Store Brands and Category Captaincy

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January 3, 2017
Abstract

In several product categories, retailers have launched store brands to compete with national brands on both price and quality. Furthermore, in some of these categories, retailers have appointed a national brand manufacturer as category captain to help expand its sales in all quality tiers within the category. However, category captains may exhibit opportunistic behaviors and even diminish the competitiveness of the store brand. Using a model of vertical differentiation, we aim to understand the strategic implications of category captaincy for the competing national brand, consumers, and the store brand. One may believe that on adopting category captaincy, the retailer gives up the power emanating from the store brand. However, our analysis shows that the retailer leverages the power to make category captaincy more profitable. Our naive intuition also suggests that category captaincy may hurt both the competing manufacturer and consumers. In a mature product category, however, the presence of the store brand turns category captaincy strictly beneficial to the competing manufacturer. In an emerging product category, category captaincy always improves consumer welfare irrespective of the presence of the store brand. Finally, when allowed to make product line recommendations, the category captain recommends the removal of the competing national brand. The resulting pruning of the product line increases both the total channel profits and consumer welfare.

Keywords: Store Brands, Category Management, Category Captain, Product Line Decisions, Distribution Channel, Vertical Differentiation.
1 Introduction

Store brands account for almost a quarter of the entire sales in US supermarkets (Howlett 2010). Retailers have strategically leveraged the quality and price of store brands to better compete with the national brands (Geyskens et al. 2010, Amaldoss and Shin 2015), garner a larger share of channel profits, and reduce their dependence on national brands (Kadiyali et al. 2000, Brady et al. 2003). At the same time, we see retailers seeking the help of a national brand manufacturer to manage all the quality tiers of a product category, including the store brand. Major retailers, such as Walmart, Target, and Kroger, have delegated the task of managing product categories to manufacturers, such as Nestlé, General Mills, Unilever, and Kellogg (Kurtulus and Toktay 2009). These manufacturers, who serve as category captains, provide efficient category-specific services that improve the profitability of the category (Dudlicek et al. 2016). For instance, Nestlé, the manufacturer of infant nutrition products, has boosted total infant nutrition category sales of several retailers by 3.4% in a 12-week period in 2013 by redesigning the baby aisle and educating new moms (Dudlicek 2013). Likewise, Pepsi helped retailers improve the total sales of ready-to-drink tea category by 16% and increase household penetration by 1.3% (Dudlicek 2013). Even convenience stores that offer a far more limited set of products compared to big-box retailers adopt category captaincy. For example, the convenience store RaceTrac has increased its sales in the wine category by appointing E.&J. Gallo Winery as the category captain (Durtschi 2016). Hence, store brands and category captaincy have become two major trends in retail markets. While most retailers are adopting both, there is apprehension that the category captain may take advantage of its leadership role in the category and diminish the competitiveness of the store brand (Desrochers et al. 2003). It is thus puzzling to see the retailer, who is seeking to curb a national brand with its store brand, delegating the category management responsibility to the very same national brand manufacturer. Thus, there is a need to carefully examine the practice of category captaincy in a product category where the retailer offers a store brand.

Typically, the retailer entrusts the category captain with the responsibility of maximizing the sales of the entire product category at the retail outlet through activities such as shelf-space allocation, in-store promotion, and product assortment. This creates scope for
the category captain to engage in opportunistic behavior at the expense of competing manufacturers (Morgan et al. 2007). For example, the category captain can foreclose a competing national brand through unfavorable shelf display and promotion activities, or even recommend the removal of a competitor’s product from the retailer’s product line (FTC 2001). Conwood, a manufacturer in the moist snuff tobacco category, in its suit against US Tobacco, who had been the category captain of major retailers, argued that US Tobacco dumped competitors’ racks and products and provided retailers with false information about competitors (ABA Section of Antitrust Law 2010). More recently, Clemmy’s, an ice cream brand, sued Nestlé for utilizing its category captain status with big retailers to shut rivals out of the market (Watson 2015). These opportunistic behaviors on the part of the category captain could hurt a competing manufacturer (Subramanian et al. 2010). Such behaviors may also hurt consumers because they can find it hard, or even impossible, to locate competing products (Carameli 2004). Hence, it is useful to investigate how category captaincy affects not only competing manufacturers but also consumers. More importantly, there is a need to investigate how the presence of the store brand moderates the effect of category captaincy on competing manufacturers and consumers.

In mature product categories, the captain improves category sales by expending effort on short-term activities such as product display, product assortment, and shelf-space allocation. In some instances, the retailer seeks a national brand manufacturer to serve as the category captain for a new or emerging product category in its store, such as fabric refresher (e.g. Febreze), household quick-cleaning pads (e.g. Swiffer), organic foods (e.g., Cascadian Farms), or drinkable breakfast (e.g., Kellogg’s To Go). In developing a new product category, however, the category captain makes long-term investments toward educating consumers, increasing consumer involvement in the category, and generating traffic for the category. This difference in the nature of efforts of the category captain raises the question whether the strategic implications of category captaincy for a new product category would be different from that for an established product category.

To examine these issues, we propose a parsimonious model of category captaincy in a retail store that offers national brands and the store brand. In our setting, the retailer decides whether or not to adopt category captaincy and, if so, which manufacturer to appoint as
the category captain. The manufacturer selected as category captain takes the effort to develop sales for the product category at a cost. However, if the retailer does not choose a category captain, the retailer takes care of category management all by itself. In addition to considering these decisions pertaining to category captaincy, our model permits the retailer and manufacturers to compete in the market based on the quality and price of their products. In this setting, the category captain can potentially leverage its leadership role to preempt a more profitable position. Thus, in deciding on whether to adopt category captaincy, the retailer carefully weighs the costs of delegating category leadership to the captain (i.e., positioning disadvantage due to the captain’s preemption) against the benefits that flow from the market expansion induced by the captain. On analyzing category captaincy in an established product category and a new product category, we obtain several interesting results.

First, one may believe that the practice of category captaincy goes against the purpose of store brands. Our analysis, however, shows that the retailer can leverage its store brand to make category captaincy more profitable. To understand this result, note that the retailer chooses to adopt category captaincy only if the category captain is so cost efficient that it can sufficiently expand the market. In the presence of the store brand, the retailer would like the market expansion to be large enough to offset the loss it suffers because of the category captain’s first-mover advantage. However, in the absence of the store brand, since the retailer does not have a product directly competing with the category captain’s national brand, the category captain’s first-mover advantage does not reduce the retailer’s profits as much; hence, the retailer adopts category captaincy even if it can induce a lower level of market expansion. These results show that the presence of the store brand motivates the retailer to set a more stringent market expansion requirement for adopting category captaincy. Therefore, on adopting category captaincy, the retailer does not give up the power emanating from the store brand; instead, the retailer leverages the power to demand a higher level of cost efficiency from the category captain.

Second, we find that the competing manufacturer is always better off with category captaincy in the presence of the store brand but not in the absence of the store brand. To see this, note that the store brand allows the retailer to claim a large portion of the
channel profits. Consequently, in the presence of the store brand, the category captain’s first-mover advantage decreases the retailer’s profits much more than those of the competing manufacturer. This implies that the competing manufacturer will be better off whenever the retailer adopts category captaincy. In the absence of the store brand, however, this is not guaranteed because the category captain’s first-mover advantage can reduce the competing manufacturer’s profits more than the retailer’s profits. Thus, the store brand could be a blessing for the competing manufacturer. Turning attention to consumers, we find that category captaincy may reduce consumer welfare both in the presence and the absence of the store brand. This is because category captaincy decreases the number of consumers served in the category either by reducing market size or by decreasing market coverage. Hence, although category captaincy in a mature product category can benefit firms, it may reduce consumer welfare.

Third, in addition to the usual in-store sales development efforts, the category captain can potentially make product line recommendations to the retailer (Kurtulus and Tokay 2009). However, it is up to the retailer whether it implements the recommendation. Our analysis shows that the category captain’s product line recommendation improves both total channel profits and consumer welfare even though the recommendation involves trimming product line length. To understand why, note that in equilibrium, the category captain recommends removal of the competing manufacturer’s national brand but not the store brand of the retailer. This is because the retailer is open to sacrificing the sales of the store brand by adjusting its quality so that the category captain is motivated to exert more effort to expand the market, while the competing national brand manufacturer is not. The better coordination of quality through elimination of the competing national brand improves total channel profits. Additionally, more consumers are served, and thereby consumer welfare improves. Therefore, though the category captain’s product line recommendation decreases the competing manufacturer’s profits, it increases total social welfare.

Finally, in a new product category, the category captain makes long-term market investments for developing the market for the category. The long-term investment of the category captain, however, has varied welfare implications for market participants. Our analysis shows that category captaincy in a new category may reduce the competing manufacturer’s profits
though it always increases consumer welfare. To follow the intuition for this finding, note that the efforts to expand the market are made before firms adjust their product qualities; thus firms cannot adjust their quality levels to motivate the captain to exert more efforts for increasing category sales. Consequently, the first-mover advantage of the category captain is relatively small, and hence the size of category captain’s profits (rather than the retailer’s profits) determines whether or not category captaincy is adopted. Since the competing manufacturer benefits from category captaincy less than the category captain, the competing manufacturer might be hurt even when the category captain finds it profitable to assume the leadership role. Moreover, the smaller first-mover advantage motivates the captain to exert more market expansion effort. This, in turn, allows the retailer to serve more consumers and thus increase consumer welfare. Next, in a new product category, the captain recommends that the retailer drop not only the competing national brand but also the store brand, yet it improves consumer welfare. Interestingly, the retailer will eliminate the store brand from its product line even without the recommendation of the category captain. This is because eliminating the store brand guarantees more profits for the category captain and encourages the captain to further invest in developing the new category. The resulting market expansion helps not only the category captain but also the retailer and consumers.

The rest of the paper is organized as follows. Section 2 provides an overview of related literature and clarifies our contribution. Section 3 introduces a model of category captaincy in the presence of the store brand. Section 4 analyzes the strategic implications of category captaincy in an established product category. Section 5 investigates the role of category captaincy in a new product category. Finally, Section 6 summarizes the findings and provides directions for further research.

2 Related Literature

Our work is directly related to the nascent theoretical literature on category captaincy. In a pioneering paper, Subramanian et al. (2010) analyze a model of category captaincy where the captain could invest in category-expanding service and share-shifting service. They show that the category captain engages in category expanding service in markets where cross-price
sensitivity is sufficiently high because the resulting market expansion helps to soften price competition. Even in cases where cross-price sensitivity is lower, the retailer may be motivated to appoint a manufacturer as category captain because the manufacturers will compete to become the category captain in such situations. They also identify conditions where a competing manufacturer can benefit from category captaincy. The model formulation and the goal of our paper are different. We consider a model where the retailer sells its own brand in addition to being the channel for the national brands. This helps us to understand how the retailer uses the store brand to compete against the national brand, and yet collaborate with the same manufacturer to develop the category. We use a vertical differentiation model so that the national brand and the store brand can have different quality levels. In our formulation, though the category captain helps to expand the market, all the firms compete for consumers on both price and quality. We also draw a distinction between an established product category and a new product category and tease out its implications for category captaincy. Next, Kurtulus and Nakkas (2011) examine the issue of retail product assortment in the context of category captaincy. They show that sometimes category captaincy can help the competing manufacturer. An important limitation of this analysis is that price and quality are exogenously determined. We examine the implications of the category captain making a product line recommendation to the retailer using a model where both price and quality are endogenous.

Our research is also related to the empirical literature on category captaincy. Using a survey, Gruen and Shah (2000) investigate the determinants and consequences of category captaincy. Based on a survey of UK retailers, Morgan et al. (2007) suggest that the discontent about category captaincy is low among non-category captain manufacturers. Gooner et al. (2011) survey American retailers to assess whether category captaincy is worth the effort of the parties involved. They find that category captaincy helps retailers to achieve better outcomes without hurting other suppliers. Nijs et al. (2014) estimate the consumer demand model using scanner panel data and then explore counterfactuals on alternative structures for an informational firewall on manufacturers and retailers. They show that a vertical firewall between the manufacturer and the retailer could actually lead to lower profitability even if category pricing is coordinated. Our research adds to this body of literature by identifying
the conditions where category captains could help the competing manufacturer, the retailer, and consumers.

Our paper builds on prior theoretical literature on store brands (e.g., Raju et al. 1995, Sayman et al. 2002; see Amaldoss and Shin 2015 for a recent review of store brand research). In contrast to the early work based on an aggregate demand formulation, more recent work has strived to examine the store brand phenomenon using models of vertical differentiation. Nasser et al. (2013) study how a manufacturer can handle the store brand by supplying the store brand or adjusting the quality of the national brand. They show that the optimal strategy of the manufacturer depends on the manufacturer’s relative cost efficiency. Amaldoss and Shin (2015) provide a theoretical rationale for the multi-tier store brand phenomenon. More importantly, they show that a national brand cannot offer a side payment large enough to wean the retailer away from the store brand. Like these two papers, we also use a vertical differentiation model that permits the store brand and national brands to have varying quality levels. Unlike this body of literature, however, we allow for category captaincy in the retail outlet and examine how the presence of the store brand moderates the effect of category captaincy on the retailer, the competing manufacturer, and consumers.

Finally, our work builds on the prior research on distribution channel. The literature has examined various issues pertaining to channel members, such as bargaining (Iyer and Villas-Boas 2003), information sharing (Mittendorf et al. 2013, Jiang et al. 2016), pricing contracts (Jeuland and Shugan 1983, Lim and Ho 2007, Ho and Zhang 2008, Amaldoss and Shin 2016), and fairness concerns (Cui et al. 2007, Cui and Mallucci 2016). We contribute to this literature by simultaneously considering two significant developments in retail markets, namely store brands and category captaincy, and investigating its implications for channel coordination and consumer welfare.

