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# The Competition and Cooperation between Private Labels and National Brands

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## Abstract

It has been well recognized that retailers have growing power relative to manufacturers. Along with this trend is the significant growth of private labels in many product categories. This paper attempts to analyze the efficiency role of private labels in new product developments from the perspectives of the whole channel. We consider a model of one retailer and one manufacturer, where the retailer has information advantage over the manufacturer about the final demand of new products. Suppose innovative products require firms to spend more R&D expenditures and to bear high risks. We derive the following results: (i) When the willingness to pay of low-valuation consumers is high enough, the manufacturer in a non-integrated channel tends to develop a sure rather than a risky but innovative new product, compared with the case in an integrated channel; (ii) When the manufacturer currently has a branded product, the positioning of that national brand relative to the new product will influence the effect of the retailer's information advantage on the innovativeness of the new product in a non-integrated channel. When the current national brand targets at high-end market while the new product intended to target at low-end market, the manufacturer tends not to introduce the new product that would be developed in an integrated channel. (iii) When the retailer initiates the new product development by making R&D expenditures for her private label, and asks the manufacturer to supply it, then the retailer can increase the level of innovativeness for the new product to the efficiency level, thus increasing channel profits.

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(iv) When the retailer can ask the manufacturer to pay slotting allowance for carrying its new product, in the absence of private labels, the manufacturer tends to develop a sure but less innovative product. Thus charging allowance fee does not help the success of innovative new products.

## 1 Introduction

It has been well recognized that retailers have growing power relative to manufacturers. The factors contributing to this phenomenon include the concentration of retailing industry, the lower efficiency of pull promotion strategies (e.g., mass media) manufacturers can use in targeting consumers, and an increasingly high proportion of consumer decisions being made in stores. Along with this trend is the significant growth of private labels in many product categories. According to A.C. Nielsen, unit sales of store brand products grew 8.6% during the past two years, vs. 1.5% for national brands (Boyle, 2003). Furthermore, in Europe private labels have become so successful that retailers have their own food technologists and R&D departments in developing their own new products (Beldona and Raisinghani, 2004). Even in the United States, the collaborative introduction of premium brands by retailers in consultation with manufacturers has made retailers less rely on manufacturers to produce new products (Beldona and Raisinghani, 2004; Dunne and Narasimhan, 1999). In developing their new products, many retailers work closely with manufacturers. For example, after lengthy joint research and development, Loblaws ( the largest Canadian grocery chain) and Colonial (a subsidiary of the Parmalat food group) came up with the successful Decadent chocolate chip cookie. Kraft also worked with 7-Eleven to develop many new products (e.g., Sugar-free Slurpee) to help broaden the brand for the latter (Zimmerman, 2001).

On the other hand, new products continue to fail at an extremely high rate. According to A.C. Nielsen (1999), the failure rate of new products is 95 percent in the United States and 90 percent in Europe (Kotler, 2000). Furthermore, when manufacturers launch new products, they often have to pay retailers a lump-sum, up -front fee, called "slotting allowance" just to place the product on shelves (Rao and Mahi, 2003; Dunne and Narasimhan, 1999). Some researchers argue that slotting allowance serves to screen successful new products from low-quality products while some researchers suggest that retailers use slotting fee to price discriminate against less powerful manufacturers, which in turn discourages new product innovation by man-

ufacturers (Rao and Mahi, 2003). This study attempts to examine the role of slotting allowance in new product development. In particular, we try to understand whether the existence of slotting allowance help the development of innovative new products. In view of the fact that many premium private labels succeed in creating entirely new categories, and the big expenditures involved in slotting allowances, Dunne and Narasimhan (1999) suggest that manufacturers can limit their risk in new product development by working with retailers to supply premium private labels, "which can actually boost innovation- not kill it." (Dunne and Narasimhan, 1999, p.5).

The purpose of this research is thus two fold. First, we try to analyze the efficiency role of private labels in developing new products, and in sharing information by retailers with manufacturers, from the perspectives of the whole channel. Second, we examine the role of slotting allowance in new product development. It becomes prevalent that many large retailers take initiative to invest in R&D, develop new products or even create a new product category (Dunne and Narasimhan, 1999). In contrast, many new products introduced by manufacturers for the last decade are line extensions without many unique features (Kotler, 2000). This research intends to provide a theory about how private labels induce retailers to make efficient level of R&D expenditures and make the best use of information within the channel, by protecting its property right of its information and investment.

