Managing Price Promotions Within a Product Line

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Abstract

In this paper, I investigate the question of how a firm producing substitutes should coordinate price promotions of these products. I model price competition between two firms, each producing two products that are horizontally differentiated with respect to some characteristic. Consumers are divided into loyals, who always purchase their preferred product, and switchers who have heterogeneous preferences for the four products. If consumers substitute easily between the products produced by one firm, the firms promote one product at a time to avoid cannibalization. If consumers mainly substitute between the products with the same characteristic, the firms often employ joint promotions with at least one product at a deep discount. If, at the same time, consumers easily substitute to the products in other categories, the firms use joint promotions less often and avoid simultaneous deep discounts.

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1 Introduction

Consider a firm that produces multiple related products. How should this firm coordinate the price promotions of its brands? Should it discount one product at a time or offer discounts on many products simultaneously? How does this decision depend on consumers' substitution patterns between products within a category and consumers' willingness to substitute to the products in other categories? The current paper addresses these questions.

As an illustration of this phenomenon, Table 1 presents over a year's worth of weekly prices for three Nabisco cookies: Chips Ahoy! 12oz (CA12), Chips Ahoy! 18oz (CA18), and Oreo 20oz (O20).

Table 1: Weekly Prices of Nabisco Cookies

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
CA12	**2.23**	**2.23**	2.39	2.39	2.39	2.39	2.39	2.39	2.39	2.39	2.39	2.39	2.43	2.43	**1.82**	2.43	**2.33**	**2.33**	2.43	2.43
CA18	2.85	2.85	**1.99**	**2.77**	**2.39**	2.89	2.89	2.89	2.89	2.89	2.89	**2.59**	**2.59**	**2.59**	**2.2**	2.94	2.94	2.94	2.94	2.94
O20	**2.93**	**2.93**	3.09	3.09	3.09	3.09	**2.97**	**2.39**	**2.97**	**2.97**	3.09	3.09	3.15	3.15	**2.36**	**1.99**	**1.99**	3.15	3.15	3.15

	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
CA12	2.43	2.43	**2.33**	**2.33**	**2.33**	**2.33**	2.43	2.43	2.43	2.43	2.43	2.43	2.43	2.43	2.43	2.43	2.43	2.43	**2.33**	**2.33**
CA18	2.94	**2.19**	**2.19**	2.94	2.94	2.94	**1.99**	**1.99**	**1.99**	**1.99**	2.94	2.94	2.94	2.94	**1.99**	**1.99**	**1.99**	**1.99**	2.94	2.94
O20	**2.59**	**2.59**	**2.69**	**2.69**	**2.69**	**2.49**	**2.49**	3.15	3.15	3.15	3.15	3.15	3.15	3.15	3.15	3.15	3.15	3.15	**2.97**	**2.97**

Note. Sales prices are in bold.

The prices from this table illustrate that Nabisco does coordinate price promotions of its products. Despite having frequent sales on both sizes of its Chips Ahoy! cookies (CA12 and CA18), there were only two weeks when these products were on sale at the same time. On the other hand, Nabisco's Oreo cookies were on sale together with either one of the Chips Ahoy! cookies in two-thirds of the Oreo sales weeks (in 12 out of 18 sale weeks). Therefore, it is evident that Nabisco avoids putting two different sizes of the same product on sale together while allowing for the joint promotions of the two different variants of its cookies. In this paper, I will explore the rationales for such coordination of price promotions by the firms.

Firms often produce multiple products, the demands for which are interdependent. Given the prevalence of such situations, it is not surprising that a large theoretical body of literature is devoted to studying the positioning of brands within product lines (by examining, for example, the firms' choices of product quality) and optimal pricing of these brands in monopolistic (Mussa and Rosen 1978, Moorthy 1984, Rochet and Choné 1998, Villas-Boas 1998) and competitive (Katz 1984, Desai 2001, Johnson and Myatt 2003) settings. While a lot is known about optimal pricing when a single price is selected for each of the products, there is little research that studies the coordination of price promotions of these products.[1] The current paper fills this gap by introducing a theoretical framework that is used to analyze the optimal promotional strategies for multi-product firms. This framework allows for heterogeneous consumer preferences, and I study the effects of consumer substitution patterns on coordination of price promotions within firms' product lines.

I set up a model with two firms, each selling two substitute products. These products come in two types, with each firm producing one product of each type. Following the sales models of Varian (1980) and Narasimhan (1988), I model price promotions as an outcome of a mixed-strategy Nash equilibrium in price competition between these firms. I allow for two types of consumers: loyals and switchers. The loyal consumers buy only their

[1] Notable exceptions are Simester (1997) and Lal and Villas-Boas (1998), which I discuss later in the introduction.

preferred brands. The switchers consider all four brands and buy the one that gives them the highest utility. With this setup, the question I study is how the substitution patterns of the switchers affect the two-dimensional probability distribution of prices.

Simester (1997) examines a similar model, but assumes that all consumers purchase two products, getting both from the same firm. He finds that a stronger substitute relationship between the two products produced by a firm leads to deeper promotions on one product and more shallow promotions on the second product. The overall size of discounts is smaller when the products have a strong substitute relationship. In addition to studying promotion depth, in my paper, I also focus on promotion frequency and the coordination of promotions between the substitute brands.

Similar results, but in a setup more closely resembling mine, were obtained by Lal and Villas-Boas (1998).[2] They model competitive interactions between two manufacturers and two retailers as a two-stage game, with the manufacturers selling their products to both retailers and setting their prices first. Since the second stage considers the competition between two retailers, each carrying two products, this stage corresponds to a competition between two firms, each selling two substitute products. Lal and Villas-Boas (1998) model consumer heterogeneity by allowing for various segments of loyal consumers: two segments loyal to a manufacturer, two segments loyal to a retailer, and four segments loyal to a manufacturer-retailer pair.

[2] Another paper that studies price promotions within a product line is Jing and Zhang (2011). However, in their model, each firm offers discounts on only one product (even if it produces two products). Therefore, this model can not be used to study the coordination of price promotions.

In contrast, I model consumer heterogeneity in a different way from Lal and Villas-Boas (1998). Instead of setting up multiple segments of consumers with loyalty to specific subsets of products, I assume that the switchers have heterogeneous preferences for all four products, and I model their tastes using a discrete choice specification. Discrete choice models serve as a main tool in empirical work for estimating consumer demands for differentiated products. Therefore, the framework presented in this paper should be of interest to the empiricists looking for a supply-side model incorporating price promotions for their estimated demands.

In order to allow for a flexible substitution pattern among the consumers, I model the preferences of the switchers using a nested logit specification with two possible hierarchical structures. In the brand-primary model, the switchers substitute more easily between different types of products than between different brands. For example, this model describes well the situation when a consumer first chooses the brand of ground coffee and then chooses the size of the container (Ansari et al. 1995).[3] In a type-primary model, the switchers substitute more easily between brands than between types of product. For example, this model corresponds to the situation when a consumer first chooses the quality tier of frozen pizza and then settles on a brand (Aribarg and Arora 2008).[4]

I find that when consumers switch easily between the products of different types pro-

[3]Other examples of a brand-primary nested logit specification include demand for digital cameras (Sriram et al. 2006) or yogurt (Draganska and Jain 2006).

[4]Other examples of a type-primary nested logit specification include demand for cars (Goldberg 1995), catsup (Besanko et al. 1998), or beer (Slade 2004). Some work allows for several consumer segments who have different hierarchical nested logit demand structures (Kannan and Wright 1991, Kamakura et al. 1996).

duced by one firm (a brand-primary model), firms discount only one product at a time. The intuition behind this result stems from the fact that a promotion on one product draws consumers from both products of the rival. It is, then, ineffective for the focal firm to promote its second product at the same time since the number of additional consumers gained from the rival's products is small. Instead, such a promotion mainly cannibalizes the first promoted brand. Therefore, the firm offers a promotion on only one of its product to draw the consumers away from the rival's products, and keeps the price of its other product high in order to get the maximum profit from its loyal consumers.

