Informational Leverage and the Endogenous Timing of Product Introductions

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Abstract

This paper provides a new rationale for bundling based on informational leverage. It is demonstrated that physically tying a product of established quality to one of unknown quality may mitigate the problem of asymmetric information encountered in the latter market. Leveraging reputation in one market to provide information about product quality in a second market can have profound implications for the timing of new product introductions. Bundling motivated by informational leverage can enhance efficiency by increasing consumer’s access to costly information. When the possibility of endogenous timing of product introduction is considered, however, the welfare consequences of bundling are ambiguous. The positive effect of market creation must be weighed against the negative effect of market delay.
I. Introduction

This paper provides a theory of informational leverage and its implications for the endogenous timing of product introductions. A firm is said to have informational leverage when it is able to use the leverage provided by its reputation in one market to overcome informational asymmetry in a second market. Most importantly, the possibility of leveraging information across markets will be shown to have profound implications for the timing of new product introductions.

Initially, I introduce the theory of informational leverage as a reason for bundling. Consider an “experience” good market in which the quality of the good is initially unknown to consumers and can be ascertained only after the good is bought and consumed by them. In this type of market, it is well known that the incentive to provide a high quality product relies on the repeat purchase mechanism (Nelson [1974], Kihlstrom and Riordan [1984], Klein and Leffler [1981], Milgrom and Roberts [1986], and Schmalensee [1978]). I consider a case where producers of the high quality products need to engage in introductory pricing to separate themselves from low quality producers. Now suppose that a new experience good (called B) with uncertain quality is introduced by a mullet-product monopolist, who has also been selling a good (called A) whose quality is already known to consumers. In such a setting, I show that irreversible bundling of the experience good (B) with the product of known quality (A) can be used as a credible signal of quality of good B. The reason is that, with bundling, for the multi-product firm to appropriate the surplus associated with product A, it is also required to sell product B. As a result, bundling can be considered as a commitment for the firm to incur the
production cost of good B in the future even if B is revealed to be of low quality and no one is willing to pay for it. This implies that bundling is more costly for the low quality producer. The asymmetry in the cost of bundling suggests that bundling can serve as a signaling device about uncertain quality of one of the products when the quality of the other product in the bundle is already known. This paper, thus, provides a new rationale for bundling based on informational leverage.

The approach in the paper is related to a new development in the theory of bundling in that it focuses on the precommitment aspects of bundling in the ensuing stages. Whinston (1991) and Choi (1994), for instance, examine whether bundling can be used as a leverage device to extend monopoly power in one market to another otherwise competitive market. Even though this paper is also interested in the interaction of two product markets through bundling, the purpose of bundling in the present paper is not the leverage of market power in an attempt to monopolize a competitive market; the model in the present paper is devoid of strategic interaction in the product market. Rather, bundling is based purely on efficiency considerations. By tying the experience good to a good of known quality, it reduces the cost of information.

The possibility of informational leverage also has important implications for the timing of product introductions. In particular, the multi-product firm may deliberately asynchronize the timing of product introductions when the qualities of both products are unknown to consumers; by sequencing the introduction of products, the multi-product firm can take advantage of informational leverage of the lead product in the introduction of the subsequent product. This paper, therefore, can be considered a first step towards a
theory of *endogenous* timing of product introductions, on which the literature is virtually nonexistent.¹ Most surprisingly, I show that the sequential introduction of two products with bundling may create markets that would not be viable as separate entities due to asymmetric information.

Furthermore, when the possibility of endogenous timing of product introductions is considered, the welfare consequences of bundling are not always benign. The positive effect of *market creation* should be weighed against the negative effect of *market delay*. Bundling is unambiguously beneficial to the extent that it mitigates informational asymmetry and creates new markets that would have failed without it. However, when it is used despite both markets being viable on their own, bundling with sequential timing of product introductions only delays the availability of the product that is introduced later.

Even though I couch the basic theory in the context of bundling, the logic of the theory indicates that any marketing arrangement that purposely associates one product with another may serve the same purpose as bundling, if the association of a high quality product with a low quality product can adversely affect the profits in the high quality product market. Therefore, any such arrangement may be considered a form of informational leverage. In order to prove this point, in section V, I apply the theory of informational leverage to brand extension where the brand name of an established product is used to introduce an experience good. In the case of brand extension, no physical tie-

¹Moorthy and Png (1992) is a notable exception. They address the issue of the timing of product introductions in a framework of durable goods markets with two types of consumers. The reason for sequential introduction of products in their paper is to avoid cannibalization of demand between two related products. They do not address the issue of informational asymmetry and, thus, the focus of their paper is rather different from mine.
ins between the two products are involved. Instead, a multi-product firm stakes its reputation as a bond for quality.

The simple model of brand extension developed in this paper is related to the model of Wernerfelt (1989) in that both uses the firm's future profits as a bond.² There are, however, major differences between the two papers. First, the source of future profits used as a bond is different. Wernerfelt's model relies on the future profits from the established product as a bonding mechanism, which requires that the quality of the old product should be unsettled in the minds of consumers for brand extension to be effective as a signal of new product quality. This implies that his theory is inapplicable to the case where the quality of old product is firmly established, which seems to be the norm in most cases of brand extension. My model is immune from this problem because it uses future profits from future products as a bond; the reputation mechanism works through the option value of profitable future products that can be associated with the name brand when their qualities are high. Second, and more importantly, my paper extends the basic framework to analyze the issue of endogenous timing of product introductions. The timing of product introductions is exogenous in the Wernerfelt model.

