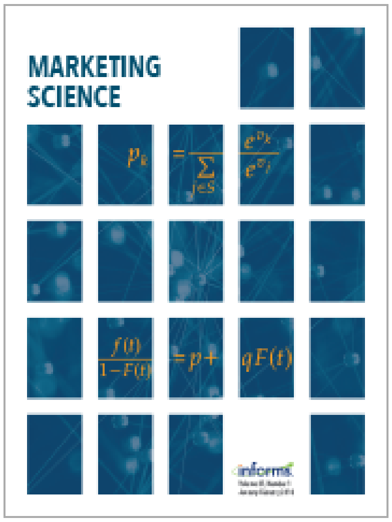


Marketing Science

Publication details, including instructions for authors and subscription information:
http://pubsonline.informs.org

Pricing Prototypical Products

Wilfred Amaldoss, Chuan He

To cite this article:
Wilfred Amaldoss, Chuan He (2013) Pricing Prototypical Products. Marketing Science 32(5):733-752. https://doi.org/10.1287/mksc.2013.0793

MARKETING SCIENCE
Vol. 32, No. 5, September–October 2013, pp. 733–752
ISSN 0732-2399 (print) | ISSN 1526-548X (online)
http://dx.doi.org/10.1287/mksc.2013.0793

Pricing Prototypical Products

Wilfred Amaldoss
Fuqua School of Business, Duke University, Durham, North Carolina 27708, wilfred.amaldoss@duke.edu

Chuan He
Leeds School of Business, University of Colorado, Boulder, Colorado 80309; and
Cheung Kong Graduate School of Business, 100738 Beijing, People's Republic of China, che@ckgsb.edu.cn

When we think of colas, Coca-Cola first comes to mind. Products such as Cola-Cola, Tide laundry detergent, and Chapstick lip balm are the prototypical products in their respective categories. For more than three decades, research in consumer psychology has accumulated evidence on how prototypicality influences memory, shapes the composition of consideration set, and affects purchase decision. Yet there is no research on how it changes the competitive behavior of firms in a horizontally differentiated market. For example, some prototypical products are priced lower than other products in their category, whereas in certain other categories the prototypical product is priced higher. We propose a novel model of spatial competition, where the prototypicality of a product influences the probability of the product being included in consumers' consideration sets without affecting its valuation. Using the model, we examine theoretically the impact of prototypicality on the pricing decisions of competing firms. Our analysis shows that when consumer valuations are low, the prototypical product is priced lower than a nonprototypical product and earns more profits. However, when consumer valuations are high, the rank order of the prices of the prototypical product and a nonprototypical product is reversed, but not the order of profits. We subject these predictions to an empirical test. The experimental results lend support for the qualitative predictions of the model.

Key words: prototypical product; pricing; competition; experimental economics; game theory
History: Received: March 26, 2012; accepted: March 22, 2013; Teck Ho served as the guest editor-in-chief and Ganesh Iyer served as associate editor for this article. Published online in *Articles in Advance* July 26, 2013.

Introduction

A well-established finding in consumer psychology is that people organize information about products in categories to facilitate decision making (see Loken et al. 2008 for a recent review). Furthermore, an individual product in a category may be regarded as the prototypical exemplar of the category (Medlin and Shaffer 1978, Alba and Hutchinson 1987). For example, *Time* magazine and Coca-Cola are the prototypical exemplars of their categories (Nedungadi and Hutchinson 1985). Moreover, the prototypical product of the category is likely to feature in a consumer's consideration set and influence her purchase decision (Nedungadi and Hutchinson 1985). Extensive research on categorization helps us to gain a nuanced understanding of how a prototypical product influences consumer choice, but there is no research on how it may affect the competitive behavior of firms in a horizontally differentiated market. For example, should a firm charge a higher or lower price for a prototypical product? We see some prototypical products, such as Pillsbury cake mix and Charmin bath tissue, being sold at a higher price compared with the nonprototypical products in their category. On the other hand, some prototypical products, such as Chapstick lip balm, Softsoap handwash, and Gillette shaving cream are priced lower than other products in their category. In this paper, we take an initial step toward understanding how the notion of prototypicality can shape the pricing behavior of firms in a horizontally differentiated market.

Consider a product category where consumers' tastes are very diverse, and they seek N different varieties. There are n $(2 \leq n \leq N)$ horizontally differentiated firms, with each firm offering a single product, and thus all the different varieties sought by consumers may not be available. One of the products is viewed as the prototypical exemplar of the category. Although one can potentially capture the notion of prototypical exemplar in different ways, we pursue a conservative approach based on the work of Rosch (1973) and Nedungadi and Hutchinson (1985). In our formulation, the prototypical product is *more* likely to be included in *consumers' consideration sets*. However, prototypicality does not influence attitude toward a product or its valuation. To understand the implications of prototypicality in a competitive market, we incorporate this notion of prototypicality into the spokes model (Chen and Riordan 2007). The spokes model is a particularly useful framework for studying product categories with numerous horizontally differentiated products, such as ice creams, breakfast cereals, soaps, shampoos, and toothpastes. On studying the equilibrium behavior of competing firms, we obtain two key results. First, some of us may expect the prototypical product to be higher priced. Perhaps, one might think that the prototypical product could take advantage of its higher salience by charging a higher price. Counter to this view, our analysis shows that the prototypical product will be priced lower when consumer valuations are low. To appreciate the intuition for this result, note that consumers' tastes are diverse, that all the varieties sought by consumers may not be available, and that consumers consider at most two products. Therefore, some consumers, whose first-preferred product is not available, need to make do with the second-preferred product in their consideration set. Furthermore, because of diversity in consumers' tastes, the proportion of consumers who consider a given product as their first-preferred product is smaller compared with those who regard it as their second-preferred product. This motivates each firm to cater not only to consumers who view its product as their first choice but also to those who consider its product as their second choice. As the prototypical product is more salient in consumers' minds, it is more likely to be included in the consideration set of most consumers. As such, the prototypical product derives a larger fraction of its demand from consumers who view it as the second-preferred product. In this context, when consumer valuations are low, the prototypical product needs to be sufficiently low priced so that it can attract consumers whose first choice is not available and for whom the prototypical product is their second choice. The same argument applies to a lesser extent to the nonprototypical products, as they are unlikely to be the second-preferred product of as many consumers. Therefore, it is profitable for the prototypical product to be the *lower*-priced product in a category.

Second, some may argue that the prototypical product should be priced higher than a nonprototypical product because a prototypical product is of higher perceived quality. Can we observe a higher-priced prototypical product even in the absence of any quality difference? Our analysis suggests that in product categories where consumer valuation is high, the prototypical product may be priced higher than a nonprototypical product. As discussed earlier, the prototypical product is included in the consideration set of most consumers, and a larger fraction of its demand comes from consumers who view it as the second-preferred product. It is indeed quite an appealing choice, especially for consumers whose first-preferred product is not available. However, there is no need to aggressively cut its price to attract these consumers, because the base valuation of the product is high. As such, the prototypical product is motivated to charge a higher price. A much smaller fraction of the demand for a nonprototypical product comes from such captive consumers, and hence it charges a lower price. Thus, when consumer valuation is high, it is profitable to sell the prototypical product at a *higher* price compared with other products in its category.

We test the key predictions of our model in an experimental market that conforms to the structural assumptions of our model. The purpose of Study 1 is to investigate whether the prototypical product could be lower priced when consumer valuations are low. Toward this goal, we maintain low consumer valuation but exogenously vary the level of prototypicality of the products available in the market, and we observe the prices that participants charge for their products. As predicted, the average price of the prototypical product is lower than the average price of nonprototypical products. Study 2 holds the valuation high and examines how the level of prototypicality affects prices. In keeping with equilibrium prediction, the average price of the prototypical product is now higher than the corresponding price of the nonprototypical products. On further examining the pricing dynamics over the course of the experiment, we discover that an adaptive learning mechanism can account for the behavior of our participants.

Related Literature. The seminal work of Rosch (Rosch 1973, Rosch and Mervis 1975) on prototypicality has stimulated a large body of work in psychology and marketing (see Loken et al. 2008 for a review). Rosch's early work shows that categories have an internal structure, with some members being more representative of the category than others. Medin and Shaffer (1978) argue that the prototype stored in memory is a specific example of category rather than an abstract average of the features of the members in the category. In extending this stream of research to consumer products, Nedungadi and Hutchinson (1985) show that some products are prototypical of their respective categories. Moreover, the probability of the prototypical product being included in consumers' consideration set is higher. This view of prototypicality does not involve any affective evaluation of the product (see Cohen 1982). Carpenter and Nakamoto (1989) argue that if consumers' preferences are weak, a pioneering brand can draw consumers' ideal point toward it, raise the valuation of the pioneer, and come to be viewed as the prototypical product of the category. Thus, consumer learning can help explain pioneering advantage in mature markets. This advantage can protect the pioneering brand from low-priced "me-too" products. In keeping with Nedungadi and Hutchinson (1985), but unlike Carpenter and Nakamoto (1989), the prototypicality of a product in our formulation merely influences the composition of consideration set *without* affecting the perceived value of the product. In a model extension, we consider the possibility that the prototypical product can have a higher valuation and explore its theoretical implications.

To the best of our knowledge, prior research has not examined the strategic implications of prototypicality in a horizontally differentiated market. In the context of e-commerce, He and Chen (2006) study how being a featured store can affect its pricing. They show that the featured store charges a higher price than any nonfeatured store if consumers *simultaneously* search for homogeneous products. In contrast to this finding, Armstrong et al. (2009) show that the prominent firm will charge a lower price than its nonprominent rivals if consumers search *sequentially* in a horizontally differentiated market. In our model, consumers do not search. We show how the relative price of the prototypical product of a category is moderated by consumer valuation.

Our work is related to the literature on horizontal product differentiation. The standard linear city model, although parsimonious, is not suitable for studying a product category with $n > 2$ firms. One can consider a circle model with the prototypical product at the center of the circle. However, by placing the prototypical product at the center, one implicitly assumes that the prototypical product is considered by all consumers. In our formulation, however, the level of prototypicality can vary. Furthermore, the prototypical product at the center of the circle competes with all other products in the market; a nonprototypical product faces local competition in that a small change in its price affects only its neighboring firms, not every product in the market. In contrast to our model, this circle model will offer the prototypical brand a location advantage over and above the product being considered by all consumers. Another drawback of the circle model is that symmetry necessitates incumbent firms to relocate in the product space upon the entry of a new firm. As our model builds on the spokes framework, there is no need to change the location of the incumbents when a new firm enters the market (Chen and Riordan 2007).

The rest of the paper is organized as follows. Section 2 lays out the model and analyzes the equilibrium prices of the prototypical product and a nonprototypical product under low and high consumer valuations. Section 3 confronts our main theoretical predictions with data from two tightly controlled laboratory studies. Finally, §4 concludes by summarizing the findings and outlining some directions for further research.

The Model

Spokes Framework

Consider a product category where consumers seek N different varieties. Firms offer only $2 \leq n \leq N$ varieties, implying that all the varieties sought by consumers may not be available. We model this product market as a spokes network on a plane (Chen and Riordan 2007, Amaldoss and He 2010). Consumers preferring variety i $(i = 1, 2, \ldots, N)$ are represented by a line l_i of length $\frac{1}{2}$. Furthermore, consumers are distributed uniformly on the spokes, and we normalize the total mass of consumers to be 1. The consumer located on spoke i at distance x from its proximal end is denoted by (l_i, x), where $x \in [0, \frac{1}{2}]$. Each firm offers a single product indexed $j \in \{1, \ldots, n\}$, and the firm is located at the origin of the spoke for that variety (namely, at $x = 0$).

As the market is horizontally differentiated, the base value of all the products is the same and is denoted by v. If the consumer located at (l_j, x) were to purchase the local product j, she would derive the following indirect utility:

$$U(l_j, x, p_j) = v - tx - p_j, \tag{1}$$

where t is her sensitivity to product characteristics, and p_j is the price of the product. But if the consumer were to purchase any other product available in the market, such as product k, where $k \neq j$, the indirect utility from the nonlocal product would be[1]

$$U(l_j, x, p_k) = v - t(1-x) - p_k. \tag{2}$$

This consumer will purchase her local product j if $U(l_j, x, p_j) > U(l_j, x, p_k)$, suggesting that the marginal consumer who is indifferent between the two products is located at a distance $\frac{1}{2} + (p_k - p_j)/(2t)$ from product j.

