business strategy of the incumbent irrespective of the decision by potential entrants.
2. Entry is unlikely under bundling but likely under independent selling.
3. Monopoly bundling reduces welfare compared to competitive independent pricing.

I presented a model which passes this test. The high burden for an antitrust authority is to argue in a real world case that the conditions for intervention are met. In other words, this paper has shown the possibility of bundling as a weapon to blockade entry but this does not relieve antitrust authorities from presenting evidence which supports intervention.

As observed by Tirole (2005), bundling (and tying) is driven by efficiency and anti-competitive rationales. "… as with other corporate strategies, a behavior that excludes rivals may actually be optimal for the dominant firm, even taking rivals' actions as given. Put differently, predation does not always imply a cost for the predator; yet the efficiency gains may be more than offset by the increase in future monopoly power from a social perspective." (Tirole, 2005, pages 20–21). The present paper can be seen as a formalization of Tirole's statement.

In the remainder I discuss three extensions of the model: the degree of product differentiation in the market with entry, B, the correlation of consumer valuations, and technological bundling which generates complementarities. The main results of this paper are robust to these modifications.

5.1. Degree of product differentiation

For pedagogical reasons I have taken the borderline case, in which under independent selling entry does not affect pricing and the market areas of the two firms only touch each other. My results are robust to introducing some competition between firms under independent selling (this follows from continuity arguments). In other words, my results still hold under sufficient product differentiation between B1 and B2 so that, in particular, the profit ordering $\pi_2(b,1) < \pi_2(i,1)$ is preserved. With less differentiation, profits in the competitive segment decrease under independent selling. If there is too little differentiation, results are markedly different because $\pi_2(b,1) < \pi_2(i,1)$ so that bundling becomes a facilitating device as in Section III.E of Nalebuff (2004) — recall that Nalebuff has considered the case in which the two firms offer homogeneous products leading to a Bertrand result. This shows that the degree of product differentiation between the two firms is an important determinant of the role of bundling.

5.2. Correlated valuations

In the analysis I have assumed that consumer valuations over the two products are uncorrelated. Let me now consider two polar cases of perfectly correlated valuations.

5.2.1. Positive correlation

Clearly, in all cases the analysis under independent selling is identical to the earlier analysis with independent valuations. With positive perfect correlation a consumer of type β derives indirect utility $2\beta-\overline{p}$ from buying the bundle, $1-\overline{p}-p_{\mathrm{B2}}$ from buying the bundle and product B2, and $(1-\beta)-p_{\mathrm{B2}}$ from buying only product B2. Here, the example has the property that bundling is neutral to the allocation and that the presence of firm 2 does not affect the pricing of firm 1. This suggests that for positive but not perfect correlation, my results still hold.

5.2.2. Negative correlation

The point of this paper is made in a very simple way when looking at negative perfect correlation. In this case valuation for the competitor's product B2 is positively perfectly correlated with valuations for product A. One may therefore expect that bundling is not an attractive property. However, because of the negative correlation between A and B1, valuation are equalized across consumers for the bundle. This suggests that in a monopoly set-up bundling is attractive for firm 1.

Under monopoly bundling all consumers have valuation 1 for the bundle and the profit-maximizing price for the bundle is $\overline{p}=1$. Hence, profit is equal to 1, as well as welfare is equal to 1.

Under competitive bundling, I first characterize consumer behavior. Indirect utility for any consumer β is $1-\overline{p}$ for the bundle, $(1-\beta)-p_{\mathrm{B2}}$ for product B2, and $\max\{2(1-\beta)-p_{\mathrm{B2}}-\overline{p},\ 1-\overline{p}-p_{\mathrm{B2}}\}$ for the bundle and product B2. As one can immediately see, buying both products can only be attractive for $\beta<1/2$. A consumer β buys the bundle (on its own or together with product B2) if $\beta<1-\overline{p}$ or $\beta>\overline{p}-p_{\mathrm{B2}}$. She buys product B2 (on its own or together with product B2) if and $\beta<(1-p_{\mathrm{B2}})$ or $\beta<\overline{p}-p_2$. One can then show that in equilibrium firm 1 sells to all consumers whereas firm 2 sells to consumers with $\beta\geq 1/3$. In equilibrium firm 1 sets its price such that $1-\overline{p}=\overline{p}-p_{B2}$ and firm 2 sets its price such that $p_{\mathrm{B2}}=\overline{p}/2$. This gives prices $\overline{p}=2/3$ and $p_{\mathrm{B2}}=1/3$.[16] Hence, equilibrium profit for firm 2 is equal to $1/9-F=0.111-F$ which is much less than what it would make under independent selling. Firm 1's profit under competitive bundling is equal to 2/3 which is much larger than under independent selling. Hence, I obtain the same profit ranking as with independent valuations. This suggests that the same ranking should hold if valuations are negatively but not perfectly correlated.

