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Private Labels and the Channel Relationship: A Cross-Category Analysis*

Retailers introduce private labels in a category not only to gain profits directly from the private label but also to use as a strategic weapon to elicit concessions from the national brand manufacturers. We show that, in certain categories, the retailer can gain better terms of trade by introducing a private label. The ability of the retailer to use the private label for this purpose is hypothesized to be inversely related to the risks consumers associate with purchasing in that category. The implications of our model are supported by data from a cross section of grocery categories.

I. Introduction

Information Resources reported (Deveney 1993*b*) that for the 13 weeks ending July 4, 1992, private-label goods accounted for 19.8% of all items sold at the grocery store and 14.8% of total dollar volume. This represented a growth rate of 2.6%, up to $7.42 billion, when compared with the same period a year earlier. The popular press has literally been teeming with articles about the successes of private-label brands in various categories. As one *Wall Street Journal* article put it, "Despite the economic recovery, legions of consumers are no longer automatically willing to pay up for big brands—even if they can easily afford them" (Deveney 1993*a*, p. 14). Further, this success has not been limited to the U.S. market but has seen marked growth in European and Japanese markets as well (Ono 1993).

National brand manufacturers seem keenly aware

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of the problem facing them. Procter and Gamble reportedly cut its prices on Tide and Cheer, its two best-selling liquids, in direct response to private-label competition (Ortega and Stern 1993). Other categories, such as cigarettes and refrigerated juices, have seen similar significant increases in competitive pressure from private labels. In response to the growing concern of national brand manufacturers, Quelch and Harding (1996) offer manufacturers a set of ideas for dealing with the private-label threat. These increases in private-label share have not only benefited retailers by introducing a new source of direct profit but also have provided them with a better position from which to bargain with the national brand manufacturers. *Grocery Marketing,* reporting on the results of the September 1993 PaineWebber retailing conference,[1] noted that, in addition to citing higher margins on private labels, retailers listed "bargaining tool with branded manufacturers" as one of the prime benefits of introducing private labels in a category (Giblen 1993).

In this article we explore the incentives of a retailer to offer private labels. We show that, when preferences are not strong and national brand buyers are willing to switch to a private label a retailer, by introducing a private label, is able to elicit a better wholesale price from the manufacturers of the national brands against which the private label competes. This effect persists *even when* there is competition at the manufacturer level. We link the willingness of consumers to switch from a national brand to a private label to the risks consumers associate with making purchases in a given category as well as measures describing the ability of a retailer to offer a private label of comparable quality to the national brands in the given category. A cross-sectional analysis of private-label shares and retail margins lends support to the model's implications.

The rest of the article is organized as follows. In the next section, we provide a brief review of the existing literature and position our article. In Section III we develop a model of consumers, a manufacturer, and a retailer and show the conditions under which a retailer will decide to offer a private label. We extend this to the case when there is more than one branded product. We derive testable implications from our model. In Section IV we describe the data sources and the measurements we use to capture the model's variables. In Section V we present the results of our empirical analysis and discuss the implications. Section VI summarizes our results and identifies directions for future research.

II. Private-Label Research

Research on private labels has been of substantial interest to marketing researchers for the better part of 3 decades. Drawing on the seminal

1. This conference included upper-level managers from 36 retailing chains.

work of Myers (1967), several studies have examined the socioeconomic and demographic characteristics of consumers who are inclined to purchase private labels (e.g., Coe 1971; Bettman 1974) as well as consumers' perceptions of these products (Belizzi, Kruckeberg, Hamilton, and Martin 1981).

The more recent line of research on private labels has primarily focused on the factors that determine the category share a private label attains as well as the reasons retailers decide to carry private labels. Sethuraman (1992) and Hoch and Banerji (1993) refuted the common perception that a private label's primary attraction was the substantial price discount, relative to national brands, at which they were sold. Sethuraman (1992) empirically demonstrated that the price difference at which a private label sells to the national brand is actually inversely related to the private label's category share, a result also found in the theoretical work of Mills (1995). Hoch and Banerji (1993) emphasize the role of quality in the private-label purchase decision. They find evidence to support the notion that perceived quality is much more important than the level of price discount in determining the private-label category share. Using category-level measures of quality variability, price discount of the private label, number of national brand manufacturers, advertising dollars spent, and several other covariates they were quite successful in explaining much of the cross-category variance in private-label share. Putsis and Dhar (1996) demonstrate that private labels are capable of expanding category expenditure instead of simply stealing share from the national brand. Cotterill, Dhar, and Putsis (1996) set out some successful tactics for marketing private labels.

In an attempt to model the profitability of a private-label introduction, Raju, Sethuraman, and Dhar (1995) develop an analytical framework for examining the conditions under which a private label is more likely to increase category profits for the retailer. Their model suggests that private labels will be more successful at increasing category profit if (1) the less intense the price competition between the national brands (holding the number of brands in the category constant) and (2) the higher the cross-price elasticity between the national brands and private label. An implication of their model is that the retailer makes less money on the national brands subsequent to the private-label introduction. In related work, Lemon and Winer (1993) and Sethuraman (1995*a*) empirically examine the cross-price elasticities between national brands and private labels to determine how price promotions, for either the national brands or private label, affect the sales of the other class of products. While Sethuraman (1995*a*) notes a high degree of cross-category variance in the effect of private-label promotion on national brand sales, both works find evidence that, at least in some instances, private-label promotions can be quite effective in taking share from the national brand as well as vice versa. Sethuraman (1995*b*)

links these cross-category differences in cross-price elasticities to some important brand-level structural variables. For instance, high share national brands are found to be much less susceptible to price promotions by private labels.

Finally, Lal (1990) provides us with a model that depicts two manufacturers who engage in alternating price promotions in order to limit the competitive encroachment of a private label. Lal shows that a strong private label is likely to increase retail pass-through of trade promotions as well as induce manufacturers to offer deeper trade discounts. Private labels then may used by the retailer to induce the national brand manufacturers to offer deeper and/or more frequent trade deals.

The extant literature on private labels has not directly addressed the strategic role of private labels in the channel relationship between the national brand manufacturers and the retailer. Building on the prior literature, we examine this issue. Specifically, we compare a scenario where the retailer has no private label with a scenario where the retailer distributes a private label to show the strategic role the private label plays. We show that private-label introduction shifts channel power toward the retailer. Finally, we conduct an empirical analysis to test the implications of our model and provide validity to our arguments.