As in Chen and Riordan (2007), consumers consider at most two products. A consumer's first-preferred product is the local variety corresponding to the spoke in which the consumer resides. The second-preferred product of the consumer is a nonlocal variety in any of the other spokes, and it is exogenously fixed a priori. The assumption that consumers consider at most two products helps to obtain a pure-strategy equilibrium and reflects the observation that consumers have a small consideration set (Hauser and Wernerfelt 1990, Nedungadi 1990). Next, we incorporate the notion of a prototypical product into the spokes model.

[1] Because the consumer located at (l_j, x) is $\frac{1}{2} - x$ units of distance away from the center of the spokes network and product k is $\frac{1}{2}$ unit of distance further away, the total distance between the consumer and the nonlocal product k is $\frac{1}{2} - x + \frac{1}{2} = 1 - x$.

Prototypical Product

Research in consumer behavior and psychology suggests the prototypical product of a category is more salient in memory (Mervis et al. 1976, Nedungadi and Hutchinson 1985, Ward and Loken 1986). The increased salience helps consumers to easily access information about the prototype from memory (Winkielman et al. 2006). High salience, however, does not guarantee that a consumer will buy the prototypical product, because the purchase decision depends on its relative price as well as the individual consumer's relative preference for it.

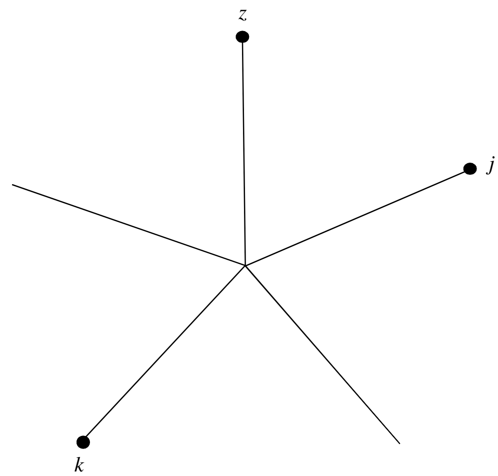
In keeping with prior literature, we model prototypicality as a cognitive construct that is unaffected by attitude and evaluation. Specifically, in our formulation, prototypicality influences the salience of a product and, in turn, the likelihood of the product being included in a consumer's consideration set (Nedungadi and Hutchinson 1985). Recall that in the spokes model, the first-preferred product of a consumer is the local product of the spoke on which the consumer resides (Chen and Riordan 2007, Amaldoss and He 2010). The consideration set of a consumer includes a second-preferred product, which could, in principle, be any of the nonlocal products. We allow the prototypicality of a product to influence the probability of the product being included in a consumer's consideration set. Specifically, as a product becomes more prototypical, it is more likely to be the second-preferred product in a consumer's consideration set if it is not already the first-preferred product.

To fix ideas, let product z be the prototypical product of a category. For consumers residing on spoke l_z, the prototypical product z is their first-preferred product because it is their local product. But for consumers not located on spoke l_z, product z is a nonlocal product. These consumers consider z as their second-preferred product with probability α, and for the remaining $1-\alpha$ probability, they consider any of the nonlocal products (including z) as their second-preferred product with equal chance. Thus, in our model, product z is the only prototypical product, and the level of its prototypicality could be in the range $1/(N-1) < \alpha < 1$. Figure 1 illustrates a market where consumers seek $N=5$ varieties, but only $n=3$ products are available. Of the available products, z is the prototypical product, and k and j are the nonprototypical products.

Consumer Demand

Using the parsimonious formulation of prototypicality, we proceed to derive the demand for the prototypical product and that for each of the nonprototypical products.

Figure 1 An Illustration of the Spokes Model with $N=5$ and $n=3$



Demand for the Prototypical Product. The demand for the prototypical product z comes from two groups of consumers. One group of consumers is located on spoke l_z, and product z is their most preferred product. The second group consists of consumers located on any of the other spokes, and for them, product z is the second-preferred product in their consideration set. Figure 2 illustrates how consumers can be segmented, and the upper panel of Table 1 summarizes the demand from each group.

Group 1 (*P*). Some of the consumers in the first group need to decide whether to purchase the prototypical product z or the other product in their consideration set (see Group 1a (P) in Figure 2). Specifically, for any consumer located on l_z, product k is her second-preferred product with probability $1/(N-1)$, where $k \in \{1, \ldots, n\}$ and $k \neq z$. As the density of such consumers is $2/N$, the demand from these consumers for product z is

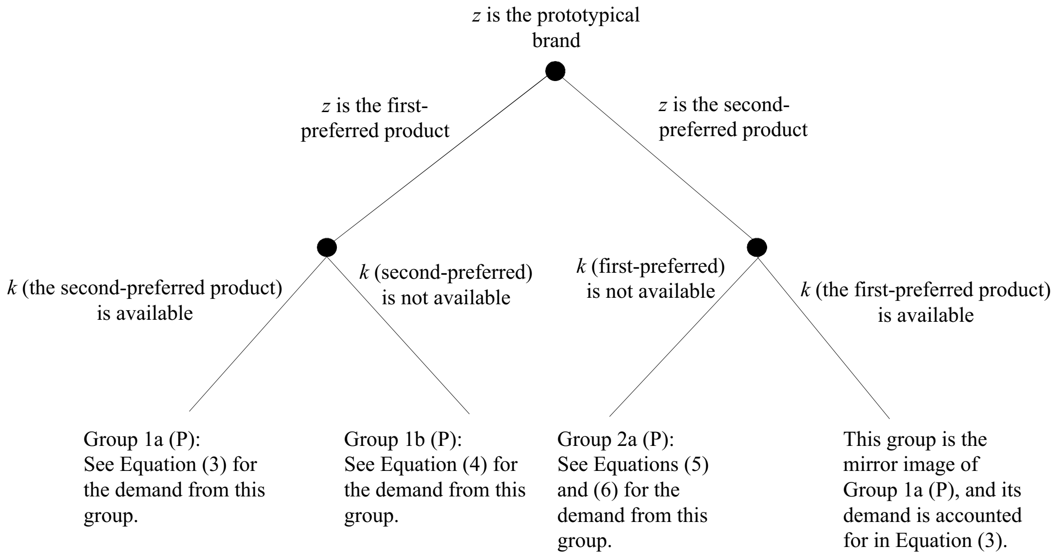
$$\frac{2}{N}\frac{1}{N-1}\sum_{k\neq z,\, k\in\{1,\ldots,n\}} \max\left\{\min\left\{\frac{1}{2}+\frac{p_k-p_z}{2t},1\right\},0\right\}. \quad (3)$$

Note that the mirror image of the consumers in this group is the set of consumers for whom product z is the second-preferred product and product k is the first-preferred product. The demand presented above includes sales to this set of consumers who form a mirror image of Group 1a (P).

Next, consumers in Group 1b (P) need to decide between buying the prototypical product and buying nothing, as their second-preferred variety is not available in the market (see Group 1b (P) in Figure 2). Note that for any consumer on spoke l_z, her second-preferred variety is not available with conditional probability $(N-n)/(N-1)$. Hence, the demand for product z from these consumers is given by

$$\frac{2}{N}\frac{N-n}{N-1}\min\left\{\max\left\{0,\frac{v-p_z}{t}\right\},\frac{1}{2}\right\}. \quad (4)$$

Figure 2 Segmentation of Prototypical Product's Consumers



Group 2 (*P*). Here, we consider the demand from consumers who regard product z as the second-preferred product in their consideration set but still view product z as the prototypical product (see Group 2a (P) in Figure 2). We know that for a consumer on spoke l_i, $i \notin \{1, \ldots, n\}$, product z is the second-preferred product with probability α. Furthermore, the density of such consumers is $(2/N)(N-n)$, and the demand for product z from these consumers is

$$\frac{2\alpha}{N}(N-n)\min\left\{\max\left\{0, \frac{v-p_z}{t}-\frac{1}{2}\right\}, \frac{1}{2}\right\}. \qquad (5)$$

Table 1 Consumer Demand by Group

Group	Demand
1a (P)	$\frac{2}{N}\frac{1}{N-1}\sum_{k\neq z,\, k\in\{1,\ldots,n\}}\max\left\{\min\left\{\frac{1}{2}+\frac{p_k-p_z}{2t}, 1\right\}, 0\right\}$
1b (P)	$\frac{2}{N}\frac{N-n}{N-1}\min\left\{\max\left\{0, \frac{v-p_z}{t}\right\}, \frac{1}{2}\right\}$
2a (P)	$\frac{2\alpha}{N}(N-n)\min\left\{\max\left\{0, \frac{v-p_z}{t}-\frac{1}{2}\right\}, \frac{1}{2}\right\}$
2o (P)	$\frac{2(1-\alpha)}{N}\frac{N-n}{N-1}\min\left\{\max\left\{0, \frac{v-p_z}{t}-\frac{1}{2}\right\}, \frac{1}{2}\right\}$
1a (NP)	$\frac{2}{N}\frac{1-\alpha}{N-1}\sum_{j\neq k,\, j\in\{1,\ldots,n\}}\max\left\{\min\left\{\frac{1}{2}+\frac{p_j-p_k}{2t}, 1\right\}, 0\right\}$
1b (NP)	$\frac{\alpha}{N}\max\left\{1+\min\left\{\frac{p_z-p_k}{t}, \frac{p_z-p_k}{t(N-1)}, \frac{1}{N-1}\right\}, 0\right\}$
1c (NP)	$\frac{2(1-\alpha)}{N}\frac{N-n}{N-1}\min\left\{\max\left\{0, \frac{v-p_k}{t}\right\}, \frac{1}{2}\right\}$
2 (NP)	$\frac{2(N-n)}{N}\frac{1-\alpha}{N-1}\min\left\{\max\left\{0, \frac{v-p_k}{t}-\frac{1}{2}\right\}, \frac{1}{2}\right\}$

As the prototypicality of product z does not influence all consumers, some consumers view it as merely their second-preferred product. For a consumer on l_i, $i \notin \{1, \ldots, n\}$, product z is just the second-preferred product with conditional probability $(1-\alpha)/(N-1)$ and the density of such consumers is $(2/N)(N-n)$. The demand for product z from this additional group of consumers is

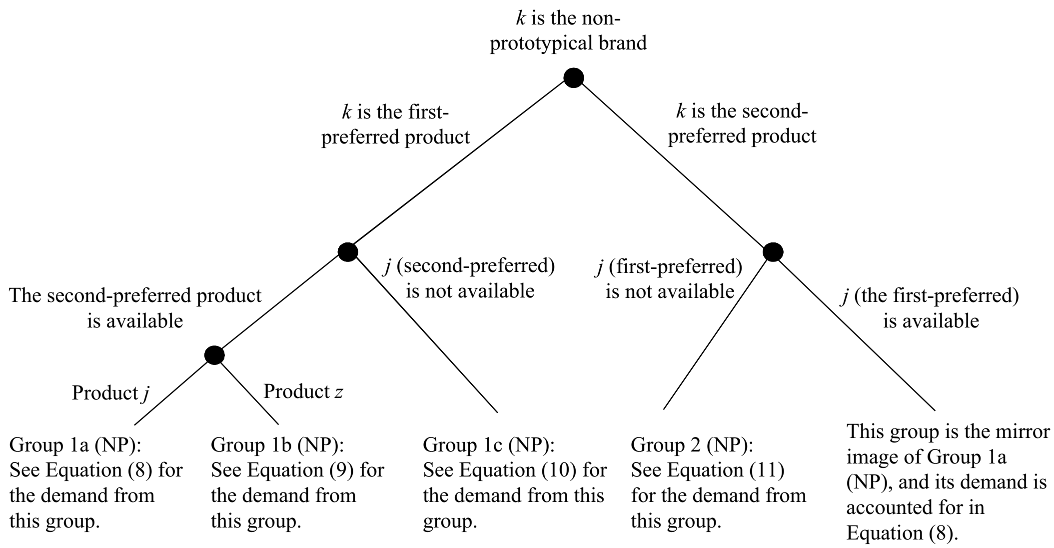
$$\frac{2(1-\alpha)}{N}\frac{N-n}{N-1}\min\left\{\max\left\{0, \frac{v-p_z}{t}-\frac{1}{2}\right\}, \frac{1}{2}\right\}. \qquad (6)$$

On aggregating the demand from this additional group (Group 2o (P)) with that from Group 1a (P), Group 1b (P), and Group 2a (P), we obtain the following total demand for the prototypical product z:

$$\begin{aligned} q_z = {} & \frac{2}{N}\frac{1}{N-1}\sum_{k\neq z,\, k\in\{1,\ldots,n\}}\max\left\{\min\left\{\frac{1}{2}+\frac{p_k-p_z}{2t}, 1\right\}, 0\right\} \\ & + \frac{2}{N}\frac{N-n}{N-1}\min\left\{\max\left\{0, \frac{v-p_z}{t}\right\}, \frac{1}{2}\right\} \\ & + \frac{2(N-n)}{N}\left(\alpha+\frac{1-\alpha}{N-1}\right) \\ & \cdot\min\left\{\max\left\{0, \frac{v-p_z}{t}-\frac{1}{2}\right\}, \frac{1}{2}\right\}. \end{aligned} \qquad (7)$$

Demand for a Nonprototypical Product. The demand for a given nonprototypical product k also comes from two groups of consumers. As discussed below, the nonprototypical product k is the most preferred product for consumers in Group 1 (NP), whereas for consumers in Group 2 (NP), it is their second-preferred product. We illustrate the consumer segmentation in Figure 3 and summarize the demand from each group in the lower panel of Table 1.

