Seeking an Aggressive Competitor: How Product Line Expansion Can Increase All Firms' Profits

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Abstract:

Conventional wisdom suggests that a firm's profits will decrease when a competitor expands its product line because the firm's sales will decrease in the presence of the new product. This paper shows that this intuition is incomplete because a competitor's product-line expansion can soften price competition. Thus, one firm's product-line expansion can cause all firms to be more profitable. We first provide an analytical model that demonstrates the possibility of profit-increasing competitor entry. We then present conditions under which a competitor's product-line expansion increases profits under two common empirical models: the mixed-logit and geographic spatial models. The results suggest that profit-increasing competitor entry is not only a theoretical possibility, but also a realistic empirical prediction. Geographic competition is especially conducive to this result.

1. Introduction

This paper asks how a firm's profits change when a competing firm expands its product line. We consider this question in the context of a horizontally differentiated product line, and find that, contrary to conventional wisdom, a firm's profits can increase with the expanded presence of the competitor.

The conventional wisdom that a firm's profits will decrease in the face of a rival's new-product introduction is supported by two potential effects. First, if prices of all other incumbent products remain unchanged, a competitor's product-line expansion will lead to either unchanged or decreasing profits since the firm will lose sales on some of their items. Second, a rival's expansion generally changes market prices, and often the change is in the direction of intensifying competition, driving down margins. In this case, profits decrease.

This conventional wisdom is incomplete because the new product may be positioned such that prices of incumbent products increase with the new-product introduction. This comes from the fact that when a company expands its product line in a horizontal dimension, it has an incentive to price its existing products less aggressively in order to avoid undercutting its ability to extract the maximum consumer surplus from its newest offering. This is especially true if the new product serves customers that were not previously served by any product, and therefore have a relatively-high willingness-to-pay for the new product. Thus, a firm that introduces the new product can become less aggressive with pricing, which allows its competitors to raise their prices, too. Thomadsen (2005) shows that the magnitude of such a price increase can be very large. This increase in prices can lead to an increase in profits for all firms as long as unit sales for the other incumbent firms do not fall too much. In fact, if the product line extension occurs in a part of the product space that is located away from the locations of the competing firms, then the competing firms may even find that number of units they sell increases due to their competitor's higher prices.

Understanding how a competitor's product-line expansion affects a firm's profits is important for understanding strategic responses in a number of situations. For example, should a firm create a barrier to entry, such as preventing a new product from obtaining access to shelf space in a supermarket, or lobbying to prevent changes in zoning laws that would allow a competing retailer from opening a second location? Should a firm contest a merger, or fight subsidies that might help a competitor expand their product line? Similarly, understanding when a competitor's product line expansion might aid your company can help clarify which demand conditions might lead to product-line expansion vs. product-line pruning as an optimal response. Further, several empirical papers (see e.g. Toivanen and Waterson 2000 or Eizenberg 2008) use the assumption that profits decrease when a competitor offers a new product to identify their model; understanding when this assumption is likely to be valid and when it is likely to be violated is key to properly evaluating the validity of the underlying empirical analysis.

Does the theoretical possibility that a rival's profits can increase mean that this will occur in practice? We use two approaches to argue that this does indeed occur. First, we examine the sets of parameters for common empirical models where product-line expansion increases the competing firm's profits. We find that this effect occurs under reasonable parametric values, especially among retail outlets competing in geographic space. Second, we demonstrate that this phenomenon occurs in the fast food industry. Specifically, we show that Burger King's profits can increase because of McDonald's opening up a new location, and demonstrate that BK outlets in Santa Clara County, California, have experienced such increases in profits, although the increases were relatively small.

We also note that this phenomenon is likely to occur in many industries. For example, Kadiyali, Vilcassim and Chintagunta (1998) look at what happened when Yoplait introduced its light yogurt – the first light yogurt by a major producer. Dannon, the dominant player, sold 5% less yogurt, while total yogurt sales among all firms increased. However, all prices – both those of Yoplait and Dannon – increased after Yoplait Light's introduction. Dannon's prices increased by over 10%, causing revenues to increase by 5% despite the sales of fewer units. An increase in revenues along with lower costs from lower-levels of production imply that profits increased. While Kadiyali et. al. explain these changes through other mechanisms, all of these effects are consistent with those that would be predicted by our standard product-differentiation model.

While most of this paper focuses on the conditions under which profits for firm A increase from firm B's product-line expansion, we also note that the new presence of the additional product can cause both firm B's prices to increase, which is beneficial for firm A, and cause firm A's sales to go down as a moderate number of customers switch from A's product to the new one. In this case, the practical impact of firm B's expansion on firm A can be close to zero as both effects approximately offset. This nevertheless goes against the conventional wisdom because in such a case firm B expands its product line in a way that the rival loses moderate levels of customers, yet the firm A is not significantly worse off.

This paper fits in a large literature in marketing and economics about competition between firms offering product lines. Most of this literature focuses on firms whose product lines are vertically differentiated, and asks how competition changes the extent of the vertically differentiated product line offered by these firms (Gal-Or 1983, Katz 1984, Moorthy 1988, Champsaur and Rochet 1989, Gilbert and Matutes 1993, Verboven 1999, Desai 2001, Johnson and Myatt 2003, Johnson and Myatt 2006). A common theme in this literature is that firms may choose to either change the quality offerings of their products, or avoid producing some products altogether, in order to reduce competition and prevent high-value customers from choosing lower-margin products. Johnson and Myatt (2003) state conditions where the response to entry from a competitor will lead to either product-line expansion or contraction.

There is also a literature on competition between firms with horizontally differentiated product lines. Doraszelski and Draganska (2006) consider duopolistic firms that can offer general-purpose goods or niche goods. They specify conditions under which the firms offer full product lines and other conditions under which the firms offer only partial product lines. Draganska and Jain (2005) study product-line length competition by oligopolistic yogurt firms, where product line length is an attribute of horizontally-differentiated product lines. They find that there are decreasing returns to scale with respect to product-line length, and make recommendations about how to adjust product-line length to competitors' price changes. Draganska and Jain (2006) analyze pricing of horizontally-differentiated product lines, and find that there is not much gain from pricing different flavors of yogurt within a product line differently, while there can be significant gains from setting different prices for different product lines. Draganska, Mazzeo and Seim (2009) examine competitive decisions by two ice cream makers about which types of vanilla ice creams to offer in different markets. They find that demand-side factors affect firms' product-line decisions, and that greater horizontal-taste heterogeneity increases firms' incentives to offer a large number of products. Thomadsen (2005) studies competition among geographically dispersed locations of multi-outlet fast food chains. He demonstrates that the multi-outlet nature of retail outlets is important for these firms' pricing strategies: McDonald's and Burger King outlets that have other co-owned outlets in the vicinity charge significantly higher prices than the same outlets would have charged if the nearby outlets had instead been operated by different owners.

While these papers form a solid foundation to understanding aspects of competition between firms with product lines, they do not directly address our question about how one firm's profits change when a competing firm expands its product line. Gilbert and Matutes (1993) considers a similar question: how do profits change when all firms pre-commit to having only one product. They show that profits are unchanged with such pre-commitment in their model, ignoring fixed costs. Draganska and Jain (2005) conduct a similar analysis for their estimated model of preferences for yogurt, and find that some firms' profits increase while others decrease if everyone were constrained to offer one product. However, the changes in profits in these papers are the result of both same-firm and cross-firm effects, not just the direct effect of how the competitor's product line expansion impacts firm profits. Finally, Lee et. al. (2009) examine a similar question about how profits change when firms open up new channels of distribution; they present a theory model that shows that if one manufacturer opens an internet channel, while their competitor is not present on the internet, profits for both firms can increase under some parameters because price competition is softened due to the expanding firm wanting to avoid cannibalization across its channels.