3 A Model of Category Captaincy

In this section, we present a model of category captaincy in a retail store that sells its own store brand along with the national brands, and examine its implications for the retailer, manufacturers, and consumers. Consider a retailer $R$ who sells its own store brand $S$ in
addition to two national brands \( N_1 \) and \( N_2 \). The two national brands are offered by two different manufacturers \( M_1 \) and \( M_2 \), respectively. Without loss of generality, we denote the manufacturer selling the higher-quality product by \( M_1 \), implying \( q_{N_1} > q_{N_2} \). The retailer is considering appointing one of the national brand manufacturers as the category captain. The category captain, denoted by \( CC \), will be entrusted with the responsibility of managing the entire product category. The category captain expends effort on in-store activities with the goal of increasing the mass of consumers buying products in the category. In particular, the category captain expands the market \( \sqrt{e} \) fold when it exerts effort \( e \) at a cost of \( \alpha_C e \), where \( \alpha_C \) is the cost-efficiency parameter of the category captain. The cost efficiency of the category captain could vary with the identity of the manufacturer, implying \( \alpha_C = \alpha_k \) with \( k = \{1, 2\} \), depending on which manufacturer is appointed as the category captain. If the retailer chooses not to appoint a category captain, then the retailer manages the category all by itself and can increase the market size \( \sqrt{e} \) fold at a cost \( \alpha_R e \), where \( \alpha_R \) is the retailer’s cost-efficiency parameter.\(^1\)

Consumers are heterogeneous in their valuation of quality. In particular, consumers’ sensitivity to quality, denoted by \( \theta \), is uniformly distributed over the interval \([a, b]\), where \( a \) is the lowest valuation of quality and \( b \) is the highest valuation of quality among the consumers in the market (\( 0 < a < b \)). Further, the (indirect) utility of purchasing product \( i \) is given by \( U_i(\theta) = \theta q_i - p_i \) where \( q_i \) is the quality and \( p_i \) is the price of the product (\( i \in \{N_1, N_2, S\}\)). Each consumer purchases the product which offers the highest utility. However, if no product offers a positive net utility, she buys nothing.\(^2\) Then, given the category expansion efforts of the category captain or the retailer (\( e \)), the demand for product \( i \) in the market is given by:

\[
z_i = \begin{cases} 
    \left( \frac{\sqrt{\alpha}}{b-a} \right) \left( b - \frac{p_i - p_{i+1}}{q_i - q_{i+1}} \right) & \text{if } \frac{p_i}{q_i} > \max_{i' \neq i} \left\{ \frac{p_{i'}}{q_{i'}} \right\} \\
    \left( \frac{\sqrt{\alpha}}{b-a} \right) \left( \frac{p_i - p_{i+1}}{q_i - q_{i+1}} - \frac{p_i}{q_i} \right) & \text{if } \frac{p_i}{q_i} < \min_{i' \neq i} \left\{ \frac{p_{i'}}{q_{i'}} \right\} \\
    \left( \frac{\sqrt{\alpha}}{b-a} \right) \left( \frac{p_i - p_{i+1}}{q_i - q_{i+1}} - \frac{p_i - p_{i+1}}{q_i - q_{i+1}} \right) & \text{otherwise,}
\end{cases}
\]

where \( i-1 \) and \( i+1 \) denote the products placed before and after product \( i \), respectively, when

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\(^1\)As noted in Subramanian et al. (2010) and Kurtulmus and Tokay (2009), the principal role of the category captain is to expand the category sales and thus, our model focuses on this aspect of category captaincy among others.

\(^2\)To allow for this possibility, we let the preference distribution have a wide support. Specifically, we assume \( b > 4.1032a \) so that the market has room to expand under any of the product configurations considered in this paper.
sorted on price per unit of quality (namely, \( \frac{p_i}{q_i} \)). Based on the above demand, Manufacturer \( Mk \)'s profits are as follows:

\[
\Pi_{Mk} = z_{Nk}(w_{Nk} - c_{Nk}) - I_k\alpha_k e, \quad k = 1, 2.
\]  

(2)

where \( w_{Nk} \) is the wholesale price of its national brand, \( c_{Nk} \) is the marginal cost of production, and \( I_k \) is the indicator that Manufacturer \( Mk \) is appointed as the category captain. We assume that the marginal cost depends on the quality of the product, and it is given by \( c_{Nk} = q_{Nk}^2 \) (See Motta 1993 and Amaldoss and Shin 2011 for similar assumptions). Similarly, the retailer’s profits are given by:

\[
\Pi_R = \sum_{k=1}^{2} z_{Nk}(p_{Nk} - w_{Nk}) + z_S(p_S - c_S) - I_R\alpha_R e, \quad k = 1, 2.
\]  

(3)

where \( p_i \) is the retail price of product \( i \) with \( i \in \{N1, N2, S\} \); \( c_S \) is the marginal cost of the store brand, which is given by \( c_S = q_S^2 \); and \( I_R \) is the indicator that the retailer assumes the role of the category captain. In most product categories, the decision to appoint a category captain is typically made after the products have been introduced in the market. Thus, the fixed costs related to product development and introduction are already incurred at the time of making the category captain decision, and these sunk costs are irrelevant in our model (see also Nasser et al. 2013). Moreover, consumer surplus is given by:

\[
CS = \sqrt{e} \sum_{i \in \{N1, N2, S\}} \int_{\theta_i}^{\bar{\theta}_i} (\theta q_i - p_i) dF(\theta),
\]  

(4)

where \( \theta_i \) and \( \bar{\theta}_i \) denote the minimum and the maximum valuation of quality, respectively, of consumers purchasing product \( i \), and \( F(\theta) \) is the cdf of the uniform distribution.

Using this model, we examine category captaincy in two categories of product: established products and new products. In an established product category, the category captain’s market development efforts are directed at in-store activities such as product display, reallocation of shelf space, and feature advertising. In a new category, in contrast, the category captain focuses on long-term investments such as educating consumers about the category and developing interest in the products. Hence, the sequence of decisions could differ by the novelty of the product category.
In an established category, the decision sequence is as follows. First, the retailer decides whether or not to appoint a category captain and whom to appoint if it appoints one. Second, the quality levels are chosen in a sequential manner with the manufacturers choosing the quality levels of their national brands before the retailer determines the quality of its store brand. This assumption reflects the common practice that retailers position their store brands after observing the positions of the national brands (see also Sayman et al. 2002). Furthermore, if the retailer appoints one of the manufacturers as the category captain, the category captain becomes the Stackelberg-leader in the quality-setting stage. However, if the retailer does not appoint a category captain, both manufacturers simultaneously make the quality decisions (but still before the retailer makes its quality choice). Since all these quality choices are made after the retailer selects the category captain, the quality levels in our model are the quality levels adjusted after the category captaincy decision (not the initial quality levels of products). The initial quality levels before the adoption of category captaincy, if different from the post-adoption quality levels, do not impact the welfare of any market participant and are thus ignored in our model. Third, the level of market expansion efforts is determined by the category captain if appointed, but by the retailer otherwise. Because category management activities related to an established product category do not require long-term commitments, we let the choice of the effort level be made after the quality decisions. Fourth, all firms set their prices. Specifically, the manufacturers first set the wholesale prices for their national brands. After observing the wholesale prices, the retailer
Figure 2: Decision Sequence (New Product Category)

sets the retail prices for all the products sold in its store. This decision sequence is illustrated in Figure 1.

In a new category, the decision sequence remains similar except that the decision on effort is made before the quality-setting decisions. This is because market development efforts involve a long-term commitment of resources. Specifically, the retailer first decides whether to appoint a category captain and, if so, which manufacturer should be the category captain. Second, either the category captain or the retailer makes the long-term investment to develop the category depending on the first-stage decision. Third, as in an established category, the manufacturers and the retailer sequentially choose the qualities of their products. Fourth, the manufacturers set the wholesale prices for their national brands, and the retailer then sets the retail prices for all products (including the store brand). Figure 2 presents this decision sequence.

We solve the game using backward induction and examine the subgame perfect equilibrium to understand the strategic behavior of all participants. We use this parsimonious model of category captaincy to analyze the phenomenon both in an established product category (in Section 4) and in a new product category (in Section 5). In both sections, we also explore the possibility that category captain could recommend changes to the product line of the retailer.
4 Category Captaincy in an Established Category

Suppose the retailer is considering appointing a manufacturer as category captain for a set of products that the retailer has been selling in its store for a while. In this established product category, the captain can help expand the market through in-store activities. Further, as we later discuss in this section, the category captain can potentially make product line recommendations to the retailer.

4.1 Equilibrium Analysis

To understand the welfare implications of category captaincy in an established product, we examine the equilibrium of our model. Below we first discuss two subgames that involve quality, effort, and pricing decisions. In Subgame C, the retailer appoints a manufacturer as category captain, whereas in Subgame B the retailer does not use a category captain (and we use this subgame as the benchmark). Then we examine the supergame where the retailer makes the category captaincy decision.

4.1.1 Subgame C

Using backward induction, we solve for the equilibrium of Subgame C. Specifically, based on the retailer’s profits given in (3) and the corresponding first-order conditions of the pricing subgame: \( \frac{\partial \Pi_R}{\partial p_{N1}} = 0, \frac{\partial \Pi_R}{\partial p_{N2}} = 0, \) and \( \frac{\partial \Pi_R}{\partial p_S} = 0, \) we obtain the optimal prices as a function of qualities and wholesale prices:

\[
p_{N1} = \frac{b_q N_1 + w_{N1}}{2}, \quad p_{N2} = \frac{b_q N_2 + w_{N2}}{2}, \quad \text{and} \quad p_S = \frac{b_q S + q_S}{2}. \quad (5)
\]

Given these retail prices, the manufacturers set wholesale prices; we can express the wholesale prices as functions of qualities. Note that depending on the relative quality of the store brand compared to the national brands, there are three possibilities \( q_{N1} > q_{N2} > q_S, \) \( q_{N1} > q_S > q_{N2}, \) or \( q_S > q_{N1} > q_{N2}. \) Accordingly, we derive three sets of wholesale prices for these three possibilities, which we do not report here because the expressions are lengthy. Let \( \Pi_{CC} \) denote the profits of the manufacturer appointed as the category captain, with these wholesale prices plugged in. Now using the first-order condition \( \frac{\partial \Pi_{CC}}{\partial e} = 0, \) the category captain will choose the effort level as follows. Note that for each of the three
possibilities, the category captain (CC) could choose either a higher or lower quality level than the competing manufacturer (CM). Hence, we have,

$$e^*(q_{CC}, q_{CM}, q_{S}) = \begin{cases} 
\frac{(q_{CC}-q_{CM})^2(q_{CC}-q_{S})^2(2b-2q_{CC}-q_{CM}-q_{S})}{16(b-a)^2\alpha_C^2(q_{CC}-q_{CM}-3q_{S})^4} & \text{if } q_{CC} > q_{CM} > q_{S} \\
\frac{(q_{CC}-q_{CM})^2(q_{CC}-q_{S})^2(q_{CM}-q_{S})^2(b-q_{CC}+q_{CM}-2q_{S})}{16(b-a)^2\alpha_C^2(q_{CM}-q_{CC}-3q_{S})^4} & \text{if } q_{CM} > q_{CC} > q_{S} \\
\frac{(q_{CC}-q_{CM})^2(q_{CC}-q_{S})^2(b-q_{CC}-q_{CM}-3q_{S})}{256(b-a)^2\alpha_C^2} & \text{if } q_{CC} > q_{S} > q_{CM} \\
\frac{q_{CC}^4(q_{CC}-q_{CM})^2(q_{CM}-q_{S})^2(q_{CM}-q_{S})^2}{16(b-a)^2\alpha_C^2} & \text{if } q_{CM} > q_{S} > q_{CC} \\
\frac{q_{CC}^4q_{CM}^2(q_{CC}-q_{CM})^2(q_{CC}-q_{CM})^2(q_{CM}+q_{S})^2}{16(b-a)^2\alpha_C^2(q_{CC}q_{CM}-4q_{CM}q_{S}+4q_{CM}q_{S}+q_{CM}q_{S})^4} & \text{if } q_{S} > q_{CC} > q_{CM} \\
\frac{q_{CC}^4q_{CM}^2(q_{CC}-q_{CM})^2(q_{CC}-q_{CM})^2(q_{CM}+q_{S})^2}{16(b-a)^2\alpha_C^2(q_{CC}q_{CM}-4q_{CM}q_{S}+4q_{CM}q_{S}+q_{CM}q_{S})^4} & \text{if } q_{S} > q_{CM} > q_{CC} 
\end{cases}$$

Given the effort of the category captain to expand the market, the retailer’s profits can be rewritten as a function of qualities: $$\Pi_R(q_{S}|q_{CC}, q_{CM})$$ for each of the above six cases. Let $$q_s^\phi(q_{CC}, q_{CM})$$ be the local best-response of the retailer, where $$\phi \in \{1, 2, 3, 4, 5, 6\}$$ denotes the six cases. The retailer determines its best response to the qualities of both national brands, and it is given by $$q_s(q_{CC}, q_{CM}) = q_s^\phi(q_{CC}, q_{CM})$$, where for each pair of $$(q_{CC}, q_{CM})$$, $$\Phi$$ satisfies $$\Pi_R(q_s^\phi(q_{CC}, q_{CM})) \geq \Pi_R(q_s^\phi(q_{CC}, q_{CM}))$$, $$\forall \phi$$. Using the best-response function, we obtain manufacturers’ profits as functions of national brand qualities:

$$\Pi_{Mj}(q_{CC}, q_{CM}, q_s^\phi(q_{CC}, q_{CM})), \text{ where } Mj = CC \text{ or } CM.$$

Based on these profits, the category captain and the competing manufacturer sequentially set the quality level of their own product. Thus, we first derive the competing manufacturer’s local response functions to the category captain’s quality choice, $$q_{CM}^{(H)}(q_{CC})$$ (when the category captain chooses the higher quality) and $$q_{CM}^{(L)}(q_{CC})$$ (when the category captain chooses the lower quality). Then the category captain’s profits as a function of its quality are given by:

$$\Pi_{CC}(q_{CC}) = \begin{cases} 
\Pi_{CC}^{(H)}(q_{CC}) & \text{if } \Pi_{CM}^{(H)}(q_{CC}) \geq \Pi_{CM}^{(L)}(q_{CC}) \\
\Pi_{CC}^{(L)}(q_{CC}) & \text{otherwise} 
\end{cases} \quad (7)$$

After solving for the category captain’s optimal quality ($$q_{CC}$$) and plugging it into the relevant response functions, we obtain the following set of equilibrium qualities:

$$q_{CC}^{E2N1S:C} = 0.2847b \quad q_{CM}^{E2N1S:C} = 0.1026b \quad q_s^{E2N1S:C} = 0.8199b$$ \quad (8)

where $$E$$ in the superscript refers to an established product category, 2N1S indicates a category with two national brands and one store brand, and $$C$$ denotes Subgame $$C$$. Using
these equilibrium qualities, we then obtain the following equilibrium profits and consumer surplus:

\[
\Pi_{CC}^{E:2N1S:C} = \frac{0.00003324b^6}{\alpha_C(b-a)^2}, \quad \Pi_{CM}^{E:2N1S:C} = \frac{0.00001658b^6}{\alpha_C(b-a)^2},
\]

\[
\Pi_{R}^{E:2N1S:C} = \frac{0.00011869b^6}{\alpha_C(b-a)^2}, \quad CS^{E:2N1S:C} = \frac{0.00005935b^6}{\alpha_C(b-a)^2},
\]

where CM in the subscript denotes the competing manufacturer. We report the full equilibrium results in the appendix.

