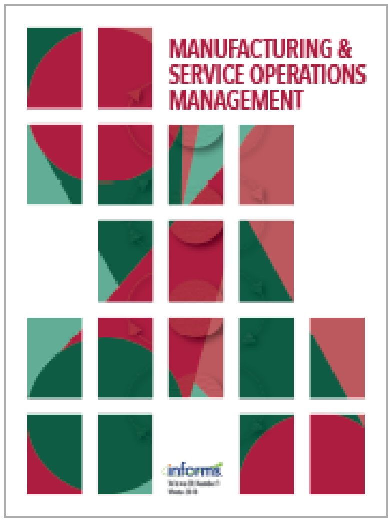

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The Role of Store Brand Spillover in a Retailer's Category Management Strategy

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Abstract. ***Problem definition***: We study a retailer's category management strategy and interactions with its supply chain partners in a setting in which increasing the store brand (SB) market share in a focal category improves the retailer's overall profitability by creating demand spillover to other categories. ***Academic/practical relevance***: Unlike most category management research, which focuses on category profit maximization, our research incorporates SB spillover observed in practice into the retailer's decision making. ***Methodology***: We analyze a game-theoretic model with one retailer, one high-quality national brand (NB) manufacturer, and one low-quality NB manufacturer. The retailer selects the assortment and sets the retail prices, and the NB manufacturers set their wholesale prices. We formulate the retailer's objective function as a weighted sum of category profit and SB market share, where the weight assigned to the SB market share captures the degree of SB spillover. ***Results***: First, overlooking SB spillover can result in suboptimal assortment and pricing decisions, leading to financial losses for the retailer. The retailer incurs the largest losses when it fails to adjust its assortment to take SB spillover into account, whereas its losses are relatively small when it carries the right assortment but fails to adjust its prices. Second, taking SB spillover into account decreases the retailer's category profit when the degree of SB spillover is high. However, a low degree of SB spillover may enable the retailer to simultaneously increase its category profit and SB market share. Third, SB spillover is never beneficial for the low-quality NB but may increase the high-quality NB's profit when the retailer removes the low-quality NB from its assortment. ***Managerial implications***: Our study sheds light on how SB spillover affects the retailer's assortment and pricing decisions and demonstrates the impact of such decisions on the retailer, the focal category, and the NBs.

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1. Introduction

Category management is a retailing practice in which a retailer groups products with similar characteristics into categories (e.g., canned vegetables, detergents, and pasta) and treats each category as a strategic business unit. A successful category management strategy enables a retailer to improve overall category performance by coordinating pricing and assortment decisions across different brands within the category (ACNielsen 2005). A typical category consists of products offered by national brand (NB) manufacturers (e.g., Procter & Gamble and Unilever) and a store brand (SB), also known as a private label, owned and marketed by retailers (Kumar and Steenkamp 2007). The SB presence in a category creates competition between the retailer and NB manufacturers for consumer dollars.

SB sales have grown significantly in the past two decades. According to the Private Label Manufacturers Association (PLMA), in 2016, SB sales reached $60.2 billion (18.4% dollar share) in supermarkets, $8.3 billion (16.5% dollar share) in drug chains, and $49.6 billion (16.6% dollar share) in mass merchandisers in the United States (PLMA 2017). Retailers such as Walmart, which relies on its Great Value brand to attract budget-conscious shoppers, and Kroger, which generates 26% of its sales revenue from SBs, continue to invest in growing their SBs (Kroger Fact Book 2016, Hamstra 2017). Retailers want to grow their SBs because they typically have higher retail margins (e.g., Ailawadi and Harlam 2004), increase retailers' leverage in their negotiations with NB manufacturers (e.g., Chintagunta et al. 2002, Scott Morton and Zettelmeyer 2004), increase consumer loyalty (e.g., Corstjens and Lal 2000, Seenivasan et al. 2016), and enable retailers to build brand equity by offering the same SB across different categories (e.g., Erdem and Chang 2012). Given these benefits, SBs play an important role in retailers' category management strategies (Alan et al. 2017).

The category management literature typically assumes that retailers ask their category managers to make pricing and assortment decisions to maximize category profitability (Zenor 1994, Basuroy et al. 2001). However, category profit maximization may overlook cross-category effects and thereby negatively affect the retailer's overall profitability (Cachon and Kök 2007). Such cross-category effects emerge for various reasons, such as (i) loss leader pricing in one category to drive store traffic and thereby increase demand in other categories (e.g., Hess and Gerstner 1987), (ii) umbrella branding in which the same brand name is used in several categories to improve brand awareness and thereby increase demand (e.g., Erdem 1998), and (iii) basket shoppers, who wish to make a purchase in multiple categories (e.g., Cachon and Kök 2007).

In theory, a retailer can maximize store profits by making pricing and assortment decisions using an optimization model that takes all cross-category effects into account. However, constructing and solving such a model is very difficult in practice because retailers offer a large number of categories, leading to many possible cross-category interactions (Chen et al. 1999). Consequently, the literature proposes intermediate approaches in which a retailer still adopts category management but asks a category manager to maximize the total contribution of her assigned category to the retailer's overall profitability (e.g., Chen et al. 1999, Cachon and Kök 2007). Such a profit contribution has two components: (i) the traditional accounting profit of the category and (ii) the cross-category spillover, which captures the impact of the focal category on other categories' profits. In our study, we adopt a similar approach and study a category manager's pricing and assortment decisions in a setting in which increasing the SB market share in the focal category increases the retailer's profits in other categories. Hereafter, we refer to the cross-category impact of SB as *SB spillover.*

In practice, SB spillover emerges, in part, because retailers adopt umbrella branding for their SBs so that increasing the SB market share in one category increases the SB demand in other categories (Sayman and Raju 2004, Erdem and Chang 2012, Amrouche et al. 2014). In empirical settings, SB spillover manifests itself as a deviation from category profit maximization. For example, Chintagunta (2002) demonstrates that a structural model in which the retailer's objective function is a weighted sum of category profit and SB market share explains the retailer's pricing behavior. Using a similar structural model, Meza and Sudhir (2010) show that the retailer deviates from the category profit-maximizing prices to increase its SB's market share. Finally, Alan et al. (2017) empirically show that the retailer's desire to increase its SB's market share prevents the retailer from maximizing category sales.

Motivated by the empirical findings in the literature regarding retailers' deviations from traditional category management practices to increase SB market share, our study has two objectives. The first objective is to examine the impact of SB spillover on a retailer's pricing and assortment decisions. Although Chintagunta (2002) and Meza and Sudhir (2010) demonstrate that retailers deviate from category profit-maximizing prices to increase SB market share, their analyses do not consider assortment changes. Analyzing a retailer's joint pricing and assortment decisions enables us to shed light on the broader impact of SB spillover on a retailer's category management strategy.

The second objective is to examine the impact of SB spillover on the retailer, focal category, and NB manufacturers. In particular, we analyze how following a traditional category profit maximization objective and thereby overlooking SB spillover affects the retailer's performance. Moreover, in light of the findings of Chintagunta (2002) and Meza and Sudhir (2010) regarding retailers' deviations from category profit-maximizing prices, we analyze whether and to what extent SB spillover requires the retailer to give up category profits. Last, analytical SB studies (e.g., Narasimhan and Wilcox 1998, Scott Morton and Zettelmeyer 2004) suggest that SBs typically hurt the NB manufacturers because they not only force the NB manufacturers to lower their wholesale prices but also steal market share from the NBs. Following these studies, we examine how SB spillover affects the NB manufacturers.

We consider a supply chain with two NB manufacturers selling through a common retailer. One NB manufacturer offers a high-quality product, whereas the other offers a low-quality product. The retailer has the option to include either, both, or neither of the NB products in its assortment; it also has the option to offer a low-quality SB product. The retailer selects the assortment and sets the retail prices to maximize a weighted sum of its category profit and its SB's market share, whereas the NB manufacturers set the wholesale prices for their products. We obtain our results by comparing the equilibrium outcomes of our model with a benchmark case in which the retailer overlooks SB spillover and maximizes its category profit.

Our analysis reveals that SB spillover requires the retailer to reduce its SB's retail price, leading to an increase in the SB's market share. In most cases, the NB manufacturers respond to this price reduction by lowering their wholesale prices, which enables the retailer to sell the NBs at lower prices. Nevertheless, the wholesale and retail prices of the high-quality NB may increase when SB spillover requires the retailer to remove the low-quality NB from its assortment. The retailer may also remove the high-quality NB from its assortment when the degree of SB spillover is high. Thus, a high degree of SB spillover may lead to a decrease in the assortment size. However, when the degree of SB spillover is relatively low, the assortment size may increase or remain unchanged. Specifically, the retailer may increase the assortment size through the introduction of the SB. The retailer may also keep the assortment size unchanged by either retaining the category profit-maximizing assortment or replacing the low-quality NB with the SB.

These pricing and assortment dynamics lead to the following insights into the impact of SB spillover on the retailer, focal category, and NB manufacturers. First, the magnitude of the retailer's financial loss due to overlooking SB spillover depends on whether the retailer carries the right assortment. In particular, the retailer's loss is relatively small when it offers the right assortment but fails to adjust its prices to take SB spillover into account. However, the retailer's loss is much larger when it fails to carry the right assortment. Second, taking SB spillover into account decreases the retailer's category profit in most cases, especially when the retailer removes one or both NBs from its assortment. The retailer may even offer the category at a loss when the degree of SB spillover is high. Nevertheless, when the degree of SB spillover is low, taking SB spillover into account may enable the retailer to simultaneously increase its category profit and SB market share. Thus, lowering the SB's retail price to facilitate SB spillover does not necessarily imply giving up category profits for the retailer. Third, SB spillover never benefits the low-quality NB manufacturer because of the close competition between the low-quality NB and the SB. However, SB spillover may increase the high-quality NB manufacturer's profit when the retailer removes the low-quality NB from its assortment. This result arises because the removal of the low-quality NB softens the competition, which, in turn, enables the high-quality NB manufacturer to charge a higher wholesale price for its product.

The rest of the article proceeds as follows. Section 2 provides an overview of the relevant literature. Section 3 presents our model, and Section 4 characterizes the retail and wholesale prices as well as the assortment observed at equilibrium. Section 5 discusses the implications of SB spillover for the retailer, focal category, and NB manufacturers. Section 6 concludes with a summary of our main findings, their implications, and directions for future research.

2. Literature Review

Our study is related to two overlapping research streams: the category management literature and the SB literature. In this section, we provide an overview of both research streams and explain their relationship to our study.

