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The economics of quality-equivalent store brands

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Abstract

A key change in the retail environment over the last 20 years has been the emergence and growth of low priced quality-equivalent store brands. National brand manufacturers with popular products seem to help retailers by supplying them with quality-equivalent store brands that are then sold for lower prices. Nevertheless, empirical research has found that this phenomenon often leads to higher average category prices. We explain this apparent contradiction using a model where a national brand manufacturer supports its product with advertising and the retailer may introduce a store brand to better serve its customers. Our analysis shows that when both the manufacturer and the retailer have market power, the launch of a quality-equivalent store brand by the retailer can lead to higher average category prices. Rather than leading to what some call "private label competition", both the manufacturer and the retailer benefit with the launch of quality-equivalent store brands. As a result, even a dominant manufacturer has an incentive to agree to a retailer's request to supply a quality-equivalent store brand.

Keywords: Retailing; Store brand; Private labels; Retailer brand; National brand; Price discrimination

1. Introduction

In 1999, the retail sector was reported to be at its highest level of concentration in history (U.S. Department of Commerce News, Census Bureau Reports, June 29, 2000). While concentration should increase retailers' power within local areas, to many, competition between retailers appears to have intensified. For the average consumer, a visible form of this competition has been the emergence of "store brands", "private labels", "house brands", or "own brands." These brands, a form of upstream integration by the retailer, are often of equal quality to nationally advertised brands at lower prices. While one might be tempted to conclude that these two trends (higher concentration and intensified retailer competition) might be offsetting, recent empirical research has shown that where "quality-equivalent" store brands have been launched, advertising by the national brands and average category prices are high (e.g. Connor & Peterson, 1992).

This paper debunks two myths surrounding store brands. First, there is a popular belief that dominant national brand manufacturers will resist supplying store brands to retailers who request them (Dunne, 1996). Intuitively, one would expect retailers to most desire store brands equivalent to national brands with monopoly positions due to special characteristics (e.g. patented features, patented formulations, or historically superior quality) and manufacturers of such brands to most likely refuse requests from retailers that want to create a store brand with identical features. In what follows, we show that a monopolistic manufacturer gains by agreeing to such requests. Similar to Wolinsky (1987), we argue that store brands are a mechanism that retailers use to discriminate between different types of consumers. In this situation, manufacturers gain as much as retailers from the introduction of quality-equivalent store brands.

Second, there is also a belief that the growth of store brands should lead to a reduction in average category prices because store brands are a low priced alternative to national brands. However, when the primary role of low priced quality-equivalent store brands is to facilitate price discrimination, we show that average prices can increase. This provides a theoretical explanation for the surprising findings of Connor and Peterson (1992).

In the next section, we discuss a number of institutional factors that affect retailing and store brands. We then develop a model linked to empirical observations. Similar to Narasimhan and Wilcox (1998), we first let the retailer decide whether or not

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to launch a private label brand. In turn, the manufacturer decides whether or not to supply it. Unlike Narasimhan and Wilcox, or more recently, Du, Lee, and Staelin (2004), we focus on the manufacturer using advertising as a strategic variable. The retailer then sets prices for the products it carries and profits are realized by the manufacturer and retailer.

While the two myths described above are the focus of our investigation, we also examine how the incentive to launch store brands is affected by market conditions. The analysis provides guidelines regarding categories where the availability of quality-equivalent store brands is likely to be high. We show that the prevalence of quality-equivalent store brands should be higher when the advertising of national brand manufacturers is relatively efficient. In sum, the model explains why an increasing number of national manufacturers supply store brands to their distributors but also why the development of quality-equivalent store brands in certain categories has been weak.

We also consider an extension based on an alternative market structure. The main model is based on a market with two segments: one which responds to advertising and the other which does not. In the extension, we assume that advertising endogenously creates segments. Because identical results are generated, the extension demonstrates the robustness of our findings.

While a number of papers have shown that advertising by manufacturers increases category prices (e.g. Lal & Narasimhan, 1996; Steiner, 1998), these fail to consider the impact of store brands or private labels on highly advertised national brands. The popular press, especially when writing of monopolist brands, sees a "battle" between the national brands and the store brands. This paper shows why this battle is, in fact, a profitable outcome for both sides of the war.

2. Retailing and store brands: empirical realities

Our focus is markets where established manufacturers distribute products to consumers through retailers that have monopoly-like power in their trading areas. Retailers carry the manufacturer's brand (i.e. the national brand) but may also have interest in selling storebranded products in the same category. However, the only source of supply for unbranded products are the same manufacturers who produce the national brand. In other words, for store brands to be available, the manufacturer of a national brand must be willing to supply it at a profitable price. One objective of our analysis is to understand how trends in pricing and advertising have come to evolve across these players. In doing so, our model builds on certain empirical facts. Two facts, in particular, are typical of many consumer categories.

1. Retailers are increasing the number of categories in which they market own-label products.
2. In many markets where retailers integrate upstream, average retail prices have not fallen, but increased; in markets where retailers integrate upstream and increase prices, manufacturers' advertising is high.

These facts have changed the landscape inside many retailers. Traditionally, retail shelves were filled with several national brands, many of which were advertised, and one or two generic products amongst which consumers could trade off price, image, and perceived quality. As retailers merge and become larger, they drop generic products and launch their own brands (store-, house-, or private- or own-label brands). In fact, the action rated as most likely for retailers was to "Stress Private Labels".[1] Following the launch of these brands, which in many cases offer identical tangible quality to the national brands, the retailers "delist" weaker national brands (those not supported by national advertising). Consumers, in many retail situations, are then left with a choice of fewer options: one or two national brands, and a store brand. The following quotation (*Frozen Food Age*, "President's Choice Continues Brisk Pace", March 1998) highlights this trend:

> According to the president of Loblaws... own-label President's Choice sits right next to a national brand with a shelf talker pointing out the price difference and this shelf setting has effectively eliminated or at least, de-emphasized the No. 2 and No. 3 brand competitors.

Empirical evidence also shows that the average price in many categories has increased especially where there is substantial national brand advertising. We now review the literature that summarizes the empirical facts and then propose a model to explain them.

Table 1
Store brands: percent market share of European supermarket's own brand products (1998)

Country	Volume %	Value %
Belgium	34.8	25.9
France	22.2	19.1
Germany	33.7	24.9
Netherlands	21.1	18.9
United Kingdom	44.7	43.2
Average	31.3	26.4

Source: A.C. Nielsen (1999).

2.1. Empirical fact #1: store brands are increasing

Many retailers have integrated upstream by launching "store", "private", or "house" brands/labels. These products are generally priced lower than nationally advertised brands while offering equivalent quality (Connor & Peterson, 1997; Hinloopen & Martin, 1977). This leads to a market structure whereby product competition is internalized by the retailer who simultaneously sells its own brand and the products of competing manufacturers.

From negligible levels in the 1950s, store brand sales represented by the mid-1990s some 18% of the entire U.S. retail market (Liesse, 1993a,b). This includes 25% of the total apparel sales, over 18% of packaged goods sales and some 15% of grocery sales. Store brands are concentrated in large retail chains. In fact, many retail chains offer upwards of 1000 store brand SKU's at each location. Because of the pioneering efforts of retailers such as Sainsbury and Tesco (United Kingdom), Carrefour (France) and Loblaws (Canada) to offer high quality

[1] The 1999 and 2000 Annual Reports of *Progressive Grocer*.

Table 2
Key quality equivalent store brand categories and national brand manufacturers who supply retailers

Product category	Products	National brand manufacturers
Automotive products	Oil, oil filters, accessories	Valvoline Oil Company, Bosch Gmbh
Cleaning products	Detergents, plastic bags, powder and liquid soaps	Colgate Palmolive, Con Agra
Disposable products	Facial tissues, mouth washes, disposable cameras, film	Eastman Kodak Company, Reynolds Metals
Do it yourself products	Power and hand tools	General Electric Corporation
Financial services	Credit lines, credit cards	Barclays Bank
Food products	Table salt, spices/seasonings, cookies, snacks, frozen food, seafood, breakfast cereals, beverages, dairy products	Borden, Heinz, Keebler, Kraft General Foods, RJ Reynolds, Parmalat, Starkist
Health and beauty aids	Toothbrushes, feminine hygiene products, rubbing alcohol, cold capsules, vitamins, tonics, first aid dressings	Baxter Healthcare Corp, James River
Miscellaneous	Dog food, kitty litter, clothing, footwear	Nabisco Brands, Ralston Purina

store brands, quality-equivalent store brands are more heavily developed in Europe and Canada than in the United States. Table 1 shows the development of store brands in various European countries.

As noted in a recent publication by the European Commission, "The role of the retailer brand has changed, particularly in the food sector. The original market position of these food brands was a low price/lower quality alternative to manufacturer brands; but…they have been repositioned, their quality improved and are increasingly associated with new product launches". As noted by Corstjens and Lal (2000), many retailers have moved to higher quality store brands due to their ability to improve retailer profitability. In fact, Dunne and Narasimhan (1999) report that the biggest change in store brands is that they have gone upmarket. Quality-equivalent store brands are physically equivalent to nationally advertised products and are often produced by the same manufacturers. Even in the U.S., a recent study for the Private Label Manufacturers Association (PLMA) found that 60% of consumers surveyed believe that private label products are the same as manufacturers' brands when it comes to the overall quality of the products, taste, availability, freshness, guarantee of satisfaction, clarity of labeling, and the quality of packaging among other attributes. American retailers with store brands span various industries including both mass and up-scale clothing stores, general discounters, regional drug store chains, regional and national grocery chains, and specialty retailers: e.g., The Gap, The Limited, Macy's, Sak's Fifth Avenue, Neiman Marcus, Wal-Mart, K-Mart, Arbor Drugs, May Drug Stores, Schnuck Markets, Dominiks, Wegman's Food Markets, Safeway, and Kinney Shoes. Beginning in the 1990s, many of these launched "quality-equivalent" store brands (similar to the trend that started earlier in Canada and Europe).