III. The Model

We consider a market with manufacturers selling branded products through a common retailer. Retailers carry multiple brands within a category and many categories in their store. Since our focus is on understanding intracategory channel effects, we model as if the retailer is carrying only one category. A branded product sold by the manufacturer through the retailer is called a national brand. It is supported by mass advertising and other merchandising efforts by the manufacturer. We also allow the retailer to carry a private label. A private-label brand is store-specific and its distribution is limited to a particular retailer. Another distinguishing characteristic of private labels is that these are not supported by consumer advertising by the manufacturers of these products but can be supported by in-store merchandising by the retailers. We assume that the national brand manufacturers are not the suppliers of private labels that compete directly with their own national brands, but there could be other national brand manufacturers supplying in related categories or subcategories that supply the private label to the retailer. For example, Ralston Purina Co., which markets the national brand Chex in the ready-to-eat cereals (RTE) market, supplies some retailers a private-label rice crispies (a subcategory of RTE cereals category) to compete against Kellogg's rice crispies. Dunne (1996) concludes that rarely will a manufacturer choose to supply a private label in a category where it markets a national brand. Manufacturers

often fear that if consumers become cognizant that the manufacturer is supplying a private-label product in the same category the consumers will rebel against the national brand. Even if a national brand manufacturer supplies a private label that competes directly with its own brand, it is often the case that the manager of the private-label account acts independently from the manager of the national brand (Quelch and Harding 1996).

On the demand side, we assume that at equal prices all consumers prefer the national brand to a private label. This assumption is conservative with respect to the implications of our model. Relaxing this assumption would serve to strengthen our results, not weaken them. We choose this preference structure because we believe that, in general, national brands are preferred by consumers to private labels. This preference asymmetry may arise due to perceived quality differences between the national brand and private label (Hoch and Banerji 1993) as well as differences in image-building advertising support. This type of support is not present for private-label products whose competitive position lies squarely on providing an acceptable level of quality at a price that is lower than that of the national brands. In essence, the manufacturer attempts to build monopoly power for his branded product by differentiating it from a simple commodity item.[2] Another source of this preference asymmetry could be due to perceived risk that consumers associate with buying the private label. Perceived risk can arise due to emotional, social, or psychological risk that consumers associate with consuming the private label. The level of perceived risk is idiosyncratic to the individual (see Hawkins, Best, and Coney 1986, ch. 16). This perceived risk leads to greater level of information search and involvement. To deal with this risk consumers may buy the most advertised brand, a well-known brand, or the most expensive brand (see Hawkins, Best, and Coney 1986, ch. 16).

On the supply or the manufacturer side, we assume that the retailer can outsource the production and delivery of the private-label product from among many competing manufacturers. Private-label production stems from both manufacturers who specialize in supplying private-label products and national brand manufacturers. National brand manufacturers have incentives to maximize capacity utilization. While evidence suggests that they are hesitant to use this excess capacity to produce private labels that compete head-to-head with their existing product, they often can, and do, use their existing idle capacity to manufacture private-label products, which can be produced with nearly identical processes to their existing national brand. Given that the retailer assigns the strategic role of private label and the fact that he or she

2. See Lal and Narasimhan (1996).

could obtain the product from any of a number of private-label manufacturers directly implies that the market for the supply of private-label products is perfectly competitive. Thus, in our model, the private-label manufacturer is not a strategic player.

In this section we formally present the assumptions underlying the models of the consumer and of the channel members. These models, when taken together, form the basis for analyzing the pricing decisions of the manufacturer and the retailer.

A. *Consumer Model*

1. Consumers purchase one unit of the goods, either national brand or private label, as long as the price of at least one of the goods is below their reservation price (r). This assumption has been common in the literature.[3]
2. At equal prices, consumers prefer the national brand to the private label.
3. Consumers are divided into two exhaustive and nonoverlapping groups. One group of consumers (α) is perfectly loyal to the national brand and thus will never purchase the private label no matter what the price difference between the national and private label. The second group (β) are brand switchers who will purchase the national brand if and only if (iff) $P_n - P_s < l$, $l \geq 0$ and the private label otherwise, where P_n is the price of the national brand and P_s is the price of the private label.[4] The market size is normalized such that $\alpha + \beta = 1$.
4. Each consumer in the switching segment is characterized by a unique l, which we term the reservation switching difference. Since different consumers have different values of l, we denote the distribution of l in the population by its cumulative density functions (c.d.f.) $F(\cdot)$.

B. *Retailer and Manufacturer Decisions*

We assume that the national brand manufacturers face a constant returns technology and the marginal cost of producing their product is set to zero. Based on the arguments sketched above, we assume that the retailer is able to buy the private label in a competitive market at a price w_s. The retailer wishes to maximize profit by strategically setting the retail price of both the national brand and the private label. The retailer is fully informed about consumer preferences. Thus, for

3. See, e.g., Narasimhan (1988); and Lal (1990).
4. See Blattberg and Sen (1974) for a discussion of the validity of segmenting consumers in this manner.

any pair (P_n, P_s), the retailer knows how the market will split and uses this knowledge in setting prices.

The national brand manufacturer has only one decision variable, the wholesale price of the national brand. The manufacturer sets the price to maximize his profits by anticipating how the wholesale price will affect the retailer's decisions.

We model the decision sequence as a Stackelberg game where the manufacturer acts as the price leader. In the first stage of the game, the manufacturer sets the wholesale price of the national brand with knowledge of the retailer's reaction function. In the second stage, the retailer sets the retail price of both the national brand and the private label. Finally, based on these prices, consumers decide which item, if any, to purchase. The manufacturer's knowledge of the retailer's reaction function assures subgame perfection of the resulting equilibrium.

We assumed the presence of only one national brand in the model we analyzed. What would happen if there are many national brands? Consider, for example, the presence of another national brand in the above model. Assume that each brand has a set of core loyal buyers and the switching consumers switch among the national brands. The brand that has a smaller share of the loyal market will have incentive to attract the switchers by lowering its wholesale price. Given sufficient inducement, the retailer will lower the retail price of the manufacturer who lowers the price below r. Thus, the retailer is better off when there is competition between the manufacturers than when there is none. However, even in the case when there are two manufacturers, the retailer will have an incentive to introduce the private label since he can put even more pressure on the manufacturers to provide greater concessions by lowering the wholesale prices. Interestingly, as the number of brands increases it might very well be the case that national brands might find it less and less in their interest to compete for the switchers since the likelihood of obtaining the switching segment should decrease with the number of competitors. This implies that as the number of national brands increases it is more likely that the retailer will increase the share of the private label. Although we have laid out some conjectures as to how our results would change if we allowed competition at the manufacturer level, to determine the exact nature of the change in the channel power structure would require a model significantly more complicated than the one we develop here. In the interest of remaining clear and concise in the focus of this article, we do not address these issues formally.