To answer the above questions, we consider a model of one manufacturer and one retailer. The manufacturer attempts to develop a new product by making R & D expenditures and the retailer has superior information relative to the manufacturer about the final demand of potential new products. The information advantage of retailers may be due to their access to scanner data as well as proprietary data based on frequent shopper card purchases, like retailers in food industries (Fisher et al. 2000; Rao and Mahi, 2003). Innovative products require firms to spend more R&D expenditures and to bear higher risks. Either the manufacturer or the retailer (in the case of private labels) can spend higher R&D so that it is more likely there exists a segment whose valuation for that new product is raised. Under the above assumptions, we derive the following results:

1. When the willingness to pay of low-valuation consumers is high enough, the manufacturer in a non-integrated channel tends to develop a sure rather than a risky but innovative new product, compared with the case in an integrated channel.

2. When the manufacturer currently has a branded product, the positioning of that national brand relative to the new product will influence the effect of the retailer's information advantage on the innovativeness of the new product in a non-integrated channel. When the current national brand targets at high-end market while the new product intended to target at low-end market, the manufacturer tends not to introduce the new product that would be developed in an integrated channel.
3. When the retailer initiates the new product development by making R&D expenditures for her private label, and asks the manufacturer to supply it, then the retailer can increase the level of innovativeness for the new product to the efficiency level, thus increasing channel profits.
4. When the retailer can ask the manufacturer to pay slotting allowance for carrying its new product, in the absence of private labels, the manufacturer tends to develop a sure but less innovative product. Thus charging allowance fee does not help the success of innovative new products.

The remaining sections are organized as follows. In the next section, we briefly review related literature. In section 3, we introduce the model and characterize various equilibria under different scenarios. Concluding remarks are given in Section 4.

## 2 Literature Review

Private labels have received more and more attention from researchers and practitioners. They are the only brands that retailers have to take full responsibility for product introduction, product sourcing and promotions (Dhar and Hoch, 1997; Pauwels and Srinivasan, 2004). Previous literature has addressed the impacts of private label entry from perspectives of retailers, national brand manufacturers, and consumers (Pauwels and Srinivasan, 2004; Chintagunta et al., 2002). For example, private label entry increases the retailer's bargaining power to national brand manufacturers (Narasimhan and Wilcox, 1998; Chintagunta et al., 2002; Mills, 1995), thus increasing the channel power of the retailer and changing the interactions between manufacturers and the retailer (Hoch and Banerji, 1993; Raju et al. 1995; Hoch 1996; Kadiyali et al., 2000). Another relevant question is whether private label entry can increase category value and sales (Mason, 1990). Pauwels

and Srinivasan (2004), using time series data, find that private label entry rarely yields category expansion. However, Ailawadi and Harlam (2004) find private label does increase percentage retail margin not only from private label but also from national brands.

Private label introduction also influences manufacturers by changing the interactions between manufacturers and the retailer. Chintagunta et al. (2002) find that it increases consumer price sensitivity for the dominant brands. Pauwels and Srinivasan (2004) find that private label introduction usually harms second-tier brand manufacturers while benefits premium-brand manufacturers. The impact of private label entry on national brand manufacturers also depends on the positioning of national brands relative to the private label (Blattberg and Wisniewski 1989). Private label often allows retailers to attract consumers of lower-priced national brands (Blattberg and Wisniewski 1989; Sethuraman et al. 1999), thus inducing brand-switching of consumers. In addition, private label entry may intensify promotional activities and lead to lower retail prices of second-tier brands.

From the viewpoints of the whole distribution channel, introducing a private label reduces the double-marginalization in a distribution channel, as shown by Mills (1995) and Bontems et al. (1999) in their game-theoretic models. However, Mills (1995) and Bontems et al. (1999) do not consider any information asymmetry or uncertainty in the final demand when the retailer attempts to introduce a new store-branded product. In this paper, unlike previous literature, we consider the role of private labels in new product development in a distribution channel.

### 3 The Model

A manufacturer  $M$  is developing a new product for its target market. The market is normalized to 1. If  $M$  spends  $k\alpha^2/2$  on  $R\&D$ , then she can develop a new product with quality  $s = f(\alpha)$ , where  $0 \leq \alpha \leq 1$  and  $f$  is a strictly increasing function. When the product's quality is  $s$ , it represents that the product will be in state  $G$  with probability  $f^{-1}(s)$  ( $= \alpha$ ) or state  $B$  with probability  $1 - f^{-1}(s)$  ( $= 1 - \alpha$ ). When the product is in state  $G$ ,  $\beta$  proportion of consumers values it at  $\theta_2$ , and  $1 - \beta$  proportion of consumers values it at  $\theta_1$ ,  $\theta_2 > \theta_1$ . When the product is in state  $B$ , all consumers value the new product at  $\theta_1$ . Because the cost of  $R\&D$  is  $k\alpha^2/2$ , the marginal cost for  $\alpha$  is increasing. Assume  $M$  produces the product costlessly.

**Assumption 1**  $k \geq \theta_2\beta \geq \theta_1$ .

Because  $k$  is large enough, it makes sure that the optimal  $\alpha$  is an interior solution. In addition, because  $\theta_2\beta \geq \theta_1$ , the product will be targeted to only the high-valuation consumers in state  $G$ .