The category management literature provides insights into retailers' pricing and assortment decisions. Although coordinating prices among all products in a category can significantly improve category performance (e.g., Zenor 1994, Basuroy et al. 2001), several factors complicate the joint optimization of retail prices. First, products in a category are substitutes. Thus, retailers should take cross-price effects into account because a product's price affects not only its own demand but also the demand for the other products in the category (e.g., Kadiyali et al. 2000, Besanko et al. 2005). Second, optimal retail prices depend on the retailer's category objective (Dhar et al. 2001, ACNielsen 2005). For example, maximizing category sales may require price reductions, especially in price-sensitive categories (Alan et al. 2017), whereas maximizing category profit may require the retailer to increase its retail prices (e.g., Zenor 1994, Basuroy et al. 2001). More importantly, category profit maximization may not be the right objective because it overlooks cross-category effects (Chen et al. 1999, Cachon and Kök 2007). Third, in a supply chain, manufacturers' strategic actions (e.g., wholesale price optimization) influence the retailer's pricing decisions (e.g., Choi 1991).

SB presence is another important determinant of a retailer's pricing decisions (Chintagunta et al. 2002). SBs provide retailers with several advantages over NBs. First, despite their lower retail prices, SBs typically have higher percentage margins because of their lower acquisition and merchandising costs (Ailawadi and Harlam 2004). Second, SB presence in a category increases the retailer's leverage over NB manufacturers (Scott Morton and Zettelmeyer 2004, Meza and Sudhir 2010). Last, SBs may improve consumers' loyalty to the retailer (Corstjens and Lal 2000, Seenivasan et al. 2016) and create an umbrella branding effect, which enables the retailer to expand its SB to other categories and thereby improve its overall profitability (Erdem and Chang 2012, Amrouche et al. 2014). These advantages motivate retailers to deviate from traditional category management objectives (e.g., category profit maximization) to increase SB market share (Chintagunta 2002, Meza and Sudhir 2010). By accounting for these dynamics, our model enables us to study how the cross-price effects, strategic retailer–manufacturer interactions, and the retailer's category objective in the presence of SB shape the retailer's pricing decisions.

Determining the right assortment size and composition is another critical and challenging task for retailers (Mantrala et al. 2009). In particular, retailers should carefully assess the advantages and disadvantages of carrying a large assortment. On the one hand, a broader assortment is associated with higher sales (e.g., Dhar et al. 2001, Borle et al. 2005) because with a large assortment, consumers are more likely to find a product that matches their needs (Boatwright and Nunes 2001). On the other hand, offering a large assortment can lead to higher costs (e.g., Dukes et al. 2009, Amaldoss and Shin 2015). The assortment studies in the operations management literature capture this trade-off via several demand models, such as the multinomial logit (e.g., Aydin and Hausman 2009, Kök and Xu 2011), exogenous demand (e.g., Smith and Agrawal 2000), locational choice (e.g., Gaur and Honhon 2006), and vertical differentiation (e.g., Pan and Honhon 2012). See Kök et al. (2015) for an overview of the assortment literature. The assortment studies typically focus on identifying structural properties and/or developing heuristics to simplify the complexity of the assortment selection problem. However, these studies do not explicitly consider SBs. In contrast, we focus on identifying the impact of SB spillover on the retailer's assortment decisions.

The SB literature in marketing studies how SBs affect retailers' assortment decisions and relationships with NB manufacturers. Narasimhan and Wilcox (1998) show that an SB introduction enables a retailer to receive better terms of trade (e.g., lower wholesale prices) from NB manufacturers. An SB introduction also enables a retailer to differentiate its assortment from its competitors (Corstjens and Lal 2000). Sayman et al. (2002) and Scott Morton and Zettelmeyer (2004) suggest that retailers should position their SBs close to the leading NBs. Du et al. (2005) also examine the retailer's SB positioning problem and show that in some cases, it is optimal for the retailer to position its SB closer to the low-quality NB. Indeed, empirical evidence (e.g., Pauwels and Srinivasan 2004) indicates that SBs typically compete closely with second-tier (low-quality) NBs. Other SB-related considerations examined in the operations and marketing literatures include, but are not limited to, retail competition in the presence of SBs (Groznik and Heese 2010), whether a retailer should source its SB from an incumbent NB manufacturer or a third-party manufacturer (e.g., Kumar et al. 2010), NBs pricing and product positioning responses to an SB introduction (e.g., Nasser et al. 2013), supply chain coordination (Fang et al. 2013), and introduction and positioning of multitier SBs (e.g., Amaldoss and Shin 2015). Sethuraman (2009) provides an overview of the analytical SB literature in marketing.

The analytical SB literature typically assumes that the retailer seeks to maximize its category profit, and it examines the impact of SB introduction by comparing two settings: a benchmark case in which there is no SB in the category and a case in which the retailer has the option to introduce its SB. In contrast, our benchmark case is a setting in which the retailer overlooks SB spillover and maximizes its category profit by selecting the best assortment, which may or may not include the SB, and the corresponding retail prices. We compare this benchmark case with an alternative case in which the retailer incorporates SB spillover into its objective function. This comparison enables us to examine how SB spillover affects the retailer's category management strategy and its interactions with the NB manufacturers.

3. Model

We consider a supply chain with two competing NB manufacturers selling through a common retailer. Manufacturer 1 offers a high-quality product, whereas manufacturer 2 offers a low-quality product. The retailer has the option to include either, both, or neither of the NBs in its assortment. In addition, the retailer has the option to offer its own SB. We use indices 1, 2, and s to represent the high-quality NB, the low-quality NB, and the SB, respectively. Let $\mathscr{A}$ denote the assortment the retailer offers to consumers. For example, $\mathscr{A} = \{1, s\}$ indicates that the retailer offers the high-quality NB and the SB but not the low-quality NB.

3.1. Consumers

Consumers are heterogeneous in their valuation of product quality. Let θ denote the quality preference parameter, which captures consumers' willingness to pay for quality. We assume that θ is uniformly distributed between 0 and 1 (i.e., $\theta \sim U[0,1]$). The utility of consuming product i for consumer type θ is given by

$$u_i(\theta) = \theta q_i - p_i, \tag{1}$$

where q_i and p_i denote the perceived quality and retail price of product i, respectively. Consumer type θ purchases product $j \in \mathscr{A}$ if $u_j(\theta) \geq u_k(\theta)$ for all $k \in \mathscr{A}\backslash\{j\}$ and $u_j(\theta) \geq 0$. If $u_i(\theta) < 0$ for all $i \in \mathscr{A}$, consumer type θ buys nothing. This consumer utility model, which allows differentiation among products through quality, is commonly used in the SB literature (e.g., Fang et al. 2013, Nasser et al. 2013, Amaldoss and Shin 2015).

3.2. Quality Levels and Product Differentiation

We normalize the SB quality to 1 (i.e., $q_s = 1$) and set $q_1 = 1 + 2\alpha$ and $q_2 = 1 + \alpha$, where $\alpha \geq 0$. That is, we assume that the SB has the lowest perceived quality and that the quality differentials, $q_1 - q_2$ and $q_2 - q_s$, are equal and exogenously set to α. (In Section 5.4, we consider a more general model with unequal quality differentials.) First, our assumption that the SB has the lowest perceived quality is based on the notion that SBs are not heavily advertised, whereas the NB manufacturers build brand equity by advertising their brands (Scott Morton and Zettelmeyer 2004). Accordingly, SBs usually have lower perceived quality than NBs because consumers often rely on brand equity as a quality cue (DelVecchio 2001, Scott Morton and Zettelmeyer 2004). Thus, our model captures a typical category in which the SB competes with the low-quality (second-tier) NBs (Pauwels and Srinivasan 2004, Fang et al. 2013). Second, our assumption of equal quality differentials enables us to parsimoniously capture the degree of product differentiation with a single parameter, α. Capturing the degree of product differentiation is important because consumers perceive SBs to be functionally competitive with NBs in categories with low product differentiation, such as salt and toothpaste, and inferior to NBs in categories with high product differentiation, such as apparel and consumer electronics (DelVecchio 2001). In our context, a small α represents a category with low product differentiation, whereas a large α represents a category with high product differentiation. Assuming exogenous quality levels is common in the literature (e.g., Du et al. 2005, Pan and Honhon 2012, Fang et al. 2013) and allows analytical tractability.

3.3. Retailer's Objective

Although category profit maximization is a common objective in analytical SB studies (e.g., Nasser et al. 2013, Amaldoss and Shin 2015), SB spillover may require a retailer to deviate from category profit maximization to increase its SB's market share. Chintagunta (2002) empirically examines a retailer's pricing behavior in a single category using a structural model in which the retailer's objective function is a weighted sum of category profit and SB market share. Chintagunta's (2002) analysis reveals that the weight assigned to the SB market share is statistically significant, which implies that the retailer, indeed, makes decisions based on multiple objectives—to maximize category profits and the SB market share. We formulate a similar objective function to assess the impact of SB spillover on the retailer's assortment and pricing decisions. Specifically, let z_i denote the demand for product $i \in \{1, 2, s\}$. Because $\theta \sim U[0, 1]$, which leads to a market size of 1, z_i also represents product i's market share. Furthermore, let w_i denote the wholesale price for product i. Following Chintagunta (2002), we define the retailer's objective function for a given assortment $\mathscr{A}$ as

$$\Pi_R^{\mathscr{A}} = \underbrace{\sum_{i \in \mathscr{A}} (p_i - w_i) z_i - K|\mathscr{A}|}_{\text{Category profit, } \pi_R^{\mathscr{A}}} + \underbrace{\gamma z_s}_{\text{SB spillover}}, \tag{2}$$

where the weight γ represents the degree of SB spillover. In addition, $|\mathscr{A}|$ denotes the assortment size and K denotes the fixed cost of including a product in the assortment. This cost term is commonly used in the assortment (e.g., Dukes et al. 2009, Pan and Honhon 2012) and store brand (e.g., Amaldoss and Shin 2015) literature streams.

The retailer's objective function [Equation (2)] represents the category's total contribution to the retailer's overall profitability. The first part, $\pi_R^{\mathscr{A}}$, captures the traditional accounting profit of the category. The second part, γz_s, captures SB spillover, which enables the retailer to leverage the SB market share in the focal category to generate higher profits in other categories. As such, $\gamma = 0$ represents a setting in which the retailer maximizes the traditional accounting profit of the category because of the absence of SB spillover, whereas $\gamma > 0$ may require the retailer to deviate from category profit maximization to take SB spillover into account. Hereafter, we refer to $\Pi_R^{\mathscr{A}}$ and $\pi_R^{\mathscr{A}}$ as the retailer's payoff and category profit, respectively.