Before proceeding to the main sections of the paper, we also note what this paper is not about. In particular, we do not seek to explain how product locations are chosen. Rather we take the locations of

product in product space as exogenously given. There are many reasons for this. First, determining the optimal locations for firms is highly dependent upon the exact details of the game being studied. For example, the optimal locations for firms is different if the players play a two-period game, where each firm chooses one location in period 1, and then firm 2 adds a product in period 2, compared with a 10 period game, where the firms each have one product on the market in period 1, and then firm 2 adds a second product which is present in periods 2-10. Recent empirical research by Bronnenberg, Dubé and Dhar (2007) and Bronnenberg, Dubé and Dhar (2009) suggests that the long-term game is the right way to model such competition for many industries. Furthermore, fixed-cost variation across locations in the market can account for locations that would appear to be sub-optimal from a demand-side perspective. Similarly, technology may restrict the set of locations that a firm could choose. The extent of technology restrictions may be such that the locations that are available to one firm may differ from the locations available to the other firm. In the case of retail competition, the analogous factor to technology may be political connectedness. Some firms may have an easy time bending zoning restrictions, while other firms may have limited location choices. Finally, firms may not completely understand the exact distribution of consumer preferences. There is a growing stream of current academic research about the proper way to measure demand and position a new product into a market. This suggests that calculating demand properly is, at best, very difficult, especially for products that have not yet been introduced into the market. Thus, it seems probable that firms would sometimes locate sub-optimally, especially if relocation is costly. Despite this, prices may be close to optimal, as prices are relatively easy to change and in most models can be obtained through a trial and error process.

For all these reasons, we treat the locations of firms as given exogenously, rather than try to model each of these potential factors. The lack of optimality of locations from solely a demand-side point of view is also consistent with what we observe in many industries. For example, one would need to consider fixed costs and franchisee incentives to explain the observed locations of the fast food restaurants used in our analysis in Section 4.2. Nevertheless, we show that profits increased with competitor entry given the locations the firms did choose.

The rest of the article proceeds as follows. Section 2 presents a basic analytical model, along with theorems that provide insight into when one firm's product-line expansion is likely to increase its rival's profits. Section 3 presents conditions under which this result occurs with a mixed-logit demand model. Section 4 examines geographic retail competition and shows conditions under which one retail chain's geographic expansion increases its competitor's profits. We show that geographic expansion is a context where expansion is especially likely to increase a rival's profits, and demonstrate that there have been instances where an existing McDonald's franchisee opening a new outlet has increased profits of competing Burger King outlets, according to an estimated model. Section 5 concludes.

2. Basic Model

In this section, we present a general model that provides intuition about when one firm's product-line expansion will increase its competitor's profits across the full set of models we consider. While the precise conditions under which the theorems below are proven do not strictly hold in all of the models presented in this paper, we demonstrate that the results are still valid for each of the models for cases where the assumptions hold to a reasonable approximation.

For all of the analysis in this paper – except for our study of the fast food market in Silicon Valley – we consider a market with 2 firms, *a* and *b*, which offer differentiated products. We assume that, at first, each firm offers one product, *a* and *b1*, respectively. We then consider how firm *a*'s profits change if firm *b* introduces a second product, *b2*.

Denote the price of product *j* as P_j. We denote the demand for *a* and *b1* when these are the only products in the market with capital *Q*: $Q_a(P_a, P_{b1})$ and $Q_{b1}(P_a, P_{b1})$, respectively. Denote demand for *a*, *b1* and *b2* when all three products are in the market with lower-case *q*: $q_a(P_a, P_{b1}, P_{b2})$, $q_{b1}(P_a, P_{b1}, P_{b2})$ and $q_{b2}(P_a, P_{b1}, P_{b2})$, respectively. We also make two assumptions to simplify our analysis.

Assumption A1: Functions Q_a, Q_{b1}, q_a, q_{b1}, and q_{b2} are continuous along all dimensions, and differentiable except (possibly) at a finite set of discrete points. Further, all own derivatives are negative, while all cross derivatives are positive. Finally, assume that $-\frac{\partial Q_j}{\partial p_j} \geq \frac{\partial Q_j}{\partial p_k}$ and that $-\frac{\partial q_j}{\partial p_j} \geq \sum_{k \neq j} \frac{\partial q_j}{\partial p_k}$ for all products *j* and *k*.

Assumption A1 states that an outlet's demand is more sensitive to its own price than to the prices of the other outlets. In particular, A1 assures us that if all firms raise their prices by a constant amount, total demand must not increase for any outlet. While relatively generic, there are a few models where the continuity and differentiability components of A1 are violated. For example, it does not apply for some Hotelling-style models with linear travel costs for certain sets of locations of products because at some prices demand will jump as one firm undercuts its rival. However, A1 is satisfied for Hotelling-style models with quadratic travel costs and most empirical models, such as mixed-logit demand models.

Assumption A2: Each firm has constant marginal costs.

Assumption A2 is made purely as a convenience. It simplifies the analysis by allowing a reduction in notation throughout the paper. We normalize each firm's marginal cost to be zero. From a theoretical view, this is completely without loss of generality given assumption A2; prices are then

interpreted as the amount that prices are above marginal cost. Footnote 3 gives more details. Note that normalizing the marginal costs to zero does not preclude cases where firms have different marginal costs because the demand functions for each firm can be asymmetric to reflect the interpretation of prices being the mark-up over these asymmetric marginal costs.

Each firm sets prices at each of its outlets to maximize the sum of profits across all of its outlets. That is, firms set prices that satisfy:

$$\max_{p_J} \sum_{j \in J} p_j \tilde{q}_j \left(p \right), \tag{1}$$

where J indexes the firm, and $\tilde{q}_j$ represents a generic quantity demand function, represented with upper-case letters when there are only two products on the market and lower-case letters when there are three products on the market, as described above.

We can then solve for the first order conditions (FOC) of the firms. When there are only two products in the market, firm b's FOC is

$$p_{b1} = \frac{Q_{b1}}{-\dfrac{\partial Q_{b1}}{\partial p_{b1}}}. \tag{2}$$

On the other hand, if firm a offers two products, the FOC for product *b1* is $p_{b1} = \dfrac{q_{b1} + p_{b2} \dfrac{\partial q_{b2}}{\partial p_{b1}}}{-\dfrac{\partial q_{b1}}{\partial p_{b1}}}$.

Plugging in the corresponding FOC for *b2* into this equation yields

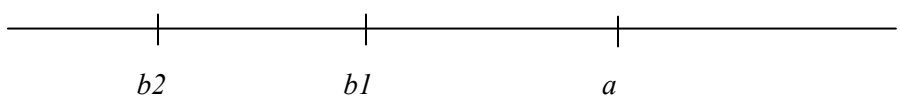
$$p_{b1} = \frac{q_{b1} + \dfrac{q_{b2} \dfrac{\partial q_{b2}}{\partial p_{b1}}}{-\dfrac{\partial q_{b2}}{\partial p_{b2}}}}{\left[-\dfrac{\partial q_{b1}}{\partial p_{b1}} + \dfrac{\dfrac{\partial q_{b1}}{\partial p_{b2}} \dfrac{\partial q_{b2}}{\partial p_{b1}}}{\dfrac{\partial q_{b2}}{\partial p_{b2}}} \right]}. \tag{3}$$

Interpreting this directly is difficult. However, we can make one more assumption which turns equation (3) into something meaningful.

Assumption A3: (1) $-\dfrac{\partial q_{b2}}{\partial p_{b2}} = \dfrac{\partial q_{b2}}{\partial p_{b1}} = \dfrac{\partial q_{b1}}{\partial p_{b2}}$, and (2) no consumer who purchases *a* before *b2*'s introduction purchases *b2* after *b2* is brought to market.