Figure 3 Segmentation of a Nonprototypical Product's Consumers



Group 1 (*NP*). The nonprototypical product k is the most preferred product for three sets of consumers. For one set of consumers in this group, their second-preferred product is available, and it is a nonprototypical product (see Group 1a (NP) in Figure 3). In particular, for any consumer located on spoke l_k, product j is her second-preferred product and a nonprototypical product with probability $(1-\alpha)/(N-1)$, where $j\in\{1,\ldots,n\}$ and $j\neq k$. As the density of such consumers is $2/N$, the demand from these consumers for product k is

$$\frac{2}{N}\frac{1-\alpha}{N-1}\sum_{j\neq k,\, j\in\{1,\ldots,n\}}\max\left\{\min\left\{\frac{1}{2}+\frac{p_j-p_k}{2t},1\right\},0\right\}. \quad (8)$$

It is useful to note that the mirror image of the consumers in this group is the set of consumers for whom product k is the second-preferred product, whereas product j is the first-preferred product. The demand presented above includes sales to this set of consumers who form a mirror image of Group 1a (NP).

The second set of consumers view the prototypical product z as the second-preferred product (see Group 1b (NP) in Figure 3). Now, for a consumer on spoke l_k, the prototypical product z is her second-preferred product with probability α. As the density of such consumers is $2/N$, the demand from these consumers for product k is $(2\alpha/N)\max\{\frac{1}{2}+(p_z-p_k)/(2t),0\}$ if $p_k\geq p_z$. But if $p_z\geq p_k$, the demand becomes $(2\alpha/N)(\frac{1}{2}+\min\{(p_z-p_k)/(2t(N-1)),1/(2(N-1))\})$. Hence the demand from this third subgroup can be written as

$$\frac{\alpha}{N}\max\left\{1+\min\left\{\frac{p_z-p_k}{t},\frac{p_z-p_k}{t(N-1)},\frac{1}{N-1}\right\},0\right\}. \quad (9)$$

Note that when $p_z\geq p_k$ such that the marginal consumer is on l_z, firm k gets all the consumers on its own spoke (l_k) but only $1/(N-1)$ fraction of consumers on l_z because these consumers consider any of the nonlocal products as their second-preferred product with equal probability.

For the third set of consumers in this group, the second-preferred variety is not available (see Group 1c (NP) in Figure 3). Because for a consumer on spoke l_k the second-preferred product is not available with probability $(N-n)/(N-1)$, the demand from this set of consumers for product k is given by

$$\frac{2(1-\alpha)}{N}\frac{N-n}{N-1}\min\left\{\max\left\{0,\frac{v-p_k}{t}\right\},\frac{1}{2}\right\}. \quad (10)$$

Group 2 (*NP*). Now we turn attention to consumers who consider the nonprototypical product k as their second-preferred product. For a consumer on l_i, $i\notin\{1,\ldots,n\}$, product k is her second-preferred product with conditional probability $(1-\alpha)/(N-1)$. As the density of such consumers with their first-preferred product not available is $(2/N)(N-n)$, the demand for product k is

$$\frac{2(N-n)}{N}\frac{1-\alpha}{N-1}\min\left\{\max\left\{0,\frac{v-p_k}{t}-\frac{1}{2}\right\},\frac{1}{2}\right\}. \quad (11)$$

Hence the total demand for the nonprototypical product k from the two groups of consumers is

$$q_k=\frac{2}{N}\frac{1-\alpha}{N-1}\cdot\sum_{j\neq k,\, j\in\{1,\ldots,n\}}\max\left\{\min\left\{\frac{1}{2}+\frac{p_j-p_k}{2t},1\right\},0\right\}$$

$$+\frac{2(1-\alpha)}{N}\frac{N-n}{N-1}\min\left\{\max\left\{0,\frac{v-p_k}{t}\right\},\frac{1}{2}\right\}$$
$$+\frac{2\alpha}{N}$$
$$\cdot\max\left\{\frac{1}{2}+\min\left\{\frac{p_z-p_k}{2t},\frac{p_z-p_k}{2t(N-1)},\frac{1}{2(N-1)}\right\},0\right\}$$
$$+\frac{2(N-n)}{N}\frac{1-\alpha}{N-1}$$
$$\cdot\min\left\{\max\left\{0,\frac{v-p_k}{t}-\frac{1}{2}\right\},\frac{1}{2}\right\}. \quad (12)$$

We assume that firms simultaneously choose their prices to maximize profits. We let the marginal cost be the same for all firms and normalize it to 0 without loss of generality. We next examine the pure-strategy equilibrium of this stylized game to gain insights into the rank order of the prices of the prototypical product and nonprototypical product in competitive markets.

Analysis

As the prototypical product is more salient in consumers' minds, one might expect the prototypical product to be priced higher than a nonprototypical product. To carefully scrutinize this issue, consider the situation when consumer valuations are low such that $\frac{1}{2}<(v-p_j)/t<1$. In this case, as $v-p_j-t<0$, some consumers may not find it attractive to buy the second-preferred product (nonlocal product).[2] Yet, as $v-p_j-t/2>0$, all consumers can buy their first-preferred product (local product). In such a situation, we may observe prices that run counter to our naive intuition. Specifically, we have the following proposition.

Proposition 1. *When consumer valuations are low, the prototypical product charges a lower price than a nonprototypical product*: $p_z^*<p_k^*$.

We prove this claim in the appendix. To follow the intuition for this result, first focus on a nonprototypical product. Note that most consumers in Group 1 (NP) could potentially purchase either of the products in their consideration set and that these consumers are less sensitive to price. In particular, when the firm offering the nonprototypical product reduces its price by one unit, the marginal consumer shifts by only $1/(2t)$ in the subgroup where consumers can purchase either product in their consideration set (see Equation (8)). By contrast, consumers in Group 2 (NP) are more sensitive to price. Specifically, if the nonprototypical product's price is reduced by one unit, the location of the marginal consumer now shifts by $1/t$ (see Equation (11)). Furthermore, when consumer valuations are low, the products are less substitutable, and as such, the relative demand from Group 2 (NP) is larger; this induces the firm offering the nonprototypical product to charge a low price.

Now, to appreciate why the prototypical product is priced lower, notice that the prototypical product is in the consideration set of most consumers ($\alpha>1/(N-1)$). Therefore, for many more consumers, the prototypical product is the only preferred product available in the market (compared with the number of consumers for whom a nonprototypical product is the only preferred product that is available in the market). As such, a larger fraction of the demand for the prototypical product comes from the more price-sensitive consumers—namely, Group 2 (P). Hence, the firm offering the prototypical product is even more motivated to reduce its price to gain sales and improve its profits. In other words, the prototypical product is considered by a larger fraction of consumers, and many of these consumers need to decide whether to buy the prototypical product or nothing because consumer valuation is low. This drives up consumers' price sensitivity and lowers the relative price of the prototypical product. Thus, when consumer valuations are low, the prototypical product's price is lower than that of a nonprototypical product.

Because the result in Proposition 1 is quite counterintuitive, one may wonder whether our results might change if we allow the prototypical product to be of a higher valuation compared with a nonprototypical product. Recall that in our model we allow the prototypicality of a product to influence the probability of the product being included in consumers' consideration set, not the product's valuation. However, an implication of Carpenter and Nakamoto's (1989) work on pioneering advantage is that the prototypical product may be valued more than a nonprototypical product. To further assess the robustness of our finding that the prototypical product could be lower priced, consider the case where the valuation of each of the nonprototypical products is v and the valuation of the prototypical product is $v+\delta$. In this case, it is easy to argue that if the valuation of the prototypical product is sufficiently high, the prototypical product will be higher priced. The key question is, will the prototypical product be lower priced in such a situation? Consistent with Proposition 1, we find that the prototypical product charges a lower price in the low valuation region as long as δ is not too large. The proof for this and all the subsequent claims can be seen in the appendix.

The preceding analysis offers insight into why a prototypical product may be priced lower. In reality, however, we also see higher-priced prototypical products. Why does this happen? Of course, it is easy

[2] This implies that the consumer valuation is below a threshold, as established in the appendix.

to argue that if a prototypical product is of higher quality or is perceived to be of higher quality, it will command a higher price. However, will we observe a higher-priced prototypical product even in a horizontally differentiated market? Our analysis suggests that it is possible. To see this possibility, consider a market where well over half of the varieties that consumers seek are available—that is, $n/N > \frac{1}{2} + 1/N$. Furthermore, let valuations be moderately high so that consumers can gain a surplus from buying any product in the market, implying $(v - p_j)/t > 1$.[3] From analyzing the pure-strategy equilibrium of firms in this market, we have the following result.

Proposition 2. *When consumer valuations are moderately high, the prototypical product charges a higher price than a nonprototypical product*: $p_z^* > p_k^*$.

The proof for this result is presented in the appendix. To appreciate the intuition for this finding, let us first examine the pricing of a nonprototypical product. When consumer valuations are high, all consumers can buy their nonlocal product as $v - p_j - t > 0$. Therefore, a larger fraction of consumers in Group 1 (NP) can buy either of the products in their consideration set. These consumers are less sensitive to a price cut, and hence the firm offering the nonprototypical product is less motivated to cut its price. Next, note that consumers in Group 2 (NP) need to decide between buying the nonprototypical product or nothing. There is no need to aggressively cut the price of the nonprototypical product to encourage these high valuation consumers to buy the product (in contrast to low valuation consumers). In particular, the demand from this group of consumers is insensitive to price as long as $p_k \le v - t$ (see the min and max operators in Equation (11)). Together, these two effects motivate the firm offering the nonprototypical product to charge a high price.

Recall that the prototypical product derives an even larger part of its demand from the less price-sensitive segment—namely, Group 2 (P). The demand from this group of consumers for the prototypical product is not sensitive to price provided $p_z \le v - t$ (see the min and max operators in Equations (5) and (6)). As such, the firm offering the prototypical product finds it attractive to charge an even higher price. Put simply, consumers for whom the prototypical product is the second-preferred product and the only product available can now buy it in equilibrium because of the high valuation. The lower price sensitivity of these captive consumers raises the relative price of the prototypical product. Hence, when consumer valuations are moderately high, we see a reversal in the rank order of prices charged by the prototypical product and a nonprototypical product: $p_z^* > p_k^*$. It is interesting to note that when valuations are sufficiently high, the firm offering the prototypical product can go as far as charging the monopoly $v - t$.[4]

Discussion

Propositions 1 and 2 highlight how prototypicality affects the rank order of prices in a horizontally differentiated market. This may raise the question of how prototypicality affects the absolute prices, not just relative prices. On examining this issue, we find that if consumer valuations are high, the price of the prototypical product as well as the prices of the nonprototypical products increase if α increases (see the supplementary analysis, available at http://dx.doi.org/10.1287/mksc.2013.0793). To see why, note that as the level of prototypicality increases, the prototypical product draws a larger fraction of its sales from consumers for whom it is the only choice available in the market. As such, the prototypical product charges a higher price as α increases. Anticipating this behavior, the nonprototypical product also charges a higher price. Thus prices are strategic complements. However, if consumer valuations are low, then an increase in prototypicality will lead to lower prices for both the prototypical product and nonprototypical products. This is because now the prototypical product tries to motivate its captive low valuation consumers to buy its product rather than nothing. Consequently, the prototypical product's price decreases as the level of prototypicality increases. The nonprototypical products also cut their prices if consumer valuations are not too low.