The remainder of the paper is organized in the following way. Section II sets up the basic two-period model and demonstrates that bundling is irrelevant in the sense that it is never profitable if consumers are uninformed about the quality of both products. Section III modifies the basic model and considers a situation in which the quality of one product is known while the quality of the other is unknown. In this case, it is shown that bundling can be an effective way of signaling the quality of the product whose quality is

²Wernerfelt (1989) uses the term "umbrella branding" for brand extension.
unknown. This possibility of informational leverage through bundling has important implications for the timing of product introductions, the focus of Section IV. Section V analyzes brand extension as informational leverage to demonstrate that the basic theory can be applied to other marketing arrangements as well. Section VI concludes.

II. The Basic Model and (Dis)incentives for Bundling

In this section, I set up the basic model of bundling that will be used to develop a theory of informational leverage in Section III. I first demonstrate that bundling is never a profitable strategy if consumers know the quality of both products or neither of them.

Let me consider two independent products A and B that can be consumed separately. The quality for each product can be either high or low: \( q^i \in \{H, L\} \), where \( i = A, B \). There is a multi-product firm which is the sole producer of products A and B. The firm knows the actual qualities of the products, but the potential consumers, whose size is normalized to 1, do not know before purchase. In other words, the products have the characteristics of an "experience good" (Nelson, 1974). The \textit{a priori} probability that the producer is endowed with the ability to produce the high quality product is denoted by \( \alpha^i \), where \( i = A, B \). The quality realization for each product is assumed to be uncorrelated across products. The high quality producer has a choice of producing either a high quality product or a low quality product. Let \( c^i_H \) and \( c^i_L \) be the cost of product \( i \) for the high quality and low quality producer, respectively, where \( i = A, B \). There are two periods. As in Kihlstrom and Riordan (1984), I assume that quality is unalterable in the second period once it is chosen in the first period. This assumption can be justified if production requires
investments in quality-specific assets that, once committed, have a low opportunity cost. This assumption is made to eliminate the analytical complications induced by the possibility that a firm initially produces high quality and then, having established a reputation, switches to low quality. The producer endowed with the ability to produce only low quality products has no choice but to produce a low quality product. Each consumer demands at most one unit of each product in each period and has an identical reservation value of 0 for high quality product, where i = A, B. If a good is of low quality, the gross surplus from the good is 0 for both products.

In the beginning of the first period, the firm makes an irreversible decision on bundling. As in Whinston (1990) and Carbajo et al. (1990), this precommitment is assumed to be possible through costly investments in product design and the production process. To focus solely on the informational reasons for bundling, I assume that there is no cost advantage or disadvantage associated with bundling. I assume that $\theta^i > c^i_H > c^i_L$. In this paper, I am mainly interested in separating equilibria where the identity of the producer is revealed through pricing.³

First, I establish that in the absence of any production cost advantage associated with bundling, unbundling always weakly dominates bundling for the multi-product monopolist. To see this, suppose that the two products are not bundled. Then, each market can be analyzed separately. Consider the market for product A. When the high quality producer charges the price of $p^A$ in the first period, it makes a profit of $\pi^A = (p^A - c^A_H) + \delta(\theta^A - c^A_H)$, where $\delta$ is the discount factor. For $p^A$ to be a price that identifies the producer.

³Alternatively, I can assume that $\alpha^i$ is sufficiently low to eliminate the possibility of a pooling equilibrium.
high quality producer, \( p^A \leq c^H_A \).

Since the high quality producer has an option of not selling the product A, the profit from the product A for the high quality producer is

\[
\pi^A = \max \left\{ (c^A_L - c^A_H) + \delta(\theta^A - c^A_H), 0 \right\}.
\]

Similarly, the profit for the high quality producer of product B is given by

\[
\pi^B = \max \left\{ (c^B_L - c^B_H) + \delta(\theta^B - c^B_H), 0 \right\}.
\]

In a separating equilibrium, the low quality producer is unable to sell and makes zero profit. The market for the high-quality product \( i \) exists if \( (c^i_L - c^i_H) + \delta(\theta^i - c^i_H) > 0 \), i.e., the second period profit from the repeat purchase outweighs the first period loss from introductory pricing. In this case, I will say that market \( i \) is viable. Otherwise, there is a complete market failure in that the existence of a low quality producer drives the high quality producer out of the market.\(^4\)

Let \( \Pi(q^A, q^B) \) denote the profit for the multi-product monopolist when the qualities of products A and B are given by \( q^A \) and \( q^B \), respectively, where \( q^A, q^B \in \{H, L\} \). Then, we have

\[
\Pi(H, H) = \pi^A + \pi^B = \max \left\{ (c^A_L - c^A_H) + \delta(\theta^A - c^A_H), 0 \right\} = \max \left\{ (c^B_L - c^B_H) + \delta(\theta^B - c^B_H), 0 \right\}
\]

\[
\Pi(H, L) = \pi^A = \max \left\{ (c^A_L - c^A_H) + \delta(\theta^A - c^A_H), 0 \right\}
\]

\[
\Pi(L, H) = \pi^B = \max \left\{ (c^B_L - c^B_H) + \delta(\theta^B - c^B_H), 0 \right\}
\]

\[
\Pi(L, L) = 0
\]