A3 implies that both of firm *b*'s products need to appeal to similar segments of consumers, while *b2* and *a* need to appeal to different segments of consumers. Specifically, A3 holds for markets where the new product is located in product space such that, after the new-product entry, *b2*'s customers only consider substituting between *b2* and *b1*; there are no consumers who, at market prices, are indifferent between *b2* and *a* or between *b2* and the outside good. For most well-behaved demand models, condition (1) implies (2), although one could develop a model where this does not hold. Unlike Assumptions A1 and A2, Assumption A3 does not generically hold across all product-differentiation models, although as we discuss later, conditions that approximately match those of A3 can hold for common empirical product differentiation models, such as mixed-logit demand models, where results analogous to those found in Theorems 1 and 2 below still hold. One model where assumption A3 does hold is in Hotelling markets where the market is covered after entry, and where *b2* is located on the opposite side of *b1* than *a*, as shown in Figure 1 below. Another example is a vertical differentiation model where the market is covered after entry, and, again, *b2* is located on the opposite side of product *b1* from product *a*.

Figure 1: Hotelling model where A3 holds.



Under A3, firm *a*'s customers only substitute between *a* and *b1*. Therefore, firm *a*'s profits must increase, decrease, or remain unchanged if p_{b1} increases, decreases, or remains the same, respectively. This is because if p_{b1} increases, firm *a* can sell a greater quantity at any given price than it could sell before, meaning that profits must be higher. An analogous argument can be made about the impact of a decrease. Under A3, it is also easy to determine whether prices for *b1* increase because equation (3) becomes $p_{b1} = \dfrac{q_{b1} + q_{b2}}{-\dfrac{\partial q_{b1}}{\partial p_{b1}} - \dfrac{\partial q_{b2}}{\partial p_{b1}}}$, yielding Theorems 1 and 2.

Theorem 1: Assume A1, A2 and A3. Suppose that the market is covered before and after product *b2* is introduced to the market, and that that firms price according to their first-order conditions before and after the new-product introduction. Then the prices p_a and p_{b1} , as well as firm *a*'s profits, remain unchanged from *b2*'s entry into the market.

Proof: See Appendix A.1.[1]

Theorem 2: Assume A1, A2 and A3. Suppose the market is not covered before product *b2* is introduced, but that it is covered after *b2* is introduced. Further, suppose that firms price according to their first-order conditions before and after the new-product introduction. Then p_{b1} and firm *a*'s profits increase.
Proof: See Appendix A.2.

These theorems give us conditions under which firms will profit from a rival's product-line expansion. Technically, the theorems apply under specific conditions that can only be met for some models of product differentiation, including the Hotelling model provided below. However, the conditions for Theorems 1 and 2 can hold in approximation for a much-wider set of models, with analogous results.

For example, in mixed-logit and geographic models, all products are substitutes for all other products, although products can be closer substitutes to some products than others. Similarly, the market is never completely covered in these models. Thus, Assumption A3 and the market coverage assumptions from Theorems 1 and 2 can never hold. However, we show in Sections 3 and 4 that the results of Theorem 2 hold in these empirical models if three conditions are met: (1) the new product *b2* is located in product space such that it is a relatively close substitute for the firm's other product, *b1*, but not for the rival firm's product, *a*, (2) the new product gains enough of its demand from the outside good, and (3) the market is saturated enough after entry. Conditions (1) and (3) together are similar to the conditions in assumption A3. Condition (2) is similar to the condition in Theorem 2 that the market cannot be covered before the market is introduced. Thus, because analogous conditions give us analogous results in the most-commonly used empirical product-differentiation models, Theorems 1 and 2 provide intuition about when product-line expansion are likely to increase a rival's profits for a broad set of models.

The theorems also demonstrate the mechanism for how a firm's product-line expansion increases its rival's profits: the firm whose product-line expands, *b*, increases its price, p_{b1}, to reduce cannibalization. In response to this price increase, the rival firm, *a*, also increases its price, although the magnitude of this price change is generally smaller than that of p_{b1}. Further, *a* gains some customers who were previously indifferent between *b1* and *a*. These results also apply to empirical demand models, although in these models *b2* also steals some of *a*'s customers, so the impact of product-line expansion on price and the number of units sold is more ambiguous in those settings.

[1] Logic similar to that in the proof leads to the following theorem for products where consumers can choose a variable quantity of their favorite product: Assume A1, A2 and A3. Suppose that the total quantity sold in the category is unchanged with product *b2*'s introduction. Then p_a, p_{b1} and firm *a*'s profits remain unchanged.

2.1 Example: Hotelling Markets

One potential critique of the analysis based on Theorems 1 and 2 is that the conditions in these theorems are not based on market primitives. That is, if one were given the utility functions of consumers and the locations of firms on a Hotelling line, one would not immediately know whether profits would increase or decrease. Instead, one would have to calculate the equilibrium market areas for the firms in each of the two cases to see whether the market was covered *ex ante* or *ex post*. Further, it is possible that the assumptions in Theorems 1 and 2, particularly pricing according to first-order conditions, rarely hold.[2]

To assuage these concerns, we analyze product-line expansion in a Hotelling model. The basic model is standard: consumers are located uniformly on a line segment from 0 to 1. Each consumer may purchase one unit of one product; if consumer i buys one unit of product j they obtain a utility:

$$U_{ij} = v - p_j - (l_i - l_j)^2, \tag{4}$$

where v represents the utility that a consumer gets from consuming any good in the category, p_j denotes the price of product j above marginal cost, and l_i and l_j represent the locations of consumer i and firm j, respectively. Many papers include coefficients on distance or price. Setting the coefficients on price and distance to one is done without loss of generality, because different coefficients only change the currency units of the price.[3] Consumers can also decide to purchase only the outside good and obtain utility $U_{i0} = 0$.

Firms compete by simultaneously setting prices in order to maximize joint profits across their portfolio of products. Consistent with the model above, we assume that there are 2 firms, a and b. Each firm initially has one outlet, located at l_a and l_{b1}, respectively, and analyze how firm a's profits change when firm b adds product $b2$ at location l_{b2}.

We can then present sufficient conditions under which we get the results of Theorems 1 and 2.

Proposition 1: Consider a market where $l_a > l_{b1} > l_{b2}$ and $1-l_a < l_{b2}$. If $v \geq l_{b1}^2 + \frac{(2 + l_{b1} + l_a)(l_a - l_{b1})}{3}$, then p_{b1}, p_a and π_a are all unchanged with the introduction of $b2$ into the market.

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[2] A firm might not price according to its first-order conditions if it is optimal to price at a kink-point on its demand curve. E.g., consider the firm on a Hotelling line located closest to zero. The firm's demand curve has a kink-point at the price where the market becomes covered on the lower side of the market. If the firm raises its prices above this point, it loses both customers at the edge of the market and customers that are indifferent between the firm and its rival. However, if the firm decreases its price, it gains customers between the firm and its rival, but there are no new customers to gain at the edge of the market. Thus, demand is more price sensitive at higher prices then lower prices.

[3] Many papers that include these coefficients analyze comparative statics in travel costs, where it is important to include these parameters. To see the normalization, note that the choice that maximizes $U_{ij} = V - AP_j - t(l_i - l_j)^2$ is clearly the same as the choice that maximizes $U_{ij} = v - aP_j - (l_i - l_j)^2$, where $v = V/t$ and $a = A/t$. This is the same as maximizing $U_{ij} = v - p_j - (l_i - l_j)^2$, where $p_j = P_j/a$, which is equivalent to changing the units of prices (e.g., Pounds Sterling vs. U.S. dollars). Profits and prices are then solved in the same unit of currency as this normalization.

Proposition 1 shows that if v is high enough, profits for firm a are unchanged from $b2$'s entry whenever $b2$ is located on the opposite side of $b1$ than a. When v is high enough, the market is covered both before and after the new entry. Under these parameter values, the firms also price according to their first-order conditions in equilibrium, so the conditions for Theorem 1 also hold. A formal proof of Proposition 1 appears in appendix A.3.