If consumers switch easily between the products of the same type produced by different firms (a type-primary model), the optimal strategies depend on the level of intertype heterogeneity. If it is small, the consumers also easily substitute between different types of the products. Therefore, a promotion of one product is effective not only in capturing the switching consumers from the rival's product of the same type, but also in capturing the switchers from the rival's product of the different type. Similar to the brand-primary model, firms mainly promote only one product at a time. Joint promotions are rare and involve shallow discounts.

When the level of intertype heterogeneity is large, the rival discounting only one of its products is less effective in capturing the switching consumers from the products of another type. Hence, the focal firm has an opportunity to offer a discount on its product of another type. This undercuts the regular price charged by the rival and captures most of the remaining switching consumers. Since the firms are using mixed strategies, it is impossible to predict which type of the product will be discounted by the rival. Therefore, the focal firm offers simultaneous discounts on both of its products in order to ensure that it undercuts the rival's regular-priced product. Hence, for the type-primary model with a high level of intertype heterogeneity, the firms often discount their products jointly. At least one of the products is offered at a deep discount.

I conclude the theoretical portion of the paper by investigating how the pricing strategies of the firms are affected by the consumers' ability to substitute away into the products in other categories, i.e., the attractiveness of an outside option. First, a strong outside good captures a significant amount of switchers and reduces the effectiveness of price promotions. Hence, the firms concentrate more on their loyal consumers and charge higher prices. Second, similar to the brand-primary model, a discount on only one of the products is sufficient in competing with the outside good. A discount on the second product does not capture many additional switchers from the outside good, but instead cannibalizes the sales of the first discounted product. Therefore, a strong outside good causes the firms to reduce the frequency of joint promotions and avoid simultaneous deep discounts.

The paper also adds to the empirical literature studying price promotions in the context of mixed-strategy equilibria (Rao et al. 1995, Villas-Boas 1995, Pesendorfer 2002, Hosken and Reiffen 2004, Berck et al. 2008). I supplement the theoretical analysis with a brief empirical section that provides correlational support for the conclusion that firms are using joint promotions less frequently for the products between which we expect the consumers to substitute more easily. I find that the firms typically do not discount together similar sizes of the same product. However, joint sales become more frequent if the size difference is substantial or the products differ in size and some other characteristic. Additionally, joint promotions are less frequent in the categories with a strong private label. Finally, I conclude the paper by offering the managerial guidelines on optimal coordination of price promotions within a product line.

2 Model

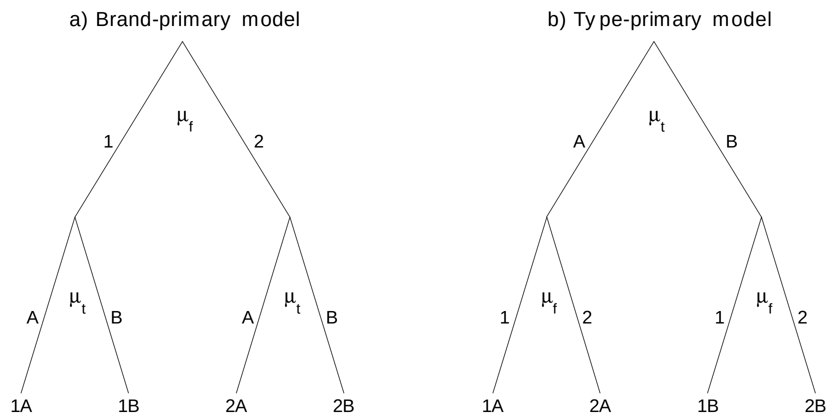
There are two firms, 1 and 2, each producing two substitute products of different types (or characteristics), A and B.[5] The firms compete in prices that are normalized to lie between 0 and 1 (the consumers' reservation price). Note that while throughout the paper I interpret the model as a competition between two manufacturers, the same setup captures the competition between two retailers carrying two substitute products. I discuss the interpretation of the results for the retailer competition in Section 6. In that Section, I also conjecture what happens when both a manufacturer and a retailer are involved in setting price promotions, but the paper does not model the manufacturer-retailer interactions.

The set of consumers has measure 1. They are divided into loyals and switchers. Each of the four products, $1A$, $1B$, $2A$, and $2B$, has a share α of loyal consumers. The remaining $1 - 4\alpha$ consumers are the switchers with heterogeneous preferences for the products. I model the switchers' preferences using the nested logit formulation, distinguishing between

[5] For example, Folgers and Nescafé both produce regular and decaffeinated coffee. Then, A stands for regular and B stands for decaffeinated coffee brands.

brand-primary and type-primary specifications (Kannan and Wright 1991, Draganska and Jain 2006, Kök and Xu 2011), as illustrated in Figure 1.

Figure 1: Brand-primary and Type-primary Specifications



In a brand-primary specification, consumers perceive two products produced by the same firm to be closer substitutes than two products of the same type, but produced by different firms. The preferences for the brand-primary specification can be conveniently modeled with a tree diagram, in which consumers first choose the brand and then choose the type of the product (Figure 1a). While such sequential timing of the purchase decision is a popular interpretation of the nested logit model, it does not imply that in reality consumers make their choice sequentially. The nested structure only identifies how consumers substitute between different products.

The term "brand-primary" implies that a firm produces two products that share the same brand name. In general, this does not have to be the case, as firms often use different brand names for the substitute products within their product lines. What is important for the firms' strategies in this model specification is that consumers substitute more easily between the products produced by the same firm than between the products of the same type. Therefore, a more accurate description of such consumer preferences is a "firm-primary specification". In order to stay consistent with the terminology in the literature, however, I will continue using the term "brand-primary specification" throughout the paper and will use the terms "brand" and "firm" interchangeably.

The switching consumer s has the following utility from purchasing a product type $t \in \{A, B\}$ conditional on brand choice $f \in \{1, 2\}$:

$$U_{stf} = \delta_{ft} - p_{ft} + \varepsilon_{stf}, \tag{1}$$

where δ_{ft} is the base utility of firm f's product of type t, p_{ft} is firm f's price for its product of type t, and ε_{stf} are independently and identically Gumbel distributed with scale parameter μ_t. Empirically, the coefficient on price (as well as the base utility) and μ_t can not be separately identified since a multiplication of this utility by a constant leaves the purchase probabilities unchanged. However, since the coefficient on price is fixed to one in my specification, we can identify μ_t.

The random term ε_{stf} measures the unobserved consumer preferences for the different types of brand f that is not captured by price. When the variance of ε_{stf} is large, the preferences are more dispersed. Then, price matters less, and the consumer choice is dominated by the unobserved portion of utility. If the variance of ε_{stf} is small, price becomes the primary determinant of the product choice. Since μ_t is proportional to the variance, it serves as a measure of consumer intertype heterogeneity.[6]

[6] An alternative interpretation of ε_{stf} is that it captures the error a consumer makes in remembering

With this utility specification, the probability of a consumer purchasing product type t conditional on brand choice f is

$$P(t|f) = \frac{e^{\left(\delta_{ft} - p_{ft}\right)/\mu_t}}{e^{\left(\delta_{fA} - p_{fA}\right)/\mu_t} + e^{\left(\delta_{fB} - p_{fB}\right)/\mu_t}}. \tag{2}$$

In order to model the brand choice, I define the inclusive value, or inclusive utility, of brand f, which (when multiplied by μ_t) reflects a consumer's utility from choosing brand f and facing products fA and fB (Train 2009). It is equal to

$$I_f = \ln\left(e^{\left(\delta_{fA} - p_{fA}\right)/\mu_t} + e^{\left(\delta_{fB} - p_{fB}\right)/\mu_t}\right). \tag{3}$$

Thus, a consumer considers brands 1 and 2 and chooses the one that brings the highest utility. This choice is also modeled as logit with the probability of choosing brand f as

$$P(f) = \frac{e^{\left(\mu_t I_f\right)/\mu_f}}{e^{(\mu_t I_1)/\mu_f} + e^{(\mu_t I_2)/\mu_f}}, \tag{4}$$

where μ_f is the scale parameter of the random term. Thus, μ_f serves as a measure of the degree of consumer interbrand heterogeneity. For the brand-primary specification, the interbrand heterogeneity is larger than the intertype heterogeneity, that is $\mu_f > \mu_t$. This reflects the assumption that consumers' tastes are more similar with respect to the different types of the same brand than with respect to the different brands of the same type.