4.1.2 Subgame B

In Subgame B, the retailer does not adopt category captaincy. Thus, Subgame B is identical to Subgame C except that the retailer (rather than the category captain) exerts effort to expand the market, and the two manufacturers simultaneously (instead of sequentially) make quality decisions. Given this similarity, we briefly describe the derivation of the equilibrium without delving into the details. First, using the pricing equilibrium derived in the previous section and the first-order condition \( \frac{\partial \Pi_R}{\partial e} = 0 \), we obtain the retailer’s optimal effort. Based on the optimal effort, we derive the optimal quality of the store brand for a given pair of the manufacturers’ qualities. Anticipating the retailer’s best response, the two manufacturers (\( M_1 \) and \( M_2 \)) simultaneously choose their own quality level. Note that in this situation, since profits differ across all three possible cases (Case 1: \( q_{N1} > q_{N2} > q_S \), Case 2: \( q_{N1} > q_S > q_{N2} \), and Case 3: \( q_S > q_{N1} > q_{N2} \)), we first derive the local equilibria for each of the three cases and then check whether there is any scope for deviation across cases from the local equilibria (see the appendix for details). The resulting equilibrium qualities of the two national brands are:

\[
q_{N1}^{E:2N1S:B} = 0.4389b, \quad q_{N2}^{E:2N1S:B} = 0.1716b,
\]

which lead to the retailer’s quality choice \( q_S^{E:2N1S:B} = 0.3310b \). Plugging these quality levels back into relevant equations, we obtain the following:

\[
\Pi_{M1}^{E:2N1S:B} = \frac{0.00001354b^6}{\alpha_R(b-a)^2}, \quad \Pi_{M2}^{E:2N1S:B} = \frac{0.00002149b^6}{\alpha_R(b-a)^2},
\]

\[
\Pi_{R}^{E:2N1S:B} = \frac{0.00036021b^6}{\alpha_R(b-a)^2}, \quad CS^{E:2N1S:B} = \frac{0.00036021b^6}{\alpha_R(b-a)^2},
\]

where B in the superscript denotes Subgame B (i.e., the benchmark).
4.1.3 Category Captaincy Decision

The retailer will adopt category captaincy if and only if both the retailer and the appointed category captain could earn more profits under category captaincy (than without it). Recall that the equilibrium profits of the two subgames are given in (9) and (11). To begin with, note that $\Pi^{E:2N1S:C}_{CC} \geq \Pi^{E:2N1S:B}_{Mk} (k = 1, 2)$ is equivalent to $\alpha_1 \leq 2.4547\alpha_R$ for $M1$ and to $\alpha_2 \leq 1.5471\alpha_R$ for $M2$. Thus, depending on the relative sizes of $\alpha_1$ and $\alpha_2$ (compared to $\alpha_R$), we could have both, one, or none of the manufacturers willing to serve as the category captain.

First, suppose that both $\alpha_1 > 2.4547\alpha_R$ and $\alpha_2 > 1.5471\alpha_R$ hold. In this case, no manufacturer would want to serve as the category captain and hence, category captaincy will not be observed in equilibrium. Next suppose $\alpha_1 \leq 2.4547\alpha_R$ and $\alpha_2 > 1.5471\alpha_R$. Then only $M1$ would be interested in being the category captain. In this case, the retailer appoints $M1$ as the category captain as long as retailer’s profits could improve by doing so: $\Pi^{E:2N1S:C}_R (\alpha_C = \alpha_1) \geq \Pi^{E:2N1S:B}_R$ (or equivalently, $\alpha_1 \leq 0.3295\alpha_R$). Similarly, if $\alpha_1 > 2.4547\alpha_R$ and $\alpha_2 \leq 1.5471\alpha_R$, only $M2$ would want to be the category captain and the retailer appoints $M2$ as the category captain if $\Pi^{E:2N1S:C}_R (\alpha_C = \alpha_2) \geq \Pi^{E:2N1S:B}_R$ (or equivalently, $\alpha_2 \leq 0.3295\alpha_R$). Finally, suppose both $\alpha_1 \leq 2.4547\alpha_R$ and $\alpha_2 \leq 1.5471\alpha_R$ hold. In this case, both manufacturers are willing to be the category captain. So the retailer is motivated to appoint as category captain the manufacturer that provides the retailer more profits. Therefore, to be appointed as the category captain, each manufacturer is willing to make a side payment $\delta_k$ to the retailer.\(^3\) In principle, $\delta_k$ could be as high as the manufacturer’s surplus from being the category captain, implying $\delta_k \leq \Delta_k (k = 1, 2)$ where

$$\Delta_k \equiv \Pi^{E:2N1S:C}_{CC} (\alpha_C = \alpha_k) - \Pi^{E:2N1S:B}_{Mk}, (k = 1, 2).$$

(12)

Given these side payments from the manufacturers, the retailer chooses $M1$ over $M2$ in equilibrium, if and only if

$$\Pi^{E:2N1S:C}_R (\alpha_C = \alpha_1) + \Delta_1 \geq \Pi^{E:2N1S:C}_R (\alpha_C = \alpha_2) + \Delta_2,$$

(13)

\(^3\)This is consistent with the practice where some retailers demand a cash payment from manufacturers for the opportunity to serve as the category captain (Merrefield 1996; see also Subramanian et al. 2010).
which is equivalent to \( \alpha_2 \geq \frac{\alpha_1 \alpha_R}{\alpha_R + 0.0523 \alpha_1} \). When this inequality holds, the minimum side payment that \( M_1 \) can make to be chosen as the category captain is the amount that makes the retailer earn at least as much as \( \Pi_R^{E:2N1S:C}(\alpha_C = \alpha_2) + \Delta_2 \). This is because \( M_2 \) will not be willing to make a side payment greater than \( \Delta_2 \). Hence, the equilibrium side payment that \( M_1 \) makes to the retailer is given by:

\[
\delta_1^* = \Pi_R^{E:2N1S:C}(\alpha_C = \alpha_2) + \Delta_2 - \Pi_R^{E:2N1S:C}(\alpha_C = \alpha_1).
\]

(14)

After taking into account the side payment, the retailer adopts category captaincy if and only if its profits are higher than the benchmark profits (earnings in the absence of category captaincy), implying \( \Pi_R^{E:2N1S:C}(\alpha_C = \alpha_1) + \delta_1^* \geq \Pi_R^{E:2N1S:B} \) (or equivalently, \( \alpha_2 \leq 0.3980 \alpha_R \)). However, if (13) does not hold, the retailer could choose \( M_2 \) as the category captain, who would offer the side payment \( \delta_2^* \) to the retailer such that the retailer earns as much as \( \Pi_R^{E:2N1S:C}(\alpha_C = \alpha_1) + \Delta_1 \). That is,

\[
\delta_2^* = \Pi_R^{E:2N1S:C}(\alpha_C = \alpha_1) + \Delta_1 - \Pi_R^{E:2N1S:C}(\alpha_C = \alpha_2).
\]

(15)

Hence, the retailer adopts category captaincy if and only if \( \Pi_R^{E:2N1S:C}(\alpha_C = \alpha_2) + \delta_2^* \geq \Pi_R^{E:2N1S:B} \) (or equivalently, \( \alpha_1 \leq 0.4065 \alpha_R \)).

Figure 3 illustrates the conditions under which category captaincy will be observed and who will be the category captain. It is easy to see that category captaincy will be observed in equilibrium if and only if (1) \( \alpha_1 \leq 0.3295 \alpha_R \) and \( \alpha_2 > 1.5471 \alpha_R \), (2) \( \alpha_1 > 2.4547 \alpha_R \) and \( \alpha_2 \leq 0.3295 \alpha_R \), or (3) \( \alpha_1 \leq 0.4065 \alpha_R \) and \( \alpha_2 \leq 0.3980 \alpha_R \). Furthermore, \( M_1 \) is appointed as the category captain if \( \alpha_2 \geq \frac{\alpha_1 \alpha_R}{\alpha_R + 0.0523 \alpha_1} \); otherwise, \( M_2 \) is chosen as the category captain. The side payment that the category captain makes to the retailer is positive only when both \( \alpha_1 \leq 0.4065 \alpha_R \) and \( \alpha_2 \leq 0.3980 \alpha_R \) hold. Based on the equilibrium derived thus far, we next examine the implications of category captaincy for firms’ profits as well as consumer surplus.

4.2 Welfare Implications of Category Captaincy

At the outset, it is useful to note that the welfare implications of category captaincy do not depend on which manufacturer is chosen to be the category captain or the potential for providing a side payment. Thus, across all types of equilibrium, we have the following finding.
Proposition 1. (a) In an established product category, category captaincy improves the profits of all firms, including the competing manufacturer. (b) Consumer welfare, however, could be hurt by category captaincy.

Because the category captain oversees the entire category, it takes the most profitable quality position and leaves relatively disadvantageous positions for the competing manufacturer and the retailer. Yet, the first part of the proposition shows that, in equilibrium, all firms will be better off with category captaincy. To see this, one needs to carefully weigh the benefit of the market expansion induced by the category captain (compared to the market expansion that the retailer can achieve on its own accord) against the cost of the disadvantageous quality positions that the retailer and the competing manufacturer need to take in the presence of the category captain. To appreciate the strength of category captain’s desire to invest in market expansion, note that in the presence of the store brand, the retailer typically earns more profits than any manufacturer in the market (Amaldoss and Shin 2015). This implies that the marginal benefit of expanding the market is higher for the retailer than that
for the category captain. Thus, if the category captain is only as cost efficient as the retailer in expanding the market, the category captain will exert much less effort than the retailer. However, if the category captain is sufficiently more cost efficient than the retailer, the category captain may exert more effort than the retailer. Therefore, the retailer adopts category captaincy only if the category captain is so efficient that the induced market expansion as well as the retailer’s cost savings more than compensates for the retailer’s disadvantageous quality position.\footnote{Our analyses in Section 4.1.3 show that the retailer adopts category captaincy when }\alpha_C > 0.3038\alpha_R\text{, category captaincy decreases the market size (i.e., }\sqrt{e^C} < \sqrt{e^B}\text{) and yet }

Next, to understand why the competing manufacturer also benefits from category captaincy, notice that the retailer’s profits from carrying the store brand are limited because of the category captain’s quality leadership. The competing manufacturer’s profits are also reduced but the reduction is of a much smaller scale compared to that suffered by the retailer. This is because the retailer earns profits from selling both the store brand and the competing manufacturer’s national brand while the competing manufacturer’s profits come only from its own product. Therefore, for any given size of the market, the category captain’s quality leadership hurts the retailer more than the competing manufacturer; hence to breakeven under category captaincy, the retailer would need a far higher market expansion than the competing manufacturer. This implies that when the retailer finds it profitable to adopt category captaincy, the competing manufacturer will also be better off.\footnote{The retailer’s incentive to adopt category captaincy is also affected by the cost saving. However, this is of a negligible size compared to the profit change due to the category captain’s quality leadership and thus omitted from the discussion. Our formal analysis in the appendix captures all of these factors.}

Since category captaincy is geared to increase sales, one may think that it would help to serve more consumers and improve consumer welfare. The second part of the proposition, however, suggests that consumers are not necessarily better off with category captaincy. The rationale for this finding is twofold. First, the category captaincy helps the retailer to enjoy the benefit of market expansion without incurring any market development cost. Thus, the retailer may adopt category captaincy even when it does not increase the overall market size due to the inefficiency associated with category captaincy. In particular, when }\alpha_C > 0.3038\alpha_R\text{, category captaincy decreases the market size (i.e., }\sqrt{e^C} < \sqrt{e^B}\text{) and yet }
the retailer adopts category captaincy if $\alpha_C$ is not large enough (that is, $\alpha_1 \leq 0.4065\alpha_R$ and $\alpha_2 \leq 0.3980\alpha_R$ as discussed in Section 4.1.3). In this case, since fewer consumers are served, consumer welfare is reduced.\(^6\) Second, even in instances where category captaincy increases the market size, it may decrease the average quality of available products and the market coverage. To see this, note that under category captaincy, the retailer sets the quality and price of the store brand so high that the store brand generates negligible sales. By doing so, the retailer lets the category captain’s profits increase without competitive pressure from the store brand, while expecting that the category captain will exert maximum effort for market expansion. Now because of the negligible sales of the store brand, which is the highest-quality product, the average quality of the products purchased by consumers is relatively low. Moreover, two national brands could serve fewer consumers. Thus, category captaincy could hurt consumers even when the category captain expands the market further than the retailer.\(^7\)

Proposition 1 pertains to a situation where the retailer sells a store brand in addition to the national brands in its outlet. Since the store brand invests the retailer with more power in the channel, one may wonder to what extent the above results are tempered by the presence of the store brand. To probe this issue, we shift attention to category captaincy in the absence of the store brand, and examine its welfare implications. In solving this game, we follow the same steps as in the above analysis with only one difference – now there are only national brands in the market and hence the retailer does not have to decide on store brand price and quality. We obtain the following equilibrium profits and consumer surplus in the absence of the store brand. In Subgame $C$, we have:

\[
\Pi^{E:2N:C}_{CC} = \frac{0.00003846b^6}{\alpha_C(b-a)^2}, \quad \Pi^{E:2N:C}_{CM} = \frac{0.0000324b^6}{\alpha_C(b-a)^2}, \quad \Pi^{E:2N:C}_R = \frac{0.0011338b^6}{\alpha_C(b-a)^2}, \quad CS^{E:2N:C} = \frac{0.00005669b^6}{\alpha_C(b-a)^2}.
\]

\(^6\)Note that even when the market size decreases with category captaincy, the competing manufacturer is still better off. This is because the positioning disadvantage of the store brand benefits the competing manufacturer and this benefit outweighs the competing manufacturer’s own positioning disadvantage.