Quality-equivalent store brands span the vast majority of consumer categories. Table 2 lists product classes where quality-equivalent store brands are present. Table 2 also provides examples of national brand manufacturers (in each category) who publicly acknowledge their role in supplying retailer brands.[2]

By the mid 1990's, more than 50% of U.S. manufacturers of branded consumer packaged goods supplied store brands (Quelch & Harding, 1996).[3] The attractiveness of supplying store brands to retailers is further underlined by the strategy of R.J. Reynolds, one of the largest consumer packaged goods manufacturers, that supplies store brands to more than 200 U.S. grocers.

2.2. Empirical fact #2: price–advertising correlations

In many product categories, there appears to be a strong correlation between pricing and advertising spending by the national brands. Despite speculation that store brands should place downward pressure on the retail prices of the national brands, the empirical evidence does not concur.

As noted earlier, competition between store brands and national brands is managed by retailers by virtue of their role as the "setter" of retail prices. Marketers frequently regard the introduction of store brands as a boon to consumers and a threat to national brands that advertise purely psychological benefits. It is not clear, however, that market power or net economic prices fall with the introduction of store brands (Hurwitz & Caves, 1988; Putsis, 1997).

The empirical literature highlights a number of observations in this context. Connor and Peterson (1992) study hundreds of grocery items and find that prices are higher in categories with high levels of advertising by the national brands. In addition, Connor and Peterson find that the "gap" between national brand and store brands is higher, the higher are category advertising levels. There are several potential explanations for this. The literature points to the informative role of advertising and researchers have shown that advertising can provide information about observable product attributes (Nelson, 1974). In addition, a number of papers show that the quantity of advertising can be a signal of hidden quality thus allowing the manufacturer to charge higher prices (Klein & Leffler, 1981; Milgrom & Roberts, 1986; Schmalensee, 1978). However, this relates to products where there are significant differences in

[2] An explanation for why branded manufacturers might supply lower quality/lower priced store brands is provided by Caves and Porter (1977). Lower quality/lower priced line extensions (fighter brands) can foreclose a market to a potential entrant. Johnson and Myatt (2003) also show that a lower quality/lower priced line extension may be the optimal response to a competitor in the same segment. However, neither paper explains why a dominant manufacturer might launch a quality-equivalent line extension.

[3] In 1993, an industry analysis ("Private Label Movement", *Harvard Business School Note*, 9-504-039) reported that more than 60% of all private label products were made by national brand manufacturers.

product quality.[4] A fundamental observation about today's store brands is that the differences in quality between the national brands and the store brands have narrowed; the growth has been in quality-equivalent store brands. Here, informative advertising would tend to reduce the price differences between brands. Of course, advertising can also serve as a source of differentiation and market power as in Tirole (1990, p. 278) and Comanor and Wilson (1979). The latter case appears most plausible for categories with store brands given both empirical observation and the content of manufacturer advertising (which generally does not refer to pricing).

In a different study, Kim and Parker (1999) detail the dynamics of trends observed in Connor and Peterson (1992) by considering the world's "most consumed" product. In that study, as the national manufacturers increase advertising expenditures, the retailers increase the prices of both the national brands and the store brands (during a period of marginal cost decline). Using a model of market conduct, they show that advertising allows the retailer to better price discriminate across two segments (brand seekers versus private label seekers), while gradually increasing the prices for both segments. While the authors confirm the trend seen in Connor and Peterson, they fail to provide a sound theoretical model of why one might observe such an outcome. They also fail to consider the impact that product line choices made by upstream players might have. A number of authors also consider the impact of store brands on cross-product conduct but they do not consider industry structure nor the dynamics of market prices (see for example, Dhar and Hoch, 1997; Mills, 1995).

In the following section, we develop a model that explains this combination of empirical facts.

3. The model

A key benefit of store brands to retailers is that they allow the retailer to discriminate between those consumers who prefer the national brand and those who are happy with quality-equivalent store brands offered at a lower price. This use of store brands was first mentioned by Wolinsky (1987). The idea is that the retailer charges higher prices for the national brands purchased by "advertising attracted" consumers, while optimizing profits from "lower price" oriented consumers with store brands. The idea that one segment of the market responds to the advertising of national brand advertising is also the basis for Soberman and Parker (2004). However, Soberman and Parker consider neither the spatial nature of retail competition nor the challenge of introducing products into channels that are decentralized.

Our model is designed to represent two specific aspects of store brand marketing. First, store brands are attractive to retailers because they enable retailers to charge different prices to consumers who are influenced by branded advertising and those who are only concerned with physical product characteristics. Second, the model captures the effect of national brand advertising on a specific segment in terms of their willingness to pay for the national brand.

The model assumes quality equivalence of the national brand and the store brand. Store brands are supplied by the national brand manufacturer (there are no alternate sources of supply). This allows us to abstract away from a retailer's desire to either increase margin or reduce the power of the manufacturer (Wilcox & Narasimhan, 1998). Instead of a "cost based" rationale for store brands, our interest is how they facilitate price discrimination and affect retail prices and profits.

From the perspective of the retailer, the model allows us to focus on two potentially conflicting effects for store brands: that of facilitating price discrimination (which is positive) and the response of manufacturers in terms of increasing wholesale prices which may be negative. In addition, retailers need to account for the added costs of developing and launching a store brand. In essence, we restrict our attention to situations where price discrimination and the cost of branded advertising are the two most important forces in the market. The idea is not to suggest that other explanations (increasing margins, building store loyalty, or countering the oppressive power of manufacturers) are not important in certain situations.

3.1. Channel structure

The game consists of three types of players: a sole national brand manufacturer, a monopolistic retailer and consumers who are uniformly distributed in a circular spatial market of unit mass with a circumference of 2. This market structure follows that of Salop (1979) and can be easily adapted to allow for competition at the retail level.[5] The game consists of four stages. In the first stage, the retailer decides whether to request the supply of a store brand from the manufacturer. This approach is similar in vein to Narasimhan and Wilcox (1998) as we let the retailer decide whether or not she wishes to launch a store brand. If the retailer has made the request, the manufacturer decides whether or not to say yes. After the product line decision, the second stage entails the manufacturer making a decision about the level of advertising for the national brand. In the third stage, the manufacturer sets wholesale prices for the national brand and the store brand (contingent on the outcome of the first stage). In the final stage, the retailer sets retail prices for the products it carries and the sales and profits are realized in the channel based on the decisions of consumers. Without loss of generality, we normalize the marginal cost of the product to 0. We now discuss consumers and how they make decisions.

As noted earlier, the game has no alternative suppliers of the "quality-equivalent" store brand (the only contract manufacturer for the retailer is the national brand manufacturer). We make this assumption for three reasons. First, we want to show that

[4] Tremblay and Martins-Filho (2001) also argue that advertising can enhance the value of a higher quality product by increasing the strength of preference for quality.

[5] When there is more than one retailer, the standard assumption is that retailers locate at equally spaced intervals around the circle. This reduces the average travel cost incured by shoppers but increases the fixed investments in retail outlets. Because the monopolistic manufacturer can effectively eliminate competition in the downstream market with wholesale pricing, little insight is gained by including more than one retailer. However, a version of the model with 2 retailers is available from the authors on request.

having a competitive supplier market is not necessary for the manufacturer to agree to supply a quality-equivalent store brand for the retailer (i.e. the manufacturer is not being held hostage by the retailer). Second, in order for the model to reflects real markets, the store brand must be tangibly equivalent, meaning it must be perfectly identical in physical quality to the national brand. We assume that only the national brand manufacturer is capable of producing such a product (perhaps due to a proprietary formulation or production process).[6] It is in this case that one might least expect a manufacturer to want a store brand on the market — what the popular press might call a "worst case scenario". Finally, this approach allows us to focus on the effect of advertising as a strategic variable (in line with the empirics discussed above).

3.2. Decisions by consumers

There are two types of consumers in the market. The first type is referred to as brand seekers (denoted by superscript b) and the other is referred to as product seekers (denoted by superscript p). We assume that a fraction λ of the market are brand seekers and $1-\lambda$ are product seekers. In contrast to product seekers, brand seekers are willing to pay a premium for the national brand that is equal to A, the advertising effort implemented by the national brand manufacturer. As discussed, there is strong evidence that some consumers are willing to pay more for an advertised brand (even when the non-advertised brand is perceived to be quality-equivalent). Psychological theory lends support to the existence of a positive relationship between advertising and prices. Experiments show that advertising can lead to higher brand evaluations because of familiarity and "mere exposure" (Anand, Holbrook, & Stephens, 1988; Heath, 1990; Obermiller, 1985). The fact that some consumers will pay more for products because of "familiarity" or "pleasurable associations" is also the basis for a perspective known as the "adverse view" of advertising; i.e., advertising leads consumers to pay premiums for products that are physically identical (Comanor & Wilson, 1974). This phenomenon underlies our model of consumer behavior.

Each consumer is identified by her distance x from the retailer in the circular market. Because consumers can be located on either side of the retailer, there are two consumers at a distance x from the retailer for all $x \in (0,1)$. To buy, a consumer incurs a transportation cost that is proportional to her distance from the retailer; i.e., a consumer at x would incur a transportation cost of tx. This formulation implies that the retailer (and the manufacturer) face downward sloping demand for both the national brand and the store brand (if it is launched). Both the national brand and store brands are assumed to provide a base benefit v to all consumers. Brand seekers obtain a further benefit proportional to the manufacturer's level of advertising when they buy the national brand.