The unconditional probability of purchasing type t of brand f is then

$$P_{ft} = P(t|f)P(f). \tag{5}$$

In a type-primary specification, consumers perceive different firms' products of the

and then comparing the prices of the two products. When these errors are large ($\mu_t \to \infty$), the choice becomes equi-probable. When there are no errors ($\mu_t = 0$), the choice is solely based on price. I thank an anonymous referee for suggesting this interpretation.

same type to be closer substitutes than the products belonging to the same firm. This specification can be represented by consumers first choosing the type of the product and then settling on the brand (Figure 1b). The set-up of the nested logit model for this scenario results in the following unconditional probability of purchasing brand f of type t:

$$P_{ft} = P(f|t)P(t), \tag{6}$$

where $P(f|t) = \frac{e^{\left(\delta_{ft}-p_{ft}\right)/\mu_f}}{e^{(\delta_{1t}-p_{1t})/\mu_f}+e^{(\delta_{2t}-p_{2t})/\mu_f}}$, $P(t) = \frac{e^{\left(\mu_f I_t\right)/\mu_t}}{e^{\left(\mu_f I_A\right)/\mu_t}+e^{\left(\mu_f I_B\right)/\mu_t}}$, and $I_t = \ln\left(e^{(\delta_{1t}-p_{1t})/\mu_f} + e^{(\delta_{2t}-p_{2t})/\mu_f}\right)$. For this specification, $\mu_t > \mu_f$, which means that consumers' tastes are more similar with respect to the different brands of the same type than with respect to the different types of the same brand. If $\mu_t = \mu_f$, the model reduces to a simple multinomial logit with four alternatives.

With the consumer demands defined in (5) or (6), depending on the model specification, the firms will choose price pairs $(p_{fA}; p_{fB})$ that maximize their profits. The profit function of firm f consists of profit from the loyals, $\alpha(p_{fA} + p_{fB})$; profit from the switchers who bought type A product from this firm, $(1 - 4\alpha)p_{fA}P_{fA}$; and profit from the switchers who bought type B product from this firm, $(1 - 4\alpha)p_{fB}P_{fB}$.

As I show in the next section, when consumer heterogeneity is sufficiently low, a pure-strategy Nash equilibrium does not exist, and it is necessary to solve for the equilibrium in mixed strategies. Traditionally, mixed-strategy equilibria in price competition were found using the techniques outlined in Varian (1980) and Narasimhan (1988). However, demands considered in these and subsequent papers are discontinuous, and the existing solution techniques do not apply to continuous demands such as the ones from (5) and (6). Sinitsyn (2008a) showed that for a large class of demand functions that includes nested logit, the support of the mixed-strategy Nash equilibrium strategies consists of a finite number of price points.

This characterization implies that in equilibrium, firm f charges price pairs $\{p^n_{fA}; p^n_{fB}\}_{n=1}^{N_f}$ with corresponding probabilities $\{\gamma^n_f\}_{n=1}^{N_f}$, where N_f is the number of price pairs firm f uses. In order to find these prices and probabilities, it is necessary to set up and solve a standard system of equations. It consists of first-order conditions that ensure that the profit function is maximized at each point of the support of the price distribution. In addition, the values of the profit function have to be identical at all points of the support. One drawback of working with completely heterogeneous consumer preferences is the absence of the analytically tractable solution, which necessitates the use of numerical methods to find the firms' optimal strategies. A thorough description of the solution procedure for the problems of this type is given in Sinitsyn (2008b and 2009). In the next section, I study the structure of the equilibrium strategies of the firms.

3 Equilibrium Strategies

In order to illustrate the effect of consumers' substitution patterns on the coordination of promotions by each firm, I will examine how changes in μ_f and μ_t affect the firms' equilibrium strategies while keeping the other parameters of the demand function fixed.

Thus, I fix $a = 0.1$, which corresponds to each brand having 10% loyal consumers and 60% of the consumers being switchers.[7] I also fix $\delta_{ft} = 0$ ($f \in \{1, 2\}, t \in \{A, B\}$), which means that on average consumers have identical valuations for all four products. This assumption is made to ensure that the observed pricing strategies of the firms are driven only by consumers' substitution patterns and not by consumers' average brand valuations.

3.1 Multinomial Logit Model ($\mu_f = \mu_t$)

Before studying the brand-primary and type-primary nested logit models, I examine the optimal strategies of the firms for the base case, in which consumers' interbrand and intertype heterogeneity are identical. This specification corresponds to multinomial logit demands, for which $\mu = \mu_f = \mu_t$. The structure of the equilibrium depends on the value of heterogeneity μ as summarized in Table 2 below. I will discuss the cases of large μ and small μ separately.

Table 2: Equilibrium Strategies in a Multinomial Logit Model ($\alpha = 0.1$)

Value of μ	Pricing Strategy
$0.192 < \mu$	$(p; p)$
$0.183 < \mu \leq 0.192$	$(1; p_{s_1}); (p_{s_1}; 1); (p_0; p_0)$
$0.096 < \mu \leq 0.183$	$(1; p_{s_1}); (p_{s_1}; 1);$
$0.094 < \mu \leq 0.096$	$(1; p_{s_1}); (p_{s_1}; 1); (1; 1)$
$0.072 < \mu \leq 0.094$	$(1; p_{s_1}); (p_{s_1}; 1); (1; p_{s_2}); (p_{s_2}; 1); (1; 1)$
$0.061 < \mu \leq 0.072$	$(1; p_{s_1}); (p_{s_1}; 1); (1; p_{s_2}); (p_{s_2}; 1); (1; p_{s_3}); (p_{s_3}; 1); (1; 1)$
$0.054 < \mu \leq 0.061$	$(1; p_{s_1}); (p_{s_1}; 1); (1; p_{s_2}); (p_{s_2}; 1); (1; p_{s_3}); (p_{s_3}; 1); (1; p_{s_4}); (p_{s_4}; 1); (1; 1)$
$\mu \leq 0.054$	equilibria with more than nine price pairs

[7] This analysis was performed for the values of α between 0.01 and 0.2 with a step of 0.01. Qualitatively, the patterns of the equilibrium prices were similar. Therefore, I only present here the results for the representative value of $\alpha = 0.1$. The Online Appendix contains the comparison of the optimal strategies for various values of α and for the case of an asymmetry in the sizes of the loyal segments.

3.1.1 Large μ ($\mu > 0.183$)

To illustrate the structure of the possible equilibria, I examine how the firms' strategies change when μ declines. When μ is large, the demands are relatively inelastic, and there exists a pure strategy Nash equilibrium $(p; p)$. As μ decreases, the consumer preferences become more homogeneous, the demands become more elastic, and the downward pressure on prices increases.[8] This leads to a decrease in the equilibrium prices.

When μ reaches 0.192, in addition to the symmetric price pair $(p_0; p_0)$, the firms' profit functions are also maximized at $(p_{s_1}; 1)$ and $(1; p_{s_1})$, where $p_{s_1} < p_0$. At these price pairs, a firm sets one low promotional price, p_{s_1}, to capture most of the switching consumers when the rival charges $(p_0; p_0)$, while the second price, 1, is kept high to capture the surplus from the loyal consumers. The equilibrium is now in mixed strategies.