### 3.1 Single Product

In this subsection, we consider the case where  $M$  can produce only one product.

#### 3.1.1 Integrated Channel

When the channel is integrated,  $M$  is faced with consumers directly, and then she can observe consumers' preference for the new product before she sets the retail price  $P$ . In other words,  $M$  observes the state before she setting  $P$  in the integrated channel. The game proceeds as follows.  $M$  first determines  $\alpha$  and thus her  $R\&D$  expenditure. Then after the state is realized,  $M$  sets the retail price  $P$  for the product, and consumers decide whether to buy or not.

Suppose that  $M$  has invested  $k\alpha^2/2$  on  $R\&D$ . If  $M$  is in state  $B$ , then  $P$  will be set at  $\theta_1$ . If  $M$  is in state  $G$ , then  $P$  will be set at  $\theta_2$  (because  $\theta_2\beta \geq \theta_1$ ). Thus when  $M$  is determining  $\alpha$ , her problem is as follows:

$$\underset{\alpha}{Max} \quad \alpha(\theta_2\beta) + (1 - \alpha)\theta_1 - \frac{1}{2}k\alpha^2 \quad (1)$$

Following the first-order condition, we have  $\alpha^* = (\theta_2\beta - \theta_1)/k$ , and then  $M$ 's expected profit  $\pi_M$  is  $\theta_1 + (\theta_2\beta - \theta_1)^2/2k$  in the equilibrium.

#### 3.1.2 Non-integrated Channel without Private Label

When the channel is not integrated,  $M$  sells the product to the retailer  $R$ , and then  $R$  sells the product to consumers. In the non-integrated channel,  $M$  is not faced with consumers directly, and then she can not observe the state before setting the wholesale price  $W$ . On the other hand, because  $R$  is faced with consumers directly, she can observe the state before she setting the retail price  $P$ . The game proceeds as follows. First,  $M$  determines  $\alpha$  and thus her  $R\&D$  expenditure. Then,  $M$  chooses wholesale price  $W$ . After observing the state and the wholesale price  $W$ ,  $R$  chooses the retail price  $P$  and the quantity  $Q$  that she purchases from  $M$ . Finally, consumers decide whether to buy or not.

Suppose that  $M$  has determined  $\alpha$  and  $W$ . If the state is  $B$  and  $0 \leq W \leq \theta_1$ , then  $R$  chooses  $P = \theta_1$  and  $Q = 1$ . If the state is  $G$  and  $0 \leq W \leq \theta_2$ , then  $R$  chooses  $P = \theta_2$  and  $Q = \beta$ .

Following  $R$ 's pricing strategy,  $M$  realizes that  $0 \leq W < \theta_1$  is dominated by  $W = \theta_1$ , and  $\theta_1 < W < \theta_2$  is dominated by  $W = \theta_2$ . Under  $W = \theta_1$ ,  $\pi_M = \theta_1 - k\alpha^2/2$ . Thus, the optimal  $\alpha$  is zero, and then  $\pi_M = \theta_1$ . Under  $W = \theta_2$ ,  $\pi_M = \alpha(\theta_2\beta) - k\alpha^2/2$ . Thus, the optimal  $\alpha$  is  $\theta_2\beta/k$ , and then  $\pi_M = (\theta_2\beta)^2/2k$ . Therefore, we have the following proposition:

**Proposition 1** *In the non-integrated channel, if  $\theta_1 \geq (\theta_2\beta)^2/2k$ , then  $\alpha = 0$  in the equilibrium; if  $\theta_1 < (\theta_2\beta)^2/2k$ , then  $\alpha = \theta_2\beta/k$  in the equilibrium.*

### 3.1.3 Allowance Fee

In this section, we consider the case where  $R$  can ask  $M$  to pay the allowance fee. When  $R$  can not develop the private label, the game proceeds as follows. First,  $M$  determines  $\alpha$  and  $W$ . After the state is realized,  $R$  offers a contract  $(Q, A)$  to  $M$  where  $Q$  is the quantity that  $R$  promises to purchase from  $M$  and  $A$  is the allowance fee that  $R$  asks  $M$  to pay. If  $M$  rejects the offer, then it ends the game. If  $M$  accepts the offer, then  $M$  pays  $A$  to  $R$  and  $R$  purchases  $Q$  units of product. Finally,  $R$  chooses  $P$ , and consumers decide whether to buy or not.