[6] Frequently, only an experienced manufacturer has the production facilities, the expertise in manufacturing and the logistics to produce *quality-equivalent* products (Dunne & Narasimhan, 1999).

Overall utility is determined by the difference between the benefits and the costs (the price paid and the transportation cost). Without advertising, a consumer located a distance x from the retailer obtains a surplus of $v-tx-p$ when she buys the manufacturer's product. Conversely, if the manufacturer has advertised and the consumer is a brand seeker, she obtains a surplus of $A+v-tx-p$ by buying the manufacturer's product. Each consumer buys at most one unit and buys the product that provides the highest surplus. However, if no product/price combination in the market provides the consumer with positive utility, that consumer does not purchase. This does not necessarily mean that she drops out of the category. It can also mean that the prices for products of "national brand" quality are such that the consumer remains with a lower quality alternative not sold by the local retailer.

We restrict our attention to parameter conditions where the manufacturer would choose to serve the entire market in the absence of advertising (in the Appendix, we show that $t < \frac{v}{4}$ is the relevant condition). The basis for this restriction is that we want to focus on conditions where the tension of having to serve two different types of consumers with the same product is the main driver of pricing (when the store brand is not available). When the market is not fully covered, market coverage is equally important as a determinant of pricing. In addition, since our model posits a market served by a sole retailer, it seems reasonable to assume that it is economically feasible for the retailer to serve the entire market.

3.3. Firm decisions

We focus on two situations. In the first, the only product in the market is the national brand (n). In this situation, the manufacturer's objective function is:

$$\pi_M = w_n(\lambda D_1^n + (1-\lambda)D_2^n) - \alpha A^2 \quad (1)$$

where D_1^n is the fraction of the brand seekers who are served and D_2^n is the fraction of product seekers who are served. The manufacturer first decides the level of advertising and then sets w to maximize profit. Similarly, the objective function for the retailer is:

$$\pi_R = (p_n - w_n)(\lambda D_1^n + (1-\lambda)D_2^n) \quad (2)$$

The retailer sets p to maximize profit given the level of advertising and wholesale price selected by the manufacturer. The subscript n denotes the wholesale and retail price for the national brand.

In the second case, both an advertised national brand and a quality-equivalent store brand (g) are available. Similar to the base case, the manufacturer quotes a wholesale price to the retailer that results in positive store brand sales from the retailer. Here, the objective function for the manufacturer is

$$\pi_M = w_n\lambda D_1^n + w_g(1-\lambda)D_2^n - \alpha A^2 \quad (3)$$

and for the retailer, the objective function is:

$$\pi_R = (p_n - w_n)\lambda D_1^n + (p_g - w_g)(1-\lambda)D_2^n - k_r \quad (4)$$

Note that the retailer incurs a fixed cost k_r to carry the store brand as well as the national brand. To find the equilibrium decisions for each scenario, we use backward induction.

We assume that brand seekers always purchase the national brand independent of whether store brand is available.[7] Brand seeker demand is found by locating the consumer in the market who is indifferent about buying. This obtains at $x_1 = \frac{A + \upsilon - p_n}{t}$. Thus, the fraction of brand seekers that buys is equal to $D_1^n = \frac{A + \upsilon - p_n}{t}$ for $p_n > A + \upsilon - t$ and $D_1^n = 1$ for $p_n \le A + \upsilon - t$. For the parameter conditions we examine, the manufacturer sets wholesale prices such that $p_n = A + \upsilon - t$ and $D_1^n = 1$.

Product seekers on the other hand buy the store brand when it is available and the national brand otherwise. Similar to brand seekers, product seeker demand is found by locating the consumer who is indifferent about buying. When store brand is available, the indifferent consumer is found at $x_2 \frac{\upsilon - p_g}{t}$ for $p_g > \upsilon - t$. With the assumptions made, the manufacturer will set the wholesale price for the store brand such that $p_g = \upsilon - t$ implying that $D_2^n = 1$. When only the national brand is available, the indifferent consumer is found at $x_2 \frac{\upsilon - p_n}{t}$ for $p_n > \upsilon - t$. Moreover, when store brand is not available, $p_n > \upsilon - t$ so product seeker demand is $D_2^g = \frac{\upsilon - p_n}{t} < 1$.

This formulation underlines the tradeoff facing the manufacturer when selling only a national brand. The higher the advertising, the higher the price the manufacturer can charge to brand seekers but the lower the fraction of the product seekers that buy. When both a national brand and a store brand are available, the manufacturer does not face the same tension. On the other hand, the increase in the retailer's profit must be sufficient to justify the expenditure k_r that is needed to launch the store brand. In the following section, we present and explain the main results.

4. Analysis and discussion

4.1. Model solution and results

When only the national brand is available, the manufacturer advertises if and only if he sets a wholesale price higher than $v - 2t$ (otherwise, the manufacturer could strictly increase profits by reducing advertising). Proposition 1 identifies equilibrium outcomes in the case of national brand only distribution (the equilibrium profits and proofs for each proposition are provided in the Appendix).

Proposition 1. a) *When the surplus available from product seekers is high* $(v > \frac{4-3\lambda}{1-\lambda} t)$ *and advertising is expensive* $\left(\alpha > \frac{1}{4}\frac{\lambda^2}{(v-2t)(1-\lambda)}\right)$, *the manufacturer does not advertise and serves all consumers. Prices are* $w_n = \upsilon - 2t$ *and* $p_n = \upsilon - t$. *Otherwise,* $A = \frac{\lambda}{2\alpha}, w_n = \frac{\lambda}{2\alpha} + \upsilon - 2t, p_n = \frac{\lambda}{2\alpha} + \upsilon - t$ *and only brand seekers buy.*

b) *When the surplus available from product seekers is lower i.e.,* $\upsilon \in \left(4t, \frac{4-3\lambda}{1-\lambda} t\right)$ *and advertising is expensive* $\left(\alpha > \frac{3\lambda t - v + v\lambda - 2t\lambda^2}{2t^2}\right)$, $A = \frac{1}{2}\frac{4t - 3\lambda t - v + \upsilon\lambda}{\lambda^2 + 2 - 3\lambda + \alpha t}$ *and some product seekers do not buy. Prices are* $w_n = (2 - \lambda)A + \upsilon - 2t$ *and* $p_n = A + \upsilon - t$. *Otherwise* $A = \frac{\lambda}{2\alpha}, w_n = \frac{\lambda}{2\alpha} + v - 2t, p_n = \frac{\lambda}{2\alpha} + \upsilon - t$ *and only brand seekers buy.*

When the surplus available from product seekers is high $\left(v > \frac{4-3\lambda}{1-\lambda} t\right)$ and advertising is expensive, the manufacturer does not advertise (i.e., the *advertised* national brand is not advertised). This occurs because the profit that the manufacturer obtains by serving all product seekers exceeds the profits that can be generated by charging higher prices to brand seekers and leaving some product seekers unserved. When advertising is less expensive $\left(\alpha < \frac{1}{4}\frac{\lambda^2}{(v-2t)(1-\lambda)}\right)$, the manufacturer advertises. However, in this situation, all product seekers find the product too expensive.

Conversely, when the surplus available from product seekers is lower i.e., $\upsilon \in \left(4t, \frac{4-3\lambda}{1-\lambda}\right)$, the manufacturer always advertises. As a result, there are some product seekers who do not buy. The proportion of product seekers served is a function of the cost of advertising α and the fraction of the market that are brand seekers λ. Basically, the lower the cost of advertising and the higher is λ, the higher is the level of advertising chosen by the manufacturer and the lower is the fraction of product seekers that buy. In fact, once α is less than a certain limit, the manufacturer will set prices such that no product seekers buy. When only the national brand is available, the more attractive is advertising (and the brand seeker segment), the worse the situation is for product seekers.

Not surprisingly, in all conditions when the manufacturer advertises, her profits are strictly decreasing in α (the cheaper is advertising, the higher are the manufacturer's profits). However, when $v \in \left(4t, \frac{4-3\lambda}{1-\lambda}\right)$, the retailer's profits are *increasing* in α. The more the manufacturer decides to advertise, the lower the fraction of product seekers that buy. The drop in volume has negative implications for the retailer's profit because the retailer's margin is relatively stable. This underlines the potential for misalignment in the incentives of the manufacturer and retailer to launch a second unadvertised brand.

We now turn to the situation where the retailer has requested provision of a quality-equivalent store brand and the manufacturer has accepted to supply it. Because of our assumption that $\upsilon > 4t$, all consumers in the market buy when the store brands are available. Proposition 2 describes the equilibrium outcome in these conditions.

Proposition 2. *When a store brand is available, the manufacturer chooses* $A = \frac{\lambda}{2\alpha}$ *and wholesale prices of* $w_n = \frac{\lambda}{2\alpha} + \upsilon - 2t$ *and* $w_g = \upsilon - 2t$. *The retailer will choose retail prices of* $p_n = \frac{\lambda}{2\alpha} + \upsilon - t$ *and* $p_g = \upsilon - t$.

With the store brand available, consumers gain the ability to buy a product that is better suited to their needs. Product seekers in particular are able to buy a product based on the base benefit alone and are not penalized (through higher pricing) for image benefits for which they have no value. In the following section, we consider the decisions of the manufacturer and the retailer to launch a store brand.

[7] When both the store brand and the national brand are available, the solution entails prices where brand seekers are indifferent between the store brand and national brand. Discrimination is easily achieved through an infinitessimal reduction in the price of the national brand.