The probability placed on $(p_0; p_0)$ decreases until this price pair disappears from the equilibrium (at $\mu = 0.183$). At this point, the firms use two price pairs, $(1, p_{s_1})$ and $(p_{s_1}, 1)$, charged with probability 0.5 each. Thus, the region, in which the firms use joint discounts on both products is relatively small ($0.183 < \mu \leq 0.192$), and it serves as a "transition" from the pure strategy Nash equilibria to the equilibria containing discounts only on one product at a time. The latter equilibria are examined in the next subsection.

[8] The Online Appendix contains the figure depicting the shape of the demand curve for various values of μ.

3.1.2 Small μ ($\mu \leq 0.183$)

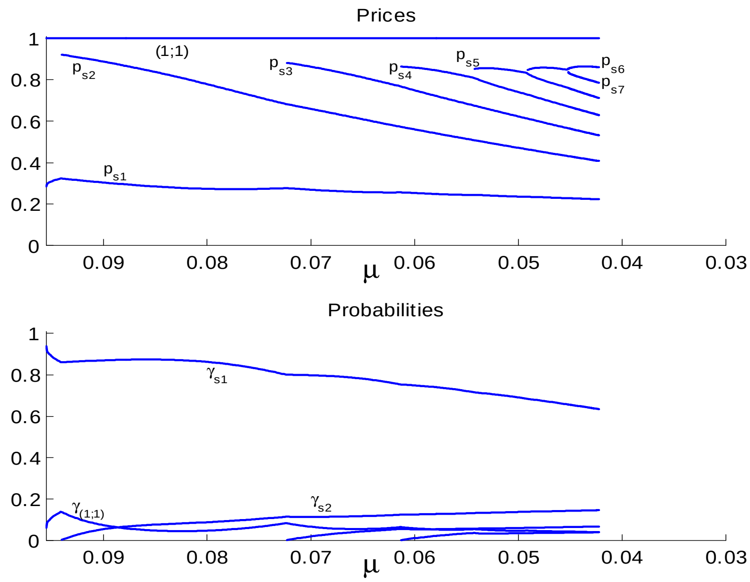
As described above, when μ reaches 0.183, each firm uses two symmetric price pairs with a deep discount on only one of the products, $(p_{s_1};1)$ and $(1;p_{s_1})$. The sale price p_{s_1} decreases with a decrease in μ until it becomes so low (at $\mu = 0.096$) that each firm has a profitable deviation to charging reservation prices for both products. At this point, in a mixed strategy equilibrium, the firms charge regular prices for both products with a small probability $\gamma_{(1;1)}$, and use price pairs $(p_{s_1};1)$ and $(1;p_{s_1})$, each with probability $\frac{\gamma_{s_1}}{2} = \frac{1-\gamma_{(1;1)}}{2}$. Thus, when the firms offer a deep promotion on one of the products, they leave the price of the other product high.

Figure 2 illustrates how the pricing strategies change in response to a further decrease in μ. The top panel of this figure shows the equilibrium prices. The reservation prices, $(1;1)$, are always present in these equilibria and are shown by the horizontal line at the level of 1 in the figure. For the price pairs, in which only one product is promoted, the value of this sale price is shown as p_{s_j}. Each p_{s_j} corresponds to two symmetric price pairs: $(p_{s_j};1)$ and $(1;p_{s_j})$. The probabilities corresponding to these price pairs are shown in the bottom panel of the figure. Note that γ_{s_j} shows the total probability of two price pairs, $(p_{s_j};1)$ and $(1;p_{s_j})$.[9]

As μ decreases, the sale prices decline until there is a large enough gap between the two prices (typically, between the highest sale price and the reservation price), a gap in which a

[9] In order not to clutter the bottom panel of Figure 2, I do not show the (comparably small) probabilities for the sale prices p_{s_5}, p_{s_6}, and p_{s_7}.

Figure 2: Equilibrium Prices and Probabilities for $\alpha = 0.1$ (Multinomial Logit)



new sale price appears. These sale prices also decline with a decrease in μ, and the process repeats.

A few noteworthy characteristics of these equilibria emerge. First, in addition to reservation prices $(1;1)$, the firms only use the price pairs in which one product is on sale. Thus, they avoid promoting both products at the same time. Second, for the smaller values of μ, the number of price pairs used by the firms in the equilibrium is larger.[10] However, the majority of the probability falls on the price pairs containing the lowest sale price. Thus, the firms frequently offer a deep promotion on one of the products while charging the regular price for the second product.

The main conclusion drawn from the base case of multinomial logit is that the firms

[10] The negative relation between consumer heterogeneity and the number of prices in mixed equilibria is a familiar property of the models of sales with heterogeneous consumers (Sinitsyn 2008b, 2009, and 2012).

coordinate their price promotions to ensure that only one out of two products is offered on sale. The intuition for this result is as follows. For a multinomial logit model, a decrease in the price of one good increases the utility of this product, which draws the demand proportionally from all other alternatives (Train 2009). Therefore, if a firm aims to carry a product that delivers the highest level of utility to a large number of switchers, it is enough to offer a discount on only one of its products. Adding a discount on the second product will lead to cannibalization—most of the increase in demand for the second product will come from the first product of this firm. At the same time, the additional demand coming from the competitor's products is small since a large portion of consumers had already switched to the first promoted product. In these circumstances, the firm is better off setting the price of its second product high in order to generate the largest possible profit from its loyal consumers. Thus, the firms promote only one product at a time.

3.2 Brand-Primary Model ($\mu_f > \mu_t$)

The intuition for offering promotions on only one product at a time from the multinomial logit model is conserved in the brand-primary model, in which consumers switch between product types more easily than between brands. With this demand specification, the larger substitution occurs between the products of the same firm. Thus, when a firm increases the utility of one of the products by decreasing its price, most of the increase in demand for this product comes from consumers shifting away from the second product of this firm. The substitution from the products of the rival firm are smaller. It is not profitable for the firm to also offer a promotion on its second product. Such promotion captures only a few additional consumers from the rival firm's brands, but it leads to a large cannibalization effect by drawing away consumers from the first product of this firm. Thus, similar to the case of multinomial logit demands, the focal firm places only one of its products on sale to fight for the switching consumers and leaves the price of the second product high to get the maximum surplus from the loyal consumers.[11]

3.3 Type-Primary Model ($\mu_t > \mu_f$)

The structure of the equilibrium strategies is different in the type-primary model, in which consumers switch more easily between different brands than between product types. Furthermore, the type of equilibrium strategies depends on the levels of heterogeneity μ_t and μ_f. Table 3 below summarizes the main features of the equilibrium strategies, which are studied in detail in the rest of this subsection.