Another approach to model SB spillover would be to maximize the retailer's store profit by explicitly considering multiple categories wherein increasing the SB market share in one category increases SB demand in other categories. Section A in the online supplement illustrates this approach with a model in which the retailer's total store profit becomes an affine function of Equation (2). Thus, Equation (2) leads to the same equilibrium outcomes and insights as the multicategory setting presented in Section A in the online supplement. We prefer analyzing Equation (2) rather than a multicategory setting for three reasons. First, retailers, in practice, typically make pricing and assortment decisions at a category level. Thus, our formulation reflects the category manager's view. Second, Equation (2) captures the managerial implications of SB spillover with a conceptually simpler formulation. Third, our formulation follows from the relevant empirical studies (e.g., Chintagunta 2002, Meza and Sudhir 2010) in which the degree of SB spillover (γ) can be estimated from a data set that only covers a single category.

3.4. NB Manufacturers' Objectives

For analytical tractability, we follow the existing literature and assume that the manufacturers' marginal cost of production is zero for all three products and that the SB is not subject to double marginalization (e.g., Raju et al. 1995, Sayman et al. 2002, Du et al. 2005). As a result, the retailer sources the SB from a third-party manufacturer at the production cost, which equals zero. That is, $w_s = 0$. In contrast, the NB manufacturers set their wholesale prices, w_1 and w_2, to maximize their profits. Manufacturer i's profit function for a given assortment $\mathscr{A}$ is

$$\pi_i^{\mathscr{A}} = w_i z_i \quad \text{for} \quad i = 1, 2, \tag{3}$$

which equals zero if product i is not in the assortment. In Section 5.4, we study an alternative model with production costs to show the robustness of our managerial insights. Section 5.4 also includes models with three and four NB manufacturers to further illustrate the robustness of our insights.

3.5. Sequence of Events

We model the interactions between the retailer and the two NB manufacturers as a three-stage game, where all parameters and objective functions are common knowledge. In stage 1, the retailer selects its assortment $\mathscr{A}$. In stage 2, the NB manufacturers that are in the assortment set their wholesale prices, w_i. Finally, in stage 3, the retailer sets the retail prices p_i for all $i \in \mathscr{A}$. We solve the game through backward induction. First, we derive the retailer's price response for a given assortment and wholesale prices. Second, we derive the manufacturers' wholesale price responses for a given assortment. Finally, we characterize the assortment that maximizes the retailer's payoff. In Section 5.4, we consider an alternative model in which the NB manufacturers move first and set their wholesale prices and the retailer moves next by selecting its assortment and setting the retail prices for the products in the assortment.

4. Analysis

4.1. Retail and Wholesale Price Responses

In this section, we analyze all possible assortments to characterize the corresponding retail and wholesale price responses. Characterization of the retail and wholesale price responses for a given assortment requires us to first derive the demand for each product. When the assortment has only one product, $p_i < q_i$ must hold for $i \in \mathcal{A}$, which leads to

$$z_i = \Pr(\theta q_i - p_i \geq 0) = 1 - \frac{p_i}{q_i}. \tag{4}$$

For example, when $\mathcal{A} = \{s\}$, $z_1 = z_2 = 0$ and $z_s = 1 - p_s/q_s = 1 - p_s$. When $|\mathcal{A}| = 2$, we can index products such that the subscripts h and l denote the high- and low-quality products in the assortment, respectively. Then, the retail prices must be such that $1 > (p_h - p_l)/(q_h - q_l) > p_l/q_l$, which leads to

$$z_h = \Pr(\theta q_h - p_h \geq \max\{0, \theta q_l - p_l\}) = 1 - \frac{p_h - p_l}{q_h - q_l}, \tag{5}$$

$$z_l = \Pr(\theta q_l - p_l \geq \max\{0, \theta q_h - p_h\}) = \frac{p_h - p_l}{q_h - q_l} - \frac{p_l}{q_l}. \tag{6}$$

For example, when $\mathcal{A} = \{1, s\}$, $z_1 = 1 - (p_1 - p_s)/(2\alpha)$, $z_2 = 0$, and $z_s = (p_1 - (1 + 2\alpha)p_s)/(2\alpha)$. Last, when all three products are in the assortment (i.e., $|\mathcal{A}| = 3$), the retail prices must be such that $1 > (p_1 - p_2)/(q_1 - q_2) > (p_2 - p_s)/(q_2 - q_s) > p_s/q_s$, which leads to

$$z_1 = \Pr(\theta q_1 - p_1 \geq \max\{0, \theta q_2 - p_2, \theta q_s - p_s\}) = 1 - \frac{p_1 - p_2}{\alpha}, \tag{7}$$

$$z_2 = \Pr(\theta q_2 - p_2 \geq \max\{0, \theta q_1 - p_1, \theta q_s - p_s\}) = \frac{p_1 + p_s - 2p_2}{\alpha}, \tag{8}$$

$$z_s = \Pr(\theta q_s - p_s \geq \max\{0, \theta q_1 - p_1, \theta q_2 - p_2\}) = \frac{p_2 - (1 + \alpha)p_s}{\alpha}. \tag{9}$$

Equations (4)–(9) imply that own- and cross-price elasticities depend on the degree of product differentiation in the category. For example, when $|\mathcal{A}| = 3$, $\partial z_2/\partial p_s = 1/\alpha$, which suggests that a change in the SB's price will have a greater impact on the low-quality NB's demand in categories with low product differentiation (i.e., low α). Accordingly, the degree of product differentiation may affect the retailer's pricing decisions. Lemma 1 characterizes the retailer's price response to the manufacturers' wholesale prices (w_1 and w_2). We present all proofs in the online supplement.

Lemma 1. *For* $\gamma \in [0, 1]$, (i) $p_1 = (q_1 + w_1)/2 = (1 + 2\alpha + w_1)/2$ *if the high-quality NB is in the assortment,* (ii) $p_2 = (q_2 + w_2)/2 = (1 + \alpha + w_2)/2$ *if the low-quality NB is in the assortment, and* (iii) $p_s = (q_s + w_s - \gamma)/2 = (1 - \gamma)/2$ *if the SB is in the assortment.*

Although the retail prices for the NBs are always positive, Lemma 1 implies that p_s would be zero when $\gamma > q_s + w_s$. Hence, we assume that $\gamma \leq q_s + w_s = 1$ to ensure a positive retail price for the SB. Lemma 1 also suggests that the retail price of the SB decreases in γ. This result is consistent with Chintagunta's (2002) finding that the retailer's desire to increase the SB market share creates a downward price pressure for the SB. Furthermore, γ may affect the NBs' retail prices because the NB manufacturers set their wholesale prices by taking γ into account. Lemma 2 characterizes the NB manufacturers' price responses for each assortment.

Lemma 2. *For a given assortment* $\mathcal{A}$, *the wholesale prices for the high- and low-quality NBs are, respectively,*

$$w_1 = \begin{cases} \dfrac{1 + 2\alpha}{2} & \text{if } \mathcal{A} = \{1\}, \\ \dfrac{2\alpha(1 + 2\alpha)}{3 + 7\alpha} & \text{if } \mathcal{A} = \{1, 2\}, \\ \dfrac{2\alpha - \gamma}{2} & \text{if } \mathcal{A} = \{1, s\}, \\ \dfrac{4\alpha - \gamma}{7} & \text{if } \mathcal{A} = \{1, 2, s\}, \end{cases}$$

and

$$w_2 = \begin{cases} \dfrac{1 + \alpha}{2} & \text{if } \mathcal{A} = \{2\}, \\ \dfrac{\alpha(1 + \alpha)}{3 + 7\alpha} & \text{if } \mathcal{A} = \{1, 2\}, \\ \dfrac{\alpha - \gamma}{2} & \text{if } \mathcal{A} = \{2, s\}, \\ \dfrac{\alpha - 2\gamma}{7} & \text{if } \mathcal{A} = \{1, 2, s\}. \end{cases} \tag{10}$$

Lemma 2 implies that for a given $\mathcal{A}$, $\partial w_i/\partial\alpha \geq 0$ for $i = 1, 2$. This is because an increase in α increases the quality differential between the NBs and the SB. A large quality differential enables the NB manufacturers to charge higher wholesale prices. Lemma 2 also implies that SB spillover creates a downward price pressure for the NBs. For example, when $\mathcal{A} = \{1, 2, s\}$,

$\partial w_1/\partial\gamma = -1/7$ and $\partial w_2/\partial\gamma = -2/7$, which suggests that the negative impact of SB spillover might be more severe for the low-quality NB. This finding is consistent with Pauwels and Srinivasan's (2004) finding that second-tier brands experience higher price sensitivity to low-quality SBs than premium brands.

Lemmas 1 and 2 allow us to derive the equilibrium wholesale prices, retail prices, and demands as well as the retailer's payoff for each assortment, all of which we present in Corollary 1 in the online supplement. Figure 1 illustrates the impact of SB spillover on the retail prices and demands through consumers' utility functions when $\mathcal{A} = \{1, 2, s\}$. In Figure 1(a), there is no SB spillover (i.e., $\gamma = 0$), whereas Figure 1(b) includes SB spillover (i.e., $\gamma > 0$). Switching from a regime with no SB spillover to a regime with SB spillover creates a parallel upward shift in $u_i(\theta) = \theta q_i - p_i$ for all three products. This is because $\partial u_i(\theta)/\partial\gamma = -\partial p_i/\partial\gamma$, which equals 1/14 for the high-quality NB, 1/7 for the low-quality NB, and 1/2 for the SB. As a result, the SB increases its market share by (i) converting some nonpurchasers to purchasers and (ii) stealing some market share from the low-quality NB. The high-quality NB also loses market share because the low-quality NB steals some customers from the high-quality NB. Mathematically, $\partial z_1/\partial\gamma = -1/(14\alpha) < 0$, $\partial z_2/\partial\gamma = -2/(7\alpha) < 0$, and $\partial z_s/\partial\gamma = (5 + 7\alpha)/(14\alpha) > 0$.

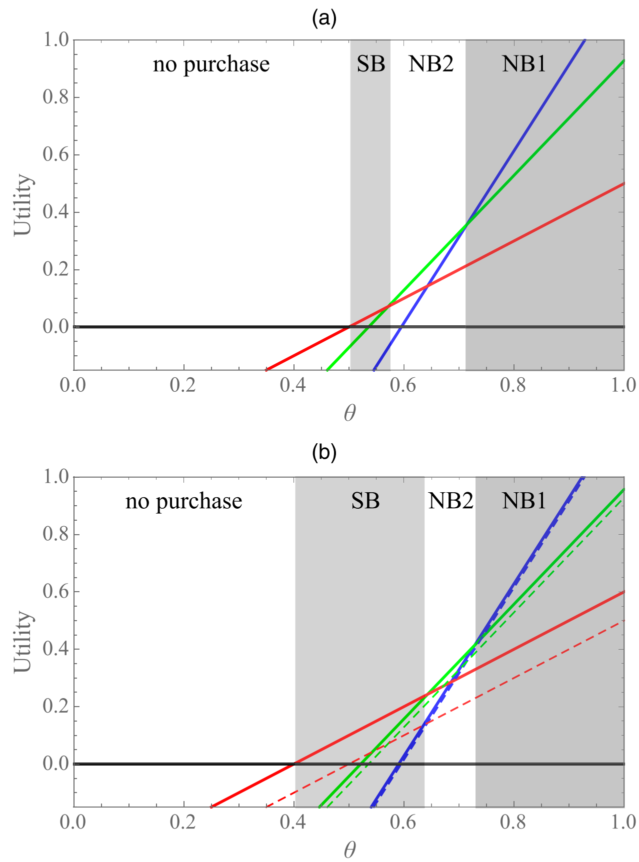
Although Figure 1 illustrates a case in which SB spillover does not lead to an assortment change, a larger γ value may lead to scenarios in which one or both NB products are priced out and removed from the assortment. As such, we analyze the retailer's assortment selection problem.