4.2. The profit and price implications

As mentioned earlier, the retailer must request a store brand and the manufacturer must agree to supply it at a wholesale price that the retailer finds attractive. Proposition 3 summarizes the conditions necessary for a store brand to be introduced.

Proposition 3. *Whenever requested, the manufacturer supplies store label at a wholesale price of* $v-2t$.

a) *When the surplus available from product seekers is high* $\left(v>\frac{4-3\lambda}{1-\lambda}t\right)$ *and advertising is expensive* $\left(\alpha>\frac{1}{4}\frac{\lambda^2}{(v-2t)(1-\lambda)}\right)$, *the retailer will not request a store brand. When advertising is less expensive, the retailer will request a store brand if* $k_r<(1-\lambda)t$.

b) *When the surplus available from product seekers is lower i.e.,* $v\in\left(4t,\frac{4-3\lambda}{1-\lambda}t\right)$ *and advertising is expensive* $\left(\alpha>\frac{3\lambda t-v+v\lambda-2t\lambda^2}{2t^2}\right)$, *the retailer will request a store brand if* $k_r<L=-\frac{1}{2}\frac{-3\lambda^2t-4t+7\lambda t+v-2v\lambda+v\lambda^2}{\lambda^2+2-3\lambda+\alpha t}$. *When advertising is less expensive, the retailer will request a store brand if* $k_r<(1-\lambda)t$.

Proposition 3 shows that the incentive of the retailer to launch a store brand is inversely related to the manufacturer's level of advertising under national brand only distribution. The extreme case obtains when the base benefit is high $v>\frac{4-3\lambda}{1-\lambda}$ and advertising is expensive $\alpha>\frac{1}{4}\frac{\lambda^2}{v-v\lambda-2t+2t\lambda}$. In these conditions, the manufacturer does not advertise and all consumers buy the national brand (see Proposition 1). As a result, the retailer does not have an incentive to launch a store brand.

When the base benefit is lower, the retailer's incentive to launch a store brand is negatively related to α, the advertising cost parameter for the manufacturer (this is shown in the Appendix). For any choice of λ, v, and t that lie within the allowable range, it is easy to show the limit $L\rightarrow 0$ as α becomes very large. In contrast, as α becomes small and approaches the limit of $\alpha=-\frac{1}{2}\frac{-3\lambda t+v-v\lambda+2t\lambda^2}{t^2}$, $L\rightarrow(1-\lambda)t$.

The retailer has the maximum incentive $(1-\lambda)t$ to launch a store brand when $\alpha<-\frac{1}{2}\frac{-3\lambda t+v-v\lambda+2t\lambda^2}{t^2}$. Here, when only the national brand is sold, product seekers do not buy: the manufacturer ignores product seekers so that it can charge high prices (facilitated by inexpensive advertising) to brand seekers. A store brand allows product seekers to participate in the market, while still allowing the manufacturer to charge high prices to brand seekers. Interestingly, in these conditions, the advertising level chosen by the manufacturer is unaffected by the introduction of a store brand.

A final comment is that the manufacturer always quotes a wholesale price to the retailer for the store brand that leads to product seekers abandoning the national brand. The manufacturer is a strict beneficiary of store brand availability because it allows the manufacturer to discriminate between brand and product seekers. In Section 4.3, we examine the relative incentives of the retailer and manufacturer to support the launch of a second unadvertised brand.

Clearly, it is important to demonstrate that the model is a reasonable representation of the store brand phenomenon. As noted earlier, the availability of quality-equivalent store brands has increased. In addition, because of media fragmentation and increasingly heterogeneous viewing habits amongst consumers, the cost of advertising has increased (it is difficult and more expensive today to ensure that the right consumers see a brand's advertising).

In this context, a key question is: does the proposed model predict that the increased availability of store brands will lead to higher average category prices? A positive answer to this question justifies the model as a reasonable representation of the store brand phenomenon. First, we assume that the cost of introducing the store brand k_r is low enough such that it is requested by the retailer and subsequently supplied by the manufacturer. We then analyze whether and when average category prices are higher with the introduction of the store brand. The findings are summarized in Proposition 4.

Proposition 4. *When* $v\in\left(4t,\frac{4-3\lambda}{1-\lambda}t\right)$ *and* $\alpha>(2-\lambda)\frac{\lambda^2}{\lambda t+4t-v}$, *the introduction of a store brand leads to an overall increase in category pricing. When* $\alpha<(2-\lambda)\frac{\lambda^2}{\lambda t+4t-v}$, *the introduction of a store brand leads to a decrease in category pricing.*

Proposition 4 legitimizes the model's representation of the market. A key determinant of whether the introduction of a store brand leads to an increase or decrease in category level pricing is the cost of advertising. When advertising is expensive and only the national brand is available, the national brand manufacturer chooses low advertising levels because product seekers are as profitable as brand seekers (the manufacturer is reluctant to raise price since that would imply loss of demand from product seekers). Here, the introduction of a store brand allows the manufacturer to charge higher prices to brand seekers without losing demand from product seekers. This alone serves to increase category level prices. However, because higher prices can now be charged to brand seekers, the manufacturer chooses a higher level of advertising (than when only the national brand is available). This further serves to increase the average price in the category. Thus, the model and its predictions are highly consistent with the conditions discussed above.

In contrast, when advertising is inexpensive and only the national brand is available, the manufacturer ignores product seekers and simply concentrates on brand seekers. Here, the main effect of introducing a store brand is to bring product seekers into the market with an affordable product. As a result, the introduction of the store brand reduces average category prices.

This implies that when store brands lead to a significant increase in category volume (as they do when advertising costs are inexpensive), they will drive down average category prices. In this situation, advertising levels will not exhibit significant change compared to pre-store brand levels. Conversely, when the introduction of a store brand does not lead to a significant increase in category volume, its main effect is to allow two different prices to be charged to consumers who were participating in the market prior to the introduction. When $\alpha>(2-\lambda)\frac{\lambda^2}{\lambda t+4t-v}$ and store brands are unavailable, most product seekers buy the national brand even though they place no value on its "image benefit". In these conditions, the store brand's introduction leads to an increase in average category prices and higher advertising. These are exactly the conditions referred to in

Connor and Peterson (1992). In addition, a cursory examination of data from the PLMA over the 1993–1998 period shows that higher category prices are associated with an increase in "private label" share when category volumes are relatively flat. In contrast, lower category prices are observed when increased "private label" shares are associated with a significant increase in category volume.[8]

4.3. Store brands or unadvertised manufacturer brands: an empirical question

We believe it is logical for the retailer to make the first move in the game (that of requesting the provision of a store brand). Retailers tend to get direct information on the market prior to manufacturers due to their greater proximity to consumers. Our model shows that the manufacturer will agree (at a reasonable wholesale price) to supply the retailer with a store brand. This does lead however, to a question regarding the possibility that the manufacturer itself launches a second non-advertised quality-equivalent brand. This would seem to be an attractive strategy for the manufacturer (at least in a context where the retailer has not made a request for a store brand). The retailer will not ask the manufacturer to supply a store brand if the costs to launch the store brand k_r exceed the potential gain. In these conditions, it may be that the potential profit gain for the manufacturer from launching a second unadvertised brand exceeds k_r. It is precisely in this situation where non-advertised manufacturer brands should be common.

A comparison of retailer and manufacturer profits shows that for most parameter conditions, there are levels of k_r (costs to launch a second brand) where the manufacturer and not the retailer has incentive to launch a quality-equivalent alternative to the national brand. These are summarized in Proposition 5.

Proposition 5. *Under the following conditions, the manufacturer (and not the retailer) has incentive to make available a quality-equivalent alternative to the national brand:*

1. *When* $\upsilon > \frac{4-3\lambda}{1-\lambda}, \alpha > \frac{1}{4}\frac{\lambda^2}{v-v\lambda-2t+2t\lambda}$ *and* $k_r < \frac{1}{4}\frac{\lambda^2-16t\alpha}{\alpha}$.
2. *When* $\upsilon > \frac{4-3\lambda}{1-\lambda}, \alpha < \frac{1}{4}\frac{\lambda^2}{\upsilon-\upsilon\lambda-2t+2t\lambda}$ *and* $k_r \in \left((1-\lambda)t, (1-\lambda)(\upsilon-2t)\right)$.
3. *When* $\upsilon \in (4t, \frac{4-3\lambda}{1-\lambda}t), \alpha \in \left(-\frac{1}{2}\frac{-3\lambda t+\upsilon-\upsilon\lambda+2t\lambda^2}{t^2}, \frac{t\lambda^2(2-\lambda)}{8t\lambda\upsilon-\lambda\upsilon^2-14\lambda t^2+24t^2-10\upsilon t+\upsilon^2}\right)$ *and* $k_r \in \left(\frac{\frac{1}{4}(1-\lambda)(2\lambda^2 t-6t\lambda v\alpha+\alpha\lambda v^2+8\lambda t^2\alpha-16\alpha t^2+8\upsilon\alpha t-\alpha v^2-t\lambda^3)}{\alpha t(\lambda^2+2-3\lambda+t\alpha)}, -\frac{1}{2}\frac{-3\lambda^2 t-4t+7\lambda t+\upsilon-2\upsilon\lambda+\upsilon\lambda^2}{\lambda^2+2-3\lambda+\alpha t}\right)$
4. *When* $\upsilon \in \left(4t, \frac{4-3\lambda}{1-\lambda}t\right), \alpha < -\frac{1}{2}\frac{-3\lambda t+\upsilon-\upsilon\lambda+2t\lambda^2}{t^2}$ *and* $k_r \in \left((1-\lambda)t, (1-\lambda)(v-2t)\right)$.