\(^7\)An interesting implication of this result is that even if the retailer does not actually introduce a store brand, the mere threat of the store brand could induce manufacturers to set their price and quality as if they were responding to the price and quality of the store brand.
whereas in Subgame $B$ we obtain:

$$\Pi_{E:2N:B}^{M1} = \frac{0.00008510b^6}{\alpha R (b-a)^2}, \quad \Pi_{E:2N:B}^{M2} = \frac{0.0007251b^6}{\alpha R (b-a)^2}$$

$$\Pi_{E:2N:B}^{R} = \frac{0.00017812b^6}{\alpha R (b-a)^2}, \quad CS^{E:2N:B} = \frac{0.00017812b^6}{\alpha R (b-a)^2}$$  \hspace{1cm} (17)

Using the above profits, it is straightforward to derive the conditions in which category captaincy will be observed and identify who will emerge as the category captain (see the proof of Proposition 2 in the appendix for the details). Figure 4 illustrates this equilibrium. On comparing the conditions for category captaincy in markets with and without the store brand, we have the following finding.

**Proposition 2.** *A retailer who uses a category captain in the absence of a store brand may not be motivated to do so in the presence of a store brand.*
ahead of other firms. This first-mover advantage benefits the category captain but hurts the profitability of the store brand, which directly competes with the national brands. Because the store brand accounts for a significant part of the retailer’s profits (Amaldoss and Shin 2015, Chintagunta et al. 2002, Pauwels and Srinivasan 2004, Meza and Sudhir 2010), the profit loss for the retailer is also considerable when it concedes the first-mover advantage to the category captain. Second, the cost of market expansion is no longer borne by the retailer but is incurred by the category captain. This market expansion cost, however, is negligible compared to the profit lost by the retailer due to the category captain’s first-mover advantage. Thus, the net disutility of appointing a category captain is substantially greater for the retailer than the potential disutility experienced by the category captain because of the market development costs. Therefore, the threshold market expansion that can justify category captaincy is higher for the retailer than for the category captain. Furthermore, category captaincy will be adopted if and only if both the retailer and the category captain can be better off with category captaincy. Thus, in the presence of the store brand, it is the retailer’s profitability that determines whether or not category captaincy is adopted.

In the absence of the store brand, on the other hand, the category captain’s profitability becomes the binding condition for adopting category captaincy. To understand why, note that in this case the retailer is not affected as much by the category captain’s first-mover advantage because the retailer has no product directly competing with the category captain’s national brand. Moreover, the category captain incurs all the cost of expanding the market. Thus, the category captain requires a higher threshold of market expansion to breakeven under category captaincy (than the retailer does).

It is useful to note that the retailer’s loss due to the category captain’s quality leadership in the presence of the store brand is greater than the market expansion cost incurred by the category captain in the absence of the store brand. Thus, the profitability condition for adopting the category captaincy is more stringent in the presence than in the absence of the store brand. In general, store brands confer on the retailer a huge advantage in its relations with manufacturers (Amaldoss and Shin 2015). Thus, it may seem that by adopting category captaincy, the retailer is relegating the category management decision to the category captain, thus voluntarily conceding some of its power to the category captain.
However, the above proposition suggests that the retailer can actually leverage the power emanating from the store brand to demand a higher level of cost efficiency from the category captain, thus profiting from its power.

We know from Proposition 1 that the competing manufacturer is always better off under category captaincy in the presence of the store brand. This observation may lead one to ask the counterfactual question: what might be the effect of category captaincy in the absence of the store brand? The following proposition answers this question.

**Proposition 3.** *In the absence of a store brand, category captaincy could hurt the competing manufacturer’s profits.*

This proposition brings to fore how the presence (or absence) of the store brand can moderate the effect of category captaincy on the competing manufacturer. This finding is a direct consequence of the less stringent condition for category captaincy in the absence of the store brand. Since both the retailer and the category captain can be better off with a less efficient category captain, the market may not expand enough to compensate for the competing manufacturer’s loss resulting from the category captain’s first-mover advantage in adjusting its quality. This result, when contrasted with Proposition 1, implies that the store brand indirectly helps the competing manufacturer by making the category captain conform to a more stringent threshold on cost efficiency. Thus, under category captaincy, the store brand could be a blessing for the competing manufacturer.

### 4.3 Product Line Decisions

A typical retailer manages a multitude of product categories with numerous products in each category. The accretion of products over time is often a cause for inefficiency in many retail outlets (Ton 2012). Thus, the retailer could potentially delegate product line decisions to the category captain. However, it is not immediately clear how such a delegation would affect the profitability of firms and consumer welfare. To investigate this issue, we extend the model to allow the category captain to make product line recommendation to the retailer and let the retailer decide whether or not to adopt the recommendation. In particular, we consider the following game, given the retailer’s category captaincy decision. First, the category captain
evaluates all the potential combinations of products the retailer could carry (in addition to its national brand) and makes a product line recommendation to the retailer. Second, the retailer decides whether or not to implement the recommendation. Then, the quality-setting game, the effort decision, and the pricing game are played as discussed in Section 3. The potential product configurations in this setting are only one national brand [1N], one national brand and one store brand [1N1S], two national brands [2N], and two national brands and one store brand [2N1S]. Upon analyzing each subgame associated with each product line configuration, we obtain the following equilibrium profits and consumer surplus. When the product line consists of only one national brand (which comes from the category captain) [1N], we have:

$$\Pi^E_{1N:C} = \frac{0.00008573b^6}{a_C(b-a)^2}, \quad \Pi^E_{1N:C} = \frac{0.00008573b^6}{a_C(b-a)^2}, \quad CS^E_{1N:C} = \frac{0.00004287b^6}{a_C(b-a)}$$  

whereas when the product line includes one national brand (from the category captain) and one store brand [1N1S], we have:

$$\Pi^E_{1N1S:C} = \frac{0.00007785b^6}{a_C(b-a)^2}, \quad \Pi^E_{1N1S:C} = \frac{0.00012028b^6}{a_C(b-a)^2}, \quad CS^E_{1N1S:C} = \frac{0.00006014b^6}{a_C(b-a)}.$$  

The profits and consumer surplus corresponding to 2N and 2N1S product configurations can be seen in (9) and (16), respectively. We also omit the derivations of the equilibrium under 1N and 1N1S product configurations because they are similar to that for 2N1S (see Section 4.1). Upon analyzing the product line decision, we have the following result.

**Proposition 4.** (a) The category captain recommends that the competing national brand be dropped. (b) The retailer can increase total channel profits by implementing the product line recommendation of the category captain. (c) Furthermore, consumer welfare improves despite the reduction in the retailer’s product line length.

The category captain makes its recommendation on the product line after assessing the profitability of all possible combinations of products. First, the category captain may want to suggest eliminating both the store brand and the competing national brand, since it could maximize its own profits. However, if both products are removed, the retailer’s profits will be severely hurt; hence the retailer would not implement such a recommendation from the category captain.
Now focus on the case where the category captain considers reducing just one product from the retailer’s full product line – that is, the product line could be trimmed to two national brands (2N), or to one national brand and one store brand (1N1S). In this case, the category captain would recommend the retailer to carry 1N1S rather than 2N, although the store brand generally hurts the category captain more than the competing national brand. This is because in the presence of a store brand, the captain can better align its incentives with that of the retailer and thus earn more profits, whereas such an alignment of incentives is harder to achieve with the competing national brand manufacturer. To see this, note that when adjusting the quality of its store brand, the retailer anticipates the category captain’s likely market expansion effort. Furthermore, the retailer recognizes that the category captain’s effort to develop the market will be proportional to the category captain’s marginal benefit and thus to the category captain’s profits. Hence the retailer strives to increase the category captain’s profits in addition to its own profits. Moreover, in an attempt to coordinate the two profits while responding to the quality of the category captain’s national brand, the retailer may even set the quality of the store brand such that the store brand has negligible sales. Appreciating this, the category captain appropriately sets its quality so that the retailer remains motivated to coordinate channel profits. Such quality coordination, however, is not possible with the competing national brand manufacturer. This is because the competing manufacturer earns profits from its national brand alone, whereas the retailer could earn profits not only from the store brand but also from national brands. Thus, the retailer could afford to sacrifice the sales of the store brand to facilitate channel coordination. Such quality coordination improves the profits of not only the category captain but also the retailer under the 1N1S product configuration (more than under the 2N configuration). Therefore, in equilibrium, the category captain recommends that the retailer carry 1N1S. The retailer implements this recommendation because it earns more profits under the 1N1S than 2N1S configuration. Interestingly, the channel profits also increase in this case despite the removal of a product and reduced market coverage. We observe such profit increases because it is easier to achieve quality coordination with two products than three products.

Next, one might expect the removal of a product from the retailer’s product line to harm
consumer welfare because it reduces competition, raises prices, and fewer consumers buy the trimmed product line. Counter to this view, the proposition shows that consumer welfare can improve despite fewer products. We observe this result because the reduced product line offers the category captain an additional incentive to better coordinate the quality choices and further expand the market. As a consequence, the retailer serves more consumers and the total consumer welfare increases despite a reduction in each individual consumer’s surplus. Thus, the category captain’s recommendation benefits the retailer and consumers but hurts the competing manufacturer, yet the total social welfare increases.

5 Category Captaincy in a New Category

In the preceding section, we examined the effect of category captaincy in an established product category. In this section, we explore how category captaincy in a new product category could vary from that in an established product category. When a category is new to a retail store, there is a need to educate consumers about the category and make them interested in the products. The retailer could make the necessary long-term investment to develop the category. Alternatively, the retailer could appoint a category captain and let the category captain make the required long-term investment. In an attempt to capture this scenario, we follow the decision sequence presented in Figure 2 and analyze the corresponding equilibrium.

5.1 Equilibrium Analysis

Since the derivation of the equilibrium corresponding to the two subgames is similar to that presented in Section 4.1, here we simply report the profits and consumer surplus. In Subgame $C$, we find that:

\[
\Pi_{CC}^{N:2N1S:C} = \frac{0.0000000023b^6}{aC(b-a)^2}, \quad \Pi_{CM}^{N:2N1S:C} = \frac{0.0000000040b^6}{aC(b-a)^2},
\]

\[
\Pi_{R}^{N:2N1S:C} = \frac{0.0000002149b^6}{aC(b-a)^2}, \quad CS_{N:2N1S:C} = \frac{0.0000001074b^6}{aC(b-a)^2},
\]
while in Subgame $B$ we have:

$$
\Pi_{M1}^{N:2N1S:B} = \frac{0.00001354 b^6}{a_C(b-a)^2}, \quad \Pi_{M2}^{N:2N1S:B} = \frac{0.00002149 b^6}{a_C(b-a)^2}, \quad \Pi_{R}^{N:2N1S:B} = \frac{0.00036021 b^6}{a_C(b-a)^2}, \quad CS^{N:2N1S:B} = \frac{0.00036021 b^6}{a_C(b-a)^2},
$$

where $N$ in the superscript denotes a new category.