Second, another interesting question is whether an increase in prototypicality will hurt a nonprototypical product's sales and profits. Consistent with our intuition, as prototypicality increases, the demand for the prototypical product increases, whereas the demand for the nonprototypical product decreases. Yet when consumer valuations are moderately high, profits of the nonprototypical product might still increase as the level of prototypicality increases. We obtain this rather counterintuitive result because an increase in prototypicality softens price competition when valuations are moderately high. Note that when α increases, the prototypical product attracts more of its sales from consumers for whom it is the only available product in their consideration sets. This permits the prototypical product to set a higher price as α increases. As prices are strategic complements, the nonprototypical products' prices also increase. More importantly, the higher price more than compensates for the loss in demand for the nonprototypical product and improves its profits.

[3] The corresponding thresholds on consumer valuations can be seen in the appendix.

[4] In particular, if $v \ge t[N(2-\alpha) + (1-\alpha)(n-4)]/((1-\alpha)(n-2))$, the prototypical product will be priced at $v - t$.

Third, in formulating our model, we considered a market where consumers seek N diverse varieties of products, but firms only offer $2 < n < N$ products. This may pose the question of how diversity in consumers' tastes affects the relative price of the prototypical product. Our analysis of this issue suggests that as diversity in consumers' tastes increases, the prices of both the prototypical and nonprototypical products decrease when consumer valuations are low. However, the opposite holds when consumer valuations are high. To grasp the rationale, note that a more diversified consumer taste has two consequences: (1) each firm's product is less likely to be the first-preferred product, and (2) the second-preferred variety is more likely to be available.[5] This implies that prototypicality is even more valuable to a firm when consumers' tastes become more diverse; furthermore, it increases a firm's incentive to cater to consumers who consider its product as the second-preferred choice. In this situation, if consumer valuations are low, consumers are more sensitive to price, lowering the equilibrium prices of prototypical as well as nonprototypical products. Conversely, if consumer valuations are high, the prototypical product can charge a higher price because of the increased demand from some of the captive consumers. The nonprototypical products can also follow this lead and raise their prices, but to a lesser extent.

Fourth, a related issue is how the number of products available in the market affects the equilibrium prices. We find that when consumer valuations are low, the prices of both the prototypical and nonprototypical products increase with n. On the contrary, when consumer valuations are moderately high, the prices of the prototypical and nonprototypical products decrease with n. To appreciate why we now obtain results that are opposite to the effect of N on equilibrium price, note that as n increases, consumers are more likely to get their first-preferred product. Thus, in contrast to N, an increase in the number of available products makes the prototypicality of a product less valuable to a firm. Hence, n and N have opposite effects on equilibrium prices.

Fifth, given that we are using a spatial differentiation model, one may be interested in understanding how product differentiation affects equilibrium prices. We find that when the degree of differentiation is moderately high (that is, $v - p_j < t < 2(v - p_j)$), the price of the prototypical product decreases with the level of differentiation, whereas the price of a nonprototypical product increases with t.[6] The reason for this result is that any further increase in the differentiation of the already moderately differentiated products forces the prototypical product to cut its price to attract customers for whom it is the second-preferred product. In this moderately differentiated market, any further increase in t encourages a nonprototypical product to focus on its customers for whom it is the first-preferred product and even raise its price for them. By contrast, when the degree of differentiation is low (namely, $t < v - p_j$), the prices of the prototypical product and nonprototypical products increase in t. This is because when the products are not sufficiently differentiated, an increase in t helps to soften price competition and raise the prices of all products.

Finally, some may wonder what would happen if a firm could influence its level of prototypicality through investment. To explore this issue, consider a two-stage model. The firm decides on the optimal level of prototypicality in the first stage, and then it chooses the optimal price in the second stage. Because of the complexity of the demand function, we do not have a closed-form solution for this problem. However, it lends itself to numerical analysis. Suppose the firm producing the prototypical product can enhance prototypicality by making an investment at a cost of $c\alpha^2$. Our analysis shows that as the diversity in consumers' tastes increases, the optimal α^* rises. We obtain this result because when consumers' tastes become more diverse, the prototypical product can benefit from being included in the consideration set of an even larger fraction of consumers. Thus prototypicality becomes more valuable when consumers' tastes become more diverse. Hence the optimal α^* increases as N increases. In the following section, we venture to assess to what extent our model can predict the rank order of prices in a competitive market.

Experimental Investigation

The theoretical analysis shows how the rank order of prices can vary with consumer valuations: if valuations are low, the prototypical product will be priced lower than a nonprototypical product, whereas if the valuations are high, the rank order will be reversed. To perform a causal test of the model, it is important to exogenously vary consumer valuations and prototypicality and then observe their effects on product prices. This level of control over demand is difficult to accomplish in a field setting. In a laboratory, however, it is easier to manipulate the demand conditions and study firm behavior (e.g., Lim and Ho 2007). Hence,

[5] Recall that the conditional probability of a consumer's second-preferred brand being not available is $(N - n)/(N - 1)$.

[6] When $t > 2(v - p_j)$ (or $(v - p_j)/t < \frac{1}{2}$), the differentiation is so high that each firm becomes a local monopoly catering only to consumers residing on its local spoke. Consumers whose first-preferred product is not available buy nothing.

we explore the possibility of testing the model in the laboratory.

Prior experimental research on horizontally differentiated markets is limited, and it has primarily examined location choices rather than price competition (Brown-Kruse et al. 1993, Brown-Kruse and Schenk 2000). Barreda-Tarrazona et al. (2011) examine both location and pricing decisions. Often, players differentiate less than the normative prediction in these experiments. In light of the sparse experimental literature, it is important to assess whether players can come to conform to the qualitative predictions of our model. In particular, we seek answers to the following two empirical questions:

1. *Will the prototypical product charge a lower price compared with a nonprototypical product when consumer valuations are low?* According to Proposition 1, the prototypical product should be lower priced compared with a nonprototypical product. More specifically, if $t=1$, $N=11$, $n=5$, $\alpha=0.55$, and $v=1.2$, we should observe $p_z^*=0.416<p_k^*=0.676$ in equilibrium. In our experiment, we assess whether participants can learn over the several iterations of the game to behave in a manner that is directionally consistent with this prediction.

2. *Will the prototypical product shift to charging a higher price compared with a nonprototypical product when consumer valuations are high?* Proposition 2 predicts that the prototypical product will charge a higher price compared with a nonprototypical product. In equilibrium, when $t=1$, $N=11$, $n=5$, $\alpha=0.55$, and $v=10$, we should see $p_z^*=8.94>p_k^*=6.46$. We test the descriptive validity of this prediction.

Experimental Design

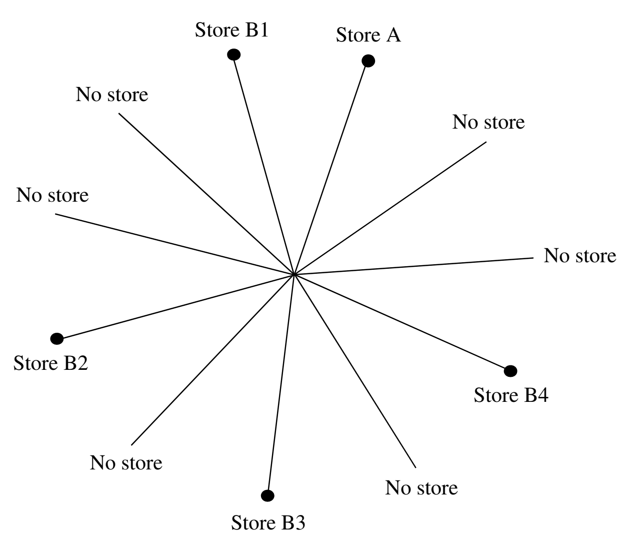
We employ a 2 (low valuation and high valuation) × 2 (type A and type B player) design with valuation as a between-participant variable and type of player as a within-participant variable. We use a total of four groups of participants with the valuation being low in two groups and high in the other two groups. We randomly assign the 15 participants in each group to three oligopolies of five participants in every trial. Recall that in our model, there is one prototypical product in a category. Accordingly, in each oligopoly, one participant plays the role of the firm offering the prototypical product, whereas the remaining four participants play the role of a firm selling a nonprototypical product. We treat prototypicality as a within-participant variable, with each participant offering the prototypical product for 10 trials and the nonprototypical product for another 40 trials. As discussed in §2, the prototypical product is more likely to be featured in consumer's consideration set. In our experiment, the probability of the prototypical product being included as the second-preferred product in consumers' consideration is 55%, whereas the corresponding probability for a nonprototypical product is 4.5%. We treat valuation as a between-participant variable with $v=1.2$ in two groups and $v=10$ in the other two groups. The other variables of the model are held constant across all the participants over all the trials: $N=11$, $n=5$, and $t=1$. By changing the participants in each oligopoly from trial to trial and not revealing their identity, we obtain data on multiple replications of the pricing game (see also Amaldoss and Jain 2005).

Procedure

The participants in the study are graduate and undergraduate students. Because we are interested in investigating the pricing behavior of firms, we abstract away from the demand side of the market by using the aggregate demand function derived from our consumer model (see Selten and Apesteguia 2005 for a similar design). Thus participants play the role of firms, whereas the computer plays the role of consumers. The detailed instructions provided to participants are available upon request.

Even though the computer plays the role of consumers according to the demand function of our model, we provided participants with a verbal description of the market so that they could understand the actions of the computer. Specifically, we illustrated a town with 11 streets emanating from the center of the town (see Figure 4). At the end of five of these streets there is a store, but there is no store on the other six streets. The products from the five stores are labeled A, B1, B2, B3, and B4. All the stores offer products of the same quality level, with the valuation being $v=1.2$ in two groups and $v=10$ in the other two groups. Each street is half a unit long with an equal number of consumers residing

Figure 4 An Illustration of the Spokes Model with $N=11$ and $n=5$



on each street. Furthermore, consumers are spread uniformly along each street. The product available on their street is the most preferred product of consumers. In addition to this product, their consideration set may include another product. The probability of product A being this second-preferred product is 55%, whereas the probability of products B1, B2, B3, or B4 being the second-preferred product is only 4.5%. Thus in our experiment, product A is the prototypical product, and products B1, B2, B3, and B4 are the nonprototypical products. In the tradition of experimental economics literature, we do not use labels such as "prototypical products" and "nonprototypical products" when describing the experimental protocol to participants. Instead, the prototypical product is referred to as product A, and the nonprototypical products are labeled B1, B2, B3, and B4. It costs money for a consumer to travel from her house to a store. It costs less to travel to a store if the consumer resides on the same street where the store is located but more if the consumer travels to another street to purchase a product. The travel cost is equal to the distance traveled. The total cost of purchasing a product thus includes the price of the product and the travel cost. Depending on the total cost of purchasing each of the products in her consideration set, a consumer first decides whether or not to purchase any product. If she decides to buy, then she selects which product to buy: A, B1, B2, B3, or B4. This description of the market is intended to help participants understand how consumers might react to stores' prices.

While setting prices, our participants can use a calculator, which is purely a computational tool and does not offer any guidance on normative behavior. The calculator is helpful to rule out poor computational skills as an explanation for our results. At the beginning of each trial, the participant offering the prototypical product is asked to indicate her product's price and the likely average price of all the nonprototypical products in the market. The prices are expressed in cents. Based on these two inputs, the calculator displays the likely profits of the prototypical product using the demand function of our consumer model. Similarly, each player offering a nonprototypical product is asked to specify her price as well as provide estimates of the likely price of the prototypical product and the likely average price of the other nonprototypical products. Using these three pieces of information, the calculator displays the likely profits from the participant's nonprototypical product. After viewing the likely profits, each participant can revise her price as well as the expected prices of her competitors. It is clarified to each participant that her competitors may not behave as she predicts. Furthermore, her actual earnings only depend on the *actual prices* charged by her competitors, *not her beliefs* about their prices. That is, a participant's likely profits will be close to her actual profits only to the extent that her expectations are accurate. The calculator thus serves as a *mere* computational tool and offers no advice on what prices our participants should charge. The calculator does, however, make it easy for participants to see the profit implications of their pricing decisions and explore ways to improve profits. We would like to emphasize that even with the aid of a calculator, the game does not reduce to a single-person optimization problem. Using the calculator, each participant can only fine-tune her price conditional on her beliefs about her opponents' prices, but the actual payoff depends on the actual decisions of opponents, not the participant's beliefs about competitors' prices. Thus the decision task in our experiment is not a trivial one.