Proposition 2: Consider a market where $\frac{(2+l_{b1}+l_a)(l_a-l_{b1})}{3}+\frac{l_{b1}^2+l_{b2}^2}{2}<\frac{2l_{b1}l_a-2l_{b1}^2+2l_{b1}^2l_a+l_{b1}l_a^{\,2}}{2l_a+l_{b1}}$, $l_a > l_{b1} > l_{b2}$, and $1-l_a < l_{b2}$. If $v\in\left(\frac{(2+l_{b1}+l_a)(l_a-l_{b1})}{3}+\frac{l_{b1}^2+l_{b2}^2}{2},\frac{2l_{b1}l_a-2l_{b1}^2+2l_{b1}^2l_a+l_{b1}l_a^{\,2}}{2l_a+l_{b1}}\right)$ then p_{b1}, p_a and π_a all increase with the introduction of $b2$ into the market.

Proposition 2 shows that if v has a moderate value – one that allows the market to be uncovered before entry, but covered after entry – then firm a's profits can increase from $b2$'s introduction to the market. Under these conditions, all prices are set by first-order conditions in equilibrium, so the conditions for Theorem 2 also hold. A formal proof of Proposition 2 appears in appendix A.4.

Both Propositions 1 and 2 can by illustrated by a numerical example, as well. Suppose $l_a = ¾$, $l_{b1} = ½$, and $l_{b2} = ¼$. If $v = 1$, then before entry, $p_{b1} = {}^{13}/_{48}$, $p_a = {}^{11}/_{48}$, and $\pi_a = {}^{121}/_{1152}$. One can quickly confirm that the market will be covered at these prices, since $\sqrt{1-13/48} > l_{b1} = ½$. After $b2$'s entry, p_{b1} and p_a – and therefore π_a – remain unchanged, while $p_{b2} = {}^{35}/_{96}$. Note that while firm a's profits do not increase, firm b's profits increase because consumers at the left end of the market now pay a higher price.

Suppose instead that $v = {}^{7}/_{16}$, but the locations of each of the products were the same as in the previous example. In this case, we cannot present an analytical solution for the equilibrium. However, we can solve the equilibrium through computational methods. Before $b2$'s introduction, $p_{b1} \approx 0.20$, $p_a \approx 0.19$, and $\pi_a \approx 0.07$. We can also verify that the market is not covered, since $\sqrt{v-p_{b1}} \approx 0.49 < 0.5$. On the other hand, after firm b adds $b2$ to the market, the prices and profits match those that occur after entry when $v = 1$: $p_{b1} = {}^{13}/_{48} \approx 0.27$, $p_a = {}^{11}/_{48} \approx 0.23$, and $\pi_a = {}^{121}/_{1152} \approx 0.11$. Finally, we can also confirm that, given $p_{b2} = {}^{35}/_{96} \approx 0.36$, the market is covered *ex post*, since $\sqrt{v-p_{b2}} \approx 0.27 > 0.25$.

Thus, we find that there exist locations and parameters for a standard Hotelling model under which all of the conditions – and results – of Theorems 1 and 2 hold.

3. Mixed-Logit Demand

The above results demonstrate that a rival's product line expansion can enhance a firm's profits. The theorems also suggest conditions under which we are most-likely to see this effect: markets where the new product obtains a significant amount of its demand from the outside good, and where the new product is located where it competes with the firm's other products but does not compete much with the rival's products. This section examines whether these findings are robust in the sense that they still hold under models of preferences that are often used in empirical work. We focus on mixed-logit demand due to its common use in marketing and economics research.

The results from Section 2 suggest that a new product is most likely to increase a competitor's profits when preferences for the new product are positively correlated with the company's other products, but negatively correlated with the rival company's products. The mechanism for this correlation of preferences has varied in the empirical literature. Papers based on the random coefficients model, such as Berry, Levinsohn and Pakes (1994) have correlation structures driven by the variance in tastes for specific product attributes. In this framework, positive correlation in preferences for a particular firm's products can be obtained by including random preferences for a brand or company-level attribute, or if all products belonging to the same firm exhibit some other common attribute. In the Bayesian literature with panel shopping data, it is common to allow the preferences for different attributes to be correlated, which makes it even easier to obtain a rich covariance structure. (See Rossi, Allenby and McCulloch 2005, or Dubé, Hitsch and Rossi 2009, for example.) Chintagunta (2001) proposes an estimation approach for a probit model with a flexible covariance structure, which is another way to achieve this type of correlation.

The model we consider is a simple mixed-logit model. Consumer i's utility from consuming product j is $U_{ij} = \omega_{ij} - p_j + \varepsilon_{ij}$. Because we are analyzing this model from a theoretical perspective, there is no loss of generality of having a coefficient of –1 on prices instead of having a different constant coefficient on price; having a different coefficient only changes the effective currency in which prices and profits are stated.[4] Allowing for heterogeneous preferences on price should not have an impact on the qualitative results of this exercise for the question posed in this paper, unless one assumes a complicated correlation between preferences for products and prices. However, a reader can also interpret our model as a willingness-to-pay model (Sonnier, Ainslie and Otter 2007). ω_{ij} represents individual-specific preferences for the product that could, in an empirical exercise, come from the underlying preferences from the product's attributes. It is the mixing over the random-coefficient ω that leads to the name mixed-

[4] As an example, if the true coefficient on price for dollars – conditional on the variance of ε – were 7, one could instead represent utility in a currency with an exchange rate of 7 units per dollar. The coefficient on prices represented in that currency would then be 1.

logit. The simulated ω_i vectors are drawn from a multivariate normal distribution as described below, and are generally not drawn independently across products. ε_{ij} represents the standard i.i.d. extreme-value type I error term that is standard in the literature. This error distribution yields market shares dictated by the multinomial-logit functional form, conditional on all of the other parameters. We follow the standard empirical practice of calculating market shares by integrating over the different values of ε, which is possible due to the integral's closed functional form.

Let ω_i represent the vector $(\omega_{i1}, ..., \omega_{iJ})^T$. The ω_i vectors are drawn from a multivariate normal distribution with the following structure:

$$\omega_i \sim N(\gamma, \sigma^2\Phi) \tag{5}$$

where γ represents the mean, σ^2 is a variance parameter and Φ is a correlation matrix, with $\varphi_{j,k}$ representing the correlation between products j and k.

Consumers can also choose to consume only the outside good, in which case they obtain $U_{i0} = \varepsilon_{i0}$. This follows the standard normalization in the empirical literature of setting the outside utility to be zero plus an error term.

Given these preferences, we examine the impact of one firm's product-line expansion on the rival firm's profits through market simulation. As in Section 2, we assume that there are two firms, *a* and *b*, each initially producing one product: *a* and *b1*, respectively. We then consider how firm *a*'s profits change when firm *b* adds a second product, *b2*, to the market. As with most empirical papers, we assume that firms sell their products directly to consumers and maximize their total profits by setting prices for each of their products. We also assume that firms have constant marginal costs, and normalize these costs to be zero without loss of generality, as explained in Section 2.

The simulation results presented in this section are conducted by drawing 1,000,000 consumers with tastes for each of the 3 products drawn from the model above. We vary the values for γ, σ^2, $\varphi_{a,b1}$ (the correlation of tastes, ω, between the two incumbent products), $\varphi_{a,b2}$ (the correlation of tastes, ω, between the single-product firm and the new product), and $\varphi_{b1,b2}$ (the correlation of tastes, ω, between the two products belonging to the firm that eventually produces both).