\(^4\)If I assume that \( \alpha^i_1 < c^i_L \), where \( i = A, B \), there is no pooling equilibrium either, since the highest price that can be charged in the first period in such an equilibrium is \( \alpha^i_1 \).
Now suppose that the two products are bundled. Then, for the price of the bundled product to signal quality, \( P \leq c^A_L + c^B_L \). Let \( \tilde{\Pi}(q^A, q^B) \) denote the corresponding profit for the multi-product monopolist when the qualities of for products A and B are given by \( q^A \) and \( q^B \) and they are sold as a bundle.\(^5\)

\[
\tilde{\Pi}(H, H) = \max \{(c^A_L + c^B_L - c^A_H - c^B_H) + \delta(\theta^A + \theta^B - c^A_H - c^B_H), 0\}
\]

\[
\tilde{\Pi}(H, L) = \max \{(c^A_L + c^B_L - c^A_H - c^B_H) + \delta(\theta^A - c^A_H - c^B_{L}), 0\}
\]

\[
\tilde{\Pi}(L, H) = \max \{(c^A_L + c^B_L - c^A_H - c^B_H) + \delta(\theta^B - c^A_{L} - c^B_H), 0\}
\]

\[
\tilde{\Pi}(L, L) = 0
\]

(2)

It can be easily verified that \( \tilde{\Pi}(q^A, q^B) \leq \Pi(q^A, q^B) \), for all \((q^A, q^B) \in \{H, L\} \times \{H, L\} \).

The discussion above leads us to conclude the following.

**Proposition 1.** When the qualities of both products are unknown to consumers in the first period, bundling cannot be used to signal quality and thus, is not a profitable strategy.

It is instructive to identify the types of the multi-product monopolist who would be strictly worse off with bundling. For simplicity, consider the case where a separating equilibrium exists in both markets if the goods are sold separately, i.e., \( \delta(\theta^i - c^i_H) > (c^i_H - c^i_L) \), where \( i = A, B \). Then, it is immediate that

\[
\Pi(H, H) = (c^A_L - c^A_H) + \delta(\theta^A - c^A_H) + (c^B_L - c^B_H) + \delta(\theta^B - c^B_H) = \tilde{\Pi}(H, H)
\]

\[
\Pi(H, L) = (c^A_L - c^A_H) + \delta(\theta^A - c^A_H) > \max\{(c^A_L - c^A_H) + \delta(\theta^A - c^A_H - c^B_H), 0\} = \tilde{\Pi}(H, L)
\]

\[
\Pi(L, H) = (c^B_L - c^B_H) + \delta(\theta^B - c^B_H) > \max\{(c^B_L - c^B_H) + \delta(\theta^B - c^A_H - c^B_H), 0\} = \tilde{\Pi}(L, H)
\]

\(^5\)Throughout the paper, profits associated with bundling will be denoted with tilde.
Thus, the multi-product monopolist of high quality in both products is indifferent to the bundling decision whereas the firms of high quality in only one product are strictly worse-off with bundling. The reason is that this type of monopolist suffers from the additional production cost of a low quality item for which consumers refuse to pay in the future when the quality is revealed. This asymmetry in the incentive to bundle suggests that the bundling decision may be used as a signal of quality. This possibility is explored in the next section by modifying the informational structure of the basic model.

III. The Modified Model

In the previous section, I established the fact that when the two products have the same informational status, bundling cannot be used as an information revelation device. Now I modify the basic model by introducing asymmetry across markets in the informational structure. More specifically, I assume that the quality of one product, say A, is already established to be of high quality whereas product B is just developed and the quality of it is unknown to potential consumers. Once again, the multi-product monopolist makes an irrevocable decision about bundling at the beginning of the first period.

To economize on space, let me assume that the monopolist’s potential surplus in market A, which is given by $\theta^A - c^A_H$, is sufficiently large that the following condition holds:\footnote{Alternatively, product A is an “inspection good” whose quality can be ascertained before purchase whereas product B is an experience good (Nelson, 1974).}

\footnote{This assumption is made only to facilitate the presentation of the main ideas and is not crucial for the analysis. I can conduct similar analysis for the case where the inequality is reversed.}
This condition ensures that the multi-product monopolist whose quality for product B is low, will still sell the bundled product even after its identity is revealed. I consider two cases.

**Proposition 2.** If \( \theta^B - (1+\delta) \frac{c^B}{c^L} < 0 \), bundling alone signals that product B is of high quality. There is no need for introductory pricing.

**Proof.** The equilibrium concept I use in this signaling game is the Perfect Bayesian Equilibrium that is immune to sequential elimination of dominated strategies. With this refinement requirement imposed, it suffices to show that bundling is a dominated strategy for the low quality producer of B. The maximum profit under bundling for the low quality producer of B is given by \((\theta^A + \theta^B - c^A_H + c^B_L ) + \delta(\theta^A - c^A_H + c^B_L )\). Under the maintained assumption \( \theta^B - (1+\delta) \frac{c^B}{c^L} < 0 \), it is straightforward to verify that the profit from bundling is smaller than the alternative profit of selling only in market A, which is given by \((1+\delta)(\theta^A - c^A_H )\).

Now suppose that \( \theta^B - (1+\delta) \frac{c^B}{c^L} > 0 \). Then, bundling alone is not sufficient to signal the quality of product B. It will, however, be shown that bundling can still minimize the losses during the introductory phase. Moreover, physical tie-in with the established product may make it possible for product B to be marketed profitably as a part of a

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\[ \theta^A - c^A_H > c^B_L \]

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For the justification of this refinement, see Milgrom and Roberts (1986) who apply this refinement to eliminate separating equilibria that entail excessive, inefficient amounts of signaling.
bundled product. This is so even when asymmetric information makes it impossible for
the high quality producer of B to sell with nonnegative profit and, therefore, the stand-
only market for B does not exist. In this case, bundling can create an otherwise
nonviable market.