On a macro level, the key insight of Proposition 5 is that when the cost of launching a quality-equivalent alternative is sufficiently high, the manufacturer has the incentive to finance the launch of a second unadvertised brand even though the retailer will not request it (i.e., the retailer's gain from launching a store brand is insufficient to cover the launch cost). In the allowable parameter space (i.e. $v > 4t$), there is only one situation (lower levels of base benefit and high advertising costs) where the retailer has greater incentive (more to gain) than the manufacturer from the launch of a second unadvertised brand.[9]

This analysis explains why manufacturers sometimes carry high-quality products that receive minimal marketing support. It is useful however, to mention an issue that might dissuade a manufacturer from this strategy. The consuming public is conditioned to accept that competing products (despite their similarity) are often priced differently. When a company chooses a premium price, it is unlikely to generate consumer outcry or anger. In contrast, when consumers learn that the same company is selling physically identical products at very different prices, the potential for consumer outcry is high. This is exactly what happened to Amazon.com in September 2000 which, due to public outcry, quickly discontinued their practice of charging different prices for the same product.[10] Perhaps if a manufacturer could avoid disclosing that it had produced a product, adverse consumer reaction could be eliminated; however, a manufacturer is legally obliged to disclose that it manufactures a product. In contrast, a retailer is not under obligation to disclose the identity of the contract manufacturer that produced its store brand. In fact, the contract signed with the supplier of the product may prevent the retailer from identifying the producer. This issue is not addressed in our model but may explain why, in many categories, retailers are better suited than national brand manufacturers to launch quality-equivalent alternatives to national brands.

Proposition 5 shows that as the cost k_r drops due to the combined effects of greater retail concentration, lower costs to develop packaging because of computer-aided design and lower costs of inventory management; a greater incidence of store brands (launched by retailers) should be observed.[11]

On a category level, the findings suggest quality-equivalent store brands should be most common in categories where national brand advertising levels are high. Said differently, when the brand seeker segment is feasible to reach with advertising, retailers have the most to gain by introducing quality-equivalent store brands. Interestingly, the categories dominated by the five largest grocery product advertisers in the U.S. are also categories where the

[8] These observations are based on a limited examination of 18 retail categories compiled by the authors, available upon request.

[9] This issue is fully discussed in the Appendix as part of the Proof of Proposition 5.

[10] Nationwide reports informed the public that prices could vary as much as 16% for the same product at Amazon based on buying history and even the brand of web browser used by the buyer. For details refer to "Amazon makes regular customers pay more", *The Register*, Sept. 6, 2000; "Amazon's Loyalty Tax: IE users pay more", The Register, Sept. 8, 2000 and "Bezos calls Amazon experiment a mistake", *Puget Sound Business Journal*, September 28, 2000.

[11] In the last 5 years, there has been significant consolidation in the retail sector in North America and Europe. Examples of consolidation in the food sector include the acquisition of Monoprix by Promodes in France (August 1999), the November 1988 takeover of Provigo by Loblaws in Canada (2 of Canada's four largest grocery retailers); and the acquisition by Ahold (a Dutch food retailer) of Giant Food (May 1998) and U.S. Foodservice (March 2000) in the U.S. References for more than 20 major mergers in the U.S., Canada and Europe are available from the authors.

penetration of store brands is well above average.[12] Conversely, when brand seekers are difficult to reach with advertising (and advertising levels are thus low), the gain to launching a store brand is lower for both channel members. Of course, because the cost of launching store brands has decreased, many categories where the advertising spend is not significant now have store brands with significant share. As noted earlier, these are exactly the conditions where increased availability of quality-equivalent store brands leads to increases in category average prices.

We should emphasize that our analysis focuses on the individual incentive of the manufacturer or the retailer to launch a second unadvertised brand. In all parameter conditions, there are values of k_r greater than the feasible range for the manufacturer or retailer alone where the increase in channel profits is greater than k_r. In this range, because the initiative for to launch a quality-equivalent brand is taken by one member of the channel (either the retailer or the manufacturer), unadvertised quality-equivalent brands will not be observed despite their potential to improve channel performance. This highlights a potential coordination problem when the cost of launching/maintaining an additional SKU is high. According to the Coase theorem, the manufacturer and the retailer will bargain to share the fixed costs of a store brand introduction if the transaction costs of bargaining are sufficiently low (Coase, 1960). There is evidence of cooperation between large retailers and manufacturers to develop and launch quality-equivalent store brands.[13] Moreover, examples of such cooperation often come from markets where the retail sector is highly concentrated (e.g. the grocery sector in Canada). This is consistent with the idea that the availability of store brands will be higher where transaction costs are low due to high retail concentration (the inverse will be true in highly fragmented retail markets). Of course, high retail concentration is but one explanation for examples of fruitful cooperation between manufacturers and retailers in the development of store brands. Innovative management is another explanation. The level of retail concentration is high in Canada but Loblaws, the leading retailer in Canada, is also amongst the world's most creative and aggressive retailers in the development of quality-equivalent store brands.

5. Extension: an alternative representation of national brand advertising

The base model is built on the assumption that the level of advertising chosen by the national brand manufacturer affects the size of the premium that brand seekers are willing to pay for the national brand. As mentioned earlier, this follows from an argument that familiarity is the basis for brand seekers' willingness to pay more for national brands. However, as noted in Hertzendorf (1993), this idea depends on the ability of all brand seekers being able to precisely monitor the quantity of advertising by the manufacturer. To demonstrate that the model findings are not dependent on the formulation used, we present an alternative formulation where a specific segment of consumers is willing to pay more for an advertised national brand but the creation of brand and product seeking segments is endogenized through exposure to advertising.

Similar to the base model, we assume that a monopolistic manufacturer serves consumers in a uniformly distributed circular market through a sole retailer. The timing of the game is identical to the base model. Without advertising, a consumer located a distance x from the retailer obtains a surplus $\upsilon - tx - p$ when she buys the manufacturer's product (to buy, a consumer must obtain positive surplus). Conversely, if the consumer has seen the manufacturer's advertising, the manufacturer's product provides an additional benefit B (the only way a consumer finds out about B is through advertising). As before, we do not delve into the basis for this benefit since there are many arguments for why a consumer might be willing to pay more for a brand seen in the media.[14] Each consumer buys at most one unit and if there is more than one product available, she selects the product that provides maximum surplus.

We assume that the advertising effort of the manufacturer reaches consumers around the market in a random fashion. The manufacturer makes a decision to advertise (or not) to a fraction ϕ of the market at a cost of A. For each exogenous cost A, we can examine a family of ϕ where a higher level of ϕ represents advertising that is less expensive on a per consumer basis. The manufacturer's advertising endogenously creates two segments of consumers around the market. The consumers who have seen the manufacturer's advertising are brand seekers and are willing to pay for the image benefit (communicated in the advertising). The consumers who did not see the manufacturer's advertising are not willing to pay for the image benefit and are product seekers.[15] We restrict our attention to parameter conditions where the manufacturer would choose to serve the entire market in the absence of advertising (i.e. $\upsilon > 4t$) and the benefit associated with the national brand is low enough such that even at maximum pricing ($p = B + \upsilon - t$), some uninformed consumers buy (i.e. $B < t$). These conditions are sufficient to demonstrate analogous results to the base model (partial coverage conditions do not provide additional insight). As before, we normalize the marginal cost to 0.

[12] In 2001, the six largest US grocery products advertisers in 2001 were Procter and Gamble, Johnson and Johnson, Unilever, L'Oreal, and Nestle (based on "100 Leading National Advertisers", *Advertising Age*, June 23, 2003). The penetration of store brands in categories where these firms are active ranged from 8% in breakfast cereals to as high as 29% in prepared mayonnaise (1997 US data gathered from the Private Labels Manufacturers Association, IRI and AC Nielsen).

[13] In Canada, Loblaws worked jointly with Colonial (a national brand manufacturer) to develop an upmarket cookie product. Colonial made significant investments in product development (Dunne and Narasimhan, 1999). Agfa also works with retailers (for which it produces store brands) to assist in segmentation, target marketing and the establishment of photo-finishing services.

[14] Alternatively, one could interpret the benefit B as being an aspect of the physical product about which consumers are uninformed. Consumers therefore re-evaluate the product after seeing the advertising. However, this interpretation implies that the store brand is not quality-equivalent and that the advertising is a signal of higher quality.

[15] This is similar to the approach of Butters (1977) and Grossman and Shapiro (1984); however, in this model, consumers are active even when they have not seen advertising. Advertising simply makes a consumer aware of the image benefit associated with the national brand.

Consider two situations. In the first, the only product in the market is the national brand (n).[16] In this situation, the manufacturer's objective function is:

$$\pi_M = w_n(\phi D_1^n + (1-\phi)D_2^n) - A \quad (5)$$

where D_1^n is the fraction of the brand seekers who are served and D_2^n is the fraction of product seekers who are served. The manufacturer first decides whether to advertise and then sets w to maximize profit. Similarly, the objective function for the retailer is:

$$\pi_R = (p_n - w_n)(\phi D_1^n + (1-\phi)D_2^n) \quad (6)$$

The retailer sets p to maximize profit given the level of advertising and wholesale price selected by the manufacturer. The subscript n denotes the wholesale and retail price of the national brand.

In the second case, both an advertised national brand and a quality-equivalent store brand (g) are available. Similar to the base case, the manufacturer quotes a wholesale price to the retailer that results in positive store brand sales from the retailer. Here, the objective function for the manufacturer is

$$\pi_M = w_n \phi D_1^n + w_g(1-\phi)D_2^n - A \quad (7)$$

and for the retailer, the objective function is:

$$\pi_R = (p_n - w_n)\phi D_1^n + (p_g - w_g)(1-\phi)D_2^n - k_r \quad (8)$$

As in the base case, we assume that the retailer incurs a fixed cost k_r to launch the store brand.