We first demonstrate that firm *b*'s product-line expansion can lead to an increase in firm *a*'s profits. The results from the Hotelling model suggest that if the introduction of *b2* leads to increased profits for firm *a*, product *b2* should appeal to a different set of people than those who like product *a*. Thus, we first present an analysis of how the market changes as a result of the new product introduction by firm *b* for various values of γ and σ^2 using the following correlation matrix:

$$\Phi = \left[\begin{array}{c|cc} 1 & 0.5 & -0.5 \\ \hline 0.5 & 1 & 0.5 \\ -0.5 & 0.5 & 1 \end{array}\right] \tag{6}$$

The results of this analysis are presented in Table 1. Table 1a presents the percentage change in firm *a*'s profits from the introduction of *b2*. There are several key points that can be learned from this table. First, given that most of the entries are positive, it is apparent that product-line expansion can increase rival firms' profits when preferences are described by the mixed-logit distribution. Second, for any level of σ^2, the extent to which profits increase from a rival's product line extension at first increase, but then decrease, in γ. When γ is low, products are competing almost as much with the outside good as with the other products, so the new product introduction has only a small impact on profits. The logic in these cases can be highlighted by thinking about what happens with negative-enough values of γ: in such a case, almost all customers choosing one of the products would only find non-negative utilities from that product and the outside good, so the impact of entry on profits would be zero. When γ is large, the sum of the market shares of the incumbent firms is approximately one before entry. Thus, there is almost no room for market expansion from the introduction of product *b2*; in these cases, the sales loss from entry is relatively large, and is not offset by higher prices. Similarly, increases in σ^2 (consumer heterogeneity) are also associated with larger profit-increases. This is both because larger σ^2 reinforces the extent to which *b2* and *a* appeal to different customers, and because the amount of market expansion that can occur from new-product entry, holding γ fixed, is larger.

Tables 1b-1d present the percentage changes in p_{b1}, p_a, and q_a that occur from *b2*'s introduction. Table 1b demonstrates that *b2*'s introduction softens price competition and increases p_{b1}, as suggested in Section 2. Table 1c demonstrates that p_a increases from *b2*'s introduction as well, but that the size of this change is smaller than the increase in p_{b1}. Thus, *a* uses the softened competitive environment as an opportunity to thicken its margins, but avoids matching prices in order to lure some consumers from *b1* to *a*. Finally, Table 1d presents the percentage change in the number of units sold by *a*. Under some parameter values, the total number of units sold decreases even as profits increase; in these cases, the softened competition offsets the loss of sales. Under other parameter values, firm *a*'s sales increase with the new product introduction. This may at first seem counter-intuitive, but this is consistent with what occurs in the Hotelling market: because the change in p_{b1} is greater than the change in p_a, some consumers who initially consume *b1* instead consume *a* after the product-line expansion. Further, because *b2* and *a* largely appeal to different segments of consumers, *a* does not lose too many customers to *b2*. In these cases, sales increase, which along with the higher prices leads to increased profits.

In order to formalize the impact of these parameters, as well as the correlation parameters φ, in a broader set of contexts than those prescribed by equation (6), we solve for equilibrium prices and profits

for over 45,000 different values of parameters, where $\gamma \in [-1, 15]$ (sampled at odd values), $\sigma^2 \in [2,14]$ (sampled at even values), $\varphi_{a,b1} \in [-0.5,0.5]$, $\varphi_{a,b2} \in [-0.5,0.5]$, and $\varphi_{b1,b2} \in [-0.5,0.5]$ (all φs sampled at intervals of ⅛). Note that any combination of φ's in this range yield a positive definite matrix. Also, we sample σ^2, the variance in consumer preferences. Some empirical papers instead report σ, the standard deviation of preferences, which will range here from 1.4 to 3.7. This represents a reasonable range for consumer heterogeneity. We then calculate the average comparative statics of entry by regressing the percentage increase in profits on the various parameters. The results are presented in Table 2.[5]

The results indicate that $\varphi_{a,b2}$ has a larger impact on the percentage increase in profit than $\varphi_{a,b1}$ or $\varphi_{b1,b2}$, with negative correlations yielding higher percentage increases in profits. A large negative value for $\varphi_{a,b2}$ means that products *a* and *b2* serve fairly different segments, so the new product is unlikely to steal many consumers from *a*; in this case, *a* will generally profit from the new entry if it leads to higher prices. Also, firm *a* gains more from the introduction of the new product if $\varphi_{a,b1}$ and $\varphi_{b1,b2}$ are large. High $\varphi_{a,b1}$ means that *a* and *b1* serve similar segments of consumers, so if *b2*'s introduction increases *b1*'s price, *a* is especially likely to benefit. High $\varphi_{b1,b2}$ means that there is a significant group of consumers who find *b1* and *b2* to be close substitutes, so a low price on *b1* is likely to cause large cannibalization with *b2*; in this case, firm *b* has more incentive to increase p_{b1}, especially to the extent that $\varphi_{a,b2}$ is less than $\varphi_{a,b1}$. γ has, on average, a negative impact on the percentage change in profits. This is consistent with the intuition discussed in Section 2, that when γ is large, most consumers already purchase either *a* or *b1* before *b2*'s introduction, so *b2*'s demand comes predominantly from stealing customers from *a* or *b1*. σ^2 has a small but positive impact, consistent with the intuition above. Adding higher-order effects of these variables, as shown in column 2, does not add much explanatory power.

4. Multi-outlet retailers

In this section, we examine a special case of product-line expansion: the opening of an outlet in a new location by a multi-outlet retail chain. Empirical models of geographically differentiated industries combine aspects of the mixed-logit model as well as the Hotelling model. We have already seen that a firm's profits can increase from a rival's product-line expansion under each of these models. The combination of these two aspects provide an even-more fertile setting for product-line expansion to increase a rival's profits.

We demonstrate that a retailer's profits can increase when its competitor expands the number of outlets it operates in two ways. First, we examine the conditions under which this can occur through a

[5] The number of digits reported in Table 2 reflects the precision of the numbers given the number of equilibria we simulate. In most cases (including all of column 1) the confidence interval represents a change of ±1 in the last digit, but in no cases is the confidence wider than ±3 for the last digit.

comparative statics exercise similar to the one presented in Section 3. We then examine the fast food market in Santa Clara County, California and apply an estimated demand model to demonstrate that profits increased for Burger King outlets in response to multi-outlet franchisees opening new McDonald's outlets in that market.

4.1 Comparative Statics

In this subsection, we consider a relatively generic empirical model of geographic competition, and compute the comparative statics of the different factors that impact how opening an additional outlet affects a rival's profits. Let $b(j)$ denote outlet j's brand. Consumers are then modeled as having the following utility: consumer i's utility of consuming from outlet j is

$$U_{ij} = \omega_{ib(j)} - p_j - td_{ij} + \varepsilon_{ij} . \tag{7}$$

$\omega_{ib(j)}$ represent's consumer i's preference for brand $b(j)$. The role of ω here is slightly different than it is in Section 3 because here the preference heterogeneity represented by ω is common for all outlets belonging to the same brand (e.g., McDonald's). We choose to model the heterogeneity this way because we feel that the most-important dimension of consumer heterogeneity is the different preferences consumers have about the different chains. This assumption seems especially reasonable since some heterogeneity for locations within a chain is built into the outlet-specific error term, ε_{ij}, although the model can easily be adopted to handle more-complex substitution patterns. We assume that $\omega_i \sim N(\gamma, \sigma^2\Phi)$, where $\Phi = \begin{bmatrix} 1 & \varphi \\ \varphi & 1 \end{bmatrix}$ is a correlation matrix. γ represents a constant utility common to all products in the category. The coefficient on price is set to – 1 without loss of generality, as explained in previous sections. In the empirical analysis later, we will use different γs for each chain, as well as an estimated price coefficient because the data's prices are denoted in dollars. d_{ij} represents the distance between the consumer and the outlet. Finally, ε_{ij} is an i.i.d., extreme value type I random term, which yields multinomial-logit demands conditional on a household's location and parameters.