**Proposition 2** *Suppose that  $R$  can ask  $M$  to pay the allowance fee, but  $R$  can not develop the private label. In the equilibrium,  $M$  chooses  $\alpha = 0$  and sets the wholesale price at  $W \leq \theta_1$ , and thus  $R$  chooses  $Q = 1$  and  $A = W$ .*

*Proof.* Suppose that  $\alpha$  and  $W$  have been determined by  $M$ . When the state is  $G$ , if  $W \leq \theta_2$ , then  $R$  is optimal to choose  $Q = \beta$  and  $A = \beta W$ ; if  $W > \theta_2$ , then  $R$  is optimal to choose  $Q = A = 0$ . When the state is  $B$ , if  $W \leq \theta_1$ , then  $R$  is optimal to choose  $Q = 1$  and  $A = \theta_1 - W$ ; if  $w > \theta_1$ , then  $R$  is optimal to choose  $Q = A = 0$ . Thus given  $\alpha$  and  $W$ ,  $M$ 's expected profit is  $-k\alpha^2/2$ . It is optimal for  $M$  to set  $\alpha = 0$ , and then the state  $B$  appears with probability one.  $\parallel$

**Proposition 3** *Suppose that  $R$  can ask  $M$  to pay the allowance fee, and  $R$  can develop the private label. In the equilibrium,  $R$  chooses  $\alpha = (\theta_2\beta - \theta_1)/k$ , and  $M$  sets the wholesale price at  $W \leq \theta_1$ . In state  $G$ ,  $R$  offers  $Q = \beta$  and  $A = W\beta$ ; in state  $B$ ,  $R$  offers  $Q = 1$  and  $A = W$ .*

### 3.1.4 Non-integrated Channel with Private Label

Now, consider the case where  $R$  is capable of doing on  $R\&D$ . In other words,  $R$  can develop a new product with her own private label. We shall first consider the case where  $\theta_1 \geq (\theta_2\beta)^2/2k$ . The game proceeds as follows.

First,  $R$  offers a contract to  $M$  where  $R$  promises to spend  $\frac{1}{2}k\alpha^2$  on R&D for developing a new product for her private label and to purchase quantity equal to 1 for the product with quality  $s = f(\alpha)$  produced by  $M$  while the wholesale price set by  $M$  has to be less than or equal to  $\theta_1$ . If  $M$  rejects, then the game returns to the case without the private label. If  $M$  accepts, she determines the wholesale price  $W$ . After the state is realized,  $R$  chooses the retail price  $P$ . Finally, consumers decide to buy or not. Note that when  $\theta_1 \geq (\theta_2\beta)^2/2k$ , if  $M$  rejects to produce the product for  $R$ 's private label, she will spend no money on R&D and obtain a profit equal to  $\theta_1$ , the same profit  $M$  can obtain by accepting  $R$ 's offer. Thus  $M$  will supply the private label for  $R$  and set  $W = \theta_1$ . Thus  $M$  guarantees herself a profit equal to  $\theta_1$ . Now  $R$ 's problem is as follows:

$$\text{Max}_{\alpha} \alpha(\beta\theta_2 - \theta_1) - \frac{1}{2}k\alpha^2 \quad (2)$$

Solving the problem above, we derive  $\alpha = (\beta\theta_2 - \theta_1)/k$ . Similarly when  $\theta_1 \leq (\theta_2\beta)^2/2k$ ,  $R$  will offer  $M$  to purchase quantity equal to 1 if the wholesale price is less than or equal to  $(\theta_2\beta)^2/2k$ . In doing so,  $R$  ensures  $M$  to have a profit not less than  $(\theta_2\beta)^2/2k$ . In this case,  $M$  will indeed choose  $W = (\theta_2\beta)^2/2k$ . Solving  $R$ 's problem yields the same  $\alpha^* = (\beta\theta_2 - \theta_1)/k$ . Therefore, we have the following proposition:

**Proposition 4** *Suppose that  $R$  can develop her own private label by spending R&D expenditures in the non-integrated channel. In the presence of a private label, the innovativeness of the new product, denoted by  $\alpha$ , can be raised to the level under vertically-integrated channel (i.e.,  $(\beta\theta_2 - \theta_1)/k$ ), thus maximizing channel profits.*

## 3.2 Product Line

In this subsection, we consider the case where  $M$  has an existing branded product (i.e., a national brand) in a heterogeneous consumer market. There are two cases: (i) Case 1: the current branded product serves the whole market, (ii) Case 2: it targets and serves only the high-end segment. In the following, we will show that the current positioning of the national brand will crucially influence  $M$ 's new product development decisions and thus the efficiency role of private label. We shall first consider case 1.