The above profits show that $M1$ would be interested in being the category captain if and only if $\alpha_1 \leq 0.0237 \alpha_R$ (which is equivalent to $\Pi_{CC}^{N:2N1S:C} \geq \Pi_{M1}^{N:2N1S:B}$), whereas $M2$ would be interested in category captaincy if and only if $\alpha_2 \leq 0.0149 \alpha_R$ (which is equivalent to $\Pi_{CC}^{N:2N1S:C} \geq \Pi_{M2}^{N:2N1S:B}$). Furthermore, the retailer is better off with category captaincy if and only if $\Pi_{R}^{N:2N1S:C} \geq \Pi_{R}^{N:2N1S:B}$ (or equivalently, $\alpha_C \leq 0.0583 \alpha_R$ where $\alpha_C$ is either $\alpha_1$ or $\alpha_2$). Therefore, category captaincy is adopted in equilibrium if $\alpha_1 \leq 0.0237 \alpha_R$ or $\alpha_2 \leq 0.0149 \alpha_R$. Moreover, the retailer appoints $M1$ as category captain if $\alpha_2 \geq \min\{0.0149 \alpha_R, \frac{\alpha_1 \alpha_R}{\alpha_R + 0.3643 \alpha_1}\}$ but $M2$ otherwise (see the proof of Proposition 5 in the appendix for the derivation of this condition). Figure 5 illustrates this equilibrium.
To better appreciate the effect of a store brand, we contrast the above results with those when the retailer does not offer a store brand. The equilibrium results when the store brand is not offered are as follows. In Subgame $C$, where the retailer appoints a category captain, we obtain:

$$\Pi_{NC}^{N:2N:C} = \frac{0.00002224\alpha^6}{\alpha_C(b-a)^2}, \quad \Pi_{NM}^{N:2N:C} = \frac{0.00001959\alpha^6}{\alpha_C(b-a)^2}, \quad (22)$$

and in Subgame $B$, where the retailer does not appoint a category captain, we have:

$$\Pi_{R1}^{N:2N:B} = \frac{0.00009639\alpha^6}{\alpha_C(b-a)^2}, \quad \Pi_{R2}^{N:2N:B} = \frac{0.00007135\alpha^6}{\alpha_C(b-a)^2}, \quad (23)$$

Using these profits, we find that the category captaincy is adopted if $\alpha_1 \leq 0.2308\alpha_R$ or $\alpha_2 \leq 0.3116\alpha_R$. Moreover, the category captaincy task is assigned to $M1$ if $\alpha_1 \leq \min\{0.2308\alpha_R, \frac{\alpha_2\alpha_R}{\alpha_R+0.1933\alpha_2}\}$ but to $M2$ otherwise (see the proof of Proposition 5 for details).

Figure 6 illustrates this equilibrium. With the aid of this equilibrium, we examine the welfare implications of category captaincy in a new category.

### 5.2 Welfare Implications of Category Captaincy

According to Proposition 1, category captaincy in an established product category improves the profits of the competing manufacturer when the retailer offers a store brand though it could reduce consumer welfare. We obtain very different results in a new product category.

**Proposition 5.** In a new product category, (a) category captaincy may hurt the competing manufacturer’s profits even in the presence of the store brand, but (b) category captaincy always improves consumer welfare.

To appreciate why the results in Proposition 5 are different from those in Proposition 1, note that in an established product category, after the retailer appoints a category captain, the category captain chooses the quality of its product ahead of the competing manufacturer and the retailer. After all the firms have set the qualities, the category captain exerts effort to expand the market for the category. Thus, in an established product category,
firms strategically choose the qualities so that the category captain is sufficiently motivated to expand the category sales. This amplifies the first-mover advantage of the category captain in setting its quality, especially in the presence of the store brand. Consequently, the retailer’s profitability, rather than the category captain’s profitability, determines whether or not category captaincy will be adopted. In particular, the retailer appoints a category captain only if the market expansion induced by the category captain is large enough to offset the substantial positioning disadvantage suffered by the retailer. Moreover, compared to the retailer, the competing manufacturer is hurt less from positioning disadvantage. Thus, when the retailer finds it profitable to adopt category captaincy, it is also profitable for the competing manufacturer.

On the contrary, in a new category, firms make their quality choices only after the category captain has committed resources to developing the category. Thus, the quality choices of the firms do not affect the market expansion effort of the category captain, and each firm maximizes its own profits while setting its quality, without striving to motivate the category

Figure 6: Category Captaincy Conditions without Store Brand (New Category)
captain and without accentuating the first-mover advantage of the category captain. Since the resulting profits of the category captain are lower, the category captain invests less in market expansion (compared to its investment in an established category). In this case, since the category captain’s first-mover advantage is relatively small and in addition the market development costs are borne by the category captain, the profitability of the category captain determines whether or not category captaincy is adopted. The competing manufacturer benefits from market expansion but is hurt by the positioning disadvantage, whereas the category captain enjoys both the market expansion benefit and the positioning advantage; hence, even after accounting for the category captain’s market expansion cost, the competing manufacturer may not benefit more than the category captain when category captaincy is adopted. Therefore, the competing manufacturer could be hurt even when the category captain finds it profitable to be a category captain. This result holds irrespective of the presence of the store brand, and it is driven by the fact that the category captain has a lower advantage in a new product category (compared to that in an established category).

Recall that according to Proposition 1, consumers could be hurt in an established category. Yet the second part of the above proposition shows that consumers are always better off with category captaincy in a new product category. To follow the rationale for this finding, note that even though the market for a new category is smaller than that for an established category, the category captain still exerts enough effort to expand the market so that the resulting market size is larger compared to its size in the absence of category captaincy. In particular, the category captain recognizes that its positioning advantage is relatively small and thus, invests to grow the market to a size that would help it recoup at least the market expansion cost. Hence, whenever category captaincy is implemented, the market grows enough to improve consumer welfare.

5.3 Product Line Decisions

In an established product category, the category captain recommends to the retailer that the competing national brand be removed but not the store brand. This is because the store brand helps the retailer to better coordinate the quality of its store brand with the category captain’s national brand and induces the category captain to expend more efforts to enlarge
the market. In a new product category, however, we obtain a different result.

**Proposition 6.** (a) The category captain will recommend eliminating the store brand in addition to the competing national brand. (b) Despite the removal of these two products, consumers are strictly better off with the reduced product line. (c) Even without the category captain’s recommendation, the retailer will eliminate the store brand on its own accord but retain both the national brands.

It is not surprising to see the category captain recommending the removal of the competing national brand. However, it is surprising to observe the category captain recommending the store brand be trimmed from the retailer’s product line and the retailer implementing it in equilibrium. Why would the retailer follow such a recommendation? To understand this issue, notice that the retailer’s profits crucially depend on the market size which, in turn, depends on the category captain’s efforts to expand the market. Recognizing that the category captain’s motivation to exert effort is driven by the marginal benefit accruing from category captaincy, the retailer prefers not to hurt the category captain’s profits. The retailer further recognizes that the store brand severely hurts the profitability of manufacturers, including the category captain. By removing the store brand, the retailer could help increase the profits of the category captain. The prospect of increased profits, in turn, encourages the category captain to invest more effort in developing the new category, and the retailer stands to benefit from the larger market. Therefore, the retailer is better off with implementing the category captain’s recommendation (rather than maintaining the status quo). In this case, although market coverage is lower because of fewer products, consumer welfare improves because of the substantial increase in market size. In other words, the increase in the market size more than compensates for the decrease in market coverage.

Finally, even when the retailer makes the product line decision without any input from the category captain, the retailer is willing to eliminate its own store brand from the product line. This is for the same reason as above. Interestingly, the retailer still keeps the com-

---

8One may wonder whether the same logic would apply to an established product category. In an established category, however, the retailer can induce the category captain to exert more effort even without eliminating the store brand by properly setting the quality of the store brand. Thus, the retailer will not remove the store brand from its product line even if the category captain were to make such a recommendation.
peting manufacturer’s national brand in its assortment in addition to the category captain’s national brand. This is because by adding the competing national brand, the retailer not only increases market coverage but also deprives the category captain of monopoly power and obtains better terms in the vertical relationship with the category captain. Although the category captain’s market expansion effort is lower in this case, it is still profitable for the retailer to keep both national brands.

6 Conclusion

The goal of the paper is to examine how the presence of a store brand moderates the effect of category captaincy on the retailer, the competing manufacturer, and consumers. Furthermore, we aim to study how category captaincy in a mature product category is different from that in a new product category. Toward this end, we propose a model of category captaincy where the category captain helps to expand the demand for the category while the national brands and the store brand compete on both price and quality to gain sales. Our theoretical analysis addresses several questions of managerial significance.

- Does the store brand make it less attractive for the retailer to adopt category captaincy?
  In the absence of category captaincy, the retailer leverages the price and quality of the store brand to compete with the national brands and take a larger share of channel profits. If the retailer adopts category captaincy, the captain would take the most profitable quality position, leaving a disadvantageous position for the store brand. This may lead to the belief that the presence of the store brand may discourage the retailer from adopting category captaincy. On the contrary, by virtue of its store brand, the retailer can earn more profits under category captaincy (see Proposition 1). The category captain recognizes that the retailer is giving up a more profitable quality position when the retailer is selecting the captain in the presence of the store brand. This permits the retailer to demand that the captain expand the category far more than what the retailer can accomplish on its own accord (see Proposition 2). The resulting market expansion helps to increase sales; thus, the retailer comes to earn more profits under category captaincy in the presence of the store brand.
• *Is the competing manufacturer hurt by category captaincy? If so, is the negative effect of category captaincy on the competing manufacturer accentuated by the store brand?*

Because the category captain takes the most profitable quality position, the competing manufacturer’s profits may be hurt in the absence of the store brand (see Proposition 3). This, however, is not true in the presence of the store brand (see Proposition 1). Since the retailer earns profits from both the store brand and the competing manufacturer’s brand, the category captain’s quality leadership hurts the retailer far more than the competing manufacturer. Hence if the market expansion induced by the category captain makes it profitable for the retailer to adopt category captaincy, the competing manufacturer will also find it profitable. Thus, the store brand alleviates the negative effect of category captaincy on the competing manufacturer.

• *Can the category captain’s product line recommendation to the retailer help address the threat posed by the store brand?*

Store brands are a major challenge for national brands. Even with the added advantage of being the category captain, the national brand manufacturer cannot eliminate the store brand in a mature product category. However, by eliminating the competing national brand, the category captain can induce better quality coordination with store brand and thus, improve the profitability of its own as well as the total channel (see Proposition 4). In a new product category, on the other hand, the captain recommends that the retailer drop not only the competing national brand but also the store brand. Yet, the total channel profits and the retailer’s profits improve (see Proposition 6). Interestingly, in this context, the retailer may be motivated to trim the store brand on its own accord in an attempt to make it even more worthwhile for the category captain to make long-term investments toward increasing category sales.

• *Can category captaincy improve consumer welfare?*

The general fear is that category captaincy will hurt consumers. Our analysis, however, identifies conditions where category captaincy can improve consumer welfare. In a new product category, the category captain makes substantial investments in developing the
category. The resulting growth in the market always improves consumer welfare (see Proposition 5). Even in a mature product category, category captaincy can increase consumer welfare if the retailer implements the product line recommendation of the category captain (see Proposition 4).

**Limitations and Directions for further research.** Our analysis makes several useful predictions about category captaincy. It will be useful to corroborate these findings using market data (e.g., Nijs et al. 2015), survey data (e.g., Basuromy et al. 2001, Gooner et al. 2011) and experimental data (Amaldoss and Shin 2011). In developing our model, we focus attention on three decision variables, namely category development effort, pricing and quality choice. In practice, the category captain can also help coordinate the promotional activities of all the products in the categories, and it would be worthwhile to explore the strategic implications of such a collaboration among competitors. Moreover, the category captain, in conjunction with the retailer, can help design product bundles, such as meal deals, that can exploit the synergies across product categories. Thus, it would be useful to investigate a model of category captaincy where the captain can help advise the retailer on cross-category synergies as well.
References


Appendix

In the appendix, we first present the equilibrium solutions for the analysis pertaining to category
captaincy in an established product and that pertaining to a new product category (Section A1),
and then use the equilibrium solutions to prove the propositions (Section A2). To help follow the
proof, we provide the summary of notation in Table A1.

<table>
<thead>
<tr>
<th>Notation</th>
<th>Explanation</th>
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<tbody>
<tr>
<td>$\theta$</td>
<td>Consumers’ sensitivity to quality</td>
</tr>
<tr>
<td>$a$</td>
<td>Lowest valuation of quality</td>
</tr>
<tr>
<td>$b$</td>
<td>Highest valuation of quality</td>
</tr>
<tr>
<td>$c_i$</td>
<td>Marginal cost of producing Product $i$</td>
</tr>
<tr>
<td>$w_{Nk}$</td>
<td>Wholesale price of national brand $k$</td>
</tr>
<tr>
<td>$p_i$</td>
<td>Retail price of Product $i$</td>
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<tr>
<td>$z_i$</td>
<td>Demand of Product $i$</td>
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<tr>
<td>$e$</td>
<td>Level of market expansion effort exerted by either the category captain or the retailer</td>
</tr>
<tr>
<td>$\alpha_C, \alpha_R$</td>
<td>Cost efficiency parameters (of the category captain and the retailer, respectively)</td>
</tr>
<tr>
<td>$I_k, I_R$</td>
<td>Indicators that Manufacturer $k$ / the retailer assumes the role of category captain</td>
</tr>
<tr>
<td>$\bar{\theta}_i$</td>
<td>Minimum valuation of quality of consumers purchasing Product $i$</td>
</tr>
<tr>
<td>$\bar{\theta}_i$</td>
<td>Maximum valuation of quality of consumers purchasing Product $i$</td>
</tr>
<tr>
<td>$\Pi_{ME}, \Pi_R$</td>
<td>Profits of Manufacturer $Mk$ and the retailer, respectively</td>
</tr>
<tr>
<td>$CS$</td>
<td>Consumer surplus</td>
</tr>
<tr>
<td>$\delta_k$</td>
<td>Side payment from Manufacturer $k$ to the retailer</td>
</tr>
<tr>
<td>$\Delta_k$</td>
<td>Manufacturer $k$’s surplus from being the category captain</td>
</tr>
</tbody>
</table>