After all the players confirm their prices, the computer displays the results of the trial. Participants offering the prototypical product are informed of their own prices and profits along with the average price and average profits of the nonprototypical products. Participants selling a nonprototypical product see on their results screen their own price and profits; in addition, they observe the price and profits of the prototypical product as well as the average price and profits of the other nonprototypical products.

At the start of the experiment, participants play five practice trials to familiarize themselves with the structure of the game. At this stage, if they have any questions about the instructions, the supervisor answers them. After all the participants become familiar with the structure of the game, they play 50 actual trials: 10 trials as the producer of the prototypical product and another 40 trials as a producer of a nonprototypical product. Neither the identity of the participant nor the identity of any of her competitors in any trial is revealed. This anonymity, together with the random assignment of participants to the three oligopolies in each trial, reduces scope for building reputation over the course of the experiment. The goal of our participants is to maximize their individual profits over the 50 trials of the game. At the end of the experiment, their cumulative earnings in the experiment are converted into dollars and paid.[7]

[7] In our experiment, we did not offer any financial incentive for participants to truthfully reveal their expectations. Providing such an incentive in addition to the profits earned in each trial would add another layer of complexity to an already complicated game and potentially impede comprehension. Therefore, the participants in our experiment, after gaining some experience, could potentially enter random numbers as their expectations and yet set their price to maximize actual profits (rather than the expected profits displayed by the calculator). Thus, after gaining some proficiency, some participants may choose not to use the calculator.

Results

We conduct our analysis on a body of 3,000 pricing decisions (2 levels of valuation × 2 groups × 15 participants per group × 50 trials per participant = 3,000 decisions). Table 2 summarizes the mean prices of the prototypical product and that of a nonprototypical product and the corresponding equilibrium predictions for each valuation condition. A repeated measures analysis of the pricing decisions shows that the interaction effect of valuation and type of player is significant, suggesting that the effect of prototypicality on price varies with valuation ($t = 16.29$, $p < 0.0001$). In keeping with Propositions 1 and 2, the rank order of the prices of the prototypical and nonprototypical products changes with the valuation condition. However, we observe departures from the point predictions of the equilibrium solution and heterogeneity in the behavior of individual participants.

Mean Price. Proposition 1 predicts that the prototypical product will be lower priced if consumer valuation is low. Across the two groups in the low valuation condition, the average price of the prototypical product is 43.89 cents, whereas the price of a nonprototypical product is 65.22 cents. A random effects analysis of the pricing decisions rejects the null hypothesis that these two mean prices are the same ($t = 9.37$, $p < 0.001$). A similar pattern of results is observed in each of the two groups. In Group 1, the price of the prototypical product is 44.11 whereas that of a nonprototypical product is 65.40 ($t = 13.04$, $p < 0.001$). In Group 2, the average prices of the prototypical product and nonprototypical product are 43.67 and 65.03, respectively ($t = 4.97$, $p < 0.001$).

According to Proposition 2, the prototypical product should be higher priced if consumer valuation is high. In the high valuation condition, the average price of the prototypical product is 89.11 dimes and the price of a nonprototypical product is 67.17 dimes. Using a random effects model, we can reject the null hypothesis that these two mean prices are the same ($t = 16.08$, $p < 0.001$). We obtain similar results at the level of individual groups. In Group 1, the price of the prototypical product is 89.57 whereas that of a nonprototypical product is 66.33 ($t = 13.77$, $p < 0.001$); in Group 2, the corresponding prices are 88.65 and 68.01, respectively ($t = 9.59$, $p < 0.001$).

Next we compare the observed behavior against the point predictions of the model. In equilibrium, the prototypical product's price should be 41.57 when $v = 1.2$. In actuality, the average price across the two groups is 43.89 ($t = 3.83$, $p < 0.001$). We can also reject the null hypothesis that the predicted and actual prices are the same at the level of individual groups (Group 1: $t = 3.66$, $p < 0.001$; Group 2: $t = 2.11$, $p < 0.036$). The nonprototypical product's price should be 67.58 in equilibrium, but on average, the price in the two groups is 65.22 ($t = 7.74$, $p < 0.001$). Again, we can reject the null hypothesis that the predicted and observed prices are the same in each of the groups (Group 1: $t = 6.72$, $p < 0.001$; Group 2: $t = 4.92$, $p < 0.001$).

Turning attention to the high valuation condition, note that in equilibrium, the prototypical product's price should be 89.43. Across the two groups in this condition, the average price of the prototypical product is 89.11. The observed difference between the theoretical prediction and the actual price is only marginally significant ($t = 1.03$, $p < 0.10$). On probing further, we note that the difference is not significant in Group 1 but is significant in Group 2 (Group 1: $t = 1.63$, $p > 0.10$; Group 2: $t = 2.52$, $p < 0.02$). The nonprototypical product's price should be 64.60 in equilibrium, but on average, the price in the two groups is 67.17. Now we can reject the null hypothesis that the predicted and observed prices are the same (Group 1: $t = 8.84$, $p < 0.001$; Group 2: $t = 4.82$, $p < 0.001$). Even though the observed prices are in keeping with the predicted rank order, we see some significant departures from the point predictions. Having examined the aggregate behavior across participants, we advance to explore the differences in the behavior of individual participants.

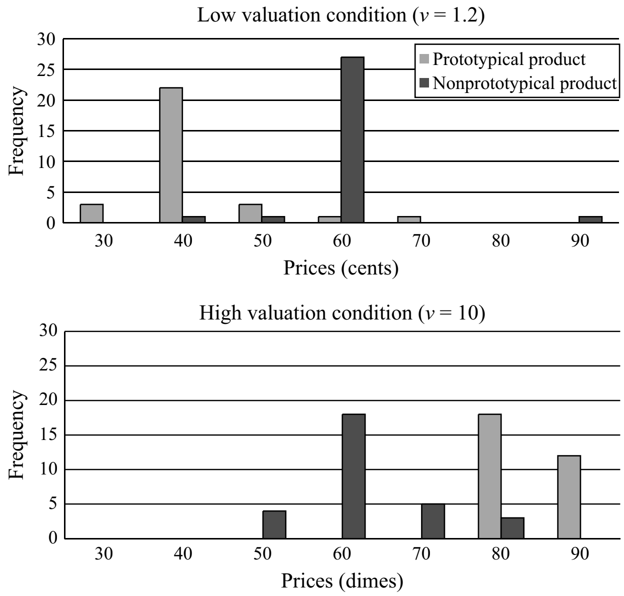
Individual Differences. Here, we investigate the average price charged by individual participants across trials. The upper panel of Figure 5 compares

Table 2 **Mean Prices**

Condition	Type of product	Group 1	Group 2	Average	Equilibrium prediction
Low valuation ($v = 1.2$)	Prototypical product	44.11 (8.5)	43.67 (12.23)	43.89 (10.51)	41.57
	Nonprototypical product	65.4 (7.96)	65.03 (12.72)	65.21 (10.61)	67.58
High valuation ($v = 10$)	Prototypical product	89.57 (1.10)	88.65 (3.79)	89.11 (2.82)	89.43
	Nonprototypical product	66.33 (8.78)	68.01 (11.11)	67.17 (10.04)	64.61

Note. Prices are expressed in cents in the low valuation condition and in dimes in the high valuation condition.

Figure 5 Distribution of Average Prices of Individual Participants



the empirical distribution of the average prices for the prototypical product with that for a nonprototypical product when consumer valuation is low. The empirical distribution is qualitatively consistent with the equilibrium solution. Specifically, the average price of the prototypical product ranges from 30 to 71, whereas that of the nonprototypical product ranges from 49.38 to 98.75. A nonparametric test rejects the null hypothesis that the average prices of the prototypical and nonprototypical products are drawn from the same distribution ($M = 13.5$, $p < 0.001$).

As the lower panel of Figure 5 shows, the empirical distribution of prices is qualitatively consistent with the equilibrium solution when consumer valuation is high. The average price of the prototypical product ranges from 83.5 to 90, whereas that of the nonprototypical product ranges from 58.45 to 88.23. Using a nonparametric test, we can reject the null hypothesis that the average prices of the prototypical and nonprototypical products are obtained from the same distribution (sign test: $M = 15$, $p < 0.001$).

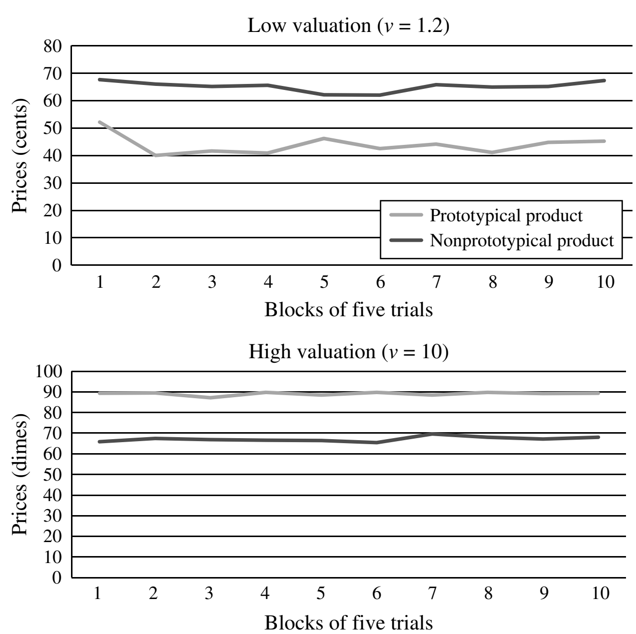
Discussion

The observed prices are consistent with the qualitative predictions of Propositions 1 and 2, but they deviate from the point predictions of the solution in small but significant ways. According to Proposition 1, the prototypical product should yield higher profits compared with a nonprototypical product *even* though the price of the prototypical product is lower. On average, the profits earned in a trial from the prototypical product and nonprototypical product are 11.20 and 4.98, respectively, when the valuation is low ($t = 33.57$, $p < 0.001$). When consumer valuation is high, the prototypical product should not only charge a higher price but also earn higher profits. Consistent with Proposition 2, the average profits earned from the prototypical product are 33.53, whereas the corresponding profits from a nonprototypical product are 7.69 ($t = 105.5$, $p < 0.001$). Thus our experiment provides empirical support for the idea that the rank order of prices of the prototypical product and nonprototypical product can vary with consumer valuation, but the prototypical product always earns higher profits.

These aggregate results may encourage one to ask the question, to what extent does the theory survive at the level of individual subjects? Recall that in our experiment, each individual participant plays the role of type A and type B players, implying that the level of prototypicality is varied within each participant. Then according to Proposition 1, each individual participant should charge a lower price for the prototypical product compared with her price for the nonprototypical product if the valuation is low. Of the 30 participants in the low valuation condition, we find that the behavior of 28 participants conforms to this prediction. Similarly, in the high valuation condition 29 of the 30 participants charged a higher price for the prototypical product compared with the nonprototypical product, as predicted by Proposition 2.

These findings may lead to another question: How did participants come to conform to the equilibrium prediction? To detect trends in the decisions of our participants, we divided the 50 trials into 10 blocks of 5 trials. The upper panel of Figure 6 presents the average price trend of type A players (prototypical

Figure 6 Trends in Prices



product) as well the average price trend of type B players (nonprototypical product) in each of the 10 blocks when the valuation is low ($v=1.2$). Likewise, the lower panel of Figure 6 presents the average price trends of type A and type B players trends when the valuation is high ($v=10$). In the following section, we examine the pricing dynamics over the course of the experiment.

Pricing Dynamics

To unravel potential adaptive mechanisms that can account for the pricing decisions of our participants over the course of the experiment, we fit the well-established experience-weighted attraction (EWA) learning model to the data. For a detailed discussion of the EWA model and its advantages, we refer the reader to Camerer and Ho (1999). Below we briefly outline the model and then discuss the results of our estimation.