C. Equilibrium When There Is No Private Label

First, we consider a game where a retailer does not carry a private label. We then consider a game where the retailer is allowed to carry a private label. Our interest is in describing the prices and profits that will emerge

in the equilibrium of the games. Suppose first that the retailer carries no private label. The retailer then maximizes

$$\Pi^r = P_n - w_n. \tag{1}$$

This function is maximized at $P_n = r$. Given this decision rule, the national brand manufacturer will set $w_n = r$ since there is no incentive for him to set his price any lower than r. Thus, in our simple model, the retailer will earn zero economic profit and the national brand manufacturer will earn a profit of r in the absence of a private label. The total channel profit then is given simply by r. This provides us with a benchmark against which to measure the effect the private label has on manufacturer and retailer profits.

It is clear that this lack of ability on the part of the retailer to credibly commit to a retail price below r for the national brand is detrimental to the retailer. What the retailer needs then is some mechanism whereby it is in fact optimal for the national brand manufacturer to set a price below r and thereby allow the retailer to extract some of the channel profits.

D. Equilibrium When the Retailer Carries a Private Label

Suppose now that the retailer introduces a private label in the category of interest. The retailer's and national brand manufacturer's profit functions are given by

$$\Pi^r = \alpha(P_n - w_n) + \beta\theta(P_n - w_n) + \beta(1 - \theta)(P_s - w_s) \tag{2}$$

and

$$\Pi^m = \alpha w_n + \beta\theta w_n, \tag{3}$$

where θ is the fraction of the switching segment who will buy from the national brand. We see then that $\theta = \text{prob}[l > P_n - P_s]$. Setting $P_n - P_s = K$ and $\theta = 1 - F(K)$, we can rewrite the profit functions as

$$\begin{aligned}\Pi^r = {} & \alpha(P_n - w_n) + \beta(1 - F(K))(P_n - w_n) \\ & + \beta F(K)(P_n - K - w_s)\end{aligned} \tag{4}$$

and

$$\Pi^m = \alpha w_n + \beta(1 - F(K))w_n, \tag{5}$$

where

K = the price difference at which the private label sells to the national brand and $F(K)$ is the c.d.f. describing the proportion of the consumer population for whom K is large enough to induce switching to the private label;

w_n = the wholesale price of the national brand, and
w_s = the wholesale price of the private label.

We see from (4) that for any given K, Π^r is strictly monotonically increasing with respect to P_n. This suggests that the retailer has only one decision variable to control, namely, K. The intuition behind this is the following. As long as $P_n \leq r$, everyone buys. The only decision for the retailer then is how to split the market. This the retailer decides based on the margin he obtains from the national brand. In equilibrium he will set K such that the marginal profits of the national brand and private label are equal. Based on the foregoing discussion, we need only to consider one decision variable, namely, the difference in prices between the two goods.

In keeping with earlier assumptions we solve the game through backward induction. First, we solve for the reaction function of the retailer. Optimizing Π^r with respect to K yields

$$K = w_n - w_s - \frac{F(K)}{f(K)}. \tag{6}$$

It is easy to see that if we allow $f(K)$ to be some arbitrary distribution then it may be difficult to find a closed-form solution for the optimal price difference K. Suppose then that $l \sim U[0, L]$. Rewriting the profit functions for the retailer and the manufacturer yields

$$\Pi^r = (P_n - w_n)\alpha + \left(1 - \frac{K}{L}\right)(P_n - w_n)\beta + \frac{K}{L}(P_n - K - w_s)\beta \tag{7}$$

and

$$\Pi^m = \alpha w_n + \beta\left(1 - \frac{K}{L}\right)w_n. \tag{8}$$

Figure 1 provides some intuition for the profit functions. The shaded area represents the portion of the β segment that will purchase the private label. As the discount K approaches L, the maximum price difference needed to induce switching for the segment, the private label takes a larger portion of the segment. Thus, the proportion of the β segment that purchases the private label can be represented as K/L. While L is exogenously given in this model, the optimal discount, K^*, will be determined endogenously from the values of β and L. We can interpret these two variables as a kind of a measure of attractiveness of the category for the retailer. As β increases the proportion of people who would be willing to switch to the private label for a given price differential increases. In contrast, as L increases the category will become less attractive to the retailer because the amount of discount needed on the

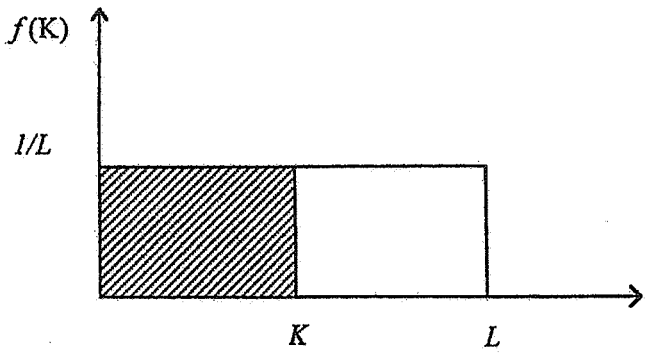

FIG. 1.—Distribution of the reservation switching differences

private label to attract the same proportion of the switching segment increases in L. As the dispersion of these reservation switching differences increases, it becomes more expensive for the retailer to attract customers to his private label. We need then to determine optimal retail prices for the national brand and private label as well as the optimal wholesale price for the national brand. This will allow us to gain insight into how introduction of a private label changes the channel relationship.[5]

Recomputing the reaction function of the retailer given the assumption that $l \sim U[0, L]$ yields

$$\hat{K} = \begin{cases} \dfrac{w_n - w_s}{2} & \text{if } \dfrac{w_n - w_s}{2} \leq L, \\ L & \text{otherwise.} \end{cases} \tag{9}$$

Taking this decision rule into account the manufacturer solves

$$w_n \in \operatorname{argmax}\left[\alpha w_n + \beta\left(1 - \frac{\hat{K}}{L}\right)w_n\right], \tag{10}$$

leading to an optimal wholesale price of

$$w_n^* = \begin{cases} \dfrac{L}{\beta} + \dfrac{w_s}{2} & \text{if } \beta \geq \dfrac{2L}{2r - w_s}, \\ L & \text{otherwise.} \end{cases}$$

We see then that different equilibria will arise in different regions of the parameter space. A summary of the different equilibria that could arise in this game are given in table 1.