Note that welfare under monopoly bundling is less than under competitive independent selling for $F<0.125$ so that Condition 3 is satisfied. Hence, for $F\in(0.111, 0.125)$ bundling blockades entry and reduces welfare. The only difference of the present specification compared to the specification with uncorrelated valuations is that here welfare under competitive bundling is greater than under competitive independent selling. (Under competitive bundling it is equal to $11/9-F=1.225-F$. This means that in this example for a given market structure bundling is always socially preferred to

[16] At $p_{\mathrm{B2}}=1/3$ firm 1's profit reach a global maximum at $\overline{p}=2/3$: the profit function is $\overline{p}$ for $\overline{p}\leq 2/3$ and $[2(1-\overline{p})+1/3]\overline{p}$ for $\overline{p}>2/3$.

independent selling. However, since bundling can be used to avoid entry, bundling reduces welfare if it implies a change in market structure. This shows that strategic effects have to be taken serious since they may reverse an otherwise unambiguous welfare comparison.

5.3. Technological bundling

Technological bundling, understood as integrating components A and B1 to generate a bundled product which improves functionality, increases the valuation for the bundled product. Suppose for simplicity, that bundling increases the valuation for the bundle by γ for all consumers. Then consumers make the same purchasing decisions as in the equilibrium of Section 3 if firm 1 were to increase the price of the bundle by γ. However, firm 1 has now an incentive to increase its market area. In the new equilibrium, firm 2 sets a lower price, covers a smaller market area and makes less profit. The welfare ranking is preserved for γ sufficiently small. This suggests that also under technological bundling antitrust authorities have reasons to scrutinize the bundling practice. Only if added consumer benefits from technological bundling are overwhelming, such a bundling practice should be automatically cleared from antitrust investigations.

Appendix A. A model in the spirit of Whinston (1990)

In this Appendix I consider a slightly modified model in which the willingness to pay for any of the two products B1 and B2 is increased by r for all consumers. That is the indirect utility is $r+\beta-p_{\mathrm{B1}}$ for buying product B1 and $r+(1-\beta)-p_{\mathrm{B2}}$ for buying product B2, where $r=1$. In the analysis of the main text $r=0$ which implies that under independent pricing both firms are local monopolist and all consumers buy good B1 or good B2. Suppose, as in Whinston (1990), that, in equilibrium, the participation constraint is not binding with competition (neither under independent selling nor under bundling). Under independent selling both firms set prices $p_{\mathrm{B1}}=p_{\mathrm{B2}}=1$ under independent selling. Product A is sold at the monopoly price $p_{\mathrm{A}}=1/2$. Profits then are $\pi_1=3/4$ and $\pi_2=1/2$, respectively. The marginal consumer strictly prefers the consumption of any of the two goods over the outside option if $r>1/2$.

Consider now bundling. At a price $p_{\mathrm{B2}}=\overline{p}$ consumer $(\alpha, \beta)=(0, 1/2)$ is indifferent between good B2 and the bundle. Also consumer $(\alpha', \beta')=(1, 0)$ is indifferent between these two options and so are all consumers $(\lambda\alpha+(1-\lambda)\alpha', \lambda\beta+(1-\lambda)\beta')$, where $\lambda\in(0,1)$. Suppose that all consumers either buy the bundle or good B2 — this turns out to be the optimal consumer choice in equilibrium. This implies that at such prices demand for good B2 is 1/4 and for the bundle consisting of goods A and B1 is 3/4. If $p_{\mathrm{B2}}<\overline{p}$, demand is

$$D_1(\overline{p}, p_{\mathrm{B2}}) = \frac{3}{4} - \frac{\overline{p}-p_{\mathrm{B2}}}{2}$$

$$D_2(\overline{p}, p_{\mathrm{B2}}) = \frac{1}{4} + \frac{\overline{p}-p_{\mathrm{B2}}}{2}.$$

The first-order conditions of profit maximization can be rearranged to define best responses (for prices $p_{\mathrm{B2}}<\overline{p}$),

$$\overline{p} = \frac{3+2p_{\mathrm{B2}}}{4}$$

$$p_{\mathrm{B2}} = \frac{1+2\overline{p}}{4}$$

In equilibrium, firms set prices $\overline{p}=7/6$ and $p_{B2}=5/6$. Consumers who are indifferent between the bundle and good B2 strictly prefer any of those two options over the outside option. Profits are $\pi_1(b,1)=0.68$ and $\pi_2(b,1)=0.35$.

If firm 2 does not enter, then, under independent pricing, firm 1 sets prices $p_A=1/2$ and $p_{B1}=(r+1)/2$ for $r\in(1/2,\ 1)$ and $p_{B1}=r$ for $r\geq 1$. This implies that for $r\geq 1$ firm 1 serves all consumers with product B1. Firm 1's profit is $\pi_1(i,0)=1/4+(r+1)^2/4$ for $r\in(1/2,\ 1)$ and $\pi_1(i,\ 0)=1/4+r$ for $r\geq 1$. Under monopoly bundling firm 1's profit, when positive, is

$$\pi_1(b,0)=\begin{cases}\overline{p}\int_0^{r+2-\overline{p}}x\mathrm{d}x & \text{if } r+1\leq\overline{p}\leq r+2\\ \overline{p}(1-\int_0^{\overline{p}-r}x\mathrm{d}x) & \text{if } r<\overline{p}<r+1\\ r & \text{if } \overline{p}\leq r\end{cases}$$