EWA Learning Model

Using the history of pricing decisions, the EWA model estimates the probability that player i will charge price p_i in the next period. In particular, the probability of player i charging price $p_i=m$ on trial $t+1$ is given by the logit function

$$\mathrm{Prob}(p_i^m(t+1)) = \frac{e^{\lambda A_i^{p_i^m}(t)}}{\sum_{j=0}^{c} e^{\lambda A_i^{p_i^j}(t)}}, \tag{13}$$

where $A_i^{p_i^m}(t)$ is the attraction of charging $p_i=m$ at time t for player i. The parameter λ indicates the sensitivity of the players to attractions. Alternatively, λ can be construed as a measure of noise in the pricing decision process. At the end of every trial, a player updates the attractiveness of a strategy based on the actual payoff and also the expected payoffs corresponding to the prices that were not chosen. While the attraction of a strategy (price) is updated, the payoff corresponding to the chosen price is given a weight equal to 1, but the expected payoffs corresponding to the unchosen prices are given a weight of δ ($0\le \delta\le 1$). The weight given to foregone payoffs could be a consequence of imagining them. As the experiment progresses, players could potentially discard old observations and become more responsive to recent observations. Hence, previous attractions are depreciated by ϕ ($0\le\phi\le 1$).

To update the attractiveness of a strategy, the model computes $N(t)$, which is the observations' equivalents of past experience. Specifically, $N(t)$ is given by $N(t)=\rho N(t-1)+1$, where $t\ge 1$ and the parameter ρ ($0\le\rho\le 1$) is the rate of depreciation. The attraction of charging price p_i^m, $A_i^{p_i^m}(t)$, is a weighted average of the payoff for period t and the previous attraction $A_i^{p_i^m}(t-1)$:

$$\begin{aligned} A_i^{p_i^m}(t) = \Big[&\phi N(t-1) A_i^{p_i^m}(t-1) \\ &+ [\delta + (1-\delta) I(p_i^m, p_i(t))]\pi_i(p_i^m(t), \mathbf{p}_{-\mathbf{i}}(t))\Big] \\ &\cdot \big[N(t)\big]^{-1}, \end{aligned} \tag{14}$$

where $\pi_i(p_i^m(t), \mathbf{p}_{-\mathbf{i}}(t))$ is the payoff received by firm i by charging price $p_i^m(t)$ in period t, given that the other players invested $\mathbf{p}_{-\mathbf{i}}(t)$ in time period t. Note that the indicator function $I(p_i^m, p_i(t))$ takes the value 1 if $p_i(t)=p_i^m$, but it is 0 otherwise. Thus, if player i sets price p_i^m on trial t, the payoff is added to $A_i^{p_i^m}(t)$. But if player i charges price $p_i\ne m$ on trial t, then only δ fraction of the payoff is added to $A_i^{p_i^m}(t)$. At the beginning of the experiment, the participants have a uniform prior on the attractiveness of any strategy, implying $A_i^{p_i^m}(0)=1$ for all m. Furthermore, we let $N(0)=1$. Thus the focus of our analysis is on understanding how the prices evolved over the course of the experiment. We also discretized the prices to natural numbers to help estimate the model parameters.

Results

To gain insights into the pricing dynamics, we estimate one set of EWA model parameters for all type A players (prototypical product) and another set for type B players (nonprototypical product) using the maximum likelihood method. Table 3 reports the parameter estimates and goodness of fit statistics such as log-likelihood (LL), Akaike information criterion (AIC), Bayesian information criterion (BIC), and pseudo-ρ^2.[8] Note that the log-likelihood for type B players is almost four times larger than that for type A players, and this is because we have four times more observations on type B players.

On examining the parameter estimates, we note that the value of λ is 2.18 and 1.44 for type A and type B players, respectively, indicating that these players are sensitive to payoffs. Furthermore, we observe that $\delta=0$ for type A players, implying that their pricing decisions are not influenced by expected payoffs. Rather, the pricing decisions of type A players are based on the payoffs earned in previous trials. Unlike type A players, type B players seem to place some weight on foregone payoffs when formulating their pricing decisions. This inference is based on the observation that $\delta=0.075$ for these players. Perhaps pricing a nonprototypical product is more

[8] Note that $\mathrm{AIC}=\mathrm{LL}-k$ and $\mathrm{BIC}=\mathrm{LL}-(k/2)\log(M)$, where k is the number of degrees of freedom and M is the sample size. The pseudo-ρ^2 is the improvement in log-likelihood (LL) compared with the log-likelihood of a model of random choices, normalized by the random model log-likelihood.

Table 3 **Parameter Estimates and Goodness of Fit**

	Type A player		Type B player	
Parameter	EWA model	Reinforcement model	EWA model	Reinforcement model
ρ	0.696**	0.000	0.735**	0.000
ϕ	0.815**	0.730**	0.872**	0.858**
δ	0.000	0.000	0.075**	0.000
λ	2.18**	0.900**	1.441**	0.409**
LL	−2,114.708	−2,122.346	−8,534.320	−8,585.404
AIC	−2,118.708	−2,124.346	−8,538.320	−8,587.404
BIC	−2,119.663	−2,127.301	−8,540.478	−8,591.562
Pseudo-ρ^2	0.198	0.195	0.191	0.186
χ^2		15.276		102.167
p-Value		0.000		0.000

**Significant at the 0.01 level.

complex because type B players have to imagine not only the likely price of the prototypical product but also the prices of competing nonprototypical products. The estimates of ϕ and ρ for type A players are 0.696 and 0.815, respectively, whereas the corresponding estimates for type B players are 0.735 and 0.872. These parameter values suggest that our participants are placing greater weight on past experience when choosing their prices.

The fact that our participants are not placing much weight on foregone payoffs may make one think whether a pure reinforcement-based learning model may fit the data better than the hybrid EWA model. Note that if $\delta=0$, $\rho=0$, and $N(0)=1$, the attractions of the EWA model become equal to the payoffs in classical reinforcement learning models. On estimating this special case, we find that fit statistics of the reinforcement-based model for type A players as follows: LL $=-2122.346$, AIC $=-2124.346$, and BIC $=-2127.301$, implying that the hybrid EWA model fits the data better than a pure reinforcement-based learning model. We observe a similar pattern of results for type B players, with the LL, AIC, and BIC for reinforcement learning being -8585.404, -8587.404, and -8591.562, respectively. We also obtained similar results when estimating the model at the level of each valuation condition. Moreover, a pure belief-based learning model performs substantially worse than a reinforcement-based learning model and not much better than a random choice model. In sum, it seems that our participants adaptively learned how to set prices over the course of the experiment. Furthermore, their pricing decisions were primarily guided by experienced payoffs rather than foregone payoffs. This finding is consistent with prior research suggesting that people come to conform to equilibrium prediction through trial and error, not by mere introspection about equilibrium play (e.g., Camerer and Ho 1999, Rapoport and Amaldoss 2000, Meyer and Hutchinson 2001, Amaldoss and Jain 2002).

Conclusion

This paper was motivated by a desire to understand how the prototypicality of a product affects its price. To this end, we captured the notion of a prototypical product in a model of horizontal differentiation. Our theoretical and experimental investigation offers insights on a few questions of practical significance.

- *When should a prototypical product be lower priced?* Some might naively expect a prototypical product to always be higher priced. Yet some prototypical products are priced lower than the other products in the category. For example, Chapstick, despite being the prototypical lip balm in the minds of many consumers, is sold at a lower price. Our analysis shows that if the base valuation for products in a category is low, then it is profitable for the prototypical product to charge a lower price compared with a nonprototypical product. We obtain this result because when firms do not offer all the varieties that consumers seek, some consumers need to decide whether to purchase their second-preferred product or buy nothing. Furthermore, the prototypical product attracts a large proportion of such consumers. Now, if consumer valuations are low, the prototypical product needs to charge a low price to entice these consumers to buy it. A nonprototypical product also serves these consumers, but they account for a much smaller proportion of its demand. Therefore, a nonprototypical product's price is not cut as aggressively.
- *When should a prototypical product be higher priced?* Some of us may expect the prototypical product to be higher priced because of its higher perceived quality. In the absence of any quality difference, is it still profitable to charge a higher price for the prototypical product? We find that even if the prototypical product does not induce any positive affect and thereby improve its perceived quality, it is profitable to charge a higher price for the prototypical product. The rationale for this is as follows: A large proportion of consumers considers the prototypical product

to be its second-preferred product. Moreover, the prototypical product is the only option for many of these consumers. Now, if valuations are high, consumers are not sensitive to price, provided the net utility is positive. Therefore, the prototypical product finds it profitable to charge a high price. In the case of a nonprototypical product, we observe a similar effect but at a much lower strength because a nonprototypical product is the second-preferred product for a far lower fraction of consumers.

- *What is the descriptive validity of our theoretical analysis?* One can point to anecdotal evidence in support of our theoretical predictions. However, it is easy to counter each example by offering some idiosyncratic explanation, such as product quality, positive affect, and brand equity. Going beyond anecdotal evidence, our theoretical analysis explains how the relative price of a product can be shaped by its prototypicality. The two experiments go even further. They provide a causal test of the model. Consistent with theory, on average, participants sell the prototypical product at a higher price than a nonprototypical product when consumer valuation is high. Furthermore, the rank order of prices is reversed when consumer valuations are lower.

Directions for Further Research

In this paper, we have only taken an initial step in analyzing the strategic implications of prototypicality. There are several avenues for further research. For example, we assumed that prototypicality is a cognitive construct; that is, it improves the salience of a product in a consumer's mind without affecting product valuation. It is possible that the prototypicality of a product could influence a consumer's affective evaluation of the product (Cohen 1982). To understand the normative implications of such affective influences, it will be useful to first pin down how emotion influences the purchase decision and then embed it in a competitive model. This will be a fruitful avenue for further research. Furthermore, prototypicality could lead to reference-dependent preferences, and this needs further scrutiny (e.g., Orhun 2009). Following Chen and Riordan (2007), we assumed that all the products are symmetric and that the consideration set size is 2. Relaxing the consideration set size to more than 2 remains a challenging avenue for further research. Moreover, we have examined how prototypicality influences prices, not how a prototype is established in the marketplace. Future research can build on the existing psychological literature and explore the possibility of developing a normative model of prototype formation in a horizontally differentiated market.

Supplemental Material

Supplemental material to this paper is available at http://dx.doi.org/10.1287/mksc.2013.0793.

Acknowledgments

The authors thank James Bettman, Preyas Desai, Sanjay Jain, John Lynch, Debu Purohit, Ambar Rao, Amnon Rapoport, Rick Staelin, and seminar participants at Carnegie Mellon University, INSEAD, Koç University, Tsinghua University, the University of Minnesota, the University of South Carolina, the University of Toronto, the University of Utah, Washington University in St. Louis, and Yale University for their comments.

Appendix

Derivation of the Demand Under Low and High Consumer Valuations

The demand for the prototypical product and that for a nonprototypical product are given by Equations (7) and (12), respectively. These expressions can be further simplified as follows. When consumer valuations are low (that is, $\frac{1}{2} < (v-p_j)/t < 1$), the demand for the prototypical product z is given by

$$q_z = \frac{1}{N}\frac{n-1}{N-1}\left(1+\frac{p_k-p_z}{t}\right)+\frac{1}{N}\frac{N-n}{N-1} + \frac{2(N-n)}{N}\left(\alpha+\frac{1-\alpha}{N-1}\right)\left(\frac{v-p_z}{t}-\frac{1}{2}\right). \quad (15)$$

The corresponding demand for a nonprototypical product can be written as

$$\begin{aligned} q_k &= \frac{1-\alpha}{N}\frac{n-2}{N-1}\left(1+\frac{p_j-p_k}{t}\right)+\frac{1}{N}\frac{1-\alpha}{N-1}\left(1+\frac{p_z-p_k}{t}\right) + \frac{\alpha}{N}\left[1+\frac{p_z-p_k}{(N-1)t}\right]+\frac{2(N-n)(1-\alpha)}{N(N-1)}\frac{v-p_k}{t} \\ &\qquad \text{for } p_z \ge p_k \text{ and } (p_z-p_k)/t<1; \\ &= \frac{1-\alpha}{N}\frac{n-2}{N-1}\left(1+\frac{p_j-p_k}{t}\right)+\frac{1}{N}\frac{1-\alpha}{N-1}\left(1+\frac{p_z-p_k}{t}\right) + \frac{\alpha}{N}\left(1+\frac{p_z-p_k}{t}\right)+\frac{2(N-n)(1-\alpha)}{N(N-1)}\frac{v-p_k}{t} \\ &\qquad \text{for } p_k \ge p_z \text{ and } (p_k-p_z)/t<1. \end{aligned} \quad (16)$$