In order to analyze how retail-chain expansion affects the profits of incumbents, we consider a linear market from 0 to 100, with consumers located uniformly at integer points. We simulate markets under different parameter values and use regression to describe the comparative statics about how the percentage increase in profits from a rival's product-line expansion changes with the different elements in the model. As in the previous sections, we assume that there are two firms in the market a and b, and calculate how a's profits change when firm b switches from selling only $b1$ to selling two products, $b1$ and $b2$. We place a at the midpoint of the linear market, and randomly draw parameters $\gamma \sim$U[0,18], $\sigma \sim$U[0,3], $\varphi \sim$U[-0.5, 0.5], location($b1$)~U[0,100], and location($b2$)~U[0,100]. For each set of parameters, we simulate 1,000 different values of ω_i, and place people with these preferences at each of the integer

points on a line. Distance is measured in terms of the number of units traveled. We set $t = 0.4$, which provides a good balance of comparative statics on a line of this length.

Table 3 presents summary comparative statics about the percentage-increase in profits from the new-product introduction, based on 10,000 draws of the parameters above.[6] The results are consistent with the intuition provided by Theorems 1 and 2, as well as the comparative statics from the mixed-logit exercise. In particular, we find that the change in profits for firm *a* decreases as γ increases, consistent with the result that profit-increasing competitor entry requires that the new product's market share largely come from the outside good; when γ is large, very few consumers choose the outside good even before *b2*'s entry. Further, we see that firm *a* is more likely to profit from firm *b* opening the new outlet when *b2* locates far from *a*, but closer to *b1*. This is consistent with the intuition from Theorem 2 that profit-increasing competitor entry requires that the new product locates in a way that produces a positive correlation in preferences for *b1* and *b2* and a negative correlation in preferences for *b2* and *a*. As was the case with the mixed logit, we observe that *b2* locating far from *a* is more important than *b2* locating close to *b1*. The correlation in preferences between *b2* and *a* is determined not only by $dist(a,b2)$, but also by φ. We observe that *b2*'s introduction is more-likely to increase *a*'s profits if the preferences across chains are negatively correlated, meaning that *b2* and *a* appeal to different segments of consumers. Consistent with the results from Section 3, we also observe that greater consumer heterogeneity (σ) increases the change in profit firm *a* incurs when firm *b* opens the new outlet. Finally, we note that in separate analysis, available from the author upon request, we added γ^2, σ^2, φ^2 and $\gamma\sigma$, which increased the R^2 by less than 0.01; thus, the linear model captures most of the important comparative statics.

4.2 The effect of McDonald's Expansion on Burger King Profits

This subsection presents results of an empirical analysis of competition between McDonald's and Burger King. Our analysis is based on the estimated demand for these products, as evaluated by the mean structural estimates in Thomadsen (2005). The structural model estimated by Thomadsen is a special case of the model presented in equation (7), with $\sigma^2 = 0$; the simulations from Section 4.1 suggest that setting $\sigma^2 = 0$ reduces the chance of finding that McDonald's opening a new outlet would increase Burger King's profits. The model differs from the model presented in Section 4.1 in that the taste intercepts, γ, are different for McDonald's and Burger King, and we no longer normalize the price coefficient to one because our prices are measured in dollars. We also use the estimated marginal costs. The estimates from Thomadsen (2005) appear in appendix A.5.

We demonstrate that it is possible for profits of Burger King franchisees to increase when an existing McDonald's franchisee opens up a new outlet. McDonald's profits can also increase if a Burger

[6] The reported coefficients are all accurate within ±1 on the last digit.

King franchisee opens a new outlet, but the magnitude is smaller. We first demonstrate this by considering a hypothetical market where consumers are located along a line as in the markets examined in Section 4.1, where the line is 10 miles long. Before entry, there is one Burger King located at the center of the line, and a McDonald's outlet located at various different locations on the line. We then measure the percentage increase in variable profits that Burger King experiences when a second McDonald's (run by the same franchisee) opens in the market at a different location. Table 6 shows the percentage increase for some sets of locations for the original McDonald's and entering McDonald's. We note first that the increase in variable profits can be above 10%. These profit numbers do not include fixed costs, so the percentage increase in total profits would be much higher, although we do not know how often the McDonald's locations will be located in such a way that such large increases will occur. In our limited dataset below, we find positive but much smaller changes in profits based on actual locations. Second, the increase in profits is largest when the original McDonald's is located close to (but not directly on top of) the Burger King, and the entrant locates a bit away on the far side. The largest profit increases occur when the entrant enters neither too close nor too far from the outlet. Of course, there are a large number of locations where the entry leads to decreased Burger King profits, especially if the new outlet is located very close to the Burger King but on the opposite side of it from the original McDonald's.

Another test of whether profits can increase in practice is to apply an estimated empirical demand model to outlets in a data set, and see whether the model predicts that profits increased from actual entry. We examine this using a dataset of 62 McDonald's and 38 Burger Kings in Santa Clara County, CA and apply the estimated model of Thomadsen (2005), which also describes the data set in detail. We limit our analysis to calculating the impact of entry from new McDonald's operated by multi-outlet franchisees on the profits of the incumbent Burger King franchisees operating a single outlet. There are up to 13 incumbent single-outlet Burger King franchisees, depending on the date of a particular entry-event. We focus on the impact of profits on independent outlets, because an increase in an independent outlet's profits also is an increase in that firm's profits, while a multi-outlet franchisee may experience increases in profits in some outlets and decreases in profits in other outlets. We consider all 15 post-January 1, 1975 entries of new outlets belonging to multi-outlet McDonald's franchisees. In total, we can calculate the changes in profits for 116 entry-incumbent combinations.

42% of these observations reveal increased profits, while only 34% led to decreased in profits. The remaining 23% of the time the entry caused no changes in profits, as would be expected if the new outlet is located sufficiently far from an incumbent outlet. We observe 14 cases where the new outlet was located within 5 miles of the Burger King outlet. In these cases, where one would expect to find effects with larger magnitudes, we observe 4 instances where McDonald's new-outlet expansion had a less than 0.01% effect on variable profits, 3 instances where entry increases variable profits by over 0.01%, and 7

instances where these same entries lead to over a 0.01% decrease in profits. The mean increase among the 3 instances of profit increase is 0.2%, while the mean decrease among the 7 decreases is -1.6%. The fact these changes in profits are small reflects a tradeoff: the benefit that the Burger King gets from nearby McDonald's outlets increasing their prices is somewhat offset by lost sales from the presence of the new outlet, leading to opposing effects that approximately offset, either in a somewhat positive or somewhat negative direction. This is especially true in the 14 observations in our data, where we do not see cases where the new McDonald's outlet entered on what could cleanly be described as the far side of another incumbent McDonald's outlet. The largest positive change in profits among independent outlets is 0.3%, from $8471 to $8494 during each decision period, which is still a measurable increase in profits.[7,8] The largest decline is -7.2%. Even if we constrain ourselves to the 4 observations where the new entry against an independent Burger King was at a distance of 3 miles or less, which are the situations where one might most expect the product-line expansion to hurt profits, we do not see that such an event is always bad: these 4 observations have profit changes of 0.3%, -0.9%, -2.4% and -7.2%.

The profit numbers reported in this section are variable profit numbers. Variable profits are profits before accounting for fixed costs, which are unobserved in our data. Thus, changes in total profits are likely to be much larger than changes in variable profits. Also, the model used to evaluate profits assumes that $\sigma = 0$. The comparative statics presented in Table 3 suggest that this assumption may lead us to under-measure the extent that profits increase when a rival opens a new outlet, especially if the correlation of preferences between the two chains in negative. This seems plausible given that McDonald's sells fried hamburgers while Burger King sells flame-broiled hamburgers, but the data is not rich enough to well-identify these effects. Nevertheless, given that we have only 10 observations where profits change by over 0.01% in either a positive or negative direction, we still find that the effect of one-firm's geographic expansion on the rival's profits can be positive.