Table 3: Equilibrium Strategies in a Type-Primary Model

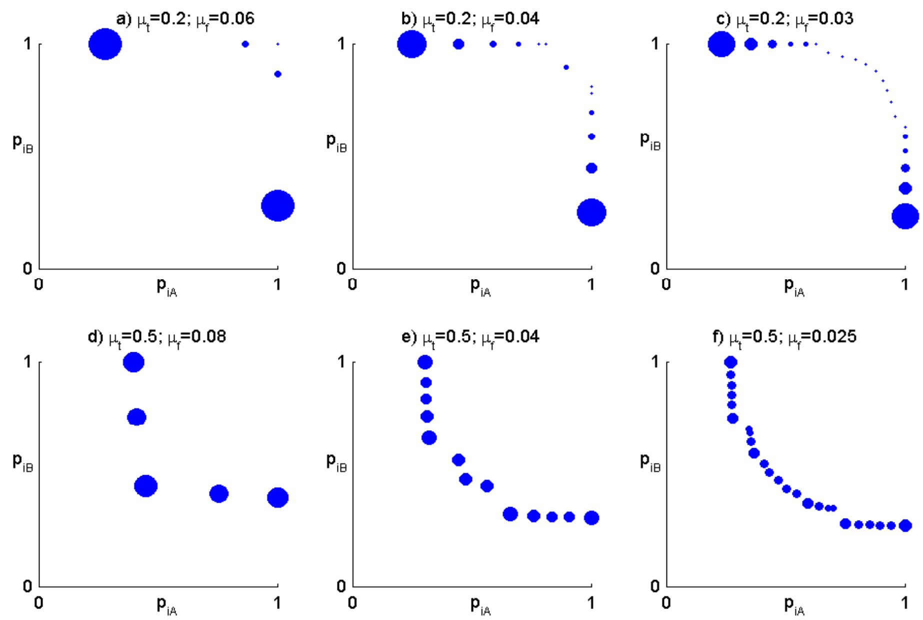
	High μ_f	Low μ_f
Low μ_t	In addition to $(1;1)$, only the price pairs with one product on sale; deep discounts	Mostly the price pairs with one product deeply discounted; few price pairs with both products on a shallow discount
High μ_t	The price pairs with either a deep discount on one product and a very shallow or no discount on another product or a medium discount on both products	Similar to the strategies for (High μ_t; High μ_f), only with more price pairs of each type

First, I discuss the effect of μ_f on the firms' strategies for a fixed level of μ_t, making

[11] In fact, not only the structure of the equilibria, but the actual strategies are very similar for the multinomial logit and brand-primary models. For example, for $\mu_f = 0.04$, as μ_t declined from 0.04 to 0.001, there were only two new price pairs added in the equilibrium while the sale prices within other price pairs did not change by more than 5%.

the comparison across columns in Table 3. Figure 3 shows these strategies in the form of the bubble graphs for small μ_t in the top row ($\mu_t = 0.2$ in a, b, and c) and for large μ_t in the bottom row ($\mu_t = 0.5$ in d, e, and f) as μ_f declines.[12] In this figure, the size of each bubble represents the probability with which a corresponding price pair is charged.

Figure 3: Equilibrium Strategies in a Type-Primary Model



For small μ_t, when μ_f is relatively large, the firms promote only one product at a time or use the reservation price for both products (the upper-left cell in Table 3 and Figure 3a). For the smaller values of μ_f, the consumers are more homogeneous with respect to their brand preferences and substitute between the brands more easily. This leads to a downward pressure on prices, and more price pairs with only one product on sale appear

[12] For the type-primary model, it is hard to present the response of prices and probabilities to continuous changes in μ_f as done in Figure 2 since often promotion depths are different within the price pairs used in equilibria. Instead, I chose to show the snapshots of the pricing strategies for a few specific values of μ_f using the bubble graphs.

in the equilibria. However, eventually the optimal strategy of the firms will include a price pair in which both products are on sale and have identical shallow discounts (Figure 3b).

The intuition for the appearance of such a price pair is as follows. Until the introduction of a price pair with identical discounts, both firms use only the price pairs in which one product is on sale. When these sale prices become small enough, there is an incentive to introduce a new sale price that lies between the highest sale price and the reservation price. The question is whether to offer this small discount on one or both products.

Consider a rival firm that sets a discount on one of its product, say, $2A$. Since this is a type-primary model, the discount is very effective in capturing the consumers from $1A$, but less effective in capturing the consumers from $1B$ and $2B$. Therefore, the total number of consumers who want to buy product B did not decrease significantly because of a discount on $2A$ making these consumers a lucrative target. Given that the rival firm keeps the price of its product of type B high, it is possible for the focal firm to offer the highest utility on type B products by giving only a small discount on its product of type B. However, the focal firm does not know whether the rival discounts its product A or product B, and, hence, it can not offer a discount on a product of other type with certainty. Therefore, the focal firm offers a small discount on both products simultaneously to ensure that it will undercut the regularly priced product of the rival firm.

This appearance of a price pair with identical small discounts on both products is similar to the findings from Lal and Rao (1997). They show that faced with a PROMO (Promotional Pricing or Hi-Lo) store offering deep promotions on only one of the products, the EDLP (Every Day Low Pricing) store that does not know which product the rival promotes chooses to offer relatively shallow discounts on both products.

For the low values of μ_f, there are more price pairs in which both products are discounted together, though the promotion depth might be different for the two products (the upper-right cell in Table 3 and Figure 3c). Despite an increase in the number of these price pairs, most probability is still placed on the price pairs in which only one product is discounted, and among them, the largest probability is placed on the price pairs which contain the deepest discount.

Now, we examine how the equilibrium strategies change when the intertype heterogeneity μ_t is high. As Figures 3d), e), and f) illustrate, the firms place a lot of probability on the price pairs in which both products are offered at a discount. In fact, in all of the equilibria for the high values of μ_t, there are only two price pairs in which one product is on sale. The rest of the prices pairs belong to two different types. In the first type, the price of one of the products is set approximately at the level of the deepest discount used by the firm. The discounts on the other product vary, but are relatively shallow. For the larger values of μ_f, most of the new prices are of this type (Figures 3d) and e). In the second type of price pairs, the discounts offered on both products are somewhat smaller than the deepest discount used by the firm, and these discounts are negatively correlated (Figure 3f). More price pairs of this type appear for the smaller values of μ_f.

A comparison across rows of Figure 3 highlights a major difference in the overall structure of the pricing strategies for the small and the large values of μ_t. For the small μ_t, most of the probability is placed on the price pairs in which only one product is discounted. The joint discounts on both products are rare and shallow. For the high μ_t, the firms rely heavily on promoting both products together and use considerably larger discounts for these joint promotions.

The intuition for this result stems from the fact that even for a type-primary model, if μ_t is small, there is some substitution between the two product types. Therefore, a discount on only one product is somewhat effective in capturing consumers from the products of the other type, and firms frequently just promote one product. In contrast, when μ_t is large, a firm offering a discount on only one of its product will not capture many consumers from the rival's product of a different type. In addition, since the substitution between the product types is weak, the cannibalization effect is small. Thus, if the firm aims to set price promotions that effectively capture the switching consumers from all of the rival's brands, it has to discount both of its products simultaneously.

To summarize the findings in this section, if brands are relatively important in consumers' choice (as is the case in a brand-primary model or a type-primary model with large μ_f and small μ_t), the firms never promote both products together. If brands are not very important in the consumer choice-making process—a type-primary model with small μ_f—then the structure of the equilibrium prices depends on the importance of product characteristics. If product characteristics are also not very important (μ_t is small, but larger than μ_f), consumers switch easily between the different product types; therefore, when a firm discounts only one of its products, this discount is effective in capturing the consumers from the rival firm's products of both types. Then, most of the time, the firms put only one product on sale. In those rare occasions when both products are promoted, the depth of these promotions is small. When product characteristics are important in consumer choice (μ_t is large), the consumers are more reluctant to switch between the product types. Then, a discount on the product of one type does not capture many consumers from the rival's product of another type. Therefore, in order to make the most use of the discounts, the firms often put both of their products on sale at the same time. The depth of promotions is larger than that for the case of small μ_t. In the next section, I will examine how these conclusions are affected by the presence of an outside good.

4 Nested Logit with an Outside Good

The nested logit model presented in Section 2 assumes that consumers necessarily buy one of the four products offered by the firms. Thus, if the prices of all products increase by the same amount, the quantity sold of each product remains the same. This is an undesirable assumption for many markets. A typical way of dealing with this issue in the empirical literature is the introduction of an outside good in the consumer choice set.