When only the national brand is available, Lemma 1 identifies the necessary conditions for a manufacturer to advertise.

Lemma 1. *If the manufacturer chooses to advertise ($\phi > 0$) then $p_n > v - t$, $D_2^n < 1$ and $D_1^n = 1$.*

When only the national brand is available and the manufacturer advertises, Lemma 1 shows that the manufacturer sets the wholesale price such that the optimal price for the retailer is to leave some consumers (who did not see advertising) unserved. The intuition for Lemma 1 is that if the manufacturer advertises, it must also raise price. Otherwise, the manufacturer could increase profit by not advertising. Following this reasoning, we write the demand from each segment of consumers as: $D_1^n = 1$ and $D_2^n = \frac{\upsilon - p}{t}$. Substituting into the objective functions and solving leads to Proposition 6 (the equilibrium profits are provided in the Appendix).

Proposition 6. 1. *When $\phi \in \left(0, \frac{1+4B-8t}{1+4B-5t}\right)$ and only the national brand is available, the prices are $w = -\frac{1}{2}\frac{\phi t + v - \phi\upsilon}{-1+\phi}$ and $p = -\frac{3}{4}\frac{t\phi + \upsilon - \phi\upsilon}{-1+\phi}$.*

2. *When $\phi \in \left(\frac{1+4B-8t}{1+4B-5t}, 1\right)$ and only the national brand is available, the prices are $w = B + \upsilon - 2t$ and $p = B + \upsilon - t$.*

[16] In conditions where the manufacturer advertises when a store brand is available and does not otherwise, the introduction of a store brand leads to an increase in average category prices. We omit discussion of this case because our main interest is situations where the national brand is advertised both before and after the store brand introduction.

Similar to the base case, when only the national brand is available, prices increase in ϕ (the level of advertising). As prices increase, the fraction of the product seekers left unserved also increases.

When both the national brand and a quality-equivalent store brand are available, the manufacturer sets wholesale prices such that the individual rationality constraint binds for both types of consumers (this follows from the restriction that $t < \frac{\upsilon}{4}$). This leads to Proposition 7.

Proposition 7. *When both the national brand and the store brand are available, the equilibrium is $w_n = B + \upsilon - 2t$, $w_g = \upsilon - t$, $p_n = B + \upsilon - t$ and $p_g = \upsilon - 2t$.*

When both the national brand and the store brand are available, all consumers in the market buy. This means that the average price in the market is $\bar{p} = \phi B + \upsilon - t$. A comparison of average category prices leads to Proposition 8.

Proposition 8. *When $\phi < \frac{1}{8B}\left(-\upsilon + 4B + t + \sqrt{(\upsilon^2 + 8B\upsilon - 2vt + 16B^2 - 56Bt + t^2)}\right)$, average category prices are increased by the introduction of a store brand. Otherwise, average category prices are reduced by the store brand's introduction.*

Despite the fact that advertising is not treated as a decision variable in this extension, we observe identical dynamics to those of the base model. For high values of ϕ (conditions that are naturally associated with conditions of inexpensive advertising), the main effect of introducing a store brand is to increase the fraction of product seekers that buy (consumers who did not see the advertising). This is done by making a less expensive product available which reduces the average price in the market. In contrast for low values of ϕ (conditions naturally associated with conditions of expensive advertising), the main effect of introducing a store brand is to allow higher prices to be charged to consumers who are brand seekers. As a result, the introduction of a store brand increases the average price in the market.

In sum, the alternate model generates findings that are analogous to those of the base model. The primary determinant of how a quality-equivalent store brand affects market prices is whether it leads to a significant increase in market size (in which case, it leads to a drop in prices) or superior price discrimination across consumers who are already active in the market. These findings do not seem to depend on the functional form that is used to represent the willingness of a specific segment to pay a premium for an advertised brand.

6. Conclusion

Our goal is to investigate several aspects of store brand marketing and understand changes in aggregate market prices that often accompany increased store brand activity within categories. We do so with a model where the retailer first decides whether to launch a store brand and the manufacturer decides whether to produce it for the retailer. The model helps to explain a number of empirical findings. As mentioned earlier, Connor and Peterson (1992) analyzed over 225

grocery categories and found that advertising is positively related to average prices in markets where store brands are significant. Our model explains this and builds on the idea that advertising has become increasingly expensive. The model also shows that when the manufacturer is the supplier of the store brand, the profit increase associated with introducing a store brand is generally higher for the manufacturer than for the retailer. Thus, the manufacturer realizes a significant gain due to the retailer's fixed investment to launch a new brand. In addition, the model suggests that there may be situations where the dominant manufacturer (and not the retailer) is the most likely candidate to launch a non-advertised quality-equivalent alternative to the national brand.

In sum, the model provides an explanation for the higher prices at retail that are observed across a number of categories where store brands have become important. In fact, work by Meza and Sudhir (2002) confirms that retailers increase the prices of national brands after store brands are introduced. Prices rise in the aggregate, despite the appearance of lower priced store brands. The model shows that the launch of store brands stimulates higher advertising by the manufacturer and there is evidence of higher levels of advertising in categories where the growth of store brands is associated with higher market prices. In addition, the vast majority of advertising in categories where brands have tangibly equivalent qualities consists of non-price "persuasive" messages.

Our analysis indicates that business reports of fierce competition between store brands and national brands may be exaggerated. For example, a recent Harvard Business Review article concludes that private label competition remains a serious threat to national brands (Quelch and Harding, 1996, p.100).[17] In contrast, we find that a store brand can increase the profitability of a national brand manufacturer even when the volume and share of the national brand decline.

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Appendix A. Derivation of Complete Coverage Condition (Advertising is Absent)

With partial coverage, the retailer's objective function is:

$$\pi_R = (p-w)\left(\frac{\upsilon-p}{t}\right) \tag{a1}$$

The optimal price for the retailer must satisfy the first order condition, therefore $\frac{\partial \pi_R}{\partial p} = -\frac{-\upsilon + 2p - w}{t} = 0 \Rightarrow p = \frac{1}{2}\upsilon + \frac{1}{2}w$. The manufacturer chooses wholesale price to ensure that the marginal consumer (at $x=1$) obtains zero surplus. Therefore, $0 = \upsilon - t - \left(\frac{1}{2}\upsilon + \frac{1}{2}w\right) \Rightarrow w = \upsilon - 2t$. But this only applies if the optimal price according to the manufacturer's optimization problem with partial coverage is lower. The manufacturer's optimization problem is

$$\pi_M = w\left(\frac{\upsilon-p}{t}\right) \tag{a2}$$

The optimal price for the manufacturer must satisfy the first order condition, therefore $\frac{\partial \pi_M}{\partial w} = \left(-\frac{1}{2}w\frac{-\upsilon + w}{t}\right) = 0 \Rightarrow w = \frac{1}{2}\upsilon$. In order for $\frac{\upsilon}{2} < \upsilon - 2t$, we require $\upsilon > 4t$. In these conditions, the manufacturer sets $w = \upsilon - 2$.

Proof of Proposition 1. We assume that the retailer sets price optimally as if coverage were partial (in fact, coverage is full for brand seekers but the manufacturer sets the wholesale price so this is just so). The retailer optimizes:

$$\pi_R = (p_n - w_n)(\lambda D_1^n + (1-\lambda)D_2^n) \tag{a3}$$

where $D_1^n = \frac{A + v - p_n}{t}$ and $D_2^n = \frac{v - p_n}{t}$. Substituting and differentiating, we obtain:

$$\frac{\partial \pi_R}{\partial p_n} = \frac{\lambda A + \upsilon - 2p_n + w_n}{t} = 0 \tag{a4}$$

which implies that $p_n = \frac{1}{2}\lambda A + \frac{1}{2}\upsilon + \frac{1}{2}w_n$. Since it is optimal for the manufacturer to ensure that all brand seekers purchase, $p_n = A + \upsilon - t \Rightarrow w_n = (2-\lambda)A + \upsilon - 2t$.