5. A brief exposition of the solution to this game can be found in app. C.

TABLE 1 Stackelberg Equilibria

Equilibrium Type	Parameter Values	Equilibrium
Type 1	$w_s \geq r$	$w_n^* = r,\ K^* = 0$
Type 2A	$r - 2L < w_s \leq r,\ \beta \leq \frac{2L}{4L + w_s}$	$w_n^* = r,\ K^* = L$
Type 2B	$w_s \leq r - 2L,\ \beta \leq \frac{2L}{2r - w_s}$	$w_n^* = r,\ K^* = L$
Type 3A	$r - 2L < w_s \leq r,\ \frac{2L}{4L + w_s} < \beta \leq \frac{2L}{2r - w_s}$	$w_n^* = r,\ K^* = \frac{r - w_s}{2}$
Type 3B	$w_s \leq r - 2L,\ \frac{2L}{2r - w_s} < \beta \leq \frac{2L + w_s}{4L}$	$w_n^* = r,\ K^* = L$
Type 4A	$r - 2L < w_s \leq r,\ \frac{2L}{2r - w_s} < \beta \leq \frac{2L}{w_s}$	$w_n^* = \frac{L}{\beta} + \frac{w_s}{2},\ K^* = \frac{L}{2\beta} - \frac{w_s}{4}$
Type 4B	$w_s \leq r - 2L,\ \frac{2L}{4L + w_s} < \beta \leq \frac{2L}{w_s}$	$w_n^* = \frac{L}{\beta} + \frac{w_s}{2},\ K^* = \frac{L}{2\beta} - \frac{w_s}{4}$
Type 5	$w_s < r,\ \beta > \frac{2L}{w_s}$	$w_n^* = \frac{L}{\beta} + \frac{w_s}{2},\ K^* = 0$

The intuition for the equilibria in table 1 is as follows. If the price at which the retailer can procure the private label is above consumers' reservation price for the category then it clearly cannot be profitable for the retailer to introduce a private label. This is an equilibrium of Type 1.[6] The equilibrium of Type 2 arises because the switching segment is too small for the retailer to credibly threaten the national brand manufacturer. The manufacturer, under no threat from the private label, raises her wholesale price to r and appropriates all channel profits. An equilibrium of Type 3 arises when the switching segment is sufficiently large to induce the retailer to introduce a private label but not sufficiently large to warrant price concessions from the national brand manufacturer. In the absence of any price concessions, the retailer considers only the private label when maximizing her profit. In contrast, an equilibrium of Type 4 indicates that the number of people that would consider purchasing the private label is large enough to induce the national brand manufacturer to lower her wholesale price. The manufacturer optimally provides a wholesale price cut to the retailer and in return the retailer does not take the entire switching segment with his private label. At the limit, the switching segment may be so large, and hence the manufacturer's price cut so deep, that the retailer forgoes any profit from sales of the private label and simply makes money on the national brand. This is an equilibrium of Type 5. Within each equilibrium type, the distinction between A and B arises because depending on whether $w_s \gtrless r - 2L$ determines how the restrictions for the given area of the parameter space need to be defined. Except for the Type 1 equilibrium, where private-label introduction is not profitable, the equilibrium types are ordered in increasing magnitude of β. The reader will notice that as you move from Type 2 to Type 5, while parameter space, which contains the equilibrium values, can be characterized by increasingly large switching segments, the equilibrium private-label share actually falls. The intuition behind this type of result will be presented in more detail in the next section.

Since we are primarily interested in how a private label forces the manufacturer to make price concessions to the retailer, we confine our comparative static analysis to the Type 4 equilibrium. The equilibrium values of all decision variables for a Type 4 equilibrium are easily computed from knowledge of w_n^* and K^*. Specifically,

$$P_s^* = r - K^* = r - \frac{L}{2\beta} + \frac{w_s}{4}, \tag{11}$$

$$P_n^* = r, \tag{12}$$

6. Setting $K^* = 0$ is equivalent to not carrying a private label since at $P_s = r$ no consumer will purchase the private label.

TABLE 2 Comparative Statics of Profit Functions

Statics	Retail Profit	Manufacturer Profit	Channel Profit
β	+	−	+
L	−	+	−
r	+	0	+

NOTE.—A plus sign indicates that the column value will increase as the row parameter increases.

and

$$w_n^* = \frac{L}{\beta} - \frac{w_s}{2}. \tag{13}$$

Substituting the optimized values of the decision variables back into the profit functions yields

$$\Pi^{m*} = \frac{(2L + \beta w_s)^2}{8\beta L} \tag{14}$$

and

$$\Pi^{r*} = r - \frac{3L}{4\beta} - \frac{3w_s}{4} + \frac{\beta w_s^2}{16L}, \tag{15}$$

and thus channel profit

$$\Pi^{c*} = r + \frac{(2L + \beta w_s)^2}{8\beta L} - \frac{3L}{4\beta} - \frac{3w_s}{4} + \frac{\beta w_s^2}{16L}. \tag{16}$$

E. Discussion of the Comparative Statics

Notice that the introduction of the private label not only shifts some of the channel profits from the manufacturer to the retailer but also reduces the profits of the channel taken as a whole. The original channel profit before the private-label introduction was given as r.[7] Since some consumers now pay $r - K$, or K less than their category reservation price, the private label also serves to shift some surplus to the consumers. What this implies is that consumers are better off if the private label is in fact introduced. The private label then not only forces the national brand manufacturer to share some surplus with the retailer but also benefits the consumers as well.

We now examine how the profits of the retailer and manufacturer as well as the total channel profit changes due to changes in the parameter values. The sign of the partial derivative of profit with respect to each of the parameters is given in table 2.

7. It can be shown that r would be the channel profit in either an integrated or nonintegrated channel.

We observe that increases in β cause channel profits to be transferred from the manufacturer to the retailer. Increasing the size of the β segment increases the ability of the retailer to threaten the national brand manufacturer. In this manner, the retailer is able to obtain a lower wholesale price on the national brand leading ultimately to higher retail profit.

The effect of L on profit is also straightforward. Increases in the dispersion of the reservation switching differences work to the advantage of the national brand manufacturer. Essentially, increases in L make it more costly for the retailer to attract consumers to the private label thereby decreasing the ability of the retailer to elicit a lower wholesale price from the national brand manufacturer. Increases in L then allow the national brand manufacturer to raise wholesale price (table 1) and thus decrease the retailer's profit. While these transfers of profit may seem quite reasonable, we will see that the mechanism by which profit is transferred, specifically the reaction of private-label share to changes in parameter values, is less than obvious.

We now examine the mechanism whereby channel profits are transferred from the manufacturer to the retailer through the retailer's strategic use of a private label. First, we will examine the effect of the size and dispersion of the switching segment on the optimal retail margin of the national brand. Through this analysis we find that the manufacturer will offer better terms of trade to the retailer when the switching segment is more "attractive." Second, we study the effect that the same parameters have on the equilibrium share of the private label. We find that, counter to what one might find intuitively reasonable, the retailer will choose to take a smaller share of the market when the number of people who would consider switching is larger.