A1  Equilibrium Solutions

A1.1 Established Product Category

1. 2N1S, Subgame $B$:

\[
\begin{align*}
q_{N1}^{2N1S:B} &= 0.4388b, 
q_{N2}^{2N1S:B} = 0.1716b, 
q_S^{2N1S:B} = 0.3310b, \\
w_{N1}^{2N1S:B} &= 0.2050b^2, 
w_{N2}^{2N1S:B} = 0.0431b^2, \\
p_{N1}^{2N1S:B} &= 0.3219b^2, 
p_{N2}^{2N1S:B} = 0.1074b^2, 
p_S^{2N1S:B} = 0.2203b^2, \\
z_{N1}^{2N1S:B} &= 0.00100181b^4, 
z_{N2}^{2N1S:B} = 0.00157073b^4, 
z_S^{2N1S:B} = 0.00444219b^4, \\
e^{Q:2N1S:C} &= 0.00036021b^6, 
\Pi_{M1}^{2N1S:B} = 0.0001354b^6, 
\Pi_{M2}^{2N1S:B} = 0.0002149b^6, 
\Pi_R^{2N1S:B} = 0.00036021b^6, 
CS^{2N1S:B} = 0.00036021b^6.
\end{align*}
\]
2. 2N1S, Subgame C:

\[
q_{CC}^{Q:2N1SC} = 0.2847b, \quad q_{CM}^{Q:2N1SC} = 0.1026b, \quad q_S^{Q:2N1SC} = 0.8199b, \\
w_{CC}^{Q:2N1SC} = 0.1370b^2, \quad w_{CM}^{Q:2N1SC} = 0.0300b^2, \\
p_{CC}^{Q:2N1SC} = 0.2109b^2, \quad p_{CM}^{Q:2N1SC} = 0.0663b^2, \quad p_S^{Q:2N1SC} = 0.7461b^2, \\
z_{CC}^{Q:2N1SC} = \frac{0.00118772b^6}{a_C(b-a)^2}, \quad z_{CM}^{Q:2N1SC} = \frac{0.00085347b^4}{a_C(b-a)^2}, \quad z_S^{Q:2N1SC} = 0, \\
e^{Q:2N1SC} = \frac{0.00003324b^6}{a_C(b-a)^2}, \quad \Pi_{CC}^{Q:2N1SC} = \frac{0.00003324b^6}{a_C(b-a)^2}, \quad \Pi_{CM}^{Q:2N1SC} = \frac{0.00001658b^6}{a_C(b-a)^2}, \\
\Pi_R^{Q:2N1SC} = \frac{0.00011869b^6}{a_C(b-a)^2}, \quad CS^{Q:2N1SC} = \frac{0.00005353b^6}{a_C(b-a)}.
\]

3. 2N, Subgame B:

\[
q_{N1}^{Q:2N:B} = 0.3934b, \quad q_{N2}^{Q:2N:B} = 0.2388b, \quad w_{N1}^{Q:2N:B} = 0.1991b^2, \quad w_{N2}^{Q:2N:B} = 0.0889b^2, \\
p_{N1}^{Q:2N:B} = 0.2963b^2, \quad p_{N2}^{Q:2N:B} = 0.1630b^2, \quad \alpha_{N1} = \frac{0.00191656b^4}{a_R(b-a)^2}, \quad \alpha_{N2} = \frac{0.00227075b^4}{a_R(b-a)^2}, \\
e^{N:2N:C} = \frac{0.00017812b^6}{a_R(b-a)^2}, \quad \Pi_{M1}^{Q:2N:B} = \frac{0.00008510b^6}{a_R(b-a)^2}, \quad \Pi_{M2}^{Q:2N:B} = \frac{0.00007251b^6}{a_R(b-a)^2}, \\
\Pi_R^{Q:2N:B} = \frac{0.00017812b^6}{a_R(b-a)^2}, \quad CS^{Q:2N:B} = \frac{0.00017812b^6}{a_R(b-a)}.
\]

4. 2N, Subgame C:

\[
q_{CC}^{Q:2N:C} = 0.3086b, \quad q_{CM}^{Q:2N:C} = 0.1051b, \quad w_{CC}^{Q:2N:C} = 0.1663b^2, \quad w_{CM}^{Q:2N:C} = 0.0338b^2, \\
p_{CC}^{Q:2N:C} = 0.2374b^2, \quad p_{CM}^{Q:2N:C} = 0.0695b^2, \quad \alpha_{CC} = \frac{0.00108276b^4}{a_C(b-a)^2}, \quad \alpha_{CM} = \frac{0.00101978b^4}{a_C(b-a)^2}, \\
e^{Q:2N:C} = \frac{0.00003846b^6}{a_C(b-a)^2}, \quad \Pi_{CC}^{Q:2N:C} = \frac{0.00003846b^6}{a_C(b-a)^2}, \quad \Pi_{CM}^{Q:2N:C} = \frac{0.00002324b^6}{a_C(b-a)^2}, \\
\Pi_R^{Q:2N:C} = \frac{0.00011338b^6}{a_C(b-a)^2}, \quad CS^{Q:2N:C} = \frac{0.00005669b^6}{a_C(b-a)}.
\]

5. 1N1S:

\[
q_N^{Q:1N1SC} = 0.3054b, \quad q_S^{Q:1N1SC} = 0.8495b, \quad w_S^{Q:1N1SC} = 0.1764b^2, \\
p_N^{Q:1N1SC} = 0.2409b^2, \quad p_S^{Q:1N1SC} = 0.7856b^2, \quad \alpha_N^{Q:1N1SC} = \frac{0.00187935b^4}{a_C(b-a)^2}, \quad \alpha_S^{Q:1N1SC} = 0, \\
e^{Q:1N1SC} = \frac{0.00007785b^6}{a_C(b-a)^2}, \quad \Pi_{CC}^{Q:1N1SC} = \frac{0.00007785b^6}{a_C(b-a)^2}, \quad \Pi_{CM}^{Q:1N1SC} = \frac{0.00012082b^6}{a_C(b-a)^2}, \quad CS^{Q:1N1SC} = \frac{0.00006014b^6}{a_C(b-a)^2}.
\]

6. 1N:

\[
q_N^{Q:1N:C} = 0.333b, \quad w_N^{Q:1N:C} = 0.2222b^2, \quad p_N^{Q:1N:C} = 0.2778b^2, \quad \alpha_N^{Q:1N:C} = \frac{0.00154321b^4}{a_C(b-a)^2}, \\
e^{Q:1N:C} = \frac{0.00008573b^6}{a_C(b-a)^2}, \quad \Pi_{CC}^{Q:1N:C} = \frac{0.00008573b^6}{a_C(b-a)^2}, \quad \Pi_{CM}^{Q:1N:C} = \frac{0.00008573b^6}{a_C(b-a)^2}, \quad CS^{Q:1N:C} = \frac{0.00004287b^6}{a_C(b-a)}.
\]
A1.2 New Product Category

1. 2N1S, Subgame B:

\[ q_{N1}^{N:2N1S:B} = 0.4388b, q_{N2}^{N:2N1S:B} = 0.1717b, q_S^{N:2N1S:B} = 0.3310b, \]
\[ w_{N1}^{N:2N1S:B} = 0.2050b^2, w_{N2}^{N:2N1S:B} = 0.0432b^2, \]
\[ p_{N1}^{N:2N1S:B} = 0.3219b^2, p_{N2}^{N:2N1S:B} = 0.1074b^2, p_S^{N:2N1S:B} = 0.2203b^2, \]
\[ z_{N1}^{N:2N1S:B} = \frac{0.001091994b}{\alpha_R(b-a)^2}, z_{N2}^{N:2N1S:B} = \frac{0.001570754b}{\alpha_R(b-a)^2}, z_S^{N:2N1S:B} = \frac{0.04414146b}{\alpha_R(b-a)^2}, \]
\[ e^{N:2N1S:C} = \frac{0.000036021b^6}{\alpha_R(b-a)^2}, \]
\[ \Pi^{N:2N1S:B} = \frac{0.000036021b^6}{\alpha_R(b-a)^2}, CS^{N:2N1S:B} = \frac{0.000036021b^6}{\alpha_R(b-a)^2}, \]

2. 2N1S, Subgame C:

\[ q_{CC}^{N:2N1S:C} = 0.1718b, q_{CM}^{N:2N1S:C} = 0.4388b, q_S^{N:2N1S:C} = 0.3310b, \]
\[ w_{CC}^{N:2N1S:C} = 0.2050b^2, w_{CM}^{N:2N1S:C} = 0.0432b^2, \]
\[ p_{CC}^{N:2N1S:C} = 0.1075b^2, p_{CM}^{N:2N1S:C} = 0.3219b^2, p_S^{N:2N1S:C} = 0.2203b^2, \]
\[ z_{CC}^{N:2N1S:C} = \frac{0.001570754b}{\alpha_C(b-a)^2}, z_{CM}^{N:2N1S:C} = \frac{0.001570754b}{\alpha_C(b-a)^2}, z_S^{N:2N1S:C} = \frac{0.04414146b}{\alpha_C(b-a)^2}, \]
\[ e^{N:2N1S:C} = \frac{0.00000303b^6}{\alpha_C(b-a)^2}, \]
\[ \Pi^{N:2N1S:C} = \frac{0.00002149b^6}{\alpha_C(b-a)^2}, CS^{N:2N1S:C} = \frac{0.00001074b^6}{\alpha_C(b-a)^2}, \]

3. 2N, Subgame B:

\[ q_{N1}^{N:2N:B} = 0.4098b, q_{N2}^{N:2N:B} = 0.1994b, w_{N1}^{N:2N:B} = 0.2267b^2, w_{N2}^{N:2N:B} = 0.0750b^2, \]
\[ p_{N1}^{N:2N:B} = 0.3182b^2, p_{N2}^{N:2N:B} = 0.1373b^2, z_{N1}^{N:2N:B} = \frac{0.00164004b}{\alpha_R(b-a)^2}, z_{N2}^{N:2N:B} = \frac{0.0020331b}{\alpha_R(b-a)^2}, \]
\[ e^{N:2N:C} = \frac{0.00013798b^6}{\alpha_R(b-a)^2}, \]
\[ \Pi^{N:2N:B} = \frac{0.00013798b^6}{\alpha_R(b-a)^2}, CS^{N:2N:B} = \frac{0.00013798b^6}{\alpha_R(b-a)^2}, \]

4. 2N, Subgame C:

\[ q_{CC}^{N:2N:C} = 0.3061b, q_{CM}^{N:2N:C} = 0.1546b, w_{CC}^{N:2N:C} = 0.1472b^2, w_{CM}^{N:2N:C} = 0.0491b^2, \]
\[ p_{CC}^{N:2N:C} = 0.2266b^2, p_{CM}^{N:2N:C} = 0.1019b^2, z_{CC}^{N:2N:C} = \frac{0.00083193b}{\alpha_C(b-a)^2}, z_{CM}^{N:2N:C} = \frac{0.00077683b}{\alpha_C(b-a)^2}, \]
\[ e^{N:2N:C} = \frac{0.0000224b^6}{\alpha_C(b-a)^2}, \]
\[ \Pi^{N:2N:C} = \frac{0.0000224b^6}{\alpha_C(b-a)^2}, CS^{N:2N:C} = \frac{0.00005355b^6}{\alpha_C(b-a)^2}, \]

5. 1N1S:

\[ q_{N}^{N:1N1S:C} = 0.1785b, q_{S}^{N:1N1S:C} = 0.3449b, w_{N}^{N:1N1S:C} = 0.0467b^2, \]
\[ p_{N}^{N:1N1S:C} = 0.1126b^2, p_{S}^{N:1N1S:C} = 0.2320b^2, z_{N}^{N:1N1S:C} = \frac{0.00005524b^4}{\alpha_C(b-a)^2}, z_{S}^{N:1N1S:C} = \frac{0.0001812b^4}{\alpha_C(b-a)^2}, \]
\[ e^{N:1N1S:C} = \frac{0.00000416b^6}{\alpha_C(b-a)^2}, \]
\[ \Pi^{N:1N1S:C} = \frac{0.0000416b^6}{\alpha_C(b-a)^2}, CS^{N:1N1S:C} = \frac{0.00001206b^6}{\alpha_C(b-a)^2}, \]
6. 1N:
\[ q_{N}^{N:1N:C} = 0.3333b, w_{N}^{N:1N:C} = 0.2222b^2, p_{N}^{N:1N:C} = 0.2778b^2, \sigma_{N}^{N:1N:C} = 0.00154321b^4, \]
\[ e^{N:1N:C} = 0.00008573b^6, \Pi_{CC}^{N:1N:C} = 0.00008573b^6, \Pi_{R}^{N:1N:C} = 0.00008573b^6, C_{S}^{N:1N:C} = 0.000042876. \]

A1.3 Derivation of Equilibrium Quality in Section 4.1.2 - Subgame B in an Established Product Category

We first derive the local equilibria in all three cases and then check for the deviation across cases from each of these local equilibria. A local equilibrium is indeed an equilibrium if there is no deviation by any manufacturer to any other case. First, on solving for the local equilibria, we have: \((q_{N1}^{(1)} = 0.2369b, q_{N2}^{(1)} = 0.1394b)\) in Case 1, \((q_{N1}^{(2)} = 0.4388b, q_{N2}^{(2)} = 0.1717b)\) in Case 2, and \((q_{N1}^{(3)} = 0.4448b, q_{N2}^{(3)} = 0.3674b)\) in Case 3. On examining the deviation possibility, we find that Manufacturer 2 can deviate from the Case 3 equilibrium by reducing \(q_{N2}^{(3)} = 0.2504b\) but above 0.0633b. However, we do not find any profitable deviation from the equilibrium of Case 1 and Case 2. More specifically, in Case 1, the only possible deviation is Manufacturer 1’s deviation to Case 2 by increasing \(q_{N1}^{(1)} = 0.3699b\) but the maximum deviation profit is given as \(\frac{0.00076b^3}{b-a}\) at \(q_{N1}^{(1)} = 0.4382b\), which is less than the equilibrium profit \(\frac{0.00076b^3}{b-a}\). In Case 2, both manufacturers can deviate from equilibrium (Manufacturer 1 to Case 1 by decreasing \(q_{N1}^{(2)} = 0.3310b\); Manufacturer 2 to Case 3 by increasing \(q_{N2}^{(2)} = 0.3310b\)). However, in Manufacturer 1’s deviation, its maximum profit \(\frac{0.00066b^3}{b-a}\) (at \(q_{N1} = 0.2548b\)) is lower than the equilibrium profit \(\frac{0.00076b^3}{b-a}\). In Manufacturer 2’s deviation, the maximum profit is given as \(\frac{0.00066b^3}{b-a}\) (at \(q_{N2} = 0.3642b\)) but it is lower than the equilibrium profit \(\frac{0.0011b^3}{b-a}\).