To compare the relative merits of bundling vis-à-vis independent marketing, I need
to consider two cases depending on whether or not product B is viable on its own.
Product B is defined to be viable if it can be marketed independently with nonnegative
profit, i.e., \( \delta(\theta^B - c^B_H) > c^B_H - c^B_L \). Tirole (1988) interprets this condition in the following
way. The left hand side (LHS) of the inequality is the Nelson effect (1974) reflecting the
fact that a high quality producer generates repeat purchases. The right hand side (RHS), a
cost differential in favor of the low-quality producer, is called the Schmalensee effect
(1978) and represents the low quality producer's incentive to masquerade as a high quality
producer. Then, a separating equilibrium exists if the Nelson effect dominates the
Schmalensee effect.

**Case I.** Tied product (B) is viable (\( \delta(\theta^B - c^B_H) > c^B_H - c^B_L \)).

In this case, market B is viable on its own and the profit from market B without
bundling is given by \( \pi^B = (c^B_L - c^B_H) + \delta(\theta^B - c^B_H) > 0 \). Therefore, it is always better to
introduce product B to the market and the total profit for the firm without bundling can be
written as:

\[
\Pi = (1 + \delta)(\theta^A - c^A_H) + [(c^B_L - c^B_H) + \delta(\theta^B - c^B_H)]
\]  

(3)

Now suppose that the multi-product firm with two high quality products decides to bundle
the two products. To distinguish itself from the low quality producer of B, the price for the bundled product P should satisfy the following incentive compatibility constraint:

\[(P - c_H^A - c_L^B) + \delta(\theta^A - c_H^A - c_L^B) \leq (1 + \delta)(\theta^A - c_H^A)\]  

(4)

i.e.,

\[P \leq \theta^A + c_L^A + \delta c_L^B\]  

(5)

Since P cannot be higher than its reservation value \(\theta^A + \theta^B\), \(P = \min[\theta^A + c_L^A + \delta c_L^B, \theta^A + \theta^B]\). With the maintained assumption of \(\theta^B - (1 + \delta)c_L^B > 0\), \(P = \theta^A + c_L^A + \delta c_L^B\).

Therefore, I can write the profit from the bundling as:

\[\Pi = (\theta^A + c_L^A + \delta c_L^B - c_H^A - c_H^B) + \delta(\theta^A + \theta^B - c_H^A - c_H^B)\]  

(6)

Comparison of the profit levels from bundling (Eq. (6)) and independent marketing (Eq. (3)) shows that bundling generates unambiguously higher profits.

\[\tilde{\Pi} - \Pi = \delta c_L^B > 0\]  

(7)

The intuition for this result is the following. For the high quality producer of B, bundling becomes irrelevant in terms of future profit when the quality of B is revealed. However, for the low quality producer, bundling is a less attractive option once information is revealed. The reason is that consumers are not willing to pay for the low quality product B and will pay only for the utility generated by product A, while the producer has to continue to incur the production cost of B (\(\delta c_L^B\)) due to irrevocable physical tie-ins with product A. In other words, bundling is a commitment which can be costly for the low quality producer. This asymmetry in the commitment cost of bundling (0 vs. \(\delta c_L^B\)) allows the high quality producer to signal its quality by bundling. Interpreted this way, it is not
surprising that the profit gain from bundling is given by \( \delta c^B_L \), which I call the costly commitment effect facing the low quality producer.

Case II. Tied product (B) is not viable \((\delta[\theta^B - c^B_H] < c^B_H - c^B_L)\).

In this case, market B is not viable on its own and the profit from market B without bundling is zero. Therefore, the total profit for the firm without bundling can be written as:

\[
\Pi = (1+\delta)(\theta^A - c^A_H). \tag{8}
\]

Now suppose that the multi-product firm with two high quality products decides to bundle the two products. To distinguish itself from the low quality producer of B, the price for the bundled product should satisfy the same incentive compatibility constraint (4) and the profit is the same as before. The difference between the profit from bundling and the profit from independent marketing is:

\[
\tilde{\pi} - \Pi = \delta c^B_L - [(c^B_H - c^B_L) - \delta(\theta^B - c^B_H)]. \tag{9}
\]

Expression (9) can be interpreted in the following way. Once again, bundling enables the monopolist to charge a higher price for the product B \((c^B_L + \delta c^B_L \text{ vs. } c^B_L)\). The first term on the RHS \(\delta c^B_L\) represents the beneficial effect of bundling due to the costly commitment effect. When product B is not viable on its own, however, bundling also absorbs the cost of satisfying the viability constraint for product B. The expression in square bracket represents this loss. Bundling will be practiced only when the benefit outweighs the cost. Proposition 3 summarizes the bundling decision for the case where \(\theta^B - (1+\delta)c^B_L < 0\).
Proposition 3. Suppose that $\theta^B(1+\delta) c^B_l > 0$. Then, when product B is introduced, it is always sold as a part of a bundled product *with* introductory pricing. More specifically:

(a) If product B is viable on its own, bundling is always beneficial.

(b) Even if product B is not viable on its own, it can be introduced with A as a part of a bundled package if $\delta c^B_l - [(e^B_H - e^B_l) - \delta(\theta^B - c^B_H)] > 0$, i.e., the costly commitment effect cum Nelson effect dominates the Schmalensee effect. Otherwise, product B is not introduced in the market.