Suppose the profit maximizing price satisfies $r\leq\overline{p}\leq r+1$. Then the profit-maximizing price is given by

$$\overline{p}=\frac{1}{3}\left(2r+\sqrt{6+r^2}\right)$$

Profit is

$$\pi_1(b,0)=\frac{1}{27}\left(18r-r^3+(r^2+6)^{\frac{3}{2}}\right)$$

For r=1, the price of the bundle is approximately 1.55, almost 85% of all consumers buy, and the profit is 1.32. Note that for r=1 $\pi_1(b,0)>\pi_1(i,0)>\pi_1(i,1)>\pi_1(b,1)$. In this case $\pi_1(i,1)<\pi_1(b,0)$ so that entry deterrence is profitable (that is, in the game, in which stages 1 and 2 are in reverse order, firm 1 commits to bundling in order to induce entry). As in Section I of Whinston (1990), bundling is only profitable if entry does not take place (because $\pi_1(i,1)>\pi_1(b,1)$) so that Condition 1 is violated.[17]

Profits are as follows:

	Monopoly	Entry
Independent selling	1.25, 0	0.75, 0.50 − F
Bundling	1.32, 0	0.68, 0.35 − F

The profit ranking is the same as in the model by Whinston (1990). In this specification, if the entry cost F satisfies that $F\in(0.35,\ 0.5)$ then firm 1 optimally uses bundling as an entry deterrent (in the game in which stages 1 and 2 are in reverse order). Introducing uncertainty with respect to entry costs at the stage in which firm 1 commits to a selling policy, firm 1 has to consider its expected profit: If it is sufficiently likely that entry costs are below 0.35 firm 1 prefers independent selling and the bundling issue does not arise.

Let me now turn to the welfare analysis. Entry deterrence is only problematic from the social point of view if it reduces social welfare, which is measured as total surplus. Welfare under monopoly bundling $W(b,0)$ indeed is less than welfare under independent pricing with competition $W(i,1)$. Since $W(b,0)<0.85+0.5+0.5=1.85$ and $W(i,1)>W(i,0)=1.875$ the welfare

[17] Recall that without commitment (i.e. in the original three-stage game) bundling is not an issue, since firm 1 chooses independent selling given entry.

ranking is $W(i,1) > W(i,0) > \mathrm{W}(\mathrm{b},0)$. Thus I have shown the following: If entry deterrence through bundling is observed in equilibrium then welfare is less than in a situation in which bundling is prohibited. In other words, Condition 3 is satisfied.

References

Adams, W.J., Yellen, J.L., 1976. Commodity bundling and the burden of monopoly. Quarterly Journal of Economics 90, 475–498.

Bakos, Yannis, Brynjolfsson, Erik, 1999. Bundling information goods: pricing, profits and efficiency. Management Science 45, 1613–1630.

Bakos, Yannis, Brynjolfsson, Erik, 2000. Bundling and competition on the Internet. Marketing Science 19, 63–82.

Carbajo, Jose, de Meza, David, Seidman, Daniel J., 1990. A strategic motivation for commodity bundling. Journal of Industrial Economics 38, 283–298.

Carlton, Dennis W., Waldman, Michael, 2002. The strategic use of tying to preserve and create market power in evolving industries. Rand Journal of Economics 33, 194–220.

Chen, Yongmin, 1997. Equilibrium product bundling. Journal of Business 70, 85–103.

Choi, Jay Pil, 1996. Preemptive R&D, rent dissipation, and the 'leverage theory'. Quarterly Journal of Economics 110, 1153–1181.

Choi, Jay Pil, 2004. Tying and innovation: a dynamic analysis of tying arrangements. Economic Journal 114, 83–101.

Choi, Jay Pil, Stefanadis, Christodoulos, 2001. Tying, investment, and the dynamic leverage theory. Rand Journal of Economics 32, 52–71.

Choi, Jay Pil, Stefanadis, Christodoulos, in press. Bundling, Entry Deterrence, and Specialist Innovators, unpublished manuscript. Journal of Business.

McAfee, R. Preston, McMillan, John, Whinston, Michael, 1989. Multiproduct monopoly, commodity bundling and correlation of values. Quarterly Journal of Economics 104, 371–384.

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

Nalebuff, Barry, 2004. Bundling as an entry deterrent. Quarterly Journal of Economics 119, 159–187.

Rey, Patrick, Tirole, Jean, in press. A Primer on Foreclosure. In: Mark Armstrong, Robert Porter (Eds.), Handbook of Industrial Organization, vol. 3.

Schmalensee, Richard, 1984. Gaussian demand and commodity bundling. Journal of Business 57, 58–73.

Tirole, Jean, 2005. The analysis of tying cases: a primer. Competition Policy International 1, 1–25.

Whinston, Michael, 1990. Tying, foreclosure, and exclusion. American Economic Review 80, 837–869.