Therefore we have multiple equilibria in the manufacturers’ quality-setting game: \((q_{N1}^{(1)} = 0.2369b, q_{N2}^{(1)} = 0.1394b)\) and \((q_{N1}^{(2)} = 0.4388b, q_{N2}^{(2)} = 0.1717b)\). Further, on comparing these two equilibria we note that
\[ \pi_{M1}^{(2)} + \pi_{M2}^{(2)} = \frac{0.0018b^3}{b-a} > \pi_{M1}^{(1)} + \pi_{M2}^{(1)} = \frac{0.001b^3}{b-a}. \]

Thus, in the Pareto-superior equilibrium, \(q_{N1} = 0.4388b\), and \(q_{N2} = 0.1717b\). We obtain the equilibrium prices, demand, and profits by plugging the equilibrium quality back into the relevant equations.

A2 Proofs

Proof of Proposition 1

Recall from Section 4.1, that the retailer adopts category captaincy in the following four cases.

- (Case 1) When \(\alpha_1 \leq 0.3295\alpha_R\) and \(\alpha_2 > 1.5471\alpha_R\): \(M1\) is appointed with no side payment.
- (Case 2) When \(\alpha_1 > 2.4547\alpha_R\) and \(\alpha_2 \leq 0.3295\alpha_R\): \(M2\) is appointed with no side payment.
• (Case 3) When $\alpha_1 \leq 0.4065\alpha_R$ and $\alpha_2 \leq 0.3980\alpha_R$ and $\alpha_2 \geq \frac{\alpha_1\alpha_R}{\alpha_R+0.0523\alpha_1}$: $M_1$ is appointed with a positive side payment.

• (Case 4) When $\alpha_1 \leq 0.4065\alpha_R$ and $\alpha_2 \leq 0.3980\alpha_R$ and $\alpha_2 < \frac{\alpha_1\alpha_R}{\alpha_R+0.0523\alpha_1}$: $M_2$ is appointed with a positive side payment.

We prove both parts of the proposition for each of these four cases. First note that the above conditions guarantee that both the retailer and the category captain are better off with category captaincy. Hence, we turn attention to the welfare implications for the competing manufacturer and consumers. We use profits and consumer surplus given in (9) and (11).

In Case 1, $\Pi_{CM}^{E:2N1S:C} \geq \Pi_{M2}^{E:2N1S:B}$ is equivalent to $\alpha_1 \leq 0.7717\alpha_R$, which always holds when the conditions for Case 1 hold. Thus, the competing manufacturer is always better off with category captaincy. In addition, $CSE:2N1S:C \geq CSE:2N1S:B$ is equivalent to $\alpha_1 \leq 0.1648\alpha_R$, which implies that consumers are hurt by category captaincy if $\alpha_1 < 0.3295\alpha_R$ and $\alpha_2 > 1.5471\alpha_R$.

In Case 2, $\Pi_{CM}^{E:2N1S:C} \geq \Pi_{M1}^{E:2N1S:B}$ is equivalent to $\alpha_2 \leq 1.2244\alpha_R$, which always holds if the conditions for Case 2 hold. Hence, the competing manufacturer is always better off with category captaincy. Moreover, $CSE:2N1S:C \geq CSE:2N1S:B$ is equivalent to $\alpha_2 \leq 0.1648\alpha_R$, which suggests that consumers are hurt by the category captaincy if $\alpha_1 > 0.1648\alpha_R$ and $\alpha_1 \geq 1.2244\alpha_R$.

In Case 3, $\Pi_{CM}^{E:2N1S:C} \geq \Pi_{M2}^{E:2N1S:B}$ is equivalent to $\alpha_1 \leq 0.7717\alpha_R$, which always holds when the conditions for Case 3 hold. Therefore, the competing manufacturer is always better off with category captaincy. Furthermore, $CSE:2N1S:C \geq CSE:2N1S:B$ is equivalent to $\alpha_1 \leq 0.1648\alpha_R$, implying that consumers are hurt by the category captaincy if $\alpha_1 < 0.1648\alpha_R$ and $\frac{\alpha_1\alpha_R}{\alpha_R+0.0523\alpha_1} \leq \alpha_2 \leq 0.3980\alpha_R$.

In Case 4, $\Pi_{CM}^{E:2N1S:C} \geq \Pi_{M1}^{E:2N1S:B}$ is equivalent to $\alpha_2 \leq 1.2244\alpha_R$, which always holds if the conditions for Case 4 hold. Hence, the competing manufacturer is always better off with category captaincy. Besides, $CSE:2N1S:C \geq CSE:2N1S:B$ is equivalent to $\alpha_2 \leq 0.1648\alpha_R$, suggesting that consumers are hurt by the category captaincy if $\alpha_1 > 0.1648\alpha_R$ and $\alpha_1 \leq 0.4065\alpha_R$.

Hence, across the four cases, the competing manufacturer is always better off with category captaincy but consumers may be hurt by category captaincy. This completes the proof. □

**Proof of Proposition 2**

We first derive the condition for category captaincy in the absence of the store brand. The retailer adopts category captaincy if and only if both the retailer and the category captain are better off. By (16) and (17), $\Pi_{CC}^{E:2N:C} \geq \Pi_{Mk}^{E:2N:B}$ (for $k = 1, 2$) is equivalent to $\alpha_1 \leq 0.4520\alpha_R$ for $M_1$ and to $\alpha_2 \leq 0.5304\alpha_R$ for $M_2$. Hence, category captaincy will be observed only if $\alpha_1 \leq 0.4520\alpha_R$ or $\alpha_2 \leq 0.5304\alpha_R$.

First, suppose $\alpha_1 \leq 0.4520\alpha_R$ and $\alpha_2 > 0.5304\alpha_R$. Since only $M_1$ would be interested in becoming the category captain, the retailer appoints $M_1$ as the category captain if and only if $\Pi_{R}^{E:2N:C}(\alpha_C = \alpha_1) \geq \Pi_{R}^{E:2N:B}$, or equivalently, $\alpha_1 \leq 0.6365\alpha_R$, which always holds.
Next, suppose $\alpha_1 > 0.4520\alpha_R$ and $\alpha_2 \leq 0.5304\alpha_R$. Since only $M2$ would want to be the category captain, the retailer chooses to use $M2$ as the category captain if and only if $\Pi_{CM}^{E2N:C}(\alpha_C = \alpha_2) \geq \Pi_{M2}^{E2N:B}$, or equivalently, $\alpha_2 \leq 0.6365\alpha_R$, which always holds.

Finally, suppose both $\alpha_1 \leq 0.4520\alpha_R$ and $\alpha_2 \leq 0.5304\alpha_R$ hold. Since both manufacturers are willing to be the category captain, they compete by providing side payments $\delta_k$ ($k = 1, 2$) to the retailer, where $\delta_k \leq \Delta_k \equiv \Pi_{CM}^{E2N:C}(\alpha_C = \alpha_k) - \Pi_{M_k}^{E2N:B}$. Note that

$$\Pi_{CM}^{E2N:C}(\alpha_C = \alpha_1) + \Delta_1 \geq \Pi_{CM}^{E2N:C}(\alpha_C = \alpha_2) + \Delta_2$$  (A2)

is equivalent to $\alpha_2 \geq \frac{\alpha_1\alpha_B}{\alpha_R - 0.0829\alpha_1}$. Thus, if $\alpha_2 \geq \frac{\alpha_1\alpha_B}{\alpha_R - 0.0829\alpha_1}$ holds, $M1$ will be chosen as the category captain with $\delta_1^* = \Pi_{CM}^{E2N:C}(\alpha_C = \alpha_2) + \Delta_2 - \Pi_{CM}^{E2N:C}(\alpha_C = \alpha_1)$. Given this, the retailer adopts category captaincy if and only if $\Pi_{CM}^{E2N:C}(\alpha_C = \alpha_1) + \delta_1^* \geq \Pi_{CM}^{E2N:B}$, or equivalently, $\alpha_2 \leq 0.6058\alpha_R$, which always holds. On the other hand, if $\alpha_2 < \frac{\alpha_1\alpha_B}{\alpha_R - 0.0829\alpha_1}$ holds, $M2$ will be chosen as the category captain with $\delta_2^* = \Pi_{CM}^{E2N:C}(\alpha_C = \alpha_1) + \Delta_1 - \Pi_{CM}^{E2N:C}(\alpha_C = \alpha_2)$. Given this, the retailer adopts category captaincy if and only if $\Pi_{CM}^{E2N:C}(\alpha_C = \alpha_2) + \delta_2^* \geq \Pi_{CM}^{E2N:B}$, or equivalently, $\alpha_1 \leq 0.5769\alpha_R$, which always holds.

Therefore, across the four cases, in the absence of the store brand, category captaincy is adopted in equilibrium if and only if $\alpha_1 \leq 0.4520\alpha_R$ or $\alpha_2 \leq 0.5304\alpha_R$.

We also know from Section 4.1 that in the presence of the store brand, category captaincy is adopted if and only if (1) $\alpha_1 \leq 0.3295\alpha_R$ and $\alpha_2 > 1.5471\alpha_R$, (2) $\alpha_1 > 2.4547\alpha_R$ and $\alpha_2 \leq 0.3295\alpha_R$, or (3) $\alpha_1 \leq 0.4065\alpha_R$ and $\alpha_2 \leq 0.3980\alpha_R$.

By comparing these conditions, it is straightforward to see that the conditions in which category captaincy is adopted in the presence of the store brand is a subset of the conditions for pursuing category captaincy in the absence of the store brand. This proves the proposition. □

**Proof of Proposition 3**

Recall from the proof of Proposition 2, that $M1$ is appointed as the category captain if $\alpha_1 \leq 0.4520\alpha_R$ and $\alpha_2 \geq \frac{\alpha_1\alpha_B}{\alpha_R - 0.0829\alpha_1}$. In this case, $\Pi_{CM}^{E2N:C} \geq \Pi_{M2}^{E2N:B}$ is equivalent to $\alpha_1 \leq 0.3205\alpha_R$, which implies that the competing manufacturer may be hurt by category captaincy if $0.3205\alpha_R < \alpha_1 \leq 0.4520\alpha_R$ and $\alpha_2 \geq \frac{\alpha_1\alpha_B}{\alpha_R - 0.0829\alpha_1}$.

Also, recall that $M2$ is appointed as the category captain if (1) $\alpha_1 > 0.4520\alpha_R$ and $\alpha_2 \leq 0.5304\alpha_R$ or (2) $\alpha_1 \leq 0.4520\alpha_R$ and $\alpha_2 \leq \min\{0.5304\alpha_R, \frac{\alpha_1\alpha_B}{\alpha_R - 0.0829\alpha_1}\}$. In this case, $\Pi_{CM}^{E2N:C} \geq \Pi_{M1}^{E2N:B}$ is equivalent to $\alpha_2 \leq 0.2731\alpha_R$, which implies that the competing manufacturer may be hurt by category captaincy if (1) $0.2731\alpha_R < \alpha_2 \leq 0.5304\alpha_R$ and $\alpha_1 \geq 0.4520\alpha_R$ or (2) $0.2731\alpha_R < \alpha_2 \leq \frac{\alpha_1\alpha_B}{\alpha_R - 0.0829\alpha_1}$ and $\alpha_1 < 0.4520\alpha_R$.

Therefore, in both cases, it is possible that category captaincy can hurt the competing manufacturer’s profits. □
Proof of Proposition 4

In this proof, we use the equilibrium profits given in (9), (16), (18), and (19), for each product line configuration. Note that at the time of making product line decision, the side payment from the category captain, if any, is already sunk, and thus not considered in this analysis. For Parts (a) and (b), among all the potential product configurations that the category captain can consider (i.e., 1N, 1N1S, 2N, and 2N1S), we have \( \Pi_{1N}^{E:2N1S:C} < \Pi_{1N}^{E:2N:C} < \Pi_{1N}^{E:1N1S:C} < \Pi_{1N}^{E:1N:C} \). Thus, the ideal product configuration candidate for the category captain is 1N. However, since \( \Pi_{1N}^{E:2N1S:C} - \Pi_{1N}^{E:1N:C} = \frac{0.000032216}{\alpha_{C}(b-a)^{2}} > 0 \), the category captain has to compensate the retailer for this loss in order to make the retailer switch to 1N from the status quo product configuration (namely, 2N1S). After accounting for this compensation, the category captain’s profits from 1N become, \( \Pi_{1N}^{E} \) (namely, 2N1S). Thus, consumers are always better off with category captaincy. In addition, the presence of the store brand, by (20) and (21), we have \( \Pi_{1N}^{E} = \frac{0.00007856}{\alpha_{C}(b-a)^{2}} \), which is smaller than \( \Pi_{1N}^{E:1N1S:C} = \frac{0.00002956}{\alpha_{C}(b-a)^{2}} \). Note that under 1N1S product configuration, the category captain does not have to provide any compensation to the retailer, since \( \Pi_{1N}^{E:1N1S} > \Pi_{1N}^{E:2N1S} \). Thus, 1N1S provides the category captain with the best profits.