Since $P_n^* = r$, we can examine the margin that the retailer obtains on the national brand simply by looking at the wholesale price charged by the national brand manufacturer. By examining how the size and dispersion (β, L) of the switching segment affect the wholesale price of the national brand manufacturer we can directly infer the effect of such parameters on the retail margin for the national brand. It is easy to show that

$$\frac{\partial w_n^*}{\partial \beta} = -\frac{L}{\beta^2} \tag{17}$$

and

$$\frac{\partial w_n^*}{\partial L} = \frac{1}{\beta}. \tag{18}$$

Thus, the model predicts that the retailer's margin on the national brand, $(r - w_n^*)$, will increase in the size of the switching segment and

decrease in the dispersion of the switching segment. On the one hand, as the size of the switching segment increases, the national brand manufacturer is willing to offer better terms of trade to the retailer in order to induce the retailer not to drop his private-label price and thus take a large amount of share from the manufacturer. The ability of the retailer to appropriate channel profits from the manufacturer is positively related to the amount of market share that the retailer can credibly threaten to steal. On the other hand, as the dispersion of the reservation switching differences increases, it becomes more expensive for the retailer to attract the same proportion of the switching segment. Thus, the manufacturer is able to raise the wholesale price of the national brand because of this reduced ability to threaten on the part of the retailer.

Since in this model we have normalized the market size to one, the retailer's profit function (15) also equals the retailer's category margin. Just as the retailer's margin on the national brand increases in β and decreases in L, it is easy to show that the category margin also increases in β and decreases in L. This will prove useful for our empirical analysis since category margin level data are readily available while category margin data specifically for national brands are not.

Next we examine the effect of β and L on the equilibrium share of the private label. The equilibrium share of the private label is calculated simply as K^*/L. Again it is easy to show that

$$\frac{\partial K^*/L}{\partial L} = \frac{w_s}{4L^2} \tag{19}$$

and

$$\frac{\partial K^*/L}{\partial \beta} = -\frac{1}{2\beta^2}. \tag{20}$$

Thus the model predicts that as the dispersion in the reservation switching difference increases, the equilibrium private-label share will increase. Similarly, the model predicts that as the size of the switching segment increases, the share of the private label will decrease. The above results seem, at least on the surface, quite counterintuitive, especially given the argument just made for the effect of β and L on w_n. Notice that the ability of the retailer to appropriate channel profits lies in the amount of market share that the retailer *could* steal. Combining (17)–(20), we see that as L increases, the retailer is willing to accept a lower private-label share in order to obtain a greater margin on the national brand. Similarly, as the size of the switching segment increases, the retailer takes a higher margin on the national brand and shifts more consumers away from the private label. Thus, there is a constant trade-off between obtaining more profit directly with the pri-

vate label and losing some of the concessions by the manufacturer or taking less direct profit with the private label and gaining concessions from the manufacturer. While the enlargement of the switching segment or the lessening of the dispersion of the reservation switching differences certainly does enhance the retailer's ability to obtain more direct profit on the private label, the retailer finds it more profitable instead to use the leverage gained to appropriate more money from the manufacturer.

F. Summary of Implications

The foregoing analytical model yields several results. These are summarized below.

1. Private labels can serve as a strategic instrument, enhancing a retailer's ability to obtain greater concessions from the manufacturers.
2. In the presence of private-label competition, the wholesale price of the national brand will be
   (*a*) positively related to the private-label market share,[8]
   (*b*) positively correlated with the dispersion/range of the switching differences; and
   (*c*) negatively related to the proportion of consumers who would consider purchasing the private label.
3. The retail category margin will be
   (*a*) negatively related to private-label share;
   (*b*) negatively related to the dispersion/range of the switching differences; and
   (*c*) positively related to the proportion of consumers who would consider purchasing the private label.
4. Private-label share will be
   (*a*) positively related to the dispersion/range of the switching differences; and
   (*b*) negatively related to the proportion of consumers who would consider purchasing the private label.

In the next section, we attempt to test the hypotheses contained in implications 3*a*–3*c*. We construct a simultaneous linear system where retail category margin and private-label share are jointly endogenous variables. Critical to testing the implications of our model is the inclusion of variables which we believe are linked to L and β. While these analytical parameters are themselves unobserved, we can collect data

8. In equilibrium, (17) establishes that $(\partial w_i^*/\partial \beta) < 0$. For any arbitrary distribution of the reservation switching differences the equilibrium private-label share will be negatively related to β.

that we can then use as proxies for these constructs. In particular, we speculate that risks consumers associate with purchasing products in a given category, a construct which will be described in the next section, is likely to be positively correlated with L and/or negatively correlated with β. Further, we link the ability of the retailer to procure a high quality private label in the category of interest to consumers' willingness to purchase a private label. Specifically, we will assume that if a retailer is easily able to procure a high quality private label then a greater proportion of consumers will be willing to try it, high β, and the dispersion of reservation switching differences will be lower, low L. The operationalization of these variables will be described in more detail in the next section. Before we describe our estimation procedure and results, we detail our data sources in the following section.

IV. Data

A. *Primary Data*

We collected data on category risk from questionnaires distributed to staff members of Washington University. This obviously is a convenient sample. We chose this to minimize the cost of the survey and maximize the response rate. Since the staff members are actual shoppers, we do not believe that restricting the sample to Washington University staff members creates any bias. Only respondents who indicated that they were the primary shopper for their household were used. Respondents were asked a series of questions concerning their perceptions of a given category.[9] Each respondent could have answered questions on up to 18 categories although many chose to skip certain categories with which they were unfamiliar. Questionnaires were returned by 42 out of 100 individuals generating 463 usable observations spanning 110 categories.

We followed the lead of previous research in constructing our risk measure. Previous research on purchase risk has conceptualized this construct as the "expected penalty" associated with making a purchase. This particular conceptualization of risk has a long history in the literature (Arndt 1967; Bauer 1967; Cox 1967; Bettman 1973). An expected penalty is essentially the disutility a consumer will suffer if the product they select fails to meet their performance expectations multiplied by the probability that this failure will actually occur. We used this conceptualization to construct a risk measure for each category. Question 4 determines how likely it is that an individual will purchase a brand of unacceptable quality given that the purchased brand is chosen randomly from the category. Question 5 assigns a prob-

9. See app. A.

TABLE 3 Categories with Extreme Risk Values

Highest Category Risk	Lowest Category Risk
Baby food	Canned beans
Frozen fish	Dried noodles
Feminine protection	Ice cream cones

ability to the individual's ability to choose a brand of desired quality.[10] Finally, question 2 measures the penalty that would be incurred by the consumer if a brand of unacceptable quality was chosen. First, a simple average was taken, across respondents, of the multiple responses to each question in a given category. Next, the average responses for questions 2, 4, and 5 were multiplied together to form a composite risk index. Thus, our composite risk measure can be thought of as the *expected penalty* of the category. We hypothesize that the greater a category's perceived risk the smaller the proportion of consumers who would be willing to purchase a private label in that category and/or the higher the dispersion of reservation switching differences. Table 3 reports the perceived risk measures for the three categories that received the highest and lowest scores.