Figure 1 summarizes Propositions 2 and 3 and depicts the region of cost parameters in which bundling is beneficial.

![Figure 1](image_url)

**Figure 1. Bundling as a Signal of Quality:** The horizontally shaded area represents the parameter space where bundling alone is sufficient to signal high quality. In the hatched area, signaling of quality requires bundling cum introductory pricing. Moreover, the shaded area above the thick line is the parameter space where bundling enables the introduction of B and improves welfare.
Three remarks are in order. First, an explanation is needed for why bundling is beneficial when the quality of one product is already established whereas bundling has no bite when the qualities of both products are unknown. The reason has something to do with the cost of posting a bond for the high quality producer whose quality is already known. When the qualities of both products are unknown, the presence of (L, L) producers prohibits the price of the bundled product from being above \((c_L^A + c_L^B)\) in a separating equilibrium; an (L, L) producer has nothing to lose in the future by mimicking the (H,H) producer with bundling. However, when the monopolist is already known to produce A with high quality, mimicking by the (L,L) type is irrelevant. In this case, bundling can effectively post a bond because bundling with low quality B necessarily impels the firm to incur an unnecessary cost of \(\delta c_L^B\) in the future in order to get the surplus from product A. Therefore, the multi-product monopolist can use bundling to signal the quality of B. It can be said that the product of known quality provides informational leverage which can be used in the market where quality information is imperfect.

Second, in the model presented above, the costly commitment effect is coming from an additional production cost facing the low quality producer of B, for which the consumer is not willing to pay once its quality is revealed. The model, however, need not be interpreted literally. Because it is precisely the bonding mechanism upon which bundling depends to signal quality, the results should be understood as more generally applicable. Many other channels other than additional production cost can make bundling serve as an instrument of informational leverage. Therefore, the result presented here
should be considered as an example of a more general result. For instance, bundling can lower the surplus from the established product even in the absence of production costs if physical tie-ins with a low quality product can degrade the performance of the high quality product when consumed together. As long as the separation of the two products is costly for consumers and as a result, induces consumers to pay less for the high quality component, bundling will serve its purpose as an instrument of informational leverage.

For example, the Windows 95 operating system is alleged to disable a key piece of competing on-line access software and make it too difficult for users to reinstall, forcing users to adopt Microsoft's on-line system (the Microsoft Network, MSN), which was bundled with the operating system (Gleick, 1995). Alternatively, if there is uncertainty in regard to the attributes of products that are important to consumers, bundling may be considered as a commitment to future R&D to support and ensure the quality of a tied product. If the new product is independently introduced, the seller might just pull the product out of the market if it turns out that the new product receives a low level of consumer acceptance and if upgrading is too costly. However, with bundling, the firm might have no choice but to support the tied product in order to avoid negative externalities on the tying product. This type of commitment is especially important for the products that involve a significant adoption cost such as computer software to induce consumers to make a purchase (Farrell and Gallini [1987] and Shepard [1987]). In this regard, it is interesting to observe that Microsoft's introductory pricing of MSN was far higher than the level expected by industry observers (New York Times, August 21, 1995),

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Footnote: Gleick (1995) quotes a Windows 95 user saying, "I want the MSN icon to go away, but I don't seem to be able to delete it. How do I get rid of the thing?"
which is consistent with the informational leverage theory.\textsuperscript{10}

Moreover, the possibility of informational leverage is not restricted to physical tying. As the discussion above indicates, informational leverage can be generated through a variety of marketing arrangements employed by a multi-product firm. The extent of these arrangements will depend on how much a low quality product can adversely affect the profits in the high quality product market. To make this point, I consider brand extension as an example in Section V. For brand extension, no physical tie-ins are involved between products. Rather, a multi-product firm uses its reputation as a bond for quality by using a brand name for an established product when it introduces a new experience good. Therefore, the theory of informational leverage can be applied to a wider variety of circumstances than bundling.

Third, in the case where the quality of only one of two product is known, there is an efficiency reason for bundling. When product B is viable on its own, bundling is inconsequential from the social planner’s perspective because with identical consumers with unit demand, the price change has only distributional consequences. In the case where product B is not viable on its own, however, bundling can also have a beneficial welfare effect because it can create a new market; without bundling the market for B will be nonexistent and the potential surplus will not be realized due to asymmetric information.\textsuperscript{11}

\textsuperscript{10}This pricing strategy may also have been driven by the Microsoft’s desire to diffuse antitrust complaints by existing on-line service providers such as America On-Line, Compuserve, and Prodigy.

\textsuperscript{11}With independent marketing, the condition for a market to exist is that the Nelson effect dominate the Schmalensee effect. With bundling, this condition is relaxed because the new condition is that the Nelson effect \textit{cum} the costly commitment effect dominate the Schmalensee effect.
IV. Endogenous Timing of Product Introductions

Section III demonstrates that bundling may be used to signal the quality of an experience good when the quality of one of the bundled product is already established whereas bundling is not useful when both products are of unknown quality. This result has implications for the timing of product introductions. To address the endogenous timing of product introductions, a three-period extension of the basic model is used to allow for the asynchronization of product introductions. More specifically, I explore whether it is useful to introduce products sequentially in order to establish the quality of one product first and then use this information as leverage in a second market.