But when consumer valuations are high (i.e., $(v-p_j)/t \ge 1$), the demand for the prototypical product is

$$\begin{aligned} q_z &= \frac{1}{N}\frac{n-1}{N-1}\left(1+\frac{p_k-p_z}{t}\right)+\frac{1}{N}\frac{N-n}{N-1}+\frac{N-n}{N}\left(\alpha+\frac{1-\alpha}{N-1}\right) \\ &\qquad \text{for } p_z \ge p_k \text{ and } (p_z-p_k)/t<1; \\ &= \frac{1}{N}\frac{N-n}{N-1}+\frac{N-n}{N}\left(\alpha+\frac{1-\alpha}{N-1}\right) \\ &\qquad \text{for } p_z \ge p_k \text{ and } (p_z-p_k)/t\ge 1; \\ &= \frac{1}{N}\frac{n-1}{N-1}\left(1+\frac{p_k-p_z}{t}\right)+\frac{1}{N}\frac{N-n}{N-1}+\frac{N-n}{N}\left(\alpha+\frac{1-\alpha}{N-1}\right) \\ &\qquad \text{for } p_k \ge p_z \text{ and } (p_k-p_z)/t<1; \\ &= \frac{2}{N}\frac{n-1}{N-1}+\frac{1}{N}\frac{N-n}{N-1}+\frac{N-n}{N}\left(\alpha+\frac{1-\alpha}{N-1}\right) \\ &\qquad \text{for } p_k \ge p_z \text{ and } (p_k-p_z)/t\ge 1. \end{aligned} \quad (17)$$

On simplifying the corresponding demand for a nonprototypical product, we have

$$\begin{aligned} q_k &= \frac{1-\alpha}{N}\frac{n-2}{N-1}\left(1+\frac{p_j-p_k}{t}\right)+\frac{1}{N}\frac{1-\alpha}{N-1}\left(1+\frac{p_z-p_k}{t}\right)\\ &\quad+\frac{\alpha}{N}\left[1+\frac{p_z-p_k}{(N-1)t}\right]+\frac{2(N-n)(1-\alpha)}{N(N-1)}\\ &\qquad\qquad \text{for } p_z\ge p_k \text{ and } (p_z-p_k)/t<1;\\ &= \frac{1-\alpha}{N}\frac{n-2}{N-1}\left(1+\frac{p_j-p_k}{t}\right)+\frac{2}{N}\frac{1-\alpha}{N-1}\\ &\quad+\frac{\alpha}{N}\left(1+\frac{1}{N-1}\right)+\frac{2(N-n)(1-\alpha)}{N(N-1)}\\ &\qquad\qquad \text{for } p_z\ge p_k \text{ and } (p_z-p_k)/t\ge 1;\\ &= \frac{1-\alpha}{N}\frac{n-2}{N-1}\left(1+\frac{p_j-p_k}{t}\right)+\frac{1}{N}\frac{1-\alpha}{N-1}\left(1+\frac{p_z-p_k}{t}\right)\\ &\quad+\frac{\alpha}{N}\left(1+\frac{p_z-p_k}{t}\right)+\frac{2(N-n)(1-\alpha)}{N(N-1)}\\ &\qquad\qquad \text{for } p_k\ge p_z \text{ and } (p_k-p_z)/t<1;\\ &= \frac{1-\alpha}{N}\frac{n-2}{N-1}\left(1+\frac{p_j-p_k}{t}\right)+\frac{2(N-n)(1-\alpha)}{N(N-1)}\\ &\qquad\qquad \text{for } p_k\ge p_z \text{ and } (p_k-p_z)/t\ge 1. \end{aligned} \tag{18}$$

Proofs

Proof of Proposition 1. The profits from the prototypical product and nonprototypical product are $\pi_z=p_zq_z$ and $\pi_k=p_kq_k$, respectively. When consumer valuations are low ($\frac{1}{2}<(v-p_j)/t<1$), the demand for the prototypical product and that for a nonprototypical product are given in Equations (15) and (16), respectively. Below we consider two cases to establish the result.

Case 1. To begin with, we consider the case where the prototypical product is higher priced (namely, $p_z-p_k>0$). On solving the first-order conditions for profit maximization, we obtain the following when $p_z\ge p_k$ and $(p_z-p_k)/t<1$:

$$\begin{aligned} p_z &= \Big[2v(N-n)\{\alpha(10N-8n-3)\\ &\quad+\alpha(4N-3n-2)[\alpha(N-2)-N]+2n-4N+1\}\\ &\quad+t\alpha[4N^3-8N^2-3N-Nn(7N-3n-17)-8n^2+2]\\ &\quad-t\alpha^2(N-2)(4N^2-7Nn-2N+3n^2+2n)\\ &\quad-t(n-1)(4N-2n-1)\Big]\\ &\quad\cdot\Big[4\alpha^2(N-2)(N-n)(4N-3n-2)\\ &\qquad+10n\alpha(3n+1)+4Nn\alpha(7N-3n-19)\\ &\qquad-16N\alpha(N^2-3N+1)-2(1-2\alpha)\\ &\qquad-(6n-1)(n+1)-4N(4N-5n-2)\Big]^{-1},\\ p_k &= \Big[2v(N-n)\{\alpha(11N-10n)\\ &\quad+4\alpha(N-n)[\alpha(N-2)-N]+2n-4N+1\}\\ &\quad+t\alpha[N^2-8N-Nn(4N-4n-9)-10n^2+8n]\\ &\quad-4t\alpha^2(N-n)^2(N-2)-t(n-1)(4N-2n-1)\Big]\\ &\quad\cdot\Big[4\alpha^2(N-2)(N-n)(4N-3n-2)\\ &\qquad+10n\alpha(3n+1)+4Nn\alpha(7N-3n-19)\\ &\qquad-16N\alpha(N^2-3N+1)-2(1-2\alpha)\\ &\qquad-(6n-1)(n+1)-4N(4N-5n-2)\Big]^{-1}. \end{aligned} \tag{19}$$

On taking the difference between the above two prices, we have

$$\begin{aligned} p_z-p_k &= \alpha\Big[2t(n^2-4n+1)+Nt(4N^2-9N+5)\\ &\quad-Nnt(3N+n-8)-t\alpha(N-n)(N-2)(n-2)\\ &\quad+2v(N-n)\{N-(N-2)[n(1-\alpha)+2\alpha]-3\}\Big]\\ &\quad\cdot\Big[4\alpha^2(N-2)(N-n)(4N-3n-2)+10n\alpha(3n+1)\\ &\quad+4Nn\alpha(7N-3n-19)-16N\alpha(N^2-3N+1)\\ &\quad-2(1-2\alpha)-(6n-1)(n+1)\\ &\quad-4N(4N-5n-2)\Big]^{-1}. \end{aligned} \tag{20}$$

Because we assume the prototypical product to be priced higher, it follows that

$$\begin{aligned} v &> t\Big[N(4N^2-9N+5)+2N\alpha(N-2)-4n(2-\alpha)\\ &\quad+2n^2(1-\alpha)-Nn(3N+n-8)-Nn\alpha(N-n)+2\Big]\\ &\quad\cdot\Big[2(N-n)\{(N-2)[(1-\alpha)n+2\alpha]-N+3\}\Big]^{-1}. \end{aligned} \tag{21}$$

Now let

$$\begin{aligned} v &= t\Big[N(4N^2-9N+5)+2N\alpha(N-2)-4n(2-\alpha)\\ &\quad+2n^2(1-\alpha)-Nn(3N+n-8)-Nn\alpha(N-n)+2\Big]\\ &\quad\cdot\Big[2(N-n)\{(N-2)[(1-\alpha)n+2\alpha]-N+3\}\Big]^{-1}, \end{aligned} \tag{22}$$

so that

$$p_z=p_k=\frac{t(N-1)^2}{(N-2)[(1-\alpha)n+2\alpha]-N+3}$$

and

$$\begin{aligned} \frac{v-p_z}{t} &= \Big[N(2N^2-5N+3)+2(n^2-3n+1)-2n\alpha(n-2)\\ &\quad-N\alpha(n-2)(N-n-2)-Nn(N+n-4)\Big]\\ &\quad\cdot\Big[2(N-n)\{(N-2)[(1-\alpha)n+2\alpha]-N+3\}\Big]^{-1}. \end{aligned} \tag{23}$$

On subtracting the denominator of the above expression from its numerator, we obtain

$$(N-2)[N(2N-3n+1)+\alpha(N-n)(n-2)+n^2-1]. \tag{24}$$

Note that the expression $N(2N-3n+1)+\alpha(N-n)(n-2)+n^2-1$ reaches its minimum when $N=n$, and in that case, the expression is reduced to $N-1$, which is more than 1. It therefore follows that $(v-p_z)/t>1$ at this v, which violates the condition $\frac{1}{2}<(v-p_j)/t<1$. Consequently, it is not feasible to have $p_z-p_k>0$. Having ruled out the possibility of the prototypical product being higher priced, we next advance to examine whether it can be lower priced.

Case 2. Now suppose that the prototypical product is lower priced, implying $p_k\ge p_z$. Furthermore, suppose that

$(p_k - p_z)/t < 1$. From the first-order conditions for maximizing profits, we obtain the following prices:

$$\begin{aligned} p_z = \Big[& t\alpha[Nn(7N-3n-15) - 4N^2(N-2) + 4n(2n-1) + N + 2] \\ & + t(n-1)(4N-2n-1) \\ & + t\alpha^2\{(N-2)[2N(N+1) - n(5N-3n+2)]\} \\ & - 2v(N-n)\{\alpha^2(N-2)(2N-3n+2) \\ & + 2n - 4N + 1 - \alpha[N(4N-3n-10) + 8n - 1]\}\Big] \\ & \cdot \Big[8N(2N-1) + n(6n+5) + 2\alpha + 1 \\ & - Nn[4\alpha(7N-3n-5N\alpha+3n\alpha) + 32\alpha^2 - 71\alpha + 20] \\ & - \alpha\{8N^2[\alpha(N-1)+5] \\ & + 3[N + 2n^2(5-4\alpha)] - 16[N^3 + \alpha(N-n)]\}\Big]^{-1}, \end{aligned} \tag{25}$$

$$\begin{aligned} p_k = \Big[& t[n - 2n^2 + 1 + 4N(n-1)] \\ & + t\alpha[4Nn(N-n-2) - N(N-7) + 10n(n-1) + 2] \\ & + t\alpha^2(N-2)[N(3N-7n+2) + 2n(2n-1)] \\ & - 2v(N-n)[\alpha^2(N-2)(3N-4n+2) \\ & - 2\alpha(2N-5)(N-n) + 2n - 4N + 1 + 2\alpha]\Big] \\ & \cdot \Big[8N(2N-1) \\ & - \alpha\{8N^2[\alpha(N-1)+5] + 3[N + 2n^2(5-4\alpha)] \\ & - 16[N^3 + \alpha(N-n)]\} + n(6n+5) + 2\alpha + 1 \\ & - Nn[4\alpha(7N-3n-5N\alpha+3n\alpha) + 32\alpha^2 - 71\alpha + 20]\Big]^{-1}. \end{aligned}$$

It follows from the above two prices that

$$\begin{aligned} p_k - p_z = \Big[& \alpha(N-n)\{2(3t-v) + Nt(4N-9) \\ & - (2v-t)(N-2)[n + (N-n)\alpha]\}\Big] \\ & \cdot \Big[8N(2N-1) - \alpha\{8N^2(\alpha(N-1)+5) \\ & + 3[N + 2n^2(5-4\alpha)] - 16[N^3 + \alpha(N-n)]\} \\ & + n(6n+5) + 2\alpha + 1 \\ & - Nn[4\alpha(7N-3n-5N\alpha+3n\alpha) \\ & + 32\alpha^2 - 71\alpha + 20]\Big]^{-1}. \end{aligned} \tag{26}$$

The prototypical product can be lower priced (that is, $p_k - p_z > 0$) if

$$v < \frac{t}{2} + \frac{5t + Nt(4N-9)}{2(n + \alpha(N-n))(N-2) + 2}. \tag{27}$$

Now assume that

$$v = \frac{t}{2} + \frac{5t + Nt(4N-9)}{2(n + \alpha(N-n))(N-2) + 2}, \tag{28}$$

so that

$$\begin{aligned} p_z = p_k &= \frac{t(N-1)^2}{2n\alpha - 2N\alpha - 2n + N^2\alpha + Nn - Nn\alpha + 1}, \\ \frac{v - p_z}{t} &= \frac{2n\alpha - 2n - 2N\alpha - 5N + N^2\alpha + Nn + 2N^2 - Nn\alpha + 4}{2(2n\alpha - 2N\alpha - 2n + N^2\alpha + Nn - Nn\alpha + 1)}. \end{aligned} \tag{29}$$

By subtracting the denominator of the above expression from its numerator, we obtain $(N-2)(2N - n - N\alpha + n\alpha - 1)$. Note that $2N - n - N\alpha + n\alpha - 1 \geq 2N - n - N + n - 1 = N - 1 > 1$. It therefore follows that $(v - p_z)/t > 1$ at this v. However, for lower values, it is feasible for $(v - p_z)/t < 1$. When consumer valuations are lower ($\frac{1}{2} < (v - p_j)/t < 1$), it follows that it is feasible for the prototypical product to be lower priced: $p_k - p_z > 0$. Specifically, it is feasible for the prototypical product to be priced lower when $v \in (v_0, v_1)$, where $v_0 = t/2 + p_k^*$ and $v_1 = t + p_z^*$, with p_k^* and p_z^* as given in Equation (25). □

Proof of Proposition 2. The profits from the prototypical product and nonprototypical product are $\pi_z = p_z q_z$ and $\pi_k = p_k q_k$, respectively. When consumer valuations are high ($(v - p_j)/t > 1$), the demand for the prototypical product and nonprototypical product are given in Equations (17) and (18), respectively. Next we focus on the pure-strategy equilibrium and consider two cases to establish the proof.