5. Discussion and Conclusion

This paper demonstrates that horizontal product-line expansion can increase a rival firm's profits. The basic mechanism for this result is that the firm that adds a new product may increase its prices on its incumbent products to avoid intra-firm cannibalization. Thus, product-line expansion can be a mechanism to credibly soften price competition. If the new product is positioned such that it does not steal too many of the rival's customers, then the impact of softened price competition can dominate the direct impact of

[7] The data is price data, so we cannot infer the frequency with which consumers decide which fast food restaurant to patronize. A rough comparison of the revenue numbers to the average sales of an outlet suggests that the decision period might be somewhere between every 3 days to a little more than once a week.

[8] There is an outlet in the dataset that experienced a 1.3% increase in variable profits. However, this outlet was owned by a franchisee who owned other outlets that experienced a decrease in profits from that event.

lost sales, and the rival's profits will increase. Even in cases where profits do not rise, the effect of increased prices can approximately offset the effect of lost sales, leading to negligible changes in profits. This basic principle was demonstrated across several classes of product differentiation models, including those commonly used in empirical research. Our findings are also consistent with the increase in revenues and prices Dannon experienced – despite lower sales – when Yoplait first introduced Yoplait Light, as documented in Kadiyali, Vilcassim and Chintagunta (1998).

We find that this phenomenon is especially likely to occur in competition among retail outlets. For example, we demonstrate that profits for Burger King franchisees can increase when a nearby McDonald's franchisee opens a new McDonald's outlet. McDonald's can also profit from a Burger King franchisee opening a new outlet, but the magnitude of this effect is smaller. This asymmetry in response is consistent with the asymmetry in impact of price from co-ownership demonstrated in Thomadsen (2005) and the asymmetry in the impact of geography on profits found in Thomadsen (2007) for the same industry.

From a theoretical view, geography is merely one type of product differentiation, but one that differs from those commonly used in the random coefficients literature in that consumers have an ideal location. We conjecture that, in general, markets where consumers have ideal levels (sometimes called "bliss points") for at least some attributes will be relatively fertile ground to find instances where one firm's product-line expansion will increase its rival's profits. In a random-coefficients set up, consumers can be interpreted as having ideal points of preferences if the utility function contains linear and squared terms of a specific attribute, as long as the coefficients on these two terms have the opposite signs. Thus, the choice of modelers to use linear functional forms in the utility function may be masking positive effects on profits from a rival's product-line expansion.

This paper's findings are important to both academics and managers. Understanding how product-line expansion impacts not just the expanding firm's profits, but also that of its rivals, is essential to understanding the nature of competition. Further, understanding whether rival firms' profits increase or decrease is an important input into understanding whether that rival is likely to respond to the new-product introduction by expanding their product line, or by trimming it: For example, if each of the rival's products becomes more profitable after the new product introduction then it is unlikely that the response to the expansion will pruning of the rival's products.

The conventional wisdom that one firm's product-line expansion decreases its rival's profits is deeply embedded in economics and marketing. This conventional wisdom often pervades academic research in the form of assumptions that are adopted by researchers without deep consideration of their applicability. For example, Eizenberg (2008) considers the question of how many products computer manufacturers should offer. One of Eizenberg's key assumptions is that if a product is unprofitable given

that the rivals have N products on the market, then that same product must be unprofitable if the rivals instead have N+1products on the market. While this assumption may be valid in Eizenberg's industry, our research demonstrates that this is not an innocent assumption.

Managers can also benefit from our study. The question about whether a company's product-line expansion will lead to a rival's expansion or pruning of their product line is not just an academic one, but also one that managers need to know in order to forecast future sales and anticipate the evolution of their industry. Another key lesson is that managers should not necessarily worry that a competitor's offering of a new product will be harmful; instead, profits may even increase. Even if profits decrease, the decrease will often be small if the competitor's new product does not compete too directly with the manager's products because the competitor will likely increase the prices of their other offerings, which will offset some of the lost sales from the entry. In many cases, a manager who is faced with competitive product-line expansion may be tempted to pre-empt the entry, or work to lobby a government or a zoning board to prevent entry. Given that these efforts are costly, our paper suggests that in many cases managers should avoid such actions. In fact, in some cases managers should lobby the government to make exceptions to laws and make entry easier for their competitors – even if the action would maintain high entry barriers to the manager's own firm.

Similarly, the mechanism behind our result is that a firm with multiple products on the market will price less-aggressively than two firms with the same products in order to avoid too much cannibalization. This suggests that a company might be better off if two of its competitors merge together, even if the new firm becomes the largest company in the industry. Under the conventional wisdom of competition, managers might be tempted to try to sway regulators to prevent such a merger, or to interfere with the merger negotiations in other ways in an attempt to stop the merger. However, having a large competitor control most of the competing rival products in the market can be beneficial in the sense that the co-ownership makes that company behave less aggressively. Thus, the manager may want to support the merger by competitors, even if the merger will lead to the introduction of the new products.

Finally, we note a potential direction for future research. We have focused most of this paper on horizontal product-line competition. Yet much of the product-line literature focuses on competition between firms that have vertically-differentiated product lines. Theorems 1 and 2 *do* apply to vertically differentiated industries, but it would be interesting to explore the extent to which these results are empirically applicable to vertical product lines.

Appendix A.1: Proof of Theorem 1

Substituting $-\frac{\partial q_{b2}}{\partial p_{b2}} = \frac{\partial q_{b2}}{\partial p_{b1}} = \frac{\partial q_{b1}}{\partial p_{b2}}$ into equation (3) yields

$$p_{b1} = \frac{q_{b1} + q_{b2}}{-\frac{\partial q_{b1}}{\partial p_{b1}} - \frac{\partial q_{b2}}{\partial p_{b1}}}. \tag{P1}$$

Note that at the pre-entry prices p_a and p_{b1}, $Q_b = q_{b1} + q_{b2}$ because the market is covered before and after the new-product introduction, and the customer representing the marginal customer between *b1* and *a* must not have changed. Similar logic dictates that $-\frac{\partial Q_b}{\partial p_{b1}} = -\frac{\partial q_{b1}}{\partial p_{b1}} - \frac{\partial q_{b2}}{\partial p_{b1}}$. Thus, given the theorem's assumptions, equation (P1) is exactly equation (2) when p_a and p_{b1} remain unchanged. Thus, the same prices satisfy the first-order conditions before and after *b2*'s entry.

Appendix A.2 Proof of Theorem 2

The first-order condition for p_{b1} after entry is given by equation (P1) above, as explained in A.1. Further, the theorem's assumptions require that $q_{b1} + q_{b2} > Q_b$ when p_{b1} and p_a are at their *ex ante* levels. Thus, the numerator of (P1) is larger than the numerator in equation (2) at *ex ante* prices. The denominator in (P1) is equal to $-\frac{\partial q_{b1}}{\partial p_{b1}} - \frac{\partial q_{b1}}{\partial p_{b2}} \leq -\frac{\partial Q_b}{\partial p_{b1}}$ at *ex ante* prices, which also implies that (P1) is greater than (2). Villas-Boas (1997), Theorem 2 shows that if the first-order condition for prices is positive at *ex ante* prices, then the equilibrium *ex post* prices (p_{b1} in particular) will increase. Firm *a*'s profits must increase since *b1*'s price increased, which means that firm *a*'s sales would increase at its *ex ante* price. Therefore, its profits must increase. (See Villas-Boas, Theorem 2.)