### Case 1: High-end New Product

The high-valuation consumers, which is  $\beta$  proportion of the consumers, value the existing branded product at  $\theta'_1$  while low-valuation consumers (with proportion  $1 - \beta$ ) value it at  $\theta_1$ . If  $M$  spends  $k\alpha^2/2$  on R&D, then the high-valuation consumers value the new product at  $\theta_2$  with probability  $\alpha$  or  $\theta'_1$  with

probability  $1 - \alpha$ . The low-valuation consumers, which is  $1 - \beta$  proportion of the consumers, value the existing and new goods at  $\theta_1$  with probability one. Assume that  $\theta_2 > \theta'_1 > \theta_1$  and  $\theta_2\beta > \theta_1 > \theta'_1\beta$ . The latter set of conditions imply that  $M$  will serve all consumers before any new product is successfully introduced.

In the integrated channel,  $M$  is faced with consumers directly. The game proceeds as follows.  $M$  first determines  $\alpha$  and thus her  $R\&D$  expenditure. Then after the state is realized,  $M$  sets the retail prices  $P_E$  and  $P_N$  for the product, and consumers decide whether to buy or not.

Suppose that  $M$  has invested  $k\alpha^2/2$  on  $R\&D$ . Because  $\theta_1 > \theta'_1\beta$ , if  $M$  is in state  $B$ , then  $P_N$  will be set at  $\theta_1$ ; if  $M$  is in state  $G$ , then  $P_N$  will be set at  $\theta_2 - (\theta'_1 - \theta_1)$ . No matter  $M$  is in state  $G$  or  $B$ ,  $P_E$  will be set at  $\theta_1$ . Thus we have the following lemma.

**Lemma 1** *When the manufacturer attempts to develop a new product in addition to her national brand that targets at the high-valuation consumers, she can select the optimal prices for the two products before the realization of the states without incurring any loss from her inferior information.*

The above lemma indicates that when the uncertainty in the new product development is inherited in the high-end product, then the optimal price for the low-end product (the current national brand) is always set to extract the surplus of the low segment and thus independent of the demand state of the new product. As for the new product,  $M$  can set its price at the willingness to pay of high-valuation consumers for the "successful" new product. Therefore,  $M$  is not hurt in any way by her information disadvantage relative to  $R$ . However, following Villas-Boas (1998),  $M$  still faces the incentive problems of  $R$  when inducing the latter to adopt a targeting strategy that is consistent with  $M$ 's intention for the product line after the new product succeeds. We report it in the following lemma.

**Lemma 2** *Suppose  $M$  currently serves the whole market by her national brand. The optimal innovativeness of the high-end new product for  $M$  in a non-integrated channel will be the same as that in an integrated channel and equals  $\alpha^* = (\theta_2 - \theta'_1)\beta/k$ .*

The above lemma shows that in a non-intergrated channel,  $M$  will not adjust the innovativeness of the new product. However, because of the information disadvantage,  $M$  may give up serving low-end consumers if their proportion or importance is too low. Furthermore, the targeting strategy in a non-integrated channel might be also different from that in an integrated channel, as shown in the following proposition.

**Proposition 5** *Due to R's incentive problems and information advantage over M, when the high-end new product succeeds, M may induce R to serve only the high-valuation consumers by the successful new product if and only if  $\beta(2 - \beta)\theta'_1 > \theta_1$ .*

Now we consider case 2 where the current national brand targets at *Highs* only.

### Case 2: Low-end New Product

For case 2 where the current national targets at *Highs*, we make the following assumptions. There exist proportion  $\beta$  of consumers, named *Highs*, who value the existing product at  $\theta_2$ , and proportion  $1 - \beta$  of consumers, named *Lows*, who values it at 0.<sup>1</sup> When the new product is in state *G*, *Highs* and *Lows* value it at  $\theta'_1$  and  $\theta_1$ , respectively. When the new product is in state *B*, both *Highs* and *Lows* value it at 0. Assume that  $\theta_2 > \beta\theta_2 > \theta_1 > \beta\theta'_1$  to highlight the importance of a successful new product in segmenting the market through the product line. In this section, we will show that in the absence of the private label, *M*'s incentives to develop an innovative product may be distorted downward, given that *M* can sell her national brand to *Highs*.

#### 3.2.1 Integrated Channel

Denote the retail prices of the existing product and the new product by  $P_E$  and  $P_N$  respectively. The game proceeds as follows. *M* first determines  $\alpha$  and thus her *R&D* expenditure. Then after the state is realized, *M* sets the retail prices  $P_E$  and  $P_N$  for the product, and then consumers decide whether to buy or not.