Second, we collected data on private labels from purchasing managers of a group of grocery retailers.[11] Data were collected only from those managers who had primary responsibility for private-label products in their organization. These questionnaires covered the same 110 categories found in the consumer questionnaires. The intention of this exercise was to determine in which product categories retailers were more easily able to offer consumers a private-label product that would compare favorably with the quality of the national branded products in the given category. This analysis is critical to our argument since we would expect this ability to be a prerequisite for the retailer to be able to gain concessions from the national brand manufacturers (i.e., if the retailer cannot find a good private-label supplier or cannot offer a product of comparable quality, then he is left with very little bargaining power).

We contacted 25 private-label purchasing managers at various U.S. grocery retailers. Of the 25 individuals contacted, 10 ultimately returned the questionnaire. Four of the 10 respondents either failed to follow the instructions of the questionnaire or answered only a small subsection of the questionnaire. These were discarded. Thus, only six completed questionnaires were used in our analysis. The results of the

10. For estimation purposes, question 5 was recoded so that high values reflect less confidence and low values reflect greater confidence.

11. See app. B for an example of a page from the questionnaire. The list of managers used was identical to the list used by Hoch and Banerji (1993).

questionnaire were factor analyzed.[12] Three factors were extracted explaining a cumulative 91% of the possible variance. Both question 1 (supplier question) and question 2 (private-label quality question) loaded positively on one factor. These two questions taken together form a measure of the ability of the retailer to offer a private label of comparable quality in the category of interest.

B. Secondary Data

We obtained category-level data on private-label penetration, average interpurchase time, and household penetration from IRI's *Marketing Factbook* (1991).[13] *The Factbook* contained usable data on 339 categories. Data on retail margins were compiled from the 1991 annual Consumer Expenditure Study found in *Supermarket Business* (1992). In some instances the level of aggregation found in the margin data was lower than the level found in the penetration data. When this occurred, a weighted average margin was formed by multiplying each relevant subcategory margin entry by the corresponding subcategory annual gross dollar sales figure and dividing this by the sum of the relevant gross dollar sales. For 16 categories no suitable match could be made between the two data sets. These categories were discarded.

We merged the primary and secondary data sets to construct one data set, which contained observations on all the relevant information form *The Factbook;* the margin data, the consumer survey data, and the management survey data. The management survey data provided the constraint on the number of categories we could include in our empirical model, since we obtained usable data on only 110 categories. Thus, the final data set, with no missing observations, contained data on 110 categories.

V. Empirical Results

A. Category Margin and Private-Label Share

Several sources have indicated that, on average, private labels offer retailers substantially higher margins than national brand products.[14] Thus, in the absence of any effects posited by our model we should observe that higher levels of private-label penetration lead to higher overall category margin. Our model indicates that the average category retail margin and private-label penetration should be inversely related. This effect would tend to mitigate the effect of the higher private-label margin on overall category margin. Hence, our model will have to over-

12. Varimax rotation; minimum eigenvalue = 1 criterion for factor extraction.
13. Please refer to *The Marketing Factbook* for definitions of measures.
14. Some sources indicate that private labels offer around a 25% higher margin on average. See Private-Label Movement (1995).

come the effect of higher private-label margins on overall category margin in order to reveal this hypothesized inverse relationship.

B. Test and Definitions of Variables

In order to test two of the implications on retail gross margin, we estimated the following linear system. Although our main focus here is to test the effect of private-label penetration on margins, it is necessary to endogenize both constructs since this is how they appear in the analytical model. Simply running a regression with margin as the dependent variable would ignore this important interaction and bias the estimated parameter values. Define

MAR_i = the retail gross margin of the ith category;
PL_i = the penetration of private labels in category i;
$RISK_i$ = a measure of category i's perceived risk (Sec. IV*A*);
SUP_i = the ability of the retailer to procure a high quality private label in category i (Sec. IV*A*); and
$INT_i = PL_i * RISK_i * SUP_i$.

Then implications 3*a*–3*c* in Section III*F* can be tested by examining the estimates of β_1 and β_2 in the following system:

$$MAR_i = \beta_0 + \beta_1 PL_i + \beta_2 INT_i + \beta_3 PEN_i + \beta_4 PURCH_i + \epsilon_i \quad (21)$$

and

$$PL_i = \alpha_0 + \alpha_1 MAR_i + \alpha_2 RISK_i + \alpha_3 SUP_i + \alpha_4 NO_i + \upsilon_i \quad (22)$$

Since we believe that category risk ($RISK_i$) and the ability of the retailer to produce a private label of acceptable quality (SUP_i) will be important moderators of the effect of private-label penetration on category margin, we have included an interaction term comprised of the product of these two variables and private-label penetration. We coded the variables such that a high value of $RISK_i$ would indicate a relatively low level of risk in category i and high values of SUP_i would indicate that it is easy for a retailer to procure a high quality private label in the category. Thus, $RISK_i * SUP_i$ acts as a measure of the retailer's ability to introduce a private label that will be attractive to consumers. In terms of our theoretical model, this interaction term acts as a proxy for β, the proportion of people who would be willing to try the private label. Our theoretical model indicates that only when β is sufficiently large will the inverse relationship emerge.

In addition to our main variables of interest, private-label penetration and those covariates directly related to it, we have included three other covariates that we believe might be important in determining the category margin. For these additional covariates we hypothesize the following.

PEN. Retailers are more likely to price competitively in categories that have higher penetration. This would lead to lower margins (see Lal and Narasimhan [1996] for an analytical exposition of this point and Chiang and Wilcox (1997) for empirical evidence of this phenomenon).

NO. Casual observation would suggest that, as the number of brands competing in a category increases, the average market share of any particular brand, including the private label, should decrease. Thus, prima facie, we might expect NO and PL to be negatively related. The argument given in Section III *B* indicates the opposite. As the number of national brands increases, it becomes less lucrative for any individual national brand to try to compete for the switching segment. Since competition for the switching segment is necessary for the retailer to receive wholesale price concessions from the national brand manufacturers, we would expect this decrease in competition to induce the retailer to take a greater share with his private label. Thus, we expect private-label penetration to be positively related to the number of national brands in a category. This conjecture is consistent with the arguments of Raju, Sethuraman, and Dhar (1995).