Returning to the manufacturer's problem, we know that wholesale price is such that $D_1^n = 1$. Thus, the manufacturer optimizes:

$$\pi_M = w_n(\lambda D_1^n + (1-\lambda)D_2^n) - \alpha A^2 \tag{a5}$$

Substituting for w_n and D_2^n and differentiating with respect to A, we have:

$$\frac{\partial \pi_M}{\partial A} = -\frac{-4t + 4A - 6\lambda A + 3\lambda t + 2\lambda^2 A + v - v\lambda + 2\alpha A t}{t} = 0 \tag{a6}$$

[17] Kotler (1994, p. 449) refers to this competition as "the battle of the private-label brands".

which is satisfied when $A=\frac{1}{2}\frac{4t-3\lambda t-v+v\lambda}{\lambda^2+2-3\lambda+\alpha t}$. But $\frac{1}{2}\frac{4t-3\lambda t-v+v\lambda}{\lambda^2+2-3\lambda+\alpha t}>0$ if and only if, $v<\frac{4-3\lambda}{1-\lambda}t$. This limit for v is strictly greater than $4t$ which leads to the following equilibrium decisions as a function of the equilibrium parameters. The manufacturer will choose $A=\frac{1}{2}\frac{4t-3\lambda t-v+v\lambda}{\lambda^2+2-3\lambda+\alpha t}$ when $v\in\left(4t,\frac{4-3\lambda}{1-\lambda}t\right)$. Here, the equilibrium prices and profits for each channel member are as follows:

$$\begin{aligned}
p_n &= \frac{1}{2}\frac{3\lambda t+3v-5v\lambda+2v\lambda^2+2v\alpha t-2\lambda^2 t-2\alpha t^2}{\lambda^2+2-3\lambda+\alpha t}\\
w_n &= \frac{1}{2}\frac{2\lambda t+2v-3v\lambda-\lambda^2 t+v\lambda^2+2v\alpha t-4\alpha t^2}{\lambda^2+2-3\lambda+\alpha t}\\
\pi_M &= \frac{1}{4}\frac{-8\alpha t^3+4v\alpha t^2+\lambda^2 t^2-2\lambda^2 tv+2\lambda tv+v^2+v^2\lambda^2-2v^2\lambda}{t(\lambda^2+2-3\lambda+\alpha t)}\\
\pi_R &= \frac{1}{2}\frac{\lambda t+v-2v\lambda+v\lambda^2-\lambda^2 t+2\alpha t^2}{\lambda^2+2-3\lambda+\alpha t}
\end{aligned} \tag{a7}$$

However, it is also necessary for $D_2^n>0$. Therefore $A<t\Rightarrow\alpha>-\frac{1}{2}\frac{-3\lambda t+v-v\lambda+2t\lambda^2}{t^2}$. Note that $\frac{\partial\pi_R}{\partial\alpha}=-\frac{1}{2}t\frac{-3\lambda^2 t-4t+7\lambda t+v-2v\lambda+v\lambda^2}{(\lambda^2+2-3\lambda+\alpha t)^2}>0$ because $-\frac{1}{2(\lambda^2+2-3\lambda+\alpha t)^2}t<0$ and the term $-3\lambda^2 t-4t+7\lambda t+v-2v\lambda+v\lambda^2$ can be rewritten as $(-1+\lambda)(4t-3\lambda t-v+v\lambda)$. The first term is negative and the second term is positive because $v<\frac{4-3\lambda}{1-\lambda}t$ by assumption.

When $\alpha<-\frac{1}{2}\frac{-3\lambda t+v-v\lambda+2t\lambda^2}{t^2}$, only brand seekers are served. Here:

$$\begin{aligned}
&A=\frac{\lambda}{2\alpha},\ w_n=\frac{\lambda}{2\alpha}+v-2t,\ p_n=\frac{\lambda}{2\alpha}+v-t\\
&\pi_M=\frac{1}{4}\lambda\frac{\lambda+4v\alpha-8t\alpha}{\alpha},\ \pi_R=\lambda t
\end{aligned}$$

When $v>\frac{4-3\lambda}{1-\lambda}$, the manufacturer compares the profit of serving both segments (without advertising) to serving brand seekers alone.

1. if $\alpha>\frac{1}{4}\frac{\lambda^2}{v-v\lambda-2t+2t\lambda}$, $A=0$, $p_n=v-t$, $w_n=v-2t$ and $\pi_R=t$ and $\pi_M=v-2t$
2. if $\alpha<\frac{1}{4}\frac{\lambda^2}{v-v\lambda-2t+2t\lambda}$, $A=\frac{\lambda}{2\alpha}$, $p_n=\frac{\lambda}{2\alpha}+v-t$, $w_n=\frac{\lambda}{2\alpha}+v-2t$, $\pi_R=\lambda t$ and $\pi_M=\frac{1}{4}\lambda\frac{\lambda+4v\alpha-8t\alpha}{\alpha}$. □

Proof of Proposition 2. The retailer optimizes prices as if coverage were partial (in fact coverage is full for both consumer types and the manufacturer sets the wholesale price so this is just so). The retailer faces the following optimization with respect to p_n and p_g:

$$\pi_R=(p_n-w_n)\lambda D_1^n+(p_g-w_g)(1-\lambda)D_2^n-k_r \tag{a9}$$

where $D_1^n=\frac{A+v-p_n}{t}$ and $D_2^n=\frac{v-p_g}{t}$. Substituting and differentiating, we obtain:

$$\begin{aligned}
\frac{\partial\pi_R}{\partial p_n} &= \lambda\frac{A+v-2p_n+w_n}{t}=0\\
\frac{\partial\pi_R}{\partial p_g} &= -\frac{-v+2p_g+v\lambda-2p_g\lambda-w_g+w_g\lambda}{t}=0
\end{aligned} \tag{a10}$$

This implies that $p_n=\frac{A+v+w_n}{2}$ and $p_g=\frac{v+w_g}{2}$. Since it is optimal for the manufacturer to ensure that all brand seekers and product seekers purchase, $p_n=A+v-t\Rightarrow w_n=A+v-2t$ and $p_g=v-t\Rightarrow w_g=v-2t$. Returning to the manufacturer's problem, we substitute the wholesale prices and demands into the manufacturer's optimization problem to obtain:

$$\pi_M=(A+v-2t)\lambda+(v-2t)(1-\lambda)-\alpha A^2 \tag{a11}$$

optimizing with respect to A, we obtain $A=\frac{\lambda}{2\alpha}$. This implies that:

$$\begin{aligned}
&p_n=\frac{\lambda}{2\alpha}+v-t,\ p_g=v-t\\
&w_n=\frac{\lambda}{2\alpha}+v-2t,\ w_g=v-2t\\
&\pi_M=\frac{1}{4}\frac{\lambda_2+4v\alpha-8\alpha t}{\alpha},\ \pi_R=t-k_r
\end{aligned} \tag{a12}$$

Note that for all positive values of α, the manufacturer advertises and serves brand seekers and product seekers with different products. □

Proof of Proposition 3. When $v>\frac{4-3\lambda}{1-\lambda}t$ and $\alpha>\frac{1}{4}\frac{\lambda^2}{v-v\lambda-2t+2t\lambda}$, the retailer strictly loses profit by launching a store brand (the retailer's profit with only the national brand is $\pi_R=t$). When $v>\frac{4-3\lambda}{1-\lambda}t$ and $\alpha<\frac{1}{4}\frac{\lambda^2}{v-v\lambda-2t+2t\lambda}$, the retailer will request a store brand when $k_r<t(1-\lambda)$. When $v\in\left(4t,\frac{4-3\lambda}{1-\lambda}t\right)$ and $\alpha>-\frac{1}{2}\frac{-3\lambda t+v-v\lambda+2t\lambda^2}{t^2}$, $\pi_R=\frac{1}{2}\frac{\lambda t+v-2v\lambda+v\lambda^2-\lambda^2 t+2\alpha t^2}{\lambda^2+2-3\lambda+\alpha t}$ without a store brand and $\pi_R=t-k_r$ with a store brand. As a result, when $k_r<L=-\frac{1}{2}\frac{-3\lambda^2 t-4t+7\lambda t+v-2v\lambda+v\lambda^2}{\lambda^2+2-3\lambda+\alpha t}$, the retailer will request a store brand. Note that $\frac{\partial L}{\partial\alpha}=\frac{1}{2}\frac{(-1+\lambda)(4t-3\lambda t-v+v\lambda)}{(\lambda^2+2-3\lambda+\alpha t)^2}t>0$ because the numerator is the product of two negative terms (recall that $v<\frac{4-3\lambda}{1-\lambda}t$) and the denominator is positive. When $v\in\left(4t,\frac{4-3\lambda}{1-\lambda}t\right)$ and $\alpha<-\frac{1}{2}\frac{-3\lambda t+v-v\lambda+2t\lambda^2}{t^2}$, the retailer will request a store brand as long as $k_r<(1-\lambda)t$. The manufacturer will accept the retailer's request whenever it is received because the profit through distributing both a national brand and a store brand is strictly greater than the profit obtained by distributing a national brand alone. □

Proof of Proposition 4. As noted in the text, we restrict our attention to situations where the launch of a store brand is feasible, i.e. $v\in\left(4t,\frac{4-3\lambda}{1-\lambda}t\right)$. The average price in the market when only a national brand is available is $\bar{p}_n=\frac{1}{2}\frac{3\lambda t+3v-5v\lambda+2v\lambda^2+2v\alpha t-2\lambda^2 t-2\alpha t^2}{\lambda^2+2-3\lambda+\alpha t}$ when $\alpha>-\frac{1}{2}\frac{-3\lambda t+v-v\lambda+2t\lambda^2}{t^2}$ and $\bar{p}_n=\frac{\lambda}{2\alpha}+v-t$ when $\alpha<-\frac{1}{2}\frac{-3\lambda t+v-v\lambda+2t\lambda^2}{t^2}$. The average price in the market when both the national brand and the store brand are available is $\bar{p}_{n+g}=\lambda p_n+(1-\lambda)p_g$. Therefore $\bar{p}_{n+g}=\frac{1}{2}\frac{\lambda^2+2v\alpha-2t\alpha}{\alpha}$.