The outside good accounts for the possibility of not purchasing any of the available options. The utility of consumer s from not purchasing any of the four products is $U_{s0} = V_0 + \varepsilon_{s0}$, where V_0 is the average utility of the outside option in the population and ε_{s0} captures the unobserved consumer preferences. Since V_0 and δ_{ft} (the base utilities of the available products) can not be separately identified, the standard econometric treatment is to normalize the average utility of the outside good, V_0, to zero. As I already normalized δ_{ft} to zero in the previous section, I will keep this setting and will examine what happens to the equilibrium strategies when I change the valuation of the outside good V_0.

It is possible to think of V_0 as the attractiveness of the substitute products in related categories. The value of V_0 is determined outside of the model and is influenced by things like advertising campaigns in the substitute categories, new findings about the health benefits of the products in these categories, or the prices of these products. To illustrate the latter effect, consider, for example, a competition in the ready-to-eat cereals category, for which an outside option can be a purchase of an oatmeal. Then, if we write out V_0 as δ_0 (the average base utility of the oatmeal purchase) minus p_0 (the weighted average of the oatmeal prices) and normalize δ_0 to 0, we obtain $V_0 = -p_0$. This means that we can interpret $-V_0$ as the price of the outside good.

An alternative candidate for the outside good is a private label.[13] Since a private label directly competes with the products in the same category, it is more appropriate to take its price as endogenous. The qualitative conclusions in this section remain the same if I allow for the endogenous price of the outside good, and I present this analysis in the Online Appendix.

It is straightforward to modify the nested logit model to account for the outside good. For example, in the type-primary model, there are now three possibilities for a type choice:

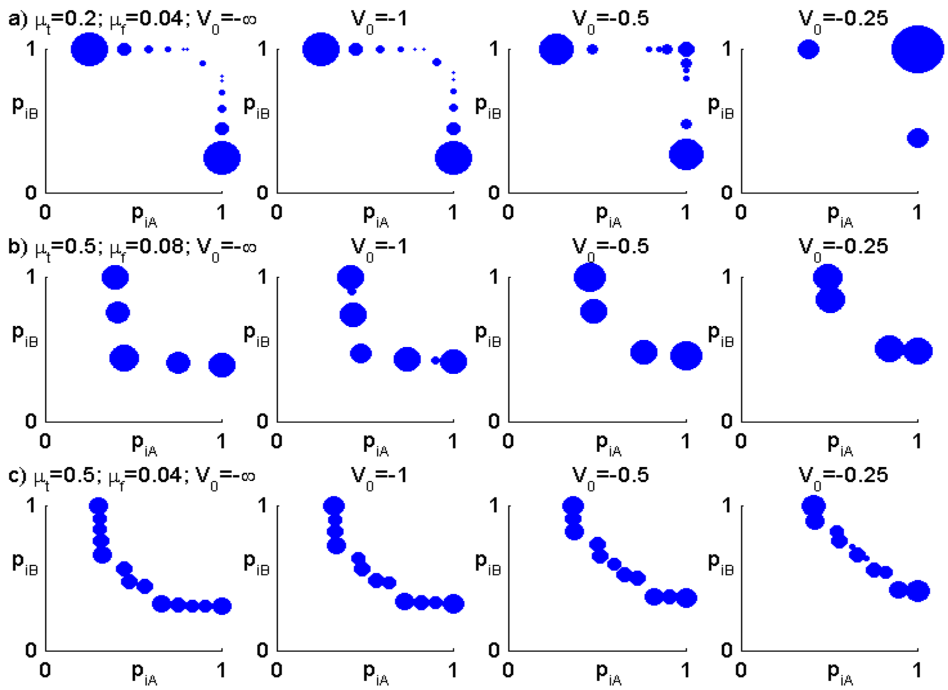
[13] I thank an anonymous referee for offering this suggestion.

type A, type B, and a no purchase option. Hence, the formula for the probability of choosing a product of type t becomes $P(t) = \frac{e^{\left(\mu_f I_t\right)/\mu_t}}{e^{\left(\mu_f I_A\right)/\mu_t}+e^{\left(\mu_f I_B\right)/\mu_t}+e^{V_0/\mu_t}}$.

In this section, I examine the effect of the strength of the outside good on the equilibrium strategies of the firms. I start with $V_0 = -\infty$, which corresponds to the model with no outside good. Then I increase V_0, making the outside good more attractive. Similar to the analysis in the previous section, since the pricing strategies often involve asymmetric discounts, it is more informative to present the snapshots of the equilibrium strategies for several values of V_0. In addition to the base case of $V_0 = -\infty$, I chose the values $V_0 = -1$ (this corresponds to the outside good being priced at the regular price of the focal products), $V_0 = -0.5$ (the outside good is priced 50% cheaper than the regular price of the focal products), and $V_0 = -0.25$ (the outside good is priced 75% cheaper than the regular price of the focal products). Figure 4 shows the equilibrium strategies for the various values of μ_t and μ_f.

Row a) from Figure 4 illustrates the case of small intertype heterogeneity μ_t. Recall from the analysis in Section 3 that for small μ_t, joint promotions are rare and involve shallow discounts. As the attractiveness of the outside good, V_0, increases, the firms stop using the price pairs in which both products are promoted, but start using the price pair with the regular price for both products. In addition, the depth of the promotions decreases. When V_0 reaches -0.25, most of the probability, 0.75, is placed on the pair of regular prices while the remaining 0.25 is equally divided between the two symmetric price pairs with only one product on sale: $(0.381; 1)$ and $(1; 0.381)$.

Figure 4: Equilibrium Strategies in a Type-Primary Model with an Outside Good



Rows b) and c) from Figure 4 illustrate the case of large intertype heterogeneity μ_t for the various degrees of interbrand heterogeneity μ_f. Some common patterns are present for both of these rows. The general equilibrium structure remains robust to the changes in the value of the outside good – there are only two symmetric price pairs with one product on sale. However, as the value of the outside good increases, the sale price in these price pairs goes up and the probability of charging them increases. In addition, the firms start avoiding simultaneous deep discounts. As V_0 increases, for the price pairs with both products on sale, the firms either use a deep discount on one product and a shallow discount on another, or use a medium discount on both products.

In summary, when the attractiveness of the outside good is high, the focal firms charge higher prices and shift probability toward the price pairs with only one product on sale (for large μ_t) or toward the price pair with the regular prices (for small μ_t). The reason for using this less competitive pricing stems from the fact that the firms find it harder to compete for the switchers when there is a strong outside option. Hence, the loyal segments become comparatively more attractive, and the firms extract a larger surplus from them by using higher prices.

Additionally, when there is a stronger outside good, the probability of using joint discounts decreases, and the firms avoid using the price pairs with a deep discount on both products. To understand the reason for this shift in pricing strategies, recall that the firms are discounting both products simultaneously because a discount on each product is mainly designed to compete with the competitor's product of the corresponding type. However, a joint discount on both products is not efficient for competing with the outside option. Similarly to the intuition from Section 3.3, a discount on only one type of the product would capture most of the switchers away from the outside option. Discounting the second product does not capture many additional switchers and leads to the cannibalization of the first discounted product. As the strength of the outside good increases, it becomes a more important competitor for the focal firm, so it switches from the strategy designed to compete with its rival (joint discounting) to the strategy that is more efficient in competing with the outside good (single-product discounting).

As I show in the Online Appendix, the above results hold if I consider the outside good to be a private label with an endogenous price. In addition, I find that the private label does not use price promotions, which is consistent with the results in Rao (1991). A stronger private label leads to a decrease in joint promotions. I present correlational support for this finding in the next section.

5 Empirical Evidence

The theoretical results from the previous sections imply that if consumers substitute easily between the products produced by the firm (as is the case for the brand-primary model or the type-primary model with small μ_t), the firm should avoid promoting its products together. If the consumers do not switch easily between the firm's products, it can successfully strengthen the effect of its promotions if it promotes its products together. In this section, I will present the empirical evidence that is correlationally consistent with the theoretical prediction.