Suppose that *M* has invested  $k\alpha^2/2$  on *R&D*. If *M* is in state *B*, then  $P_E$  will be set at  $\theta_2$  and only *Highs* will be served. If *M* is in state *G*, she has two feasible strategies. She can offer existing and new products to *Highs* and *Lows*, respectively.  $P_N$  will be set at  $\theta_1$  and  $P_E$  will be set at  $\theta_2 - (\theta'_1 - \theta_1)$ . Alternatively, she can offer existing product to serve *Highs* only by setting  $P_E$  at  $\theta_2$ . Given  $\beta\theta'_1 < \theta_1$ , the second strategy is dominated. Thus the problem facing *M* when developing her new product is as follows:

$$\text{Max}_{\alpha} \quad \alpha\{\beta[\theta_2 - (\theta'_1 - \theta_1)] + (1 - \beta)\theta_1\} + (1 - \alpha)\beta\theta_2 - \frac{1}{2}k\alpha^2 \quad (3)$$

The first-order condition yields  $\alpha^* = (\theta_1 - \beta\theta'_1)/k$ . Thus *M*'s expected profit  $\pi_M$  is  $\beta\theta_2 + (\theta_1 - \beta\theta'_1)^2/2k$ .

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<sup>1</sup>It is worth noting that if *Lows* value the current product at  $\theta_1$  instead of 0, the results remain the same.

### 3.2.2 Non-integrated Channel without Private Label

When the channel is not integrated and  $R$  can not develop a new product with private label, the game proceeds as follows. First,  $M$  determines  $\alpha$  and thus her  $R\&D$  expenditure. Then,  $M$  chooses  $W_E$  and  $W_N$  where  $W_E$  is the wholesale price of the existing product and  $W_N$  is the wholesale price of the new product. After observing the state and the wholesale prices  $W_E$  and  $W_N$ ,  $R$  chooses the retail prices  $P_E$  and  $P_N$  and the quantities  $Q_E$  and  $Q_N$  where  $Q_E$  the quantity of the existing product that she purchases from  $M$  and  $Q_N$  the quantity of the new product that she purchases from  $M$ . Finally, consumers decide whether to buy or not.

Suppose that  $M$  has invested  $k\alpha^2/2$  on  $R\&D$ . In state  $B$ , retailer will set  $P_E$  at  $\theta_2$  and only Highs will be served if  $W_E \leq \theta_2$ .

In state  $G$ , retailer has four feasible strategies:

- Strategy 1. Serving Highs and Lows with the existing product and the new product, respectively.
- Strategy 2. Serving all consumers with the new product.
- Strategy 3. Serving Highs only with the existing product.
- Strategy 4. Serving Highs only with the new product.

It can be easily shown that it does not pay for  $M$  to induce  $R$  to serve Highs only with the new low-end product should it succeed, after making  $R\&D$  expenditures. That is, inducing  $R$  to adopt strategy 4 in state  $G$  is not optimal for  $M$ . We shall consider only the first three strategies of  $R$ . Let us discuss Strategy 1 at first. Retailer will implement Strategy 1 if  $W_N \leq (\theta_1 - \beta\theta'_1)/(1 - \beta)$  and  $W_E - W_N \leq \theta_2 - \theta'_1$ . Given retailer's two binding constraints, we can derive that  $W_E^* = \theta_2 - (\theta'_1 - \theta_1)/(1 - \beta)$  and  $W_N^* = (\theta_1 - \beta\theta'_1)/(1 - \beta)$ .  $M$ 's problem is as follows:

$$\text{Max}_{\alpha} [\theta_2 - (\theta'_1 - \theta_1)/(1 - \beta)] + [\alpha(1 - \beta)(\theta_1 - \beta\theta'_1)/(1 - \beta)] - \frac{1}{2}k\alpha^2 \quad (4)$$

Following the first-order condition, we have  $\alpha^* = (\theta_1 - \beta\theta'_1)/k$ , and then  $M$ 's expected profit  $\pi_M$  is  $\beta\theta_2 - \beta(\theta'_1 - \theta_1)/(1 - \beta) + (\theta_1 - \beta\theta'_1)^2/2k$  in the equilibrium.

Now consider Strategy 2. Retailer will implement Strategy 2 if  $W_N \leq (\theta_1 - \beta\theta'_1)/(1 - \beta)$ ,  $W_E \leq \theta_2$ ,  $W_E - W_N \geq \theta_2 - \theta'_1$ , and  $\beta W_E - W_N \geq \beta\theta_2 - \theta_1$ . Assume  $\beta\theta_2 - \theta_1 \leq \theta_2 - \theta'_1$ , then the first two constraints are binding. we

can derive that  $W_E^* = \theta_2$  and  $W_N^* = (\theta_1 - \beta\theta'_1)/(1 - \beta)$ .  $M$ 's problem is as follows:

$$\text{Max}_{\alpha} \alpha[(\theta_1 - \beta\theta'_1)/(1 - \beta)] - (1 - \alpha)\beta\theta_2 - \frac{1}{2}k\alpha^2 \quad (5)$$

By the first-order condition, we have  $\alpha^* = \text{Max}\{0, [(1 - \beta)(\theta_1 - \beta\theta_2) - \beta(\theta'_1 - \theta_1)]/(1 - \beta)k\} = 0$ . The optimal R&D investment level is equal to 0. Thus  $M$ 's expected profit when inducing  $R$  to adopt strategy 2, equals  $\beta\theta_2$ , which is equal to that under strategy 3 and 4. The expected profit for  $M$  when inducing  $R$  to adopt strategy 3 (i.e., serving Highs only with the existing national brand) or 4 (i.e., serving Highs only with the new product) equals  $\beta\theta_2$ ; it means that  $M$  will not invest in R&D and set  $W_E$  at  $\theta_2$ . Comparing the profit under strategy 1 with that under the other strategies gives us the following proposition.