Next, observe that \( \Pi_{1N}^{E:1N:C} < \Pi_{1N}^{E:2N:C} < \Pi_{1N}^{E:2N1S:C} < \Pi_{1N}^{E:1N1S:C} \). Hence, the retailer will implement the category captain’s product line recommendation, 1N1S. In this case, the total channel profits are given by \( \Pi_{1N1S:C}^{E} = \Pi_{1N1S:C}^{E} + \Pi_{1N1S:C}^{E} = \frac{0.00009843}{\alpha_{C}(b-a)^{2}} \), while the status quo channel profits are given by \( \Pi_{1N1S:C}^{E} + \Pi_{1N1S:C}^{E} + \Pi_{1N1S:C}^{E} = \frac{0.00006852}{\alpha_{C}(b-a)^{2}} \). Therefore, the retailer increases total channel profits by implementing the recommendation of the category captain.

For Part (c), observe that \( CS^{E:2N1S:C} < CS^{E:1N1S:C} \). Hence the result follows. □

Proof of Proposition 5

We prove the proposition both in the presence and the absence of the store brand. First, in the presence of the store brand, by (20) and (21), we have \( \Pi_{1N}^{N:2N1S:C} \geq \Pi_{Mk}^{N:2N1S:B} \) for \( k = 1, 2 \) is equivalent to \( \alpha_{1} \leq 0.0237\alpha_{R} \) for \( M1 \) and to \( \alpha_{2} \leq 0.0149\alpha_{R} \) for \( M2 \). In addition, since \( \Pi_{1N}^{N:2N1S:C}(\alpha_{C} = \alpha_{1}) \geq \Pi_{1N}^{N:2N1S:B} \) is equivalent to \( \alpha_{C} \leq 0.0583\alpha_{R} \) (for any \( \alpha_{C} = \alpha_{1}, \alpha_{2} \)), whenever the manufacturer is willing to serve as the category captain, the retailer is willing to adopt category captaincy. Thus, the category captain will be observed if and only if \( \alpha_{1} \leq 0.0237\alpha_{R} \) or \( \alpha_{2} \leq 0.0149\alpha_{R} \). We consider the following three cases.

First, when \( \alpha_{1} \leq 0.0237\alpha_{R} \) and \( \alpha_{2} > 0.0149\alpha_{R} \) hold, only \( M1 \) would be interested in being the category captain and hence \( M1 \) is appointed as the category captain in equilibrium. In this case, \( CS^{N:2N1S:C} \geq CS^{N:2N1S:B} \) is equivalent to \( \alpha_{1} \leq 0.0298\alpha_{R} \), which always holds under the above condition. Thus, consumers are always better off with category captaincy. In addition, \( \Pi_{1N1S:C}^{N:2N1S:B} \) is equivalent to \( \alpha_{1} \leq 0.0188\alpha_{R} \), which implies that the competing firm is hurt by category captaincy if \( 0.0188\alpha_{R} < \alpha_{1} \leq 0.0237\alpha_{R} \) and \( \alpha_{2} > 0.0149\alpha_{R} \).

Second, when \( \alpha_{1} > 0.0237\alpha_{R} \) and \( \alpha_{2} \leq 0.0149\alpha_{R} \) hold, only \( M2 \) would want to be the category captain and is appointed as the category captain in equilibrium. In this case, both \( CS^{N:2N1S:C} \geq \Pi_{1N1S:C}^{N:2N1S:B} \)
$CS^{N,2N1S:B}$ and $\Pi^{N,2N1S:C}_{CM} \geq \Pi^{N,2N1S:B}_{M1}$ are equivalent to $\alpha_2 \leq 0.0298\alpha_R$, which always holds under the above condition. Hence, both consumers and the competing firm are always better off with category captaincy.

Third, if both $\alpha_1 \leq 0.0237\alpha_R$ and $\alpha_2 \leq 0.0149\alpha_R$ hold, both manufacturers are willing to be the category captain and thus, compete by providing side payments $\delta_k$ ($k = 1, 2$) to the retailer, where $\delta_k \leq \Delta_k \equiv \Pi^{N,2N1S:C}_{CC}(\alpha_C = \alpha_k) - \Pi^{N,2N1S:B}_{M_k}$. Note that

$$\Pi^{N,2N1S:C}_{R}(\alpha_C = \alpha_1) + \Delta_1 \geq \Pi^{N,2N1S:C}_{R}(\alpha_C = \alpha_2) + \Delta_2$$

(A3)

is equivalent to $\alpha_2 \geq \frac{\alpha_1\alpha_R}{\alpha_R + 0.3643\alpha_1}$. Therefore, in equilibrium, the retailer appoints $M1$ as the category captain if $\alpha_2 \geq \frac{\alpha_1\alpha_R}{\alpha_R + 0.3643\alpha_1}$ but the retailer chooses $M2$ otherwise.

If $\alpha_2 \leq \frac{\alpha_1\alpha_R}{\alpha_R + 0.3643\alpha_1}$, $M1$ becomes the category captain in equilibrium and in this case, $CS^{N,2N1S:C} \geq CS^{N,2N1S:B}$ is equivalent to $\alpha_1 \leq 0.0298\alpha_R$, while $\Pi^{N,2N1S:C}_{CM} \geq \Pi^{N,2N1S:B}_{M2}$ is equivalent to $\alpha_2 \leq 0.0149\alpha_R$, both of which always hold under the above conditions: $\frac{\alpha_1\alpha_R}{\alpha_R + 0.3643\alpha_1} \leq \alpha_2 \leq 0.0149\alpha_R$. Thus, both consumers and the competing manufacturer are always better off with category captaincy.

On the other hand, if $\alpha_2 < \frac{\alpha_1\alpha_R}{\alpha_R + 0.3643\alpha_1}$, $M2$ becomes the category captain in equilibrium and in this case, both $CS^{N,2N1S:C} \geq CS^{N,2N1S:B}$ and $\Pi^{N,2N1S:C}_{CM} \geq \Pi^{N,2N1S:B}_{M2}$ are equivalent to $\alpha_2 \leq 0.0298\alpha_R$, which always holds under the above condition of $\alpha_2 \leq 0.0149\alpha_R$. Thus, both consumers and the competing manufacturer are always better off with category captaincy.

Across the three cases, in the presence of the store brand, consumers are always better off but the competing manufacturer is hurt with category captaincy if and only if $0.0188\alpha_R < \alpha_1 \leq 0.0237\alpha_R$ and $\alpha_2 > 0.0149\alpha_R$.

Next, in the absence of the store brand, by (22) and (23), $\Pi^{N,2N:C}_{CC} \geq \Pi^{N,2N:B}_{M_k}$ (for $k = 1, 2$) is equivalent to $\alpha_1 \leq 0.2308\alpha_R$ for $M1$ and to $\alpha_2 \leq 0.3116\alpha_R$ for $M2$, while $\Pi^{N,2N:C}_{R}(\alpha_C = \alpha_1) \geq \Pi^{N,2N:B}_{R}$ is equivalent to $\alpha_C \leq 0.7762\alpha_R$ (for any $\alpha_C = \alpha_1, \alpha_2$). This implies that whenever the manufacturer is willing to serve as the category captain, the retailer is willing to adopt category captaincy. Therefore, the category captain will be observed if and only if $\alpha_1 \leq 0.3116\alpha_R$ or $\alpha_2 \leq 0.7762\alpha_R$, which we divide into the following three cases.

First, suppose $\alpha_1 \leq 0.3116\alpha_R$ and $\alpha_2 > 0.7762\alpha_R$ hold. Then, $M1$ becomes the category captain in equilibrium. In this case, $CS^{N,2N:C} \geq CS^{N,2N:B}$ is equivalent to $\alpha_1 \leq 0.3881\alpha_R$ and $\Pi^{N,2N:C}_{CM} \geq \Pi^{N,2N:B}_{M2}$ is equivalent to $\alpha_1 \leq 0.2745\alpha_R$, both of which always hold under the above condition. Thus, both consumers and the competing firm are always better off with category captaincy.

Second, suppose $\alpha_1 > 0.3116\alpha_R$ and $\alpha_2 \leq 0.7762\alpha_R$ hold. Then, $M2$ becomes the category captain in equilibrium. In this case, $CS^{N,2N:C} \geq CS^{N,2N:B}$ is equivalent to $\alpha_2 \leq 0.3881\alpha_R$, which always holds under the above condition. This implies that consumers are always better off with category captaincy. However, $\Pi^{N,2N:C}_{CM} \geq \Pi^{N,2N:B}_{M1}$ is equivalent to $\alpha_2 \leq 0.2033\alpha_R$, which implies that the competing firm is hurt by the category captaincy if $0.2033\alpha_R < \alpha_2 \leq 0.3116\alpha_R$ and
$\alpha_1 > 0.2308\alpha_R$.

Third, if both $\alpha_1 \leq 0.3116\alpha_R$ and $\alpha_2 \leq 0.7762\alpha_R$ hold, both manufacturers are willing to be the category captain and thus, compete by providing side payments $\delta_k$ ($k = 1, 2$) to the retailer, where $\delta_k \leq \Delta_k \equiv \Pi_{CC}^{N:2N:C}(\alpha_C = \alpha_k) - \Pi_{M_k}^{N:2N:B}$. Note that

$$\Pi_{R}^{N:2N:C}(\alpha_C = \alpha_1) + \Delta_1 \geq \Pi_{R}^{N:2N:C}(\alpha_C = \alpha_2) + \Delta_2$$

(A4)

is equivalent to $\alpha_1 \leq \frac{\alpha_2 \alpha_R}{\alpha_R + 0.1933\alpha_2}$. So in equilibrium, the retailer appoints $M1$ as the category captain if $\alpha_1 \leq \frac{\alpha_2 \alpha_R}{\alpha_R + 0.1933\alpha_2}$ but it chooses $M2$ otherwise.

Suppose $\alpha_1 \leq \frac{\alpha_2 \alpha_R}{\alpha_R + 0.1933\alpha_2}$ holds. Then, $M1$ becomes the category captain in equilibrium and in this case, $CS^{N:2N:C} \geq CS^{N:2N:B}$ is equivalent to $\alpha_1 \leq 0.3881\alpha_R$ and $\Pi_{CM}^{N:2N:C} \geq \Pi_{M2}^{N:2N:B}$ is equivalent to $\alpha_1 \leq 0.2745\alpha_R$, both of which always hold under the above condition. Hence, both consumers and the competing firm are always better off with category captaincy.

On the other hand, suppose $\alpha_1 > \frac{\alpha_2 \alpha_R}{\alpha_R + 0.1933\alpha_2}$ holds. Then, $M2$ becomes the category captain in equilibrium, and in this case $CS^{N:2N:C} \geq CS^{N:2N:B}$ is equivalent to $\alpha_2 \leq 0.3881\alpha_R$, which always holds under the above condition. This implies that consumers are always better off with category captaincy. However, $\Pi_{CM}^{N:2N:C} \geq \Pi_{M1}^{N:2N:B}$ is equivalent to $\alpha_2 \leq 0.2033\alpha_R$, which implies that the competing firm is hurt by the category captaincy if $0.2033\alpha_R < \alpha_2 \leq 0.3116\alpha_R$ and $\frac{\alpha_2 \alpha_R}{\alpha_R + 0.1933\alpha_2} < \alpha_1 \leq 0.2308\alpha_R$.

Across the three cases, in the absence of the store brand, consumers are always better off but the competing manufacturer is hurt with category captaincy if and only if $0.2033\alpha_R < \alpha_2 \leq 0.3116\alpha_R$ and $\alpha_1 \geq \min\{0.2308\alpha_R, \frac{\alpha_2 \alpha_R}{\alpha_R + 0.1933\alpha_2}\}$.

Therefore, both in the presence and the absence of the store brand, category captaincy always improves consumer welfare but could hurt the competing manufacturer. Hence the result follows.

$\Box$

**Proof of Proposition 6**

First note that in a new product category, the equilibrium profits and consumer surplus are as follows: when the product line consists of only one national brand (which comes from the category captain) [1N],

$$\Pi_{CC}^{N:1N:C} = \frac{0.00008573b^6}{c(b-a)^2}, \quad \Pi_{R}^{N:1N:C} = \frac{0.00008573b^6}{c(b-a)^2}, \quad CS^{N:1N:C} = \frac{0.0004287b^6}{c^2(b-a)},$$

and when the product line includes one national brand (of the category captain) and one store brand [1N1S],

$$\Pi_{CC}^{N:1N1S:C} = \frac{0.000000411b^6}{c(b-a)^2}, \quad \Pi_{R}^{N:1N1S:C} = \frac{0.0002411b^6}{c(b-a)^2}, \quad CS^{N:1N1S:C} = \frac{0.0001206b^6}{c^2(b-a)}.$$  

Note that the profits and consumer surplus under 2N and 2N1S configurations have been provided in (20) and (22), respectively.
Using these profits and consumer surplus, we prove the three parts of the proposition. For Part (a), note that among all the potential product configurations (i.e., 1N, 1N1S, 2N, and 2N1S), we find that $\Pi_{CC}^{N:2N1S;C} < \Pi_{CC}^{N:1N1S;C} < \Pi_{CC}^{N:2N;C} < \Pi_{CC}^{N:1N;C}$. Thus, the category captain will recommend 1N configuration. Since $\Pi_{R}^{N:1N;C} > \Pi_{R}^{N:2N1S;C}$ also holds, the retailer will accept the category captain’s recommendation, namely 1N. Therefore, in equilibrium, 1N will be implemented.

For Part (b), observe that $CS^{N:1N;C} > CS^{N:2N1S;C}$. Hence, consumer welfare improves if the retailer follows the recommendation of the category captain. Finally, for Part (c), since $\Pi_{R}^{N:2N1S;C} < \Pi_{R}^{N:1N1S;C} < \Pi_{R}^{N:1N;C} < \Pi_{R}^{N:2N;C}$, the retailer will choose to implement 2N even if it makes the product line decision all by itself. This proves Part (c). $\square$