I use data from the Dominick's chain in Chicago, collected over an eight-year period in the 1990s. I select the most popular product in each category, for which the dataset also contains two different types of related products produced by the same firm. The first related product is identical to the selected one except that it has a different size. The second related product also has a different size and either has a different brand name or differs from the selected product in another important non-size characteristic (for example, liquid vs sheet fabric softener or canned vs bottled soda). I examine how the price promotions of the selected product are coordinated with the price promotions of these two related products produced by the same firm.

I hypothesize that two products that differ only in size are closer substitutes than two products that differ in two characteristics including size. This hypothesis is supported by the recent empirical findings that there is heavy cannibalization (i.e., substitution) between different pack-sizes of the same brand. There is lower cannibalization if the products differ in packaging (Dawes 2012).[14] For such substitution patterns, the theoretical model predicts that the firms would use joint promotions more frequently for the products that differ in multiple characteristics.

I measure the degree with which different products are promoted together by formally testing a hypothesis that their promotions are independent. First, I compute the theoretical distribution of the number of joint promotions under the assumption of independence in the following way. If there are W weeks of data and the first product was on sale for S_1 of those weeks, then the probability of a price promotion of the first product is S_1/W. Similarly, the probability of a price promotion of the second product is S_2/W, where S_2 is the number of weeks the second product was promoted. If the promotions were independent, the probability of a joint promotion in any given week would be $(S_1/W)(S_2/W)$, and the number of weeks with joint promotions would be distributed binomially with parameters W and $(S_1/W)(S_2/W)$.

Then, the value of this binomial cumulative distribution function (CDF) computed at

[14] Most of the categories studied in Dawes (2012) are also from the Dominick's dataset.

the observed number of weeks in which both products were promoted, provides a measure of the degree with which these products are promoted jointly. If the value of the CDF is close to one, the firm tends to promote its products at the same time. If the value of the CDF is close to zero, the firm avoids joint promotions and favors discounting one product at a time.

Table 4 presents the selected products from various categories (column 2) and the values of the CDF of a binomial distribution of independent joint sales of the selected product with the same product of different size (column 3) or with the product differing in multiple characteristics (column 4). The values below 0.1 and above 0.9 are in bold.

The numbers presented in Table 4 show that there is a lot of heterogeneity across categories in the way firms coordinate promotions of their related products. Nevertheless, in almost all product categories (in 20 out of 22), the numbers in column 3 were smaller than the numbers in column 4. This means that the firms were less likely to promote together their products that only differed in size rather than their products that differed in size and some other characteristic. In the most frequently occurring combination, present in 12 out of 22 categories, the number in column 3 is between 0.1 and 0.9, while the number in column 4 is above 0.9. This means that in these categories, I can not reject the hypothesis that the promotions of the different sizes of the same product are independent. However, at the same time, these firms do promote together their products that differ in multiple characteristics.[15]

[15] Rao (1995) highlights the importance of accounting for the promotion length when testing for the independence of promotions. This analysis did not change the qualitative findings and is presented in the

Table 4: Joint Sales of Related Products

Category	Selected Product	On Sale Together with a Product with Different	
		Size Only	Size and Non-Size Characteristic
Analgesics	Advil 24ct	**0.007** (Advil 50ct)	**0.981** (Anacin 50ct)
Bathroom Tissues	Scott 1ct	0.206 (Scott 4ct)	0.232 (Cottonelle 4ct)
Beer	Miller Lite 12/12oz	0.876 (Miller Lite 24/12oz)	0.642 (Milwaukee's Best 24/12oz)
Bottled Juices	Mott's Apple Juice 64oz	0.578 (Mott's Apple Juice 32oz)	**0.909** (Mott's Clamato Juice 32oz)
Canned Soup	Campbell Chicken Noodle 10.75oz	0.576 (Campbell Chicken Noodle 19oz)	**0.995** (Home Cookin' Chicken Noodle 19oz)
Cereals	Cheerios 15oz	**0.999** (Cheerios 10oz)	**1.000** (Total Whole Grain 12oz)
Cheeses	Kraft American Singles 12oz	0.332 (Kraft American Singles 16oz)	**0.999** (Kraft Philadelphia Cream Cheese 8oz)
Cookies	Chips Ahoy! 12oz	0.136 (Chips Ahoy! 18oz)	**0.989** (Oreo 20oz)
Dish Detergent	Sunlight Dish Liquid 22oz	0.335 (Sunlight Dish Liquid 40oz)	**0.977** (Sunlight Dishwasher Liquid 65oz)
Fabric Softeners	Downy 64oz	0.154 (Downy 120oz)	**0.980** (Downy 40ct)
Front-end-candies	Snickers	**0.995** (Snickers King)	**1.000** (M&Ms)
Frozen Entrees	Stouffer's Mac&Cheese 12oz	**1.000** (Stouffer's Mac&Cheese 20oz)	**1.000** (Stouffer's Lasagna 21oz)
Frozen Juices	Minute Maid Orange Juice 12oz	0.539 (Minute Maid Orange Juice 6oz)	**0.946** (Bacardi Mixers 10oz)
Grooming Products	Gillette Sensor 10ct	**0.903** (Gillette Sensor 5ct)	**0.987** (Gillette Good News 5ct)
Laundry Detergents	Tide Liquid 100oz	0.192 (Tide Liquid 150oz)	**0.999** (Tide Ultra 110oz)
Oatmeal	Quaker Quick Oats 18oz	0.741 (Quaker Quick Oats 42oz)	**0.999** (Quaker Instant Oatmeal 15oz)
Paper Towels	Scott 3ct	0.136 (Scott 1ct)	**0.973** (Viva 1ct)
Refrigerated Juices	Tropicana Orange Juice 64oz	0.274 (Tropicana Orange Juice 96oz)	**0.901** (Tropicana Orange Juice 3/8oz)
Snack Crackers	Ritz Cracker 16oz	**0.018** (Ritz Cracker 12oz)	**0.926** (Triscuit 9.5oz)
Soaps	Dove 2pk	0.878 (Dove 3.5oz)	**1.000** (Lever 2000 10oz)
Soft Drinks	Pepsi 2LT	**0.040** (Pepsi 3LT)	0.411 (Pepsi 6/12oz)
Toothpastes	Colgate 8.2oz	0.270 (Colgate 6.4oz)	0.817 (Ultra Brite 6oz)

Note. The number in each cell shows the CDF of a binomial distribution of independent joint sales.

The most stark examples of the impact of size vs multiple characteristics on coordination of promotions of related products are in the Snack Crackers and Analgesics categories. In

Online Appendix.

the latter category, Wyeth avoids promoting the different sizes (24ct and 50ct) of its Advil brand at the same time (the value of the CDF is 0.007). However, it often promotes its 24ct Advil and 50ct Anacin together (the value of the CDF is 0.981).[16] In the former category, Nabisco avoids promoting together the different sizes (16oz and 12oz) of Ritz Crackers (the value of the CDF is 0.018), but often puts its 16oz Ritz Crackers on sale together with 9.5oz Triscuit (the value of the CDF is 0.926).

Out of the remaining 8 categories, the most common combination, present in 4 of them (Cereals, Front-end-candies, Frozen Entrees, and Grooming Products), has both values of the CDF above 0.9. This means that the firms in these categories tend to jointly discount their products, even those differing only in size. Economies of scope in promotions is one potential explanation for this behavior. It is easier to set the same promotion timing for all products in the product line; hence, an increase in profits must be substantial in order to force pricing managers to consider separate promotion weeks for different products.