4.2. Characterization of the Optimal Assortment

The retailer selects the assortment with the highest payoff. For expositional clarity, we explain the retailer's assortment selection decision in two steps. In the first step, the retailer compares two assortments with the same size (e.g., $\{1, 2\}$ versus $\{1, s\}$). In the second step, the retailer compares two assortments with different sizes (e.g., $\{1, 2\}$ versus $\{1, 2, s\}$).

Two assortments with the same size have the same fixed cost K. Thus, for a given assortment size, a comparison between two assortments reduces to two parameters, the degree of product differentiation, α, and the degree of SB spillover, γ. For $|\mathcal{A}| = 1$, the retailer has three assortment choices, $\{1\}$, $\{2\}$, and $\{s\}$. Comparing the payoffs of $\{1\}$ and $\{2\}$ reveals that the retailer prefers $\{1\}$ over $\{2\}$. Intuitively, both NBs can generate the same demand (i.e., $z_1 = z_2 = 1/4$), but the high-quality NB enables the retailer to earn a higher unit margin (i.e., $p_1 - w_1 = (1 + 2\alpha)/4$ versus $p_2 - w_2 = (1 + \alpha)/4$), which makes $\{2\}$ unattractive for the retailer. The comparison between $\{1\}$ and $\{s\}$ is more subtle.

Figure 1. (Color online) Utility Functions for Each Product in the Absence and Presence of SB Spillover



Notes. We generate these figures by setting $\alpha = 1$. Figure 1(a) shows the utility functions for each product for $\gamma = 0$. Consumers with $\theta \in [0, 0.5)$ do not purchase because all three products generate negative utility for them. Consumers with $\theta \in [0.5, 0.57)$ buy the SB. Consumers with $\theta \in [0.57, 0.71)$ buy the low-quality NB. Consumers with $\theta \in [0.71, 1]$ buy the high-quality NB. Figure 1(b) shows the utility functions for each product for $\gamma = 0.2$. Consumers with $\theta \in [0, 0.40)$ do not purchase. Consumers with $\theta \in [0.40, 0.64)$ buy the SB. Consumers with $\theta \in [0.64, 0.73)$ buy the low-quality NB. Consumers with $\theta \in [0.73, 1]$ buy the high-quality NB. The dashed lines in Figure 1(b) represent the utility of each product for $\gamma = 0$.

On the one hand, the high-quality NB has a quality advantage over the SB. On the other hand, the SB is not subject to double marginalization and helps the retailer generate SB spillover. A comparison of these two assortments' payoffs (i.e., $\pi_R^{\{1\}} = (1 + 2\alpha)/16 - K$ versus $\pi_R^{\{s\}} = (p_s + \gamma)z_s - K = (1 + \gamma)^2/4 - K$) reveals that the retailer prefers $\{1\}$ over $\{s\}$ when α is high relative to γ.

Comparisons between the assortments with two products lead to similar insights. Specifically, as we formalize in the next proposition, the retailer always prefers $\{1, s\}$ over $\{2, s\}$ because of the quality difference between the two NBs. In addition, the retailer prefers $\{1, 2\}$ over $\{1, s\}$ when α is high relative to γ. In summary, we find that $\{2\}$ or $\{2, s\}$ can never be the optimal assortment because of the second NB's quality disadvantage. Moreover, a high α makes the NBs more attractive, whereas a high γ makes the SB more attractive for the retailer.

In the second step, the retailer identifies the optimal assortment by comparing the payoffs of the following assortments: $\emptyset$, the best assortment of size one (either $\{1\}$ or $\{s\}$), the best assortment of size two (either $\{1,2\}$ or $\{1,s\}$), and $\{1,2,s\}$. The fixed cost K becomes relevant in these comparisons. Intuitively, a large K forces the retailer to carry a small assortment. Nevertheless, even when K is relatively large, the retailer may still carry a large assortment if α and γ are also large. Thus, the characterization of the optimal assortment requires a joint analysis of all three model parameters, α, γ, and K. Proposition 1 formally characterizes the set of parameters in which each assortment is optimal. For expositional clarity, we illustrate those sets in Figure 2 and provide their definitions in the proof of Proposition 1.

Proposition 1. *For $\alpha \geq 0$, $\gamma \in [0,1]$, and $K \geq 0$, the optimal assortment is*

$$\mathscr{A}^*(\alpha,\gamma,K) = \begin{cases} \emptyset & \text{if } (\alpha,\gamma,K) \in \Omega_1, \\ \{s\} & \text{if } (\alpha,\gamma,K) \in \Omega_2, \\ \{1,2\} & \text{if } (\alpha,\gamma,K) \in \Omega_3, \\ \{1,s\} & \text{if } (\alpha,\gamma,K) \in \Omega_4, \\ \{1,2,s\} & \text{if } (\alpha,\gamma,K) \in \Omega_5, \end{cases} \tag{11}$$

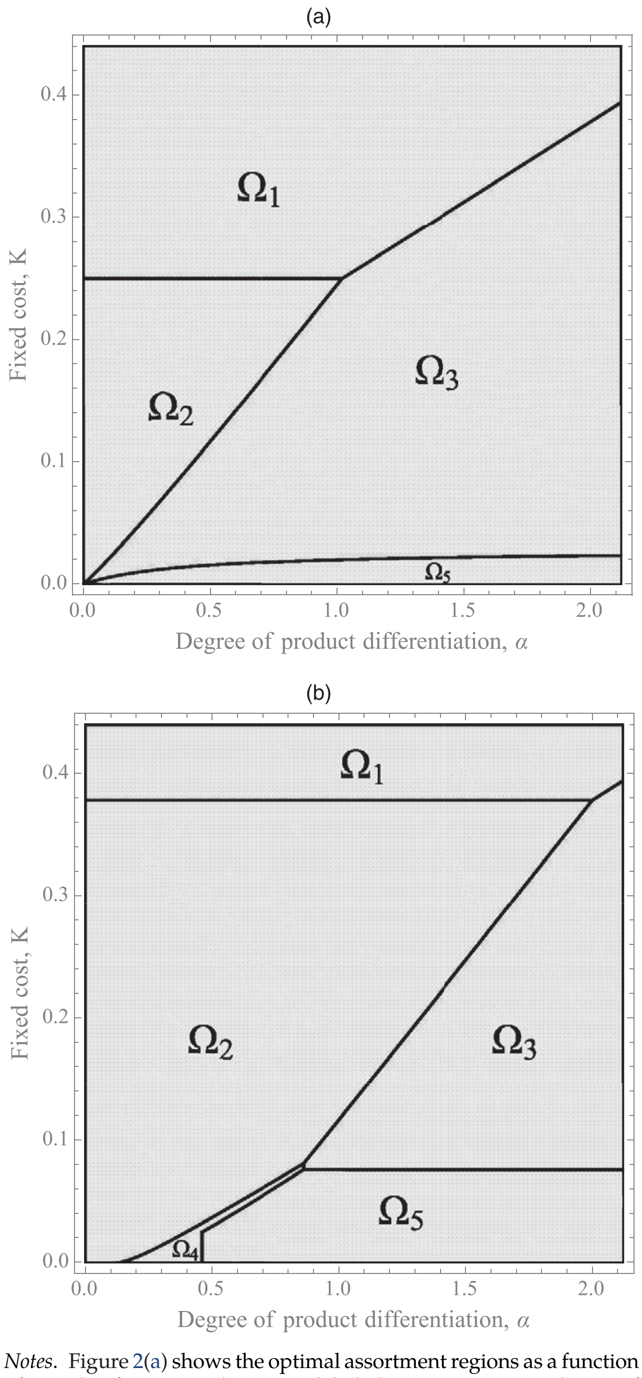
where $\Omega_1,\ldots,\Omega_5$ are formally defined in Equations (14)–(18) *in the proof of the proposition. Furthermore, Ω_4 is an empty set when $\gamma = 0$.*

The proof of Proposition 1 shows that—similar to $\{2\}$ and $\{2,s\}$—$\{1\}$ is inferior to one of the remaining assortments for all (α,γ,K). The rest of the proof constructs the sets $\Omega_1,\ldots,\Omega_5$, which are mutually exclusive and exhaustive subsets of all feasible (α,γ,K). Thus, the optimal assortment is one of the assortments presented in Equation (11). Furthermore, we show that $\{1,s\}$ cannot be the optimal assortment when there is no SB spillover (i.e., $\gamma = 0$).

Because the NB manufacturers set their wholesale prices after the retailer selects its assortment, carrying a product with zero demand would increase the retailer's assortment cost, $K|\mathscr{A}|$, without changing the wholesale prices, retail prices, or demands for the other products in the assortment. Thus, in contrast to settings in which the retailer carries a zero-demand SB to put price pressure on the NBs (e.g., Chen et al. 2011), the retailer in our setting only carries products with positive demand in its assortment (i.e., $z_i > 0$ for all $i \in \mathscr{A}^*$).

Figure 2(a) illustrates Ω_1, Ω_2, Ω_3, and Ω_5 in the absence of SB spillover and leads to insights into the roles of α and K. Consistent with prior research (e.g., Pan and Honhon 2012, Amaldoss and Shin 2015), the optimal assortment size, $|\mathscr{A}^*|$, decreases in the fixed cost K. Although the retailer carries all three products for small K values and does not offer the category for large K values (Ω_5 and Ω_1 in Figure 2(a), respectively), medium K values create a trade-off between the SB and the NBs. The degree of product differentiation, α, captures

Figure 2. Illustration of Proposition 1 for $\gamma = 0$ and $\gamma = 0.2$



Notes. Figure 2(a) shows the optimal assortment regions as a function of α and K for $\gamma = 0$. The region labeled as Ω_1 represents the set of $(\alpha, 0, K)$ in which the optimal assortment is $\emptyset$. Similarly, the regions labeled as Ω_2, Ω_3, and Ω_5 represent the set of $(\alpha, 0, K)$ in which the optimal assortment is $\{s\}$, $\{1,2\}$, and $\{1,2,s\}$, respectively. Figure 2(b) shows the optimal assortment regions as a function of α and K for $\gamma = 0.2$. The regions labeled as Ω_1, Ω_2, Ω_3, Ω_4, and Ω_5 represent the set of (α,γ,K) in which the optimal assortment is $\emptyset$, $\{s\}$, $\{1,2\}$, $\{1,s\}$, and $\{1,2,s\}$, respectively.

this trade-off. A small α implies that the quality differential between the SB and NBs is small. As a result, the retailer prefers the SB because it is not subject to double marginalization. When α is large, the large quality differentials between the SB and NBs force the retailer to carry the NBs. Accordingly, when K has a medium value, $\{s\}$ is optimal for small α values and $\{1,2\}$ is optimal for large α values (i.e., Ω_2 and Ω_3 in Figure 2(a), respectively). Thus, we conclude that the SB is more prevalent in categories in which α is small. This is consistent with practice wherein SB market shares are strongest in categories in which consumers perceive little differentiation such as paper products (Nielsen 2014).