The endogenous timing of product introductions is analyzed in a three period model in which the multi-product monopolist has a choice between simultaneous and sequential product introductions. The monopolist has two products, and both qualities are initially unknown to consumers. In the first period, the monopolist decides to introduce both of them or only one of them. In the case of simultaneous introduction, I assume that they are independently marketed since from section II, we know that unbundling weakly dominates bundling when both qualities are unknown to consumers. If only one product is introduced in the first period, the monopolist can introduce the remaining product in the second period. At this time, the monopolist makes an irreversible decision regarding whether to introduce the second product as a bundled product with the one introduced earlier. To simplify the analysis, discounting is ignored in this section (δ = 1). I consider three cases depending on the viability of products when they are marketed independently.
IV. 1. Only one product is viable.

Without loss of generality, let me call the viable product A. Then, the conditions under which only one product is viable are:

\[ \pi^A = (c_L^A - c_H^A) + 2(\theta^A - c_H^A) > 0, \quad \pi^B = (c_L^B - c_H^B) + 2(\theta^B - c_H^B) < 0 \]

In this case, introducing two products simultaneously in the first period is dominated by introducing only A. The question is whether the monopolist has incentive to introduce product B in the second period as part of a bundled product.

The decision problem in the second period is the same one analyzed in the previous section. I can conclude that product B will be introduced later as a bundled product if either \( \theta^B < 2c_L^B \) or \( \theta^B > 2c_H^B - 2c_L^B \) (see section III).\(^{12}\) In the former case, product B is introduced without introductory pricing whereas in the latter case it is introduced with introductory pricing. Therefore, informational leverage provided by product A through bundling allows product B to be introduced later profitably even in the case that B is not viable on its own. In this case, bundling also enhances welfare because the alternative is the complete failure of market B and nonrealization of surplus in that market due to asymmetric information.

IV. 2. Both products are viable on their own.

For both products to be independently viable, the following conditions must hold:

\[ \pi^i = (c_L^i - c_H^i) + 2(\theta^i - c_H^i) > 0 \]

In this case, both products can be profitably marketed independently. I examine whether

\(^{12}\)Note that I ignore the discount factor in this section, i.e., set \( \delta = 1 \).
sequential product introduction can be useful even in this case. First, note that if products are independently marketed, it is never optimal to introduce the products sequentially because the firm foregoes one period of profit with no corresponding benefit. When both products are viable, the profit from simultaneous introduction will be the same whether the goods are bundled or not as in the two period model. The profit from simultaneous introduction is given by:

$$\Pi = \pi^A + \pi^B = [(c^A_L - c^A_H) + (c^B_L - c^B_H)] + 2[(\theta^A - c^A_H) + (\theta^B - c^B_L)]$$  \hspace{1cm} (10)$$

Now consider an alternative strategy of introducing one product first and a second product later, bundled with the first product. Suppose that product A is introduced and its quality is revealed in the first period. Once again, for ease of presentation, let me assume that $\theta^A - c^A_H > c^B_L$ holds. I consider two subcases.

**Case I.** $\theta^B < 2c^B_L$

In this case, bundling in the second period is a dominated strategy for the multi-product firm who already established the quality of product A and has a low quality product B.

$$(\theta^A + \theta^B - c^A_H - c^B_L) + (\theta^A - c^A_H - c^B_L) < 2(\theta^A - c^A_H)$$  \hspace{1cm} (11)$$

The LHS of inequality (11) is the maximum possible profit from bundling while the RHS represents the profit from product market A from the second period onwards. Therefore, bundling alone is sufficient to signal the quality of product B and the monopolist can charge the full information price $\theta^A + \theta^B$.

$$\tilde{\Pi} = (c^A_L - c^A_H) + 2(\theta^A + \theta^B - c^A_H - c^B_H)$$  \hspace{1cm} (12)$$
In this case, \( \bar{\Pi} - \Pi = c^B_H - c^B_L \); sequential introduction with bundling is a strictly better strategy for the multi-product firm even though both of them can be introduced in the first period with positive profit. The increase in profit due to sequential introduction with bundling, \( c^B_H - c^B_L \), represents the loss from introductory pricing for product B with independent marketing. The reason is that by delaying the introduction of product B until the second period and using the leverage provided by the quality of product A, the multi-product firm can charge the full information price from the time of product introduction. This allows the multi-product firm to avoid the loss in the introductory phase associated with independent marketing.

**Case II.** \( \theta^B > 2c^B_L \)

In this case, bundling alone is no longer sufficient to signal quality. For the separation of types, introductory pricing is required. The price of the bundled product in the second period should satisfy the same type of incentive compatibility constraint as (4).

Ignoring the discount factor (i.e., set \( \delta = 1 \)), the incentive compatible price is given by \( P = \theta^A + 2c^B_L \). The profit from sequential introduction cum bundling is:

\[
\bar{\Pi} = (c^A_L - c^A_H) + [\theta^A + 2c^B_L - c^A_H - c^B_H] + (\theta^A + \theta^B - c^A_H - c^B_H)
\]  

(13)

Comparison of (10) and (13) yields:

\[
\bar{\Pi} - \Pi = c^B_L - (\theta^B - c^B_H)
\]

The tradeoff is the following. Sequential introduction allows the multi-product firm higher introductory pricing due to informational leverage provided by the product introduced earlier. This beneficial effect is \( c^B_L \). The firm, however, foregoes one period
of profit, $\theta^B - c^B$, by delaying introduction one period.

Figure 2 depicts the region in which sequential product introduction can be profitable assuming that product A is viable on its own and introduced in the first period.