Straightforward comparisons imply that $\bar{p}_n>\bar{p}_{n+g}$ when $\alpha<(2-\lambda)\frac{\lambda^2}{\lambda t+4t-v}$ and $\bar{p}_n<\bar{p}_{n+g}$ when $\alpha>(2-\lambda)\frac{\lambda^2}{\lambda t+4t-v}$. In addition, $(2-\lambda)\frac{\lambda^2}{\lambda t+4t-v}>-\frac{1}{2}\frac{-3\lambda t+v-v\lambda+2t\lambda^2}{t^2}$ because $(2-\lambda)\frac{\lambda^2}{\lambda t+4t-v}+\frac{1}{2}\frac{-3\lambda t+v-v\lambda+2t\lambda^2}{t^2}=-\frac{1}{2(\lambda t+4t-v)t^2}(-v+3\lambda t)(-v+\lambda v+4t-3\lambda t)$. The first term is negative, the second term is negative since $v>4t$ and the third term is positive since $v<\frac{4-3\lambda}{1-\lambda}t$. Thus, for any combination of t, λ, and v in the allowable zone there exists a region where prices increase due to the introduction of a quality-equivalent store brand and a region where prices decrease. When $\alpha<-\frac{1}{2}\frac{-3\lambda t+v-v\lambda+2t\lambda^2}{t^2}$, prices decrease with the introduction of a store brand because $\frac{\lambda}{2\alpha}+v-t>\frac{1}{2}\frac{\lambda^2+2v\alpha-2t\alpha}{\alpha}$ i.e., $\frac{\lambda}{2\alpha}+v-t-\frac{1}{2}\frac{\lambda^2+2v\alpha-2t\alpha}{\alpha}=\frac{1}{2}\lambda\frac{1-\lambda}{\alpha}>0$ strictly. □

Proof of Proposition 5. As noted in Proposition 3, when $v>\frac{4-3\lambda}{1-\lambda}t$ and $\alpha>\frac{1}{4}\frac{\lambda^2}{v-v\lambda-2t+2t\lambda}$, the retailer loses profit by launching a store brand (the retailer's profit with only the national brand is $\pi_R=t$). Therefore, in these conditions, the manufacturer will launch an unadvertised brand if and only if $k_r<\frac{1}{4}\frac{\lambda^2-16t\alpha}{\alpha}$. When $v>\frac{4-3\lambda}{1-\lambda}t$ and $\alpha<\frac{1}{4}\frac{\lambda^2}{v-v\lambda-2t+2t\lambda}$, the retailer will launch a store brand when $k_r<t(1-\lambda)$. When $k_r\in[t(1-\lambda),(v-2t)(1-\lambda)]$, the manufacturer (and not the retailer) has an incentive to launch a second unadvertised brand. Note that the manufacturer's gain is strictly greater than the retailer's when $v>\frac{4-3\lambda}{1-\lambda}t$.

Following Proposition 3, the increase in sub-game profit for the retailer when $v\in\left(4t,\frac{4-3\lambda}{1-\lambda}t\right)$ is $-\frac{1}{2}\frac{-3\lambda^2 t-4t+7\lambda t+v-2v\lambda+v\lambda^2}{\lambda^2+2-3\lambda+\alpha t}$ when $\alpha>-\frac{1}{2}\frac{-3\lambda t+v-v\lambda+2t\lambda^2}{t^2}$ and $(1-\lambda)t$ otherwise. When $v\in\left(4t,\frac{4-3\lambda}{1-\lambda}t\right)$ and $\alpha>-\frac{1}{2}\frac{-3\lambda t+v-v\lambda+2t\lambda^2}{t^2}$, the manufacturer gains $\frac{1}{4}\frac{t\lambda^4+2\lambda^2 t-3t\lambda^3-8\alpha\lambda^2t^2+6t\alpha v\lambda^2+8v\alpha t-14t\lambda v\alpha-16\alpha t^2+24\lambda t^2\alpha-\alpha v^2-\alpha v^2\lambda^2+2\alpha\lambda v^2}{\alpha t(\lambda^2+2-3\lambda+t\alpha)}$ and $(1-\lambda)(v-2t)$ otherwise. When $v\in(4t,\frac{4-3\lambda}{1-\lambda}t)$ and $\alpha>-\frac{1}{2}\frac{-3\lambda t+v-v\lambda+2t\lambda^2}{t^2}$, the manufacturer's gain less the retailer's gain is equal to $\frac{1}{4}\frac{(1-\lambda)(2\lambda^2 t-6t\lambda v\alpha+\alpha\lambda v^2+8\lambda t^2\alpha-16\alpha t^2+8v\alpha t-\alpha v^2-t\lambda^3)}{\alpha t(\lambda^2+2-3\lambda+t\alpha)}$. The root of this expression is $\alpha^*=\frac{t\lambda^2(2-\lambda)}{8t\lambda v-\lambda v^2-14\lambda t^2+24t^2-10vt+v^2}$. When α is less than this root, the expression is strictly positive. When α is greater than this root the expression is strictly negative. In other words, for sufficiently high costs of advertising, the retailer's gain (from introducing a store brand) can exceed the manufacturer'sgain. For example, when $t=1$, $v=4.5$ and $\lambda=0.5$, conditions that satisfy $v\in\left(4t,\frac{4-3\lambda}{1-\lambda}t\right)$ and $\alpha>-\frac{1}{2}\frac{-3\lambda t+v-v\lambda+2t\lambda^2}{t^2}$ (this limit is negative so all positive values of α satisfy it), $\alpha^*=3$. Therefore the manufacturer's gain is greater than the retailer's gain when $\alpha<3$ and vice versa for $\alpha>3$.

When $v\in\left(4t,\frac{4-3\lambda}{1-\lambda}t\right)$ and $\alpha<-\frac{1}{2}\frac{-3\lambda t+v-v\lambda+2t\lambda^2}{t^2}$, the manufacturer's gain from the introduction of a store brand is strictly greater than the retailer's since $(1-\lambda)(v-2t)-(1-\lambda)t=(1-\lambda)(v-3t)$ and $v>4t$ by assumption. □

Proof of Proposition 6. The timing in the alternative model is 1) manufacturer advertises at ϕ, 2) the manufacturer sets the wholesale price, 3) the retailer sets the price and 4) the market clears. Assume the manufacturer advertises and there are people in the market who do not buy. Then:

$$\pi_R=(p-w)\left(\phi+(1-\phi)\frac{v-p}{t}\right) \tag{a13}$$

The retailer optimizes price:

$$\frac{\partial\pi_R}{\partial_p}=\frac{\phi t+v-2p-\phi v+2\phi p+w-w\phi}{t}=0\Rightarrow p=-\frac{1}{2}\frac{\phi t+v-w\phi-\phi v+w}{-1+\phi} \tag{a14}$$

Assuming all consumers informed of the benefit buy, the manufacturer's problem is to maximize profit with respect to wholesale price:

$$\pi_M=w\left(\phi+(1-\phi)\frac{v-p}{t}\right)-A \tag{a15}$$

Substituting for p, this can be rewritten as:

$$\pi_M = \frac{1}{2}\frac{w\phi t + wv - w\phi v + w^2\phi - w^2 - 2At}{t} \tag{a16}$$

The first order condition for wholesale price is:

$$\frac{\partial \pi_M}{\partial w} = \frac{1}{2}\frac{\phi t + \upsilon - \phi\upsilon + 2w\phi - 2w}{t} = 0 \Rightarrow w = -\frac{1}{2}\frac{\phi t + \upsilon - \phi v}{-1+\phi} \tag{a17}$$

This implies that the optimal price for the retailer is $p = -\frac{3}{4}\frac{\phi t + v - \phi v}{-1+\phi}$ and the profits of the retailer and manufacturer are: $\pi_R = -\frac{1}{16}(\phi t + 4\upsilon - 4\phi\upsilon - 3 + 3\phi)\frac{\phi t + 3 - 3\phi - 2\upsilon + 2\phi v}{(-1+\phi)t}$ and $\pi_M = -\frac{1}{8}\frac{\phi^2 t^2 + \phi^2\upsilon^2 - 2\phi^2 t\upsilon + 2\phi t\upsilon + 8At\phi - 2\phi v^2 + v^2 - 8At}{(-1+\phi)t}$. Note that for this solution to apply, it is necessary that $p < 1 + B - 2t$, the reservation price for informed consumers (i.e. brand seekers). Substituting we obtain the condition that $\phi < \frac{1+4B-8t}{-5t+1+4B}$. When $\phi > \frac{1+4B-8t}{-5t+1+4B}$, the manufacturer will set price such that it is optimal for the retailer to set the retail prices at the reservation price for informed consumers i.e., $w = B + v - 2t$ and $p = B + v - t$. This implies that $\pi_R = -B + t + \phi B$ and $\pi_M = -\frac{B^2 - 3Bt - \phi B^2 + vB - tv - v\phi B + 2t^2 + 2t\phi B + At}{t}$. □

Proof of Proposition 7. This proposition obtains easily by substituting the reservation prices for the consumers (informed and uninformed) at $x = 1$ into the profit functions of the retailer and manufacturer. □

Proof of Proposition 8. From Proposition 6, the average price in the market when $\phi < \frac{1+4B-8t}{-5t+1+4B}$ is $\bar{p}_{\text{only nat}} = -\frac{3}{4}\frac{\phi t + v - \phi v}{-1+\phi}$. The average price when a store brand product is available is given by $\bar{p}_{\text{nat \& pl}} = \phi p_n + (1-\phi)p_g$ (all consumers in the market buy). Substituting we obtain $\bar{p}_{\text{nat \& pl}} = \phi B + v - t$. The difference

$$\Delta = \bar{p}_{\text{nat \& pl}} - \bar{p}_{\text{only nat}} = \phi B + v - t + \frac{3}{4}\frac{t\phi + v - \phi v}{-1+\phi} \tag{a18}$$

equals zero when $\phi = \frac{1}{8B}\left(-v + 4B + t + \sqrt{(v^2 + 8Bv - 2vt + 16B^2 - 56Bt + t^2)}\right)$ and $\phi = \frac{1}{8B}\left(-v + 4B + t - \sqrt{(v^2 + 8Bv - 2vt + 16B^2 - 56Bt + t^2)}\right)$. The second root is negative and the expression is increasing for $\phi > 0$. Hence, when ϕ is greater than the first root, $\bar{p}_{\text{nat \& pl}} > \bar{p}_{\text{only nat}}$. □

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