Figure 2(b) shows that the impacts of α and K remain qualitatively similar when there is SB spillover (i.e., when $\gamma > 0$). Nevertheless, a comparison of Figures 2(a) and 2(b) reveals that the retailer might deviate from the category profit-maximizing assortment to take SB spillover into account. Table 1 lists all possible assortment transitions that can emerge when the retailer shifts from category profit maximization ($\gamma = 0$) to maximizing its payoff. Note that in four cases, the retailer keeps its assortment unchanged, whereas the remaining six cases result in assortment changes. These assortment configurations lead to two main observations. First, SB spillover may lead to $\mathscr{A}^*(\alpha,\gamma,K) = \{1,s\}$, which the retailer never offers under a category profit maximization objective (i.e., $\gamma = 0$). Second, SB spillover (i) may lead to an increase in the assortment size (e.g., a switch from $\{1,2\}$ to $\{1,2,s\}$), (ii) may change the assortment composition while keeping the assortment size unchanged (e.g., a switch from $\{1,2\}$ to $\{1,s\}$), or (iii) may lead to a decrease in the assortment size (e.g., a switch from $\{1,2,s\}$ to $\{s\}$).

A common feature of the six assortment changes is that they all enable the retailer to increase its SB's market share. Indeed, SB spillover expands the set of (α,K) values in which the retailer includes the SB in its assortment. We can observe this result by comparing $\Omega_2 \cup \Omega_5$ in Figure 2(a), where Ω_2 and Ω_5 are the two sets in which the retailer offers the SB when $\gamma = 0$, and $\Omega_2 \cup \Omega_4 \cup \Omega_5$ in Figure 2(b), where Ω_2, Ω_4, with Ω_5 are the three sets in which the retailer offers the SB when $\gamma > 0$. Similarly, SB spillover shrinks the set of (α,K) values in which the retailer offers the NBs. We can observe this result by comparing $\Omega_3 \cup \Omega_5$ in Figure 2(a) with $\Omega_3 \cup \Omega_4 \cup \Omega_5$ in Figure 2(b).

Table 1. Possible Assortment Transitions When the Retailer Switches from Category Profit Maximization ($\gamma = 0$) to Payoff Maximization ($\gamma > 0$)

	$\mathscr{A}^*(\alpha,\gamma,K)$ for $\gamma > 0$				
$\mathscr{A}^*(\alpha,0,K)$	$\varnothing$	$\{s\}$	$\{1,2\}$	$\{1,s\}$	$\{1,2,s\}$
$\varnothing$	✓	✓			
$\{s\}$		✓			
$\{1,2\}$		✓	✓	✓	✓
$\{1,2,s\}$		✓		✓	✓

In summary, we have so far characterized the optimal assortment and the corresponding retail and wholesale prices. Next, we study the impact of SB spillover on the retailer, focal category, and NB manufacturers.

5. Impact of SB Spillover

5.1. Impact on the Retailer

A common assumption in the category management literature is that retailers seek to maximize category profitability (Zenor 1994, Basuroy et al. 2001). Accordingly, we analyze a setting in which the retailer (or the category manager) overlooks SB spillover and seeks to maximize category profitability. Clearly, overlooking SB spillover can never make the retailer better off. Nevertheless, our goal is to better understand the drivers of the retailer's financial loss by analyzing (i) how the model parameters affect the retailer's loss and (ii) when overlooking SB spillover is most harmful to the retailer. To formally analyze the retailer's loss due to overlooking SB spillover, we define

$$\Delta\Pi_R(\alpha,\gamma,K) \equiv \Pi_R^*(\alpha,\gamma,K) - (\pi_R^*(\alpha,0,K) + \gamma z_s^*(\alpha,0,K)). \tag{12}$$

The first part of Equation (12), $\Pi_R^*(\alpha,\gamma,K)$, is the retailer's equilibrium payoff when it selects its assortment and sets retail prices by taking SB spillover into account. The second part of Equation (12), $\pi_R^*(\alpha,0,K) + \gamma z_s^*(\alpha,0,K)$, is the retailer's payoff when it makes pricing and assortment decisions to maximize its category profit without taking SB spillover into account. Note that despite overlooking SB spillover, the category profit-maximizing actions create some SB spillover, $\gamma z_s^*(\alpha,0,K)$, for the retailer as long as $z_s^*(\alpha,0,K) > 0$. Proposition 2 examines how changes in the model parameters affect the retailer's loss, $\Delta\Pi_R$.

Proposition 2. *For each feasible assortment transition listed in Table 1, the signs of the partial derivatives of $\Delta\Pi_R$ with respect to α, γ, and K are as follows:*

		Sign of the partial derivative		
$\mathscr{A}^*(\alpha,0,K)$	$\mathscr{A}^*(\alpha,\gamma,K)$	$\frac{\partial\Delta\Pi_R(\alpha,\gamma,K)}{\partial\alpha}$	$\frac{\partial\Delta\Pi_R(\alpha,\gamma,K)}{\partial\gamma}$	$\frac{\partial\Delta\Pi_R(\alpha,\gamma,K)}{\partial K}$
$\varnothing$	$\varnothing$	0	0	0
$\varnothing$	$\{s\}$	0	+	−
$\{s\}$	$\{s\}$	0	+	0
$\{1,2\}$	$\{1,2\}$	0	0	0
$\{1,2\}$	$\{1,s\}$	−	+	0
$\{1,2\}$	$\{s\}$	−	+	+
$\{1,2\}$	$\{1,2,s\}$	+/−	+	−
$\{1,2,s\}$	$\{s\}$	−	+	+
$\{1,2,s\}$	$\{1,s\}$	−	+	+
$\{1,2,s\}$	$\{1,2,s\}$	−	+	0

where +, −, and 0 indicate that the partial derivative is positive, negative, and zero, respectively, and +/− indicates that the partial derivate can be positive or negative, depending on the parameters.

$\Delta\Pi_R$ does not depend on the degree of product differentiation, α, in the first four rows listed in Proposition 2. Conversely, $\partial\Delta\Pi_R/\partial\alpha = 0$ for these four assortment transitions. $\partial\Delta\Pi_R/\partial\alpha \le 0$ in five of the remaining six cases. That is, an increase in α mitigates the loss the retailer incurs because of overlooking SB spillover. This is because an increase in α makes the NBs more profitable for the retailer. Consequently, overlooking SB spillover becomes less damaging because the NBs' contribution to the retailer's payoff increases. The only exception to this result emerges when $\mathcal{A}^*(\alpha, 0, K) = \{1, 2\}$ and $\mathcal{A}^*(\alpha, \gamma, K) = \{1, 2, s\}$ because an increase in α increases the payoffs of $\{1, 2\}$ and $\{1, 2, s\}$ at different rates due to the SB presence in $\mathcal{A}^*(\alpha, \gamma, K)$. As a result, $\Delta\Pi_R$ is nonmonotone in α.

As expected, when the SB is in the optimal assortment, an increase in γ makes overlooking SB spillover more detrimental to the retailer (i.e., $\partial\Delta\Pi_R/\partial\gamma \ge 0$ when $\{s\} \subseteq \mathcal{A}^*(\alpha, \gamma, K)$). In contrast, $\partial\Delta\Pi_R/\partial K$ may be zero, positive, or negative, depending on whether and how taking SB spillover into account affects the assortment size. In particular, $\partial\Delta\Pi_R/\partial K = 0$ when SB spillover does not change the assortment size, and $\partial\Delta\Pi_R/\partial K < 0$ when $|\mathcal{A}^*(\alpha, \gamma, K)| > |\mathcal{A}^*(\alpha, 0, K)|$. In such cases, taking SB spillover into account creates additional fixed costs for the retailer because of the increase in the assortment size. Conversely, when $|\mathcal{A}^*(\alpha, \gamma, K)| < |\mathcal{A}^*(\alpha, 0, K)|$, an increase in K increases the retailer's loss. In such cases, the retailer not only suffers from not reaping the full benefit of SB spillover but also incurs higher fixed costs because of carrying a larger assortment.

Although the above comparative statics are useful for understanding how changes in the model parameters affect the loss the retailer incurs because of overlooking SB spillover, they do not reveal the magnitude of the retailer's loss. Because of the analytical complexity of $\Delta\Pi_R$, we rely on a numerical study to identify the cases in which overlooking SB spillover results in the largest losses for the retailer. Specifically, we calculate $\Delta\Pi_R$ for 86,961 unique (α, γ, K) combinations. Table 2 reports the average absolute and percentage losses the retailer incurs because of overlooking SB spillover for each feasible assortment transition listed in Table 1. (See the notes to Table 2 for the details of our numerical study.)