PURCH. Categories characterized by a high number of purchases per household will be the subject of more intense retail competition and thus should exhibit lower overall margins. Even if few households purchase in this category (low PEN), those households who do purchase are more likely to use this category's price in their store choice decision since it is more likely to comprise a relatively large part of their grocery budget (see Wilcox and Narasimhan [1997] for a detailed explanation of this point).

C. *Parameter Estimates*

In order to utilize the information contained in both equations simultaneously, two-stage least squares (2SLS) is used to estimate this system. The results of the estimation can be found in table 4.

The results of this model are better analyzed by substituting the values RISK and SUP can take on into the margin equation and examining the coefficient of PL as a function of such values. Define $\tilde{\beta}_1 = \hat{\beta}_1 + \hat{\beta}_2(\text{RISK} * \text{SUP})$, where $\hat{\beta}_1$ and $\hat{\beta}_2$ are the estimated values of β_1 and β_2, respectively. Then, the effect of private-label penetration on margin can be expressed as

$$\tilde{\beta}_1 = .459 - .076(\text{RISK} * \text{SUP}). \tag{23}$$

Substituting the values RISK and SUP actually take on in the data, we find that $\tilde{\beta}_1 \in [-2.56, 7.03]$. We see then that as the ability of the retailer to steal share from the manufacturer increases, $\tilde{\beta}_1$ decreases. This result supports our analytical model well. At low levels of risk and high procurement ability the retailer is able to use the ability

TABLE 4 Estimated System

Independent Variables	PL		MAR	
Intercept	4.652	(.884)	26.005	(19.496)
Private-label penetration (PL)	*	*	.459	(3.194)
Margin (MAR)	.257	(1.287)	*	*
Category risk (RISK)	.195	(.412)	*	*
Ease of private-label supply (SUP)	.236	(1.999)	*	*
PL * RISK * SUP (INT)	*	*	−.076	(3.902)
Penetration	*	*	−.087	(3.607)
Average number of purchases per buyer (PURCH)	*	*	−.183	(1.775)
Number of brands (NO)	.056	(5.935)	*	*
R^2	.09		.15	
Adjusted R^2	.08		.14	

NOTE.—*t*-statistics are in parentheses. The asterisk indicates that this particular variable is not in the model.

of the private label to attract customers in order to gain better terms of trade from the manufacturer. Our results point out that higher private-label penetration need not be associated with higher category margin especially in categories with low perceived risk and high availability of a quality private label.

We observe this nonmonotonic relationship between category margin and private-label penetration because, if a retailer has significant ability to steal national brand share through the introduction of a private label, then as the retailer takes more share with the private label he gives up some of the wholesale price cuts that the national brand manufacturer would have granted him if he had taken a smaller share. This is not the case when the retailer's private label is weak in terms of its ability to steal share. In such a case whatever share the retailer is able to gain with his private label will have a larger effect on the category margin since the increase in overall margin due to the private label's higher margin will not be offset by a loss in price concessions from the national brand manufacturers. An example of such a category might be baby food. Given the high involvement in the purchase of baby food, it is not surprising that it scored very high in perceived category risk. We can conclude from this that it would be very difficult for a retailer to lure consumers away from the national brand baby food to the private-label baby food and hence the national brand manufacturers would not be very inclined to drop the wholesale price of their product if in fact a private label was introduced. Thus, whatever share is obtained with private-label baby food is likely to have a large effect on the category margin since it will not be offset with decreased manufacturer price concessions.

Two of three variables included in the empirical model, but not directly included in our theoretical model, do appear to be important de-

terminants of retail margin and private-label penetration. Consistent with the findings of Chiang and Wilcox (1997), we find an inverse relationship between category margin and category penetration. The data, however, did not provide strong support for the hypothesized relationship between purchase frequency and margin. Finally, consistent with the findings of Raju, Sethuraman, and Dhar (1995), private-label penetration is negatively related to the number of brands operating in a category.

VI. Summary, Limitations, and Areas for Future Research

This article examined a retailer's strategic use of a private label as a means of obtaining better terms of trade from a national brand manufacturer. Our empirical analysis lends moderate support for the proposed modeling framework. One conclusion of this analysis then is that market share may very well not be a good yardstick by which to measure the success of a private label. Indeed, the model presented here suggests that the market share of a private label and the profitability of the private label may be inversely related. Certainly there are institutional arrangements that lead us to be wary of our conclusion. Most importantly, since the quality of individual private labels may vary widely across stores we would expect β and L to vary widely also. Analytically then, we ought to find lower wholesale prices offered to stores with private labels characterized by a high number of potential buyers and/or a low dispersion in the reservation switching differences. However, the Robinson-Patman Act prohibits this type of pricing behavior. Thus, the manufacturer is limited in her ability to offer special trade terms to the stores that have stronger private labels. This mitigates our conclusion of a low market share for a successful private label because if the manufacturer is not able to react optimally, by setting a lower wholesale price for a specific store or chain of stores, then the retailer would respond by taking a larger share of the market with his private label. Finally, in our model the manufacturer has only one strategic variable, the wholesale price. While the empirical analysis did show evidence of wholesale price adjustment by the manufacturers in the face of a potentially successful private label, slotting allowances, coop advertising allowances, and free product are other ways of transferring money from the manufacturer to the retailer. It is certainly conceivable that a manufacturer could find other ways, other than lowering wholesale price, to compensate the retailer for maintaining a certain price level on his private label and thereby not stealing too much of the manufacturer's share.

We should point out two important market structure issues. In our model, there is no competition at the manufacturer or retail level. We believe that our model's implications on retail margin will continue to

hold even if competition at the manufacturer level is introduced. Likewise, competition at the retail level is not a crucial omission since private labels are store-specific and hence monopoly power on the private label is not unduly restrictive.

There are several directions in which this research may be extended. First, our model does not allow for information diffusion about private label product quality. Models that take into account consumers' perceptions of private-label quality as well as category risk could provide a richer description of the competitive position of the retailer. For example, even if perceived category-level risk is high, a retailer could gain some advantage in the channel if a high quality private label persisted in the category for some time. Information diffusion concerning the quality of the private label may be able to offset at least partially the perceived category risk. Also, our model assumes constant fixed category-level demand. Models that allow for category demand expansion would more fully capture the benefits to the retailer of introducing a private label.

We see then that the simple model that we have put forward certainly does not capture all the intricacies of the change in the channel relationship between the manufacturer and the retailer when a private label is introduced. However, it does lead us to take a harder look at what we mean by the success of a private label. Such a characterization cannot be made in a vacuum. A private label provides the retailer with not only a chance for profit derived from sales of the product itself but also a competitive weapon to be used when dealing with the manufacturer.