**Proposition 6** *In the absence of the private label,  $M$  will choose not to develop her new product if and only if  $k \geq \frac{(1-\beta)(\theta_1-\beta\theta'_1)^2}{2\beta(\theta'_1-\theta_1)}$ .*

Comparing case 2 with case 1, we find that the positioning of the new product relative to the current national brand crucially influences the effect of  $R$ 's information advantage on the innovativeness of the new product. We report it in the following proposition.

**Proposition 7** *When  $M$  intends to introduce a high-end new product in addition to her low-end current product,  $M$  will choose to introduce this new product despite her information disadvantage relative to  $R$ ; In contrast, when  $M$  intends to introduce a low-end new product in addition to her current high-end product, she may give up the new product due to her information disadvantage relative to  $R$ .*

### 3.2.3 Allowance Fee

In this section, we consider the case where  $R$  can ask  $M$  to pay the allowance fee. When  $R$  can not develop the private label, the game proceeds as follows. First,  $M$  determines  $\alpha$ ,  $W_E$  and  $W_N$ . After the state is realized,  $R$  offers a contract  $(Q_E, Q_N, A)$ . If  $M$  rejects the offer, then it ends the game. If  $M$  accepts the offer, then  $M$  pays  $A$  to  $R$  and  $R$  purchases  $Q_E$  units of the existing product and  $Q_N$  units of the new product. Finally,  $R$  chooses  $P_E$  and  $P_N$ , and consumers decide whether to buy or not.

**Proposition 8** *Suppose that  $R$  can ask  $M$  to pay the allowance fee, but  $R$  can not develop the private label. In the equilibrium,  $M$  chooses  $\alpha = 0$  and  $W_E \leq \theta_2$ , and  $R$  chooses  $A = W_E$ , then  $Q_E = \beta$ .*

*Proof.* When  $M$  has chosen  $\alpha > 0$ , the cost of  $R\&D$  is sunk. Because  $R$  can ask  $M$  to pay the allowance fee,  $M$ 's sale profit will be transferred to  $R$  by the allowance fee. Therefore,  $M$  will incur a loss if  $\alpha > 0$ , and then  $M$  chooses  $\alpha = 0$  in the equilibrium.  $\parallel$

### 3.2.4 Non-integrated Channel with Private Label

Now, consider the case where  $R$  is capable of doing on  $R\&D$ . In other words,  $R$  can develop a new product with her own private label. We shall consider the case where  $k \geq \frac{(1-\beta)(\theta_1-\beta\theta'_1)^2}{2\beta(\theta'_1-\theta_1)}$ . The game proceeds as follows. First,  $R$  offers a contract to  $M$  where  $R$  promises to spend  $\frac{1}{2}k\alpha^2$  on  $R\&D$  for developing a new product for her private label and to purchase  $1 - \beta$  quantity of the new product with quality  $s = f(\alpha)$  and  $\beta$  quantity of the existing national brand produced by  $M$  while the wholesale prices  $W_E$  and  $W_N$  set by  $M$  have to be less than or equal to  $\theta_1$  and  $\theta_2 - (1 - \beta)\theta_1/\beta$ , respectively. If  $M$  rejects, then the game returns to the case without the private label. If  $M$  accepts, she determines the wholesale price  $W_N$  and  $W_E$ . After the state is realized,  $R$  chooses the retail price  $P_N$  and  $P_E$ . Finally, consumers decide to buy or not. Note that when  $k \geq \frac{(1-\beta)(\theta_1-\beta\theta'_1)^2}{2\beta(\theta'_1-\theta_1)}$ , if  $M$  rejects to produce the product for  $R$ 's private label, she will spend no money on  $R\&D$  and obtain a profit equal to  $\beta\theta_2$ , the same profit  $M$  can obtain by accepting  $R$ 's offer. Thus  $M$  will supply the private label for  $R$ , and set  $W_N = \theta_1$  and  $W_E = \theta_2 - (1 - \beta)\theta_1/\beta$ . In this way,  $M$  guarantees herself a profit equal to  $\beta\theta_2$  and  $R$ 's problem becomes the following:

$$\text{Max}_{\alpha} \alpha\{\beta[\theta_2 - (\theta'_1 - \theta_1)] + (1 - \beta)\theta_1\} + (1 - \alpha)\beta\theta_2 - \beta\theta_2 - \frac{1}{2}k\alpha^2 \quad (6)$$