Table 2 reveals two important insights regarding the magnitude of the loss the retailer incurs because of overlooking SB spillover. First, the retailer's loss is relatively small when it selects the right assortment (i.e., when $\mathcal{A}^*(\alpha, 0, K) = \mathcal{A}^*(\alpha, \gamma, K)$) but fails to adjust its prices to take SB spillover into account. For

Table 2. Retailer's Average Loss Due to Overlooking SB Spillover

$\mathcal{A}^*(\alpha, 0, K)$	$\mathcal{A}^*(\alpha, \gamma, K)$	$\Delta\Pi_R(\alpha, \gamma, K)$	$\frac{\Delta\Pi_R(\alpha, \gamma, K)}{\Pi_R^*(\alpha, \gamma, K)}$
$\varnothing$	$\{s\}$	0.31	100.00%
$\{1, 2\}$	$\{s\}$	0.30	56.71%
$\{1, 2, s\}$	$\{s\}$	0.38	48.64%
$\{1, 2\}$	$\{1, s\}$	0.26	34.25%
$\{1, 2, s\}$	$\{1, s\}$	0.24	29.45%
$\{1, 2\}$	$\{1, 2, s\}$	0.11	16.13%
$\{s\}$	$\{s\}$	0.08	15.24%
$\{1, 2, s\}$	$\{1, 2, s\}$	0.09	10.99%
$\{1, 2\}$	$\{1, 2\}$	0.00	0.00%
$\varnothing$	$\varnothing$	0.00	—

Notes. We calculate $\Delta\Pi_R$ for 86,961 unique scenarios generated from 21 values of α, 101 values of γ, and 41 values of K. Specifically, α ranges from 0 to 2 in increments of 0.1, γ ranges from 0 to 1 in increments of 0.01, and K ranges from 0 to 0.4 in increments of 0.01. Focusing on γ values between 0 and 1 is consistent with our assumption that $\gamma \in [0, 1]$. Restricting α to be between 0 and 2 and K to be between 0 and 0.4 enables us to remain consistent with the ranges we use in Figure 2. In our robustness tests, which we do not report in the paper because of space limitations, we verify that analyzing wider ranges of α and K does not change our qualitative insights. We list the feasible assortment transitions in a descending order based on the average percentage loss the retailer incurs because of overlooking SB spillover. The percentage loss is undefined in the last row because $\Pi_R^*(\alpha, \gamma, K) = 0$ when $\mathcal{A}^*(\alpha, \gamma, K) = \varnothing$. The first six cases (the last four cases) are the ones in which taking SB spillover into account requires (does not require) an assortment change.

example, the retailer's average loss is 10.99% when $\mathcal{A}^*(\alpha, 0, K) = \mathcal{A}^*(\alpha, \gamma, K) = \{1, 2, s\}$. However, the average loss is much higher when the retailer fails to carry the right assortment. For example, when $\mathcal{A}^*(\alpha, 0, K) = \{1, 2\}$ and $\mathcal{A}^*(\alpha, \gamma, K) = \{1, s\}$, overlooking SB spillover and thereby including the low-quality NB (rather than the SB) in the assortment leads to a 34.25% loss for the retailer, on average. Second, among the cases in which the retailer fails to carry the right assortment, the retailer incurs the largest losses when $\mathcal{A}^*(\alpha, \gamma, K) = \{s\}$, but it instead carries another assortment (i.e., $\varnothing$, $\{1, 2\}$, or $\{1, 2, s\}$) because of its focus on maximizing its category profit. These three cases have the biggest deviations from the optimal SB market share (i.e., $z_s^*(\alpha, \gamma, K) - z_s^*(\alpha, 0, K)$). Consequently, the retailer incurs the largest losses.

In summary, the retailer incurs the largest losses when it fails to adjust its assortment to take SB spillover into account, whereas its losses are relatively small when it carries the right assortment but fails to adjust its prices. Thus, our findings suggest that the empirical studies that focus only on the pricing impact of SB spillover without considering assortment effects (e.g., Chintagunta 2002, Meza and Sudhir 2010) may underestimate the impact of SB spillover on a retailer's category management strategy as well as the financial losses associated with overlooking SB spillover.

5.2. Impact on the Focal Category

In our model, SB spillover may require the retailer to deviate from category profit maximization.

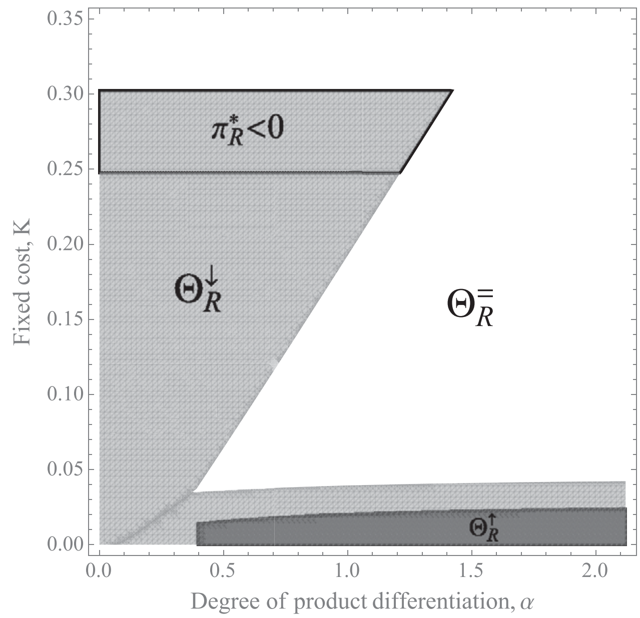
Chintagunta (2002, p. 151), who empirically examines a similar setting in which the retailer's objective function is a weighted sum of category profit and the SB market share, argues that "the retailer is willing to give up some [category] profits in pursuing a higher share for the store brand." Accordingly, we examine whether SB spillover necessitates that the retailer gives up category profits in our setting. To do so, we define $\Delta\pi_R(\alpha,\gamma,K) \equiv \pi_R^*(\alpha,\gamma,K) - \pi_R^*(\alpha,0,K)$ to formally assess the impact of SB spillover on the retailer's category profit. Proposition 3 examines $\Delta\pi_R$.

Proposition 3. *SB spillover does not affect the retailer's category profit (i.e., $\Delta\pi_R = 0$) when $(\alpha,\gamma,K) \in \Theta_R^{=}$, increases the retailer's category profit (i.e., $\Delta\pi_R > 0$) when $(\alpha,\gamma,K) \in \Theta_R^{\uparrow}$, and decreases the retailer's category profit (i.e., $\Delta\pi_R < 0$) when $(\alpha,\gamma,K) \in \bar{\Theta}_R^{\downarrow}$, where $\Theta_R^{=}$, $\Theta_R^{\uparrow}$, and $\Theta_R^{\downarrow}$ are formally defined in the proof of the proposition in Equations* (19)–(21), *respectively. Furthermore, the retailer's category profit is negative (i.e., $\pi_R^*(\alpha,\gamma,K) < 0$) when $(\alpha,\gamma,K) \in \Theta_R^{-}$. Θ_R^{-}, which is a subset of $\Theta_R^{\downarrow}$, is formally defined in the proof of the proposition in Equation* (22).

Figure 3 illustrates the sets $\Theta_R^{=}$, $\Theta_R^{\uparrow}$, $\Theta_R^{\downarrow}$, and Θ_R^{-} as a function of α and K for a specific γ value. The set $\Theta_R^{=}$ includes (α,γ,K) values for which the optimal assortment is either $\varnothing$ or $\{1,2\}$ both when $\gamma = 0$ and $\gamma > 0$. The retailer's category profit remains unchanged for such (α,γ,K) values because SB spillover is insufficient to justify the addition of the SB to the assortment. Notably, $\Theta_R^{\uparrow}$ and $\Theta_R^{\downarrow}$ include (α,γ,K) values for which the retailer makes price and, in some cases, assortment changes, which affect product demands as well as the retailer's unit margins. That is, the retailer, indeed, gives up category profits to increase SB market share in some cases, but in other cases, SB spillover enables the retailer to increase its category profit. We illustrate $\Theta_R^{\downarrow}$ and $\Theta_R^{\uparrow}$ with two examples. Table 3 provides a summary of our examples.

Example 1. In this example, we focus on the set of (α,γ,K) values for which $\mathscr{A}^*(\alpha,0,K) = \mathscr{A}^*(\alpha,\gamma,K) = \{s\}$. The retailer increases the SB's market share by lowering its price. The increase in the SB demand from $1/2$ to $(1+\gamma)/2$ is insufficient to offset the decrease in the SB's margin from $1/2$ to $(1-\gamma)/2$. Consequently, the retailer's category profit decreases (i.e., $\Delta\pi_R = -\gamma^2/4 < 0$). Moreover, when $\gamma > \sqrt{1-4K}$, $\pi_R^*(\alpha,\gamma,K) = (1-\gamma^2)/4 - K < 0$. That is, a high degree of SB spillover (i.e., a large γ) requires the retailer to offer the category at a loss because when γ is large, the SB's total gross margin, which decreases from $1/4$ to $(1-\gamma^2)/4$, is insufficient to cover the fixed cost, K. In this example, the impact of SB spillover on the retailer's pricing decisions and category profit is consistent with the loss-leader phenomenon in retailing in which retailers reduce prices of some products or categories to attract consumers to their stores, in the hope that they will also purchase other, more profitable products (e.g., Hess and Gerstner 1987, Li et al. 2013).

Figure 3. Illustration of Proposition 3 for $\gamma = 0.1$



Notes. The area labeled as $\Theta_R^{\uparrow}$ represents the set of (α,K) in which switching from $\gamma = 0$ to $\gamma = 0.1$ increases the retailer's equilibrium category profit. $\Theta_R^{=}$ represents the set of (α,K) in which switching from $\gamma = 0$ to $\gamma = 0.1$ does not affect the retailer's equilibrium category profit. $\Theta_R^{\downarrow}$ represents the set of (α,K) in which switching from $\gamma = 0$ to $\gamma = 0.1$ decreases the retailer's equilibrium category profit. The area labeled as $\pi_R^* < 0$ is a subset of $\Theta_R^{\downarrow}$ and represents the set of (α,K) in which the retailer's category profit is negative.

Example 2. In this example, we focus on the set of (α,γ,K) values for which $\mathscr{A}^*(\alpha,0,K) = \mathscr{A}^*(\alpha,\gamma,K) = \{1,2,s\}$. Such (α,γ,K) values are depicted in the lower right-hand corner of Figure 3. Table 3 shows that SB spillover decreases the demand for the NBs and increases the SB demand. These observations are well aligned with the retailer's desire to increase its SB's market share to take advantage of SB spillover. The increase in the SB demand is driven by the reduction in the SB's retail price. In other words, the retailer sells more of its SB at a lower margin. In contrast, SB spillover increases the retailer's unit margins from the NBs. This finding is directionally consistent with the finding in the literature that SB presence helps a retailer receive better terms of trade (e.g., lower wholesale prices) from the NB manufacturers (e.g., Narasimhan and Wilcox 1998, Scott Morton and Zettelmeyer 2004). Our example goes one step further and suggests that SB spillover puts additional pressure on the NB manufacturers to further reduce their wholesale prices.

This example reveals that taking SB spillover into account may increase the retailer's category profit.