In three other categories (Bathroom Tissues, Beer, and Toothpaste), both values of the CDF are between 0.1 and 0.9, which means that I can not reject the hypothesis that the promotions of related products in these categories are independent. In the last category, Soft Drinks, Pepsi avoids putting its $2L$ and $3L$ bottles of soda on sale together (the value of the CDF is 0.04), but does not coordinate the sales of its $2L$ bottles and 6-packs of $12oz$ cans (the value of the CDF is 0.411). This means that Pepsi is less likely to offer joint sales on its two closely related products, which is consistent with the theoretical results in the

[16] These brand are produced by the different companies now. Insight Pharmaceuticals acquired Anacin in 2003 while Advil is produced by Pfizer, which purchased Wyeth in 2009.

paper.

An alternative explanation for the observed promotion patterns focuses on the objectives of the retailer.[17] For example, the retailer may prefer to discount different brands at the same time since advertising such price promotions is likely to attract more shoppers to its stores than advertising price promotions on multiple sizes of the same brand. To test this explanation, I separated the categories from Table 4 into two groups: in the first group, the products that differ in size and some other characteristic have the same brand name while in the second group, the brand name is one of the characteristics that differentiates these products. For each product category, I computed the difference between the values in column 4 and in column 3. This difference measures the relative likelihood of the firms promoting jointly their less substitutable products. The average differences were not statistically different from each other (0.48 for the group with the same brand name vs 0.40 for the group with different brand names). This suggests that the retailer did not make an extra effort to jointly discount different brands in comparison to the frequency of joint discounts of products differing in multiple characteristics but carrying the same brand.

Another intuitive hypothesis about consumers' behavior is that they substitute easier between products of similar size than between products of vastly different sizes. Then, the theoretical model predicts that for a pair of products with a larger size difference there should be more joint promotions. Therefore, for the categories, in which the top product was offered in at least three different sizes, I tested whether the small and the large sizes of

[17] I thank two anonymous referees for suggesting this possibility.

the same product were promoted jointly at least as often as the small and the medium sizes and the medium and the large sizes. This was the case for 8 out of 10 categories.[18] The clearest example of this difference in coordination of price promotions is in the Analgesics category. Wyeth almost never promotes its small (25ct) and medium (50ct) Advil together (the value of the CDF is 0.007) or its medium (50ct) and large (100ct) Advil together (the value of the CDF is 0.067). However, it often jointly promotes its small and large Advil (the value of the CDF is 0.98).

Finally, in Section 4, I found that a stronger outside good causes the firms to decrease the frequency of joint promotions. The intuition for this result stemmed from the fact that discounting one product at a time is a more efficient strategy for competing with an outside good, and the firms rely more on this strategy when the outside good is a more important competitor. As discussed in Section 4, one candidate for an outside good is a private label. Hence, I use the market share of a private label to proxy the strength/importance of an outside good in each category.[19]

I find that there is a strong negative correlation ($\rho = -0.44$) between the share of the private label and the frequency of joint promotions of different sizes of the same brand. For example, in the five categories with the highest incidence of joint promotions (Cereals, Front-end-candies, Frozen Entrees, Grooming Products, Soaps), the average market share of the private label is less than 2%. In contrast, in the five categories with the lowest incidence of joint promotions (Analgesics, Cookies, Paper Towels, Snack Crackers, Soft Drinks), the

[18] The table containing this analysis is presented in the Online Appendix.

[19] The table with the shares of a private label for all categories is presented in the Online Appendix.

average market share of the private label is above 14%. This means that, consistent with the theoretical prediction, the firms reduce the frequency of joint promotions when an outside good has a strong presence in a category.[20]

Taken together, this empirical evidence confirms that firms are using joint promotions less frequently for the products between which we expect the consumers to substitute more easily. The firms typically avoid putting the similar sizes of the same product on sale together. However, joint sales become more frequent if the size difference is substantial or the products also differ in other, non-size characteristics. The firms use joint sales less often when the market share of a private label is higher.

6 Managerial Guidelines and Concluding Remarks

The results presented in this and Lal and Villas-Boas's (1998) work combined with the analysis of price promotions of complementary products from Sinitsyn (2012) serve as a guidance for pricing managers on how to coordinate price promotions of multiple products within a firm's product line. With the knowledge of the exact demand structure, it is possible to use the framework presented in this paper to derive the optimal promotional strategies.

In general, the guidelines are as follows. For the manufacturers, if a brand name is a

[20] The correlation between the frequency of joint promotions of products that differ in two characteristics and the share of a private label is also negative, but not significant ($\rho = -0.098$). One possibility for this result is that there is not a lot of variation in the frequency of joint promotions of products that differ in two characteristics as the firms tend to jointly promote such products in almost all categories.

more important determinant of consumer choice than product characteristics, simultaneous promotions of substitutes should be avoided in order to curb cannibalization effects. Only when product characteristics become a significantly more important determinant of consumer choice than a brand name should a manufacturer consider promoting its substitutes together. The greater the importance of product characteristics is, the more often a manufacturer should employ joint promotions using larger discounts.

As noted above, in a brand-primary setting, a manufacturer should avoid joint promotions. However, the length of a product line is often large enough that it is practically unfeasible to separate the promotions of all substitute products. In such cases, a manufacturer should select the products exhibiting the least substitutability with each other and promote them together. These promotions should be shallow.

If a category is characterized by a strong private label or if the consumers easily switch to the products in other categories, a manufacturer should shift away from joint promotions and avoid simultaneous deep discounts. Finally, for the complementary products, the larger is the premium that consumers put on purchasing two complementary products from the same firm, the more often they should be promoted together (Sinitsyn 2012).

It is possible to apply the results of this paper to the retailer competition. Take two retailers each carrying two substitute brands. If consumers are relatively unlikely to switch between the retailers, but substitute easily between the products carried by the same retailer, a retailer should avoid promoting these products together. If, on the other hand, consumers care more about the brand they purchase and are likely to switch to a different retailer in search of a cheaper price, a retailer benefits from joint promotions of the products it carries.

The situation becomes more complicated if both a manufacturer and a retailer are involved in setting price promotions. Then, the optimal strategies should depend on three dimensions of consumer substitution: between the retailers, between the manufacturers (brands), and between the product characteristics. For example, if consumers do not switch easily between the retailers, each retailer should aim to promote only one product at a time in order to avoid cannibalization. If, at the same time, a brand name is a more important determinant of consumer choice than product characteristics, the manufacturers are also interested in avoiding joint promotions; hence, the interests of the parties in a vertical channel coincide. If, on the other hand, the consumers' choice is mainly driven by product characteristics, the manufacturers aim to employ joint promotions. This goes against the interests of the retailer; hence, a compromising solution must be negotiated.

The additional complications arise, however, because the retailers' strategy should in turn impact the manufacturers' strategy. In the example above, the retailer aims to promote only one product at a time, deliberately avoiding joint promotions of the products from different manufacturers. This decreases the probability that these products end up on sale together in comparison to this probability in the model presented in the paper, where the realizations of the manufacturers' mixed strategies are independent. Since the probability of being the only firm with a sale increases, the manufacturers find the promotions more attractive. They are likely to increase the frequency and/or depth of promotions as well as altering the probability of joint promotions. The formal analysis of such scenario that incorporates competition between multiple retailers and multiple manufacturers, each producing multiple products is beyond the scope of this paper, but should be a natural next step in the research on product line price promotions.

Of course, the suggestions outlined above can be altered to allow for the specific market structure. For example, one notable exception to the offered guidelines is uniform pricing of multiple flavors/scents of otherwise identical products. While the demand for such products corresponds to the brand-primary nested logit specification (Draganska and Jain 2006), the firms nevertheless set identical prices within their product lines. Therefore, promotions of such products also happen simultaneously, contrary to the suggestions of the current paper. The reasons for the presence of uniform pricing are consumers' concern about price fairness (Chen and Cui 2013) and the findings that profit gains from price differentiation are small (Draganska and Jain 2006, McMillan 2007).

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