Note, however, that with sequential introduction, social welfare is strictly reduced in this case due to the delay of product introduction even though it is profitable for the multi-product firm.

![Figure 2: Simultaneous versus Sequential Product Introduction](image)

**Figure 2. Simultaneous versus Sequential Product Introduction:** The shaded area represents the region where sequential introduction with bundling is more profitable. In the horizontally-hatched area, bundling alone is sufficient to signal quality and no introductory pricing is needed. In the cross-hatched area, introductory pricing is needed.

Up to now, the profit of sequential product introduction was derived assuming that product A is the first one introduced. However, which product will be the lead product is endogenously determined by the monopolist. Therefore, my theory of informational
leverage also serves as a theory of the endogenous sequencing of product introduction.

To address the issue of the order of product introduction, I define $\bar{\Pi}^i$ to be the profit of sequential product introduction when product $i$ is introduced first, where $i=A, B$. Then, three profit levels should be compared, $\bar{\Pi}^A$, $\bar{\Pi}^B$ and $\Pi$. Product $i$ will be the lead product with sequential marketing if $\bar{\Pi}^i = \max\{ \bar{\Pi}^A, \bar{\Pi}^B, \Pi \}$. Otherwise, two products are introduced simultaneously and independently.

**IV.3. Neither product is viable on its own.**

For neither product to be viable on its own, the following condition need be satisfied:

$$\pi^i = (c_l^i - c_h^i) + 2(\theta^i - c_h^i) < 0.$$  \hspace{1cm} (14)

This is the most interesting case. It can be demonstrated that even though both products are not viable, it is possible to avoid market failure by introducing these two products sequentially. To demonstrate this possibility, suppose that

$$\theta^A - c_h^A > c_l^B \quad \text{and} \quad \theta^B > 2c_l^B$$  \hspace{1cm} (15)

Consider a strategy of introducing products sequentially with $A$ as the lead product. Then, the total profit summed over the three periods can be written as Eq. (13).

Therefore, the condition for sequential product introduction to be profitable is:

$$\bar{\Pi} = (c_l^A - c_h^A) + [\theta^A + 2c_l^B - c_h^A - c_h^B] + (\theta^A + \theta^B - c_h^A - c_h^B) > 0$$  \hspace{1cm} (16)

It is easy to verify that the set of parameters that satisfy conditions (14), (15), and (16) is not empty as shown in the following numerical example.
Example. Let $\theta^A = 10$, $c^A_L = 7 - \epsilon$, $c^A_H = 9$, $\theta^B = 2$, $c^B_L = 1 - \epsilon$, $c^B_H = 1 - \frac{2}{3}$, where $\epsilon$ is a small positive number. Then,

$$\pi^A = (c^A_L - c^A_H) + 2(\theta^A - c^A_H) = - \epsilon, \quad \pi^B = (c^B_L - c^B_H) + 2(\theta^B - c^B_H) = - \epsilon.$$ 

Therefore, both products are not profitable with independent marketing. With sequential marketing with bundling, however, the profit is

$$\Pi = (c^A_L - c^A_H) + [\theta^A + 2c^B_L - c^A_L + c^B_H] + (\theta^A + \theta^B - c^A_H - c^B_H) = \frac{2}{3} - 3\epsilon > 0.$$ 

Even though each product is not viable on its own, once the quality of one product is established, the other product can be introduced profitably by leveraging off the quality of the known product. If this profit from the second product outweighs the loss from the first period product, both products can be marketed by sequencing the introduction of the products judiciously. The welfare implications of bundling in this case is unambiguously beneficial because without it the market outcome is outright market failure.

The endogenous sequencing of product introductions in my model also provides an alternative theory of the diversification process of a multi-product firm over time. One common explanation revolves around financial market imperfections. For example, if financial markets are imperfect, a gradual expansion in the array of product offerings by a firm may be driven by the liquidity constraint facing the firm in introducing the whole spectrum of products at the same time. In this case, the resources necessary to expand the firm’s product offering may have to be raised by retained earnings, which explains a

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13This is in sharp contrast to Choi’s (1994) leverage theory for R&D competition in which bundling can be profitable only if there is a slack in the (preemptive) constraint in one market. Here the market viability constraint is binding in both markets in that neither market can survive independently. However, it is possible that markets for both products can be created profitably with the help of informational leverage.
gradual expansion process in product offerings. However, according to my model, sequencing in the introduction of products may be used to leverage off the reputation of the already known product, even though it had enough financial resources for simultaneous introduction in order to use informational leverage provided by sequential introduction.

V. Brand Extension as a Theory of Informational Leverage

Up to now, I used bundling to demonstrate the possibility of informational leverage. As discussed in section III, however, informational leverage is not limited to bundling. In this section, I present a simple model of brand extension as another application of informational leverage. In the case of brand extension, no physical tie-ins between the two products are involved. Instead, a multi-product firm stakes its reputation as a bond for quality.

There is a multi-product monopolist who produces a product A whose quality is already established to be high. Consider an infinite horizon model in which the monopolist is endowed with an opportunity to introduce a new product with probability \( \alpha \) in each period. Given a chance to introduce a new product, the conditional probability that the monopolist will be endowed with the ability to produce a high quality product is given by \( \beta \). For simplicity, consumers are assumed to have identical reservation values of 0 for each new product if its quality is high. If a good is of low quality, the gross surplus from the good is 0. The cost of each new product is given by \( c_H \) and \( c_L \) for the high quality and low quality producers, respectively, where \( c_H > c_L \). In each period a new product is
available, the monopolist has a choice of extending the brand name of the established product to the new one. We are interested in whether brand extension can be used as a signal of quality. For this purpose, once again, we focus on the separating equilibria.