Table 3. Two Examples on the Impact of SB Spillover on the Retailer's Category Profit

	Example 1		Example 2	
Performance metric	$\gamma = 0$	$\gamma > 0$	$\gamma = 0$	$\gamma > 0$
Optimal assortment, $\mathscr{A}^*(\alpha, \gamma, K)$	$\{s\}$	$\{s\}$	$\{1, 2, s\}$	$\{1, 2, s\}$
High-quality NB demand, z_1			$\frac{2}{7}$	$\frac{2}{7} - \frac{\gamma}{14\alpha}$
Low-quality NB demand, z_2			$\frac{1}{7}$	$\frac{1}{7} - \frac{2\gamma}{7\alpha}$
SB demand, z_s	$\frac{1}{2}$	$\frac{1+\gamma}{2}$	$\frac{1}{14}$	$\frac{1}{14} + \frac{\gamma}{2} + \frac{5\gamma}{14\alpha}$
High-quality NB margin, $p_1 - w_1$			$\frac{1}{2} + \frac{5\alpha}{7}$	$\frac{1}{2} + \frac{5\alpha}{7} + \frac{\gamma}{14}$
Low-quality NB margin, $p_2 - w_2$			$\frac{1}{2} + \frac{3\alpha}{7}$	$\frac{1}{2} + \frac{3\alpha}{7} + \frac{\gamma}{7}$
SB margin, $p_s - w_s$	$\frac{1}{2}$	$\frac{1-\gamma}{2}$	$\frac{1}{2}$	$\frac{1-\gamma}{2}$
Category profit, $\pi_R^*(\alpha, \gamma, K)$	$\frac{1}{4} - K$	$\frac{1-\gamma^2}{4} - K$	$\frac{1}{4} + \frac{13\alpha}{49} - 3K$	$\frac{1-\gamma^2}{4} + \frac{13\alpha+4\gamma}{49} - \frac{11\gamma^2}{49\alpha} - 3K$

Specifically, the change in the retailer's category profit due to SB spillover is

$$\Delta\pi_R(\alpha, \gamma, K) = \pi_R^*(\alpha, \gamma, K) - \pi_R^*(\alpha, 0, K) = \frac{\gamma(16\alpha - 49\alpha\gamma - 44\gamma)}{196\alpha}, \quad (13)$$

which is positive when $\gamma < 16\alpha/(44 + 49\alpha)$. For such small γ values, combining higher NB margins with the increase in the SB demand leads to an increase in the retailer's category profit. In contrast, when γ is relatively large (i.e., $\gamma \geq 16\alpha/(44 + 49\alpha)$), the retailer shifts most of the demand to its SB, but the SB margin, $(1 - \gamma)/2$, becomes so small that the retailer's category profit declines.

More generally, the retailer's category profit decreases when (i) it cannot justify offering the category in the absence of SB spillover but offers the category in the presence of SB spillover (i.e., (α, γ, K) such that $\mathscr{A}^*(\alpha, 0, K) = \varnothing$ and $\mathscr{A}^*(\alpha, \gamma, K) = \{s\}$), (ii) it removes one or both NBs from the assortment (e.g., (α, γ, K) such that $\mathscr{A}^*(\alpha, 0, K) = \{1, 2, s\}$ and $\mathscr{A}^*(\alpha, \gamma, K) = \{1, s\}$), and (iii) it keeps both NBs in the assortment while steeply reducing the SB's retail price to take advantage of the high degree of SB spillover (e.g., (α, γ, K) such that $\mathscr{A}^*(\alpha, 0, K) = \mathscr{A}^*(\alpha, \gamma, K) = \{1, 2, s\}$ and γ is relatively large). Indeed, making steep price reductions may require the retailer to offer the category at a loss. Nevertheless, the retailer does not always need to give up category profits to take SB spillover into account. In particular, SB spillover increases the retailer's category profit when α is relatively large and γ is relatively small so that the retailer carries all three products in its assortment (i.e., $\mathscr{A}^*(\alpha, \gamma, K) = \{1, 2, s\}$) without cutting retail prices too much. This finding reveals a key feature of SB spillover: As long as the degree of SB spillover is not too high, SB spillover can lead to a situation in which the retailer simultaneously increases its SB's market share and category profit.

In summary, SB spillover has four main implications for the retailer's category profitability. First, it may enable the retailer to earn higher unit margins from the NBs. Second, when the degree of SB spillover is low, the retailer's category profit may increase. Third, when the degree of SB spillover is high, the retailer's category profit may decrease. Fourth, when the degree of SB spillover is high, the profit decrease might be so steep that the retailer may lose money from the focal category.

5.3. Impact on the NB Manufacturers

The relevant SB literature (e.g., Chintagunta 2002, Meza and Sudhir 2010) is silent on the impact of the retailer's deviations from category profit maximization on the NB manufacturers. In contrast, our setting with one low-quality and one high-quality NB enables us to examine the impact of SB spillover on the NB manufacturers. Our pricing analysis for a given assortment reveals that SB spillover decreases the demand for NB products and their wholesale prices. However, the impact of assortment changes on these two factors is difficult to predict a priori. Therefore, we define $\Delta\pi_i(\alpha, \gamma, K) \equiv \pi_i^*(\alpha, \gamma, K) - \pi_i^*(\alpha, 0, K)$ for $i = 1, 2$ to formally assess the impact of SB spillover on the NB manufacturers. Proposition 4 examines $\Delta\pi_1$ and $\Delta\pi_2$.

Proposition 4. *SB spillover does not affect the high-quality NB manufacturer (i.e., $\Delta\pi_1 = 0$) when $(\alpha, \gamma, K) \in \Theta_1^{=}$. The high-quality NB manufacturer benefits from SB spillover (i.e., $\Delta\pi_1 > 0$) when $(\alpha, \gamma, K) \in \Theta_1^{\uparrow}$ and suffers from SB spillover (i.e., $\Delta\pi_1 < 0$) when $(\alpha, \gamma, K) \in \Theta_1^{\downarrow}$, where $\Theta_1^{=}$, $\Theta_1^{\uparrow}$, and $\Theta_1^{\downarrow}$ are formally defined in the proof of the proposition in Equations* (23)–(25), *respectively.*

The low-quality NB manufacturer never benefits from SB spillover. In particular, SB spillover does not affect the low-quality NB manufacturer (i.e., $\Delta\pi_2 = 0$) when $(\alpha, \gamma, K) \in \Theta_2^{=}$ but hurts the low-quality NB manufacturer (i.e., $\Delta\pi_2 < 0$) when $(\alpha, \gamma, K) \in \Theta_2^{\downarrow}$, where $\Theta_2^{=}$ and $\Theta_2^{\downarrow}$ are formally defined in the proof of the proposition in Equations (26) *and* (27), *respectively.*

SB spillover has no impact on the low-quality NB manufacturer if its product is not in the assortment when $\gamma = 0$. That is, $\Theta_2^{=}$ includes (α, K) values for which

$\mathscr{A}^*(\alpha, 0, K) = \varnothing$ or $\mathscr{A}^*(\alpha, 0, K) = \{s\}$. Intuitively, if the low-quality NB is not in the assortment when $\gamma = 0$, the retailer does not include this product in its assortment when $\gamma > 0$. Thus, the low-quality NB manufacturer has zero profit regardless of whether $\gamma = 0$ or $\gamma > 0$ in those cases. $\Theta_2^{=}$ also includes (α, γ, K) values for which $\mathscr{A}^*(\alpha, 0, K) = \mathscr{A}^*(\alpha, \gamma, K) = \{1, 2\}$. That is, if SB spillover is insufficient for the retailer to deviate from $\{1, 2\}$, the low-quality NB manufacturer's profit remains unchanged.

The set $\Theta_2^{\downarrow}$ includes the cases in which the retailer (i) removes the low-quality NB from the assortment (e.g., a switch from $\{1, 2\}$ to $\{s\}$), (ii) adds the SB to the assortment while keeping the low-quality NB in the assortment (e.g., a switch from $\{1, 2\}$ to $\{1, 2, s\}$), or (iii) continues to carry the low-quality NB in the assortment along with the SB (e.g., $\mathscr{A}^*(\alpha, 0, K) = \mathscr{A}^*(\alpha, \gamma, K) = \{1, 2, s\}$). The low-quality NB manufacturer's profit decreases in these cases because it lowers its wholesale price and loses market share to the SB.

The high-quality NB manufacturer's experience is similar to that of the low-quality NB manufacturer in most cases. For example, SB spillover does not affect its profit if its product is not in the assortment when $\gamma = 0$. Similarly, its profit declines when its product is removed from the assortment (e.g., a switch from $\{1, 2, s\}$ to $\{s\}$). However, in contrast with the low-quality NB manufacturer, the high-quality NB manufacturer may benefit from SB spillover in some cases. Specifically, $\Theta_1^{\uparrow}$ includes some (α, γ, K) values for which the retailer removes the low-quality NB from the assortment while keeping the high-quality NB in the assortment. Figure 4 illustrates this possibility with a numerical example in which we show how $\Delta\pi_1(\alpha, \gamma, K)$ changes in γ for fixed α and K. For $\gamma \in [0, 0.65)$, the optimal assortment is $\{1, 2\}$, which implies that SB spillover has no impact on category decisions and performance (i.e., $\Delta\pi_1 = 0$). When $\gamma \in [0.65, 0.89)$, the retailer carries $\{1, 2, s\}$, and the high-quality NB suffers from SB spillover (i.e., $\Delta\pi_1 < 0$). The optimal assortment is $\{1, s\}$ for $\gamma \in [0.89, 1]$. Note that the high-quality NB's profit is higher in this region than in the base case in which there is no SB spillover (i.e., $\Delta\pi_1 > 0$).

The main driver of the increase in the high-quality NB manufacturer's profit is that the quality differential between the high- and low-quality NBs (i.e., $q_1 - q_2 = \alpha$) is smaller than that between the high-quality NB and the SB (i.e., $q_1 - q_s = 2\alpha$). In other words, the competition between the two NBs is more intense than that between the high-quality NB and the SB. As a result, the retailer's switch from $\mathscr{A}^*(\alpha, 0, K) = \{1, 2\}$ to $\mathscr{A}^*(\alpha, \gamma, K) = \{1, s\}$ enables the high-quality NB manufacturer to charge a higher wholesale price for its product and thereby increase its profit. Continuing with our example, when $(\alpha, \gamma, K) = (3, 0, 1/4)$, $\mathscr{A}^* = \{1, 2\}$, $p_1^* = 4.38$, $w_1^* = 1.75$, and $z_1^* = 0.29$, which leads to $\pi_1^* = w_1^* z_1^* = 0.51$. In contrast, when $(\alpha, \gamma, K) = (3, 0.95, 1/4)$, $\mathscr{A}^* = \{1, s\}$, $p_1^* = 4.76$, $w_1^* = 2.53$, and $z_1^* = 0.21$, which leads to $\pi_1^* = w_1^* z_1^* = 0.53$. Therefore, $\Delta\pi_1 = 0.53 - 0.51 = 0.02$.