Case 1. In this case we suppose that the prototypical product is higher priced (namely, $p_z \geq p_k$). Furthermore, we assume that $(p_z - p_k)/t < 1$. From the first-order conditions for profit maximization, we obtain the following prices:

$$\begin{aligned} p_k &= \frac{t[(2n-1)(2N-n-1) + \alpha(N-2n)(N-n)]}{(n-1)[2(n-2)(1-\alpha)+3]}, \\ p_z &= \Big[t\{\alpha(N-n)[Nn - \alpha(N-2)(n-2)] + 4n(N+n\alpha) \\ &\quad - 2(n^2+N) - 2\alpha(n+1) - (5N\alpha+1)(n-1)\}\Big] \\ &\quad \cdot \Big[(n-1)[2(n-2)(1-\alpha)+3]\Big]^{-1}. \end{aligned} \tag{30}$$

Note that

$$\begin{aligned} p_z - p_k = \Big[& \alpha t[Nn(N-n-2) + 2n(n-1) \\ & - \alpha(N-n)(N-2)(n-2) + 5N - N^2 - 2]\Big] \\ & \cdot \Big[(n-1)[2(n-2)(1-\alpha)+3]\Big]^{-1}. \end{aligned} \tag{31}$$

Since $N \geq n \geq 2$, the denominator of the above expression is nonnegative. The numerator of the above expression is nonnegative if

$$\alpha \leq \frac{Nn(N-n-2) - N(N-5) + 2n(n-1) - 2}{(N-n)(N-2)(n-2)}. \tag{32}$$

Given that $\alpha \in (0, 1)$, the above inequality holds when $2 \leq N < 2(n-1)$. Thus it is feasible for the prototypical product to be higher priced.

Next consider the alternative subcase where $p_z \geq p_k$ but $(p_z - p_k)/t \geq 1$. In this situation, the prices are

$$\begin{aligned} p_k &= \frac{t[N(2-\alpha) - n(1-\alpha)]}{(n-2)(1-\alpha)}, \\ p_z &= v - t. \end{aligned} \tag{33}$$

To satisfy the conditions $p_z \geq p_k$ and $(p_z - p_k)/t \geq 1$, we must have $v \geq t[N(2-\alpha) + (1-\alpha)(n-4)]/((1-\alpha)(n-2))$. Thus the prototypical product can be priced higher.

Case 2. Here, we consider the case where the prototypical product is lower priced—namely, $p_k \geq p_z$. First, consider the subcase in which $(p_k - p_z)/t < 1$. The prices corresponding to this subcase are

$$\begin{aligned} p_k = &\Big[t\big\{\alpha^2(N-n)(N-2)^2 + (2n-1)(2N-n-1) \\ &+ \alpha[N(3N-4n-5)+2n(n+1)+2]\big\}\Big] \\ &\cdot \Big[(n-1)[\alpha(3N-2n-2)+2n-1]\Big]^{-1}, \\ p_z = &\Big[t\big\{\alpha^2(N-2)[N(2N-3n-2)+n(n+2)] \\ &+ (2n-1)(2N-n-1) + \alpha[Nn(N-n-7) \\ &+ N(4N-5)+2n(2n+1)+2]\big\}\Big] \\ &\cdot \Big[(n-1)[\alpha(3N-2n-2)+2n-1]\Big]^{-1}. \end{aligned} \tag{34}$$

Note that

$$\begin{aligned} p_k - p_z &= \frac{t\alpha(N-n)\{2n(1-\alpha) - N[n+1+\alpha(N-n-2)]\}}{(n-1)[\alpha(3N-2n-2)+2n-1]} \\ &= 0 \end{aligned} \tag{35}$$

if $\alpha = -(N(n+1)-2n)/((N-2)(N-n))$. This implies that $\alpha < 0$ as $N \geq n \geq 2$, but $\alpha > 0$ by definition. Therefore, the prices above are not feasible.

Next consider the subcase where the prototypical product is lower priced $(p_k \geq p_z)$ but $(p_k - p_z)/t \geq 1$. The prices corresponding to this subcase are

$$\begin{aligned} p_k &= \frac{t(2N-n-2)}{n-2}, \\ p_z &= v - t. \end{aligned} \tag{36}$$

The conditions $p_k \geq p_z$ and $(p_k - p_z)/t \geq 1$ can be met if $v \leq t(2N-n-2)/(n-2)$.

Recall that the prototypical product (z) charges $v-t$ in two situations: when $p_z \geq p_k$ and $(p_z - p_k)/t \geq 1$ and when $p_k \geq p_z$ and $(p_k - p_z)/t \geq 1$. Both theses prices cannot prevail at the same time. To identify which one of these two situations will prevail, we examine which will yield higher profits to the nonprototypical product.

When $p_z \geq p_k$ and $(p_z - p_k)/t \geq 1$, we have

$$\pi_k = \frac{t(n-2N+N\alpha-n\alpha)^2}{N(1-\alpha)(N-1)(n-2)}. \tag{37}$$

But when $p_k \geq p_z$ and $(p_k - p_z)/t \geq 1$, a nonprototypical product's profits are

$$\tilde{\pi}_k = \frac{t(1-\alpha)(n-2N+2)^2}{N(N-1)(n-2)}. \tag{38}$$

Note that

$$\begin{aligned} \pi_k - \tilde{\pi}_k &= \frac{t(N\alpha-2\alpha+2)[4N-2(n+1)(1-\alpha)-3N\alpha]}{N(1-\alpha)(N-1)(n-2)} \\ &= \frac{t(N\alpha-2\alpha+2)\{N+[3N-2(n+1)](1-\alpha)\}}{N(1-\alpha)(N-1)(n-2)} \\ &\geq 0. \end{aligned} \tag{39}$$

Therefore, we will not observe a lower-priced prototypical product $(p_k \geq p_z)$ when $(p_k - p_z)/t \geq 1$.

In sum, in equilibrium, we can see a higher-priced prototypical product $(p_z \geq p_k)$; furthermore, $(p_z - p_k)/t < 1$ if

$$v \leq \frac{t(N(2-\alpha)+(1-\alpha)(n-4))}{(1-\alpha)(n-2)}$$

and

$$\alpha \leq \frac{Nn(N-n-2)-N(N-5)+2n(n-1)-2}{(N-n)(N-2)(n-2)}. \quad \square$$

References

Alba J, Hutchinson W (1987) Dimensions of consumer expertise. *J. Consumer Res.* 13(4):411–454.

Amaldoss W, He C (2010) Product variety, informative advertising and price competition. *J. Marketing Res.* 47(1):146–156.

Amaldoss W, Jain S (2002) David vs. Goliath: An analysis of asymmetric mixed-strategy games and experimental evidence. *Management Sci.* 48(8):972–991.

Amaldoss W, Jain S (2005) Pricing of conspicuous goods: A competitive analysis of social effects. *J. Marketing Res.* 42(1):30–42.

Armstrong M, Vickers J, Zhou J (2009) Prominence and consumer search. *RAND J. Econom.* 40(2):209–233.

Barreda-Tarrazona I, García-Gallego A, Georgantzís N, Andaluz-Funcia J, Gil-Sanz A (2011) An experiment on spatial competition with endogenous pricing. *Internat. J. Indust. Organ.* 29(1):74–83.

Brown-Kruse J, Schenk D (2000) Location, cooperation and communication: An experimental examination. *Internat. J. Indust. Organ.* 18(1):59–80.

Brown-Kruse J, Cronshaw M, Schenk D (1993) Theory and experiments on spatial competition. *Econom. Inquiry* 31(1):139–165.

Camerer C, Ho TH (1999) Experience-weighted attraction learning in normal form games. *Econometrica* 67(4):837–874.

Carpenter G, Nakamoto K (1989) Preference formation and pioneering advantage. *J. Marketing Res.* 26(3):285–298.

Chen Y, Riordan M (2007) Price and variety in the spokes model. *Econom. J.* 117(522):897–921.

Cohen J (1982) The role of affect in categorization: Toward a reconsideration of the concept of attitude. Mitchell A, ed. *Advances in Consumer Research*, Vol. 9 (Association for Consumer Research, Provo, UT), 94–100.

Hauser J, Wernerfelt B (1990) An evaluation cost model of evoked sets. *J. Consumer Res.* 16(4):393–408.

He C, Chen Y (2006) Managing e-marketplace: A strategic analysis of non-price advertising. *Marketing Sci.* 25(2):175–187.

Lim N, Ho T-H (2007) Designing price contracts for boundedly rational customers: Does the number of blocks matter? *Marketing Sci.* 26(3):312–326.

Loken B, Barsalou LW, Joiner C (2008) Categorization theory and research in consumer psychology: Category representation and category-based inference. Haugtvedt CP, Kardes F, Herr P, eds. *Handbook of Consumer Psychology* (Lawrence Erlbaum Associates, Mahwah, NJ), 133–163.

Medlin D, Shaffer M (1978) Context theory of classification learning. *Psych. Rev.* 85(3):207–238.

Mervis C, Catlin J, Rosch E (1976) Relationship among goodness-of-example, category norms, and word frequency. *Bull. Psychonomic Soc.* 7(3):283–284.

Meyer RJ, Hutchinson JW (2001) Bumbling geniuses: The power of everyday reasoning in multi-stage decision making. Hoch S, Kunreuther H, eds. *Wharton on Making Decisions* (John Wiley & Sons, New York), 37–61.

Nedungadi P (1990) Recall and consumer consideration sets: Influencing choice without altering brand evaluations. *J. Consumer Res.* 17(3):263–276.

Nedungadi P, Hutchinson W (1985) The prototypicality of brands: Relationships with brand awareness, preference and usage. Hirschman EC, Holbrook M, eds. *Advances in Consumer Research*, Vol. 12 (Association for Consumer Research, Provo, UT), 498–503.

Orhun AY (2009) Optimal product line design when consumers exhibit choice set-dependent preferences. *Marketing Sci.* 28(5):868–886.

Rapoport A, Amaldoss W (2000) Mixed strategies and iterative elimination of strongly dominated strategies: An experimental investigation of states of knowledge. *J. Econom. Behav. Organ.* 42(4):483–521.

Rosch E (1973) On the internal structure of perceptual and semantic categories. Moore TE, ed. *Cognitive Development and Acquisition of Language* (Academic Press, New York), 111–144.

Rosch E, Mervis C (1975) Family resemblances: Studies in the internal structure of categories. *Cognitive Psych.* 7(4):573–605.

Selten R, Apesteguia J (2005) Experimentally observed imitation and cooperation in price competition on the circle. *Games Econom. Behav.* 51(1):171–192.

Ward J, Loken B (1986) The generality of typicality effects on preference and comparison: An exploratory test. Houston M, ed. *Advances in Consumer Research*, Vol. 13 (Association for Consumer Research, Provo, UT), 126–131.

Winkielman P, Halberstadt J, Fazendeiro T, Catty S (2006) Prototypes are attractive because they are easy on the mind. *Psych. Sci.* 17(9):799–806.