Solving the above problem gives us  $\alpha = (\theta_1 - \beta\theta'_1)/k$ . Thus  $R$ 's expected profit  $\pi_R$  is  $(\theta_1 - \beta\theta'_1)^2/2k$ . Therefore, we have the following proposition:

**Proposition 9** *Suppose that  $R$  can develop her own private label by spending  $R\&D$  expenditures in the non-integrated channel. In the presence of the private label, the innovativeness of the new product, denoted by  $\alpha$ , can be raised to the level under vertically-integrated channel (i.e.,  $(\theta_1 - \beta\theta'_1)/k$ ), thus maximizing channel profits.*

## 4 Conclusion

In this paper, we show that when the retailer has information advantage over the manufacturer, the incentives of the manufacturer to develop and

introduce new products will be distorted. For this reason, the manufacturer may under- or over-invest in R&D, thus reducing channel profits.

Our result shows that the presence of private label can increase channel profits, which is consistent Mills (1995) and Bontems et al.(1999). However, the efficiency role of the private label is different from that of Mills (1995) and Bontems et al.(1999) as explained below. In the absence of the private label, the manufacturer, facing the uncertainty inherited in the new product development and the information disadvantage relative to the retailer, may well choose to introduce a sure but less innovative product so that he can ensure the distribution of the new product by the retailer and avoid wastful R&D expenditures. When the retailer takes the responsibility of spending R&D, and guarantees the manufacturer, if supplying the private label for the former, the same profit  $M$  can obtain from a sure product, then the expenditures in R&D will achieve the same level as under a vertically integrated channel. In other words, private label increases efficiency because it allows the retailer who has more information about the new product become the residual claimant.

When the manufacturer supplies the private label for the retailer who is responsible for R&D expenditures, even when the manufacturer has her own national brand, the likelihood of new product introduction and its success will be higher, compared with the case when there is no private label.

As for the role of slotting allowance, we find that in the absence of the private label, charging slotting allowance prevents the manufacturer from new product development and helps the retailer to extract channel profits. Therefore, consistent with Rao and Mahi (2003), slotting allowance is more like a symbol of retailer power, than a way of screening new products by retailers.

## Appendix

**Proof of Lemma 2** We shall first show that the optimal  $\alpha$  in an integrated channel and then just sketch the proof for the nonintegrated channel. In determining  $\alpha$ ,  $M$ 's problem is as follows:

$$\underset{\alpha}{Max} \alpha\{\beta[\theta_2 - (\theta'_1 - \theta_1)] + (1 - \beta)\theta_1\} + (1 - \alpha)\theta_1 - \frac{1}{2}k\alpha^2 \quad (7)$$

Following the first-order condition, we have  $\alpha^* = (\theta_2 - \theta'_1)\beta/k$ , and then  $M$ 's expected profit  $\pi_M$  is  $\theta_1 + (\theta_2 - \theta'_1)^2\beta^2/2k$  in the equilibrium. For a non-integrated channel, it can be easily shown that setting  $W_E \leq W_N$  is a dominant strategy for  $M$ . Thus in what follows we only consider the sub-games where  $W_E$  is less than or equal to  $W_N$  after  $M$  determines  $\alpha$ . Before the demand state of the new product realizes,  $M$  can induce  $R$  to adopt the following targeting strategies:

- (i) in state G serving *Highs* by the new product and serving *Lows* by the current national brand while in state B serving all consumers by the current product;
- (ii) in state G serving *Highs* only by the new product while in state B serving all consumers by the current product;
- (iii) both in state G and in state B serving *Highs* only;
- (iv) in state G serving *Highs* only while in state B serving no consumers.

The optimal  $\alpha^*$ 's and profits under the four strategies are as follows:

Strategy	$\alpha^*$	$\Pi_M$
Strategy (i)	$\beta(\theta_2 - \theta'_1)/k$	$\theta_1 - [\beta(\theta'_1 - \theta_1)]/(1 - \beta) + [(\theta_2 - \theta'_1)^2\beta^2]/2k$
Strategy (ii)	$(\beta\theta_2 - \theta_1)/k$	$\theta_1 - [\beta(\theta'_1 - \theta_1)]/(1 - \beta) + (\beta\theta_2 - \theta_1)^2/2k$
Strategy (iii)	$\beta(\theta_2 - \theta'_1)/k$	$\beta\theta'_1 + [(\theta_2 - \theta'_1)^2\beta^2]/2k$
Strategy (iv)	$\beta\theta_2/k$	$\beta\theta_2^2/2k$

We disregard strategy (iv) since it implies that  $M$  sells nothing when the new product fails. Comparing profits under the other three strategies yields the conditions in the Lemma 2.

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