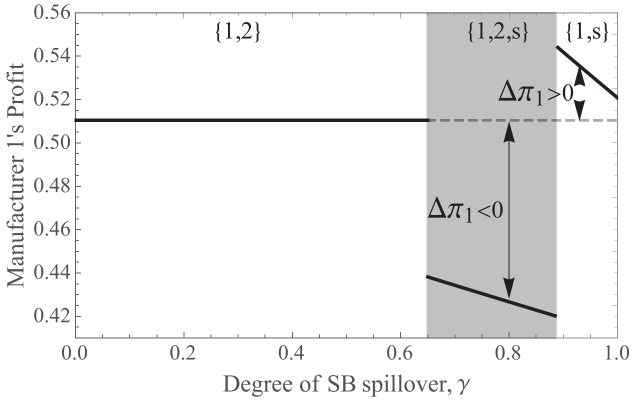
In summary, we find that SB spillover is never beneficial for the low-quality NB manufacturer because it is a close competitor to the SB. As such, any action taken to increase the SB's market share hurts the low-quality NB manufacturer. In contrast, SB spillover may be beneficial for the high-quality NB manufacturer when the retailer removes the low-quality NB from its assortment. This is because the competition between the SB and the high-quality NB is less intense because of a larger quality differential between these two products.

5.4. Robustness Tests

Our study leads to three main managerial insights. First, overlooking SB spillover can result in suboptimal assortment and pricing decisions, leading to financial losses for the retailer. The retailer incurs the largest losses when it fails to adjust its assortment to take SB spillover into account, whereas its losses are relatively small when it carries the right assortment but fails to adjust its prices. Second, taking SB spillover into account decreases the retailer's category profit when the degree of SB spillover is high. However, a low degree of SB spillover may enable the retailer to simultaneously increase its category profit and SB market share. Third, SB spillover is never beneficial for the low-quality NB but may increase the high-quality NB's profit. In this section, we test the robustness of these insights by relaxing some of our modeling assumptions.

5.4.1. Production Costs and Quality Differentials. In our model, we assume zero production costs and equal quality differentials (i.e., $q_1 - q_2 = q_2 - q_s = \alpha$). In Section B.1 in the online supplement, we consider an alternative model in which we relax both assumptions. First, we set $(q_1, q_2, q_s) = (1 + \kappa\alpha, 1 + \alpha, 1)$, where $\kappa > 1$. In this case, $\kappa = 2$ corresponds to our original model with equal quality differentials. When $\kappa > 2$, the high-quality NB has a larger quality advantage over the other products, whereas $\kappa \in (1, 2)$ implies a smaller quality advantage. Second, we assume a convex production cost structure by setting $c_i(q_i) = \beta q_i^2$, where c_i denotes the production cost for $i \in \{1, 2, s\}$ with $\beta \geq 0$. Introducing β and κ as additional model parameters influences the equilibrium outcomes. For example, production costs increase the equilibrium wholesale and retail prices. Nevertheless, our three main managerial insights regarding the impact of SB spillover on the category stakeholders continue to hold. Thus, we conclude that our managerial insights are not driven by the equal quality differentials and/or the zero

Figure 4. High-Quality NB Manufacturer's Profit as a Function of γ



Notes. We generate this figure by setting $\alpha = 3$ and $K = 1/4$. The equilibrium assortment is $\{1, 2\}$ for $\gamma \in [0, 0.65)$, $\{1, 2, s\}$ for $\gamma \in [0.65, 0.89)$, and $\{1, s\}$ for $\gamma \in [0.89, 1]$. Here, $\Delta\pi_1 = 0$ when $\mathcal{A}^*(\alpha, \gamma, K) = \{1, 2\}$, $\Delta\pi_1 < 0$ when $\mathcal{A}^*(\alpha, \gamma, K) = \{1, 2, s\}$, and $\Delta\pi_1 > 0$ when $\mathcal{A}^*(\alpha, \gamma, K) = \{1, s\}$.

production costs assumptions. See Section B.1 in the online supplement for details.

5.4.2. Number of National Brand Manufacturers. Our model has two NB manufacturers. In Section B.2 in the online supplement, we study alternative models with three and four NBs. For analytical tractability and consistency with our original formulation, we assume zero production costs and set $(q_1, q_2, q_3, q_s) = (1 + 3\alpha, 1 + 2\alpha, 1 + \alpha, 1)$ in the model with three NBs. Similarly, we set $(q_1, q_2, q_3, q_4, q_s) = (1 + 4\alpha, 1 + 3\alpha, 1 + 2\alpha, 1 + \alpha, 1)$ in the model with four NBs. Although these models lead to larger assortments than our original model, our managerial insights regarding the retailer's loss associated with overlooking SB spillover and the impact of SB spillover on the retailer's category profit continue to hold. Moreover, we find that the lowest-quality NB that is in direct competition with the SB never benefits from SB spillover. However, medium- and high-quality NBs (i.e., the first two NBs in the model with three NBs and the first three NBs in the model with four NBs) may benefit from SB spillover due to the removal of their lower-quality competitors from the assortment. See Section B.2 in the online supplement for details.

5.4.3. Sequence of Events. In our model, the retailer moves first by selecting its assortment. The NBs move next and set their wholesale prices. Last, the retailer sets the retail prices. In Section B.3 in the online supplement, we analyze an alternative model in which the NB manufacturers move first by setting their wholesale prices and the retailer moves next by selecting its assortment and setting the retail prices. This alternative model has analytical challenges because the retailer's and the NB manufacturers' objective functions have discontinuities. Nevertheless, we numerically show that our managerial insights continue to hold when the NB manufacturers move first. See Section B.3 in the online supplement for details.

In summary, on the basis of the analyses presented in Section B in the online supplement, we conclude that our managerial insights are robust to alternative model formulations with respect to quality differentials, production costs, number of NB manufacturers, and sequence of events.

6. Conclusions

We analyze a retailer's category management strategy and interactions with its supply chain partners in a setting in which increasing the SB market share in the focal category improves the retailer's overall profitability by creating demand spillover to other categories. Our analysis focuses on a supply chain setting with one retailer, one high-quality NB manufacturer, and one low-quality NB manufacturer. We formulate the retailer's objective function as a weighted sum of category profit and the SB market share, where the weight assigned to the SB market share captures the degree of SB spillover. Comparing the equilibrium outcomes of this setting with those of a benchmark setting in which the retailer maximizes its category profit allows us to answer the following questions.

What is the impact of SB spillover on the retailer's category management strategy? We show that SB spillover requires the retailer to reduce the price of its SB, which leads to an increase in the SB's market share. In most cases, the NB manufacturers follow this price reduction by lowering their wholesale prices, enabling the retailer to sell the NBs at lower prices. Nonetheless, SB spillover may lead to an increase in the wholesale and retail prices of the high-quality NB when the retailer removes the low-quality NB from its assortment. The retailer may also remove the high-quality NB from its assortment when the degree of SB spillover is high. Thus, a high degree of SB spillover can lead to a decrease in the assortment size. However, when the degree of SB spillover is relatively low, the assortment size may increase or remain unchanged. Specifically, the retailer may increase the assortment size through the introduction of the SB. The retailer may also keep the assortment size unchanged by either retaining the category profit-maximizing assortment or replacing low-quality NB with the SB. Overall, our findings suggest that overlooking SB spillover can lead to suboptimal assortment and pricing decisions for the retailer.

What are the financial consequences of overlooking SB spillover for the retailer? We show that the magnitude of the retailer's loss depends on whether the retailer carries the right assortment. In particular, the retailer's loss is relatively small when the retailer offers the right assortment but fails to adjust its prices to take SB spillover into account. However, the retailer's loss is much larger when it fails to carry the right assortment. This is because the SB's market share, which determines the magnitude of SB spillover, is relatively less sensitive to the retail prices when the retailer carries the right assortment. Conversely, carrying a suboptimal assortment, especially when it is optimal to carry the SB as the only product in the assortment, can have a sizable impact on the SB's market share. These findings imply that the empirical studies that focus only on the pricing impact of SB spillover without considering assortment effects (e.g., Chintagunta 2002, Meza and Sudhir 2010) may underestimate the impact of SB spillover on a retailer's category management strategy as well as the financial losses associated with overlooking SB spillover.

How does taking SB spillover into account affect the retailer's category profit? The answer depends on the degree of SB spillover. When the degree of SB spillover is low, the retailer may simultaneously increase its category profit and SB market share. Thus, taking SB spillover into account does not necessarily mean lower category profits for the retailer. Nevertheless, the price and assortment changes associated with SB spillover lead to a decline in the retailer's category profit in many cases, especially when the retailer removes one or both NBs from its assortment. Indeed, when the degree of SB spillover is high, the price reductions may be so steep that the retailer may offer the category at a loss. These findings suggest that retailers need to set the right performance targets for their category managers to reap the full benefits of SB spillover. For example, rewarding a category manager based on her assigned category's profit may incentivize her to overlook SB spillover to keep her assigned category's profit high at the expense of lower profits in other categories. In other words, when there is SB spillover, incorporating the SB market share into the category manager's performance targets maybe necessary to align the category manager's incentives with the retailer's objective of maximizing store profitability.

How does SB spillover affect the NB manufacturers' profits? SB spillover is never beneficial for the low-quality NB manufacturer because its product closely competes with the SB, which is the lowest quality product in our model. Because of the close competition between the two products, any action the retailer takes to increase its SB's market share lowers the low-quality NB manufacturer's profit. Although SB spillover may also hurt the high-quality NB, in some cases, it may be beneficial for the high-quality NB manufacturer. In particular, the high-quality NB manufacturer's profit may increase when the retailer removes the low-quality NB from the assortment because such removal softens the competition in the category, which, in turn, enables the high-quality NB manufacturer to charge a higher wholesale price for its product. These findings imply that differentiating their products from SBs may help the NB manufacturers mitigate the adverse consequences of SB spillover.

In summary, we contribute to the literature by analyzing a retailer's pricing and assortment decisions in the presence of SB spillover and explaining how such decisions affect the retailer, the focal category, and the NB manufacturers. Our findings are based on a stylized model with several simplifying assumptions. We show the robustness of our managerial insights by relaxing some of our assumptions (e.g., unequal quality differentials and the number of NB manufacturers in the category). Future research may relax our remaining assumptions to generalize our findings. Specifically, we assume that the SB has the lowest quality in the category. Given the rise of high-quality SBs, in practice, it would be useful to examine the impact of SB spillover in settings in which the retailer offers a premium SB. Our prediction regarding the impact of SB spillover on the NB manufacturers may reverse in such settings because the SB may closely compete with the premium NBs, and therefore the low-quality NB manufacturers that are not in close competition with the SB may end up benefiting from SB spillover. In addition, we assume that the quality component of our model represents the perceived quality differences between the SB and the NBs. As such, we assume exogenous quality levels. Investigating an alternative setting in which the retailer and/or the NB manufacturers optimize the quality levels of their products might be useful to understand how SB spillover affects product positioning in a category. Nonetheless, analytical tractability would be an obstacle because of the addition of a quality optimization stage to a three-player, three-stage game. Finally, given the right data, it would be fruitful to empirically examine how SB spillover affects retailers' assortment and pricing decisions as well as their interactions with NB manufacturers. We hope that our research will generate further interest in understanding the operational implications of store brands.

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