Appendix A

Sample Questions

The following questions concern the category Disposable Diapers.

1. On average, how often do you purchase in the category Disposable Diapers?
   a) more than once a week
   b) about once a week
   c) 1–3 times a month
   d) several times a year
   e) 1–3 times a year
   f) never
2. If a product in the category Disposable Diapers failed to meet your performance expectations, this would be a

1	2	3	4	5	6	7
minor inconvenience					major problem	

3. How difficult do you believe it is to produce a product which has an acceptable quality level in the category Disposable Diapers?

1	2	3	4	5	6	7
fairly easy					quite difficult	

4. How much quality variability do you believe exists in the various products in this category?

   1 2 3 4 5 6 7
   quality is uniform over products in this category ... high quality variability among products in this category

5. How confident do you feel in your ability to choose a brand, in the category Disposable Diapers, which best suits your needs?

   1 2 3 4 5 6 7
   very little confidence ... extremely confident

6. How likely would you be to purchase a private-label product in the category Disposable Diapers?

   1 2 3 4 5 6 7
   highly unlikely ... very likely

Appendix B

Private-Label Questionnaire

Please indicate whether you agree or disagree with the following statements for each of the given categories. You may indicate your answer by choosing the appropriate number from the following scale and writing that number in the corresponding space.

1 2 3 4 5 6 7
completely disagree ... completely agree

If you feel that you cannot make an informed response to some of the questions for some of the categories, please simply skip these questions.

Category	It is easy to find a reliable private-label supplier in this category.	The quality of private-label products compares favorably with the national brand products.	Consumers have a high degree of brand loyalty for products in this category.	The quality of products in this category is fairly uniform.
1. Bathroom cleaners	____	____	____	____
2. All Purpose cleaners	____	____	____	____
3. Air fresheners	____	____	____	____
4. Liquid soaps	____	____	____	____
5. Bar soaps	____	____	____	____
6. Skin moisturizers	____	____	____	____
7. Skin cleansers/acne medication	____	____	____	____
8. Disposable foil pans	____	____	____	____
9. Batteries	____	____	____	____
10. Cigarettes	____	____	____	____
11. Prepared Mexican food	____	____	____	____
12. Paper bags	____	____	____	____

Appendix C

Derivation of Stackelberg Equilibrium

The game is solved through backward induction. The retailer's profit function is given by

$$\Pi^r = (P_n - w_n)\alpha + \left(1 - \frac{K}{L}\right)(P_n - w_n)\beta + \frac{K}{L}(P_n - K - w_s)\beta. \quad \text{(C1)}$$

The first-order conditions for maximizing retail profit is

$$\frac{\partial \Pi^r}{\partial K} = \frac{\beta(w_n - w_s - 2K)}{L} = 0 \quad \text{(C2)}$$

$$\Rightarrow \hat{K} = \frac{w_n - w_s}{2}. \quad \text{(C3)}$$

Substituting the retailer's reaction function into the manufacturer's profit function yields

$$\Pi^m = \alpha w_n + \beta w_n\left(1 - \frac{w_n - w_s}{2L}\right). \quad \text{(C4)}$$

The first-order condition for maximizing manufacturer profit is

$$\frac{\partial \Pi^m}{\partial w_n} = 1 - \frac{\beta w_n}{L} + \frac{\beta w_s}{2L} = 0. \quad \text{(C5)}$$

Recalling that $\alpha + \beta = 1$

$$\Rightarrow w_n^* = \frac{L}{\beta} + \frac{w_s}{2}, \quad \text{(C6)}$$

which after substitution

$$\Rightarrow K^* = \frac{L}{2\beta} - \frac{w_s}{4}. \quad \text{(C7)}$$

Type 1 Equilibrium

It is clear that if the private label cannot be procured at a cost less than the consumers' reservation price for the category, then the private label cannot be profitably introduced. No further proof of this is necessary.

Type 2 Equilibrium

From (C6), a necessary and sufficient condition for $w_n^* < r$ is that $\beta > 2L/(2r - w_s)$. From (C7), a necessary and sufficient condition for $K^* < L$ is that $\beta > 2L/(4L + w_s)$. It is straightforward to show that $2L/(2r - w_s) < 2L/(4L + w_s)$ iff $w_s < r - 2L$ and $2L/(2r - w_s) > 2L/(4L + w_s)$ iff $w_s > r - 2L$. Since the maximum value w_n^* can take on is r, and the maximum of K^* is L, this implies that if $w_s > r - 2L$ then $\beta < 2L/(4L + w_s)$ is a sufficient condition for $w_n^* = r$ and $K^* = L$ and if $w_s \leq r - 2L$, then $\beta < 2L/(2r - w_s)$ is a sufficient condition for the same equilibrium values.

Type 3 Equilibrium

In a similar argument to the one above, if $w_s \leq r - 2L$ and hence $2L/(2r - w_s) \leq 2L/(4L + w_s)$, it is possible for β to satisfy the inequalities $\beta < 2L/(4L + w_s)$ and $\beta > 2L/(2r - w_s)$. In this area of the parameter space (C6) and (C7) imply that $w_n < r$ and $K^* = L$. However, imposing subgame perfection rules out this equilibrium since if the retailer takes the entire switching segment in the second stage it is clearly not optimal for the manufacturer to set any price below r in the first stage. Thus, the retailer's reaction forces the manufacturer's price to r. When $w_s > r - 2L$ and hence $2L/(2r - w_s) > 2L/(4L + w_s)$, then it is possible for β to jointly satisfy the inequalities $\beta > 2L/(4L + w_s)$ and $\beta < 2L/(2r - w_s)$, which suggests from (C6) and (C3) that $w_n = r$ and $K^* = (r - w_s)/2$.

Type 4 Equilibrium

From (C7), a necessary and sufficient condition for $K^* > 0$ is $\beta < (2L/w_s)$. From above it is clear then that if $w_s \leq r - 2L$ then $\beta > 2L/(4L + w_s)$ is a sufficient condition for $\beta > 2L/(2r - w_s)$, the conditions necessary for $w_n^* < r$ and $K^* < L$. Hence, in this area of the parameter space if $2L/(4L + w_s) < \beta \leq (2L/w_s)$ then w_n^* and K^* are governed by (C6) and (C7). The argument is analogous for equilibrium 4.

Type 5 Equilibrium

From (C7) $K^* \geq 0$ iff $\beta \leq (2L/w_s)$. Since $\beta > (2L/w_s)$ necessarily implies $\beta > 2L/(2r - w_s)$, the condition necessary for $w_n^* < r$, then in the area of the parameter space where $\beta > (2L/4w_s)$, w_n will be governed by (C6), and $K^* = 0$.

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