Consider the following type of equilibrium. Consumers believe that a new product is of high quality if the established brand is used for the new product as long as all the previous products with the same brand name were of high quality. Once the brand name is extended to a low quality product, consumers ignore any signaling value of brand extension and respond only to price signaling in the future. The monopolist extends brand name to only high quality products. In that case it charges a price $p$. Without brand extension, the price needed to signal a high quality is $c_L$. Once consumers buy the product and the quality is ascertained to be high, the monopolist can charge the reservation price $\theta$.

For these strategies to form an equilibrium, the low quality producer of a new product should not have the incentive to exercise brand extension. Note that in this model, brand extension has no consequences for the products already introduced since their qualities are already known to consumers. Let us define:

$$v^{bx} = (p - c_H) + \frac{\delta(\theta - c_H)}{1 - \delta}$$

$$v = (c_L - c_H) + \frac{\delta(\theta - c_H)}{1 - \delta}$$

Then, $v^{bx}$ is the value of having a high quality product when brand extension is used whereas $v$ is the value without brand extension. I assume that each product is viable on its own, i.e., $v > 0$. For brand extension to be profitable for the high quality producer, it is required that $c_0 < p (\leq \theta)$. 

26
If the monopolist has a low quality product in a given period and refrains from brand extension, its continuation expected profit is:

\[ 0 + \frac{\delta}{1-\delta} \gamma v^x, \text{ where } \gamma = \alpha \beta. \]

If it were to deviate and sell at the price of \( p \) with brand extension, its profit is:

\[ (p - c_H) + \frac{\delta}{1-\delta} \gamma v. \]

By deviating, the firm can earn the short-term gain of \((p - c_H)\). However, it destroys future opportunities of brand extension. For deviation not to be profitable, the following condition should hold:

\[ \frac{\delta}{1-\delta} \gamma \geq 1. \]

The parameter \( \gamma \) represents the frequency of future profit opportunities. Therefore, it is easier for brand extension to serve as a signal of quality with a higher \( \gamma \).

Wernerfelt (1988) also provide a theory of brand extension in which extending an established brand name to a new product can signal that the new product is of high quality. In both models, the multi-product firm use its reputation as a bond for quality by using a brand name for an established product. However, there is a major difference in the way a bond is posted across models. Wernerfelt’s model relies on the future profits from the established product as a mechanism to post a bond. This requires that consumers remain uncertain about the quality of the established product, although they have already experienced it. Otherwise, there cannot be any harmful repercussions from extending a brand name to a low quality new product since brand extension does not involve any...
physical tie-ins and relies only on consumers' perception (for instance, if I like Coke Classic and I am sure about its quality, why should I refrain from consuming it just because I do not like Cherry Coke that shares the same brand Coke?). It is, therefore, necessary that the quality of the old product be unsettled in the minds of consumers for brand extension to be effective as a signal of new product quality. This implies that his theory is inapplicable to the case where the quality of the old product is firmly established. My model avoids this problem by assuming the existence of (uncertain) future opportunities for new product introductions. This allows the multi-product firm to use as a bond future profits from future products that can be associated with the same brand if their qualities turn out to be high. In this case, the reputation mechanism works through the option value of future branding opportunities.

VI. Conclusion

This paper provides a theory of informational leverage in which a firm leverages off a good's reputation in one market to alleviate the problem of informational asymmetry encountered in a second market. Its implications for the endogenous timing of product introductions are also explored.

The theory is first introduced in the context of bundling. As with umbrella branding analyzed by Wernerfelt (1988), bundling a product of unknown quality with an

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14 According to Wernerfelt (1989, p.459), brand extension in his model is tantamount to "inviting consumers to pool their experience with the two products to infer the quality of both."

15 Wernerfelt's (1989) model also suffers from a plethora of equilibria not uncommon in signaling models and the particular branding equilibrium relies heavily on specific out-of-equilibrium beliefs. He gives conditions that establish umbrella branding as a unique equilibrium when the sequential equilibria are refined with the Cho-Kreps criterion (Cho and Kreps, 1987). However, the conditions are complicated and hard to interpret, if not impossible.
already proven high quality one serves as a mechanism to post a bond; it is a costly commitment for a low quality producer because he has to continue incurring the production cost of the low quality item for which consumers refuse to pay once its quality is revealed. This possibility of informational leverage has important implications for the endogenous sequencing of product introductions. The most surprising result is that the sequential introduction of new products allows the use of informational leverage, and thus makes it possible that both products be introduced even when neither of them is viable on its own.

The welfare implications of bundling are also discussed. Many special features of the model enable me to draw a clear cut conclusion on the welfare implications of bundling. When at least one of the products is not viable on its own, bundling is efficiency enhancing because it creates an otherwise nonexistent market. However, when both products are viable on their own, sequencing impairs welfare. The reason for welfare reduction is different from the usual leverage theory where bundling is used to extend monopoly power in one market to the other. Rather in this paper, it rather comes from a delay in product availability.

There are many extensions worth pursuing to test the robustness of the model. One obvious extension would be to allow for heterogeneous reservation values of consumers. Another dimension of heterogeneity to be examined is consumers' information regarding the quality of products. For instance, there could be two types of consumers, the informed and the uninformed. Even though I am optimistic about the robustness of the basic insight of this paper, a detailed study awaits further research.
References


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