Appendix A.3: Proof of Proposition 1

When $l_a > l_{b1} > l_{b2}$, $1 - l_a < l_{b2}$ and $v \geq l_{b1}^2 + \frac{(2 + l_{b1} + l_a)(l_a - l_{b1})}{3}$, then $p_{b1} = \frac{(2 + l_{b1} + l_a)(l_a - l_{b1})}{3}$, $p_a = \frac{(4 - l_{b1} - l_a)(l_a - l_{b1})}{3}$ and $\pi_a = \frac{(4 - l_{b1} - l_a)^2 (l_a - l_{b1})}{18}$ before and after *b2* is introduced.

If v is large, there exists a location $x = \frac{p_a - p_{b1}}{2(l_a - l_{b1})} + \frac{l_{b1} + l_a}{2}$ such that all consumers located at x are indifferent between consuming each of these two products. Demand for *b1* before *b2*'s introduction is then x. We can then solve for the firm's first-order condition:

$$\frac{p_a - 2p_{b1}}{2(l_a - l_{b1})} + \frac{l_{b1} + l_a}{2} = 0 \rightarrow p_{b1} = \frac{p_a}{2} + \frac{(l_{b1} + l_a)(l_a - l_{b1})}{2} \tag{P2}$$

Similarly, firm *a* has an analogous first-order condition:

$$p_a = \frac{p_{b1}}{2} + \frac{(2 - l_{b1} - l_a)(l_a - l_{b1})}{2}. \tag{P3}$$

Solving these, we get $p_{b1} = \frac{(2 + l_{b1} + l_a)(l_a - l_{b1})}{3}$ and $p_a = \frac{(4 - l_{b1} - l_a)(l_a - l_{b1})}{3}$.

Now suppose that firm *a* begins producing another product *b2* with location $l_{b2} < l_{b1}$. There exists a location $y = \frac{p_{b1} - p_{b2}}{2(l_{b1} - l_{b2})} + \frac{l_{b1} + l_{b2}}{2}$ where consumers are indifferent from consuming product *b1* and product *b2*. Demand for product *b2* is then *y*, and demand for product *b1* is $(x - y)$. Rearranging, the first order conditions for firm *b*'s prices are then

$$p_{b1}: \qquad p_{b1} = \frac{(l_a - l_{b2})(l_a - l_{b1})(l_{b1} - l_{b2}) + p_a(l_{b1} - l_{b2}) + 2p_{b2}(l_a - l_{b1})}{2(l_a - l_{b2})} \tag{P4}$$

$$p_{b2}: \qquad p_{b2} = p_{b1} + \frac{(l_{b2} + l_{b1})(l_{b1} - l_{b2})}{2} \tag{P5}$$

Plugging (P5) into (P4) yields $p_{b1} = \frac{p_a + (l_a + l_{b1})(l_a - l_{b1})}{2}$, which is the same first-order condition as equation (P2). Therefore, because firm *a*'s first-order condition remains unchanged, prices and profits for firm *a* must remain unchanged. This will be the equilibrium as long as the market is covered before *b2*'s introduction: $\sqrt{v - p_{b1}} > l_{b1} \rightarrow v - \frac{(2 + l_{b1} + l_a)(l_a - l_{b1})}{3} > l_{b1}^2$.

Given this, we can calculate *a*'s profits as:

$$\pi_a = \left(\frac{(4 - l_{b1} - l_a)(l_a - l_{b1})}{3}\right)\left(1 - \frac{l_{b1} + l_a}{2} + \frac{\frac{(2 + l_{b1} + l_a)(l_a - l_{b1})}{3} - \frac{(4 - l_{b1} - l_a)(l_a - l_{b1})}{3}}{2(l_a - l_{b1})}\right)$$

$$= \left(\frac{(4 - l_{b1} - l_a)(l_a - l_{b1})}{3}\right)\left(\frac{4 - l_{b1} - l_a}{6}\right) = \frac{(4 - l_{b1} - l_a)^2(l_a - l_{b1})}{18}.$$

Appendix A.4: Proof of Proposition 2

Under the conditions for proposition 2, $p_a = \frac{p_{b1}}{2} + \frac{(2-l_{b1}-l_a)(l_a-l_{b1})}{2}$ and p_{b1} satisfies $\sqrt{v-p_{b1}} - \frac{p_{b1}}{2\sqrt{v-p_{b1}}} + \frac{l_a-l_{b1}}{2} + \frac{p_a-2p_{b1}}{2(l_a-l_{b1})} = 0$ before *b2*'s entry. After the introduction of *b2*, p_{b1} = $\frac{(2+l_{b1}+l_a)(l_a-l_{b1})}{3}$, p_{b2} = $\frac{2(1+l_a)^2-2(1+l_{b1})^2+3({l_{b1}}^2-{l_{b2}}^2)}{6}$, p_a = $\frac{(4-l_{b1}-l_a)(l_a-l_{b1})}{3}$ and π_a = $\frac{(4-l_{b1}-l_a)^2(l_a-l_{b1})}{18}$. We must demonstrate this, plus the fact that this implies that profits increase.

In order for the first-order condition for *b1* to be

$$\sqrt{v-p_{b1}} - \frac{p_{b1}}{2\sqrt{v-p_{b1}}} + \frac{l_a-l_{b1}}{2} + \frac{p_a-2p_{b1}}{2(l_a-l_{b1})} = 0 . \qquad \text{(P6)}$$

before *b2*'s introduction, it must be that p_{b1} is above the price where consumers at location 0 choose to purchase *b1*. This price is $p_{b1} = v - l_{b1}^2$. At this price, (P6) must be positive. The calculations supporting (P3) as *a*'s FOC are the same as those provided in Proposition 1. Plugging (P3) into (P6) yields

$$\sqrt{v-p_{b1}} - \frac{p_{b1}}{2\sqrt{v-p_{b1}}} - \frac{3p_{b1}}{4(l_a-l_{b1})} + \frac{2-3l_{b1}+l_a}{4} = 0 . \qquad \text{(P7)}$$

At $p_{b1} = v - l_{b1}^2$, (P7) becomes $l_{b1} - \frac{v}{2l_{b1}} + \frac{l_a}{2} - \frac{3(v-l_{b1})}{4(l_a-l_{b1})} + \frac{(2-l_{b1}-l_a)}{4} > 0$ iff v < $\frac{2l_{b1}l_a - 2l_{b1}^2 + 2l_{b1}^2 l_a + l_{b1}{l_a}^2}{2l_a + l_{b1}}$.

After *b2* is introduced to the market, the prices and profits are equivalent to those in Proposition 1 as long as $\sqrt{v-p_{b2}} > l_{b2}$. This happens whenever $v - \frac{2(1+l_a)^2-2(1+l_{b1})^2+3({l_{b1}}^2-{l_{b2}}^2)}{6} > l_{b2}^2$ → $v > \frac{2(1+l_a)^2-2(1+l_{b1})^2+3({l_{b1}}^2+{l_{b2}}^2)}{6} = \frac{4l_a+2{l_a}^2-4l_{b1}+{l_{b1}}^2+3{l_{b2}}^2}{6} = \frac{(2+l_{b1}+l_a)(l_a-l_{b1})}{3} + \frac{l_{b1}^2+l_{b2}^2}{2}$.

We can see that p_{b1} must increase with entry, which in turn implies that π_a increases, by plugging p_{b1} = $\frac{(2+l_{b1}+l_a)(l_a-l_{b1})}{3}$ into (P7). At this price, $\sqrt{v-p_{b1}} - \frac{p_{b1}}{2\sqrt{v-p_{b1}}} - \frac{3p_{b1}}{4(l_a-l_{b1})} + \frac{2-3l_{b1}+l_a}{4}$ $= \sqrt{v-p_{b1}} - \frac{p_{b1}}{2\sqrt{v-p_{b1}}} - \frac{2+l_{b1}+l_a}{4} + \frac{2-3l_{b1}+l_a}{4} = \sqrt{v-p_{b1}} - \frac{p_{b1}}{2\sqrt{v-p_{b1}}} - l_{b1}$<0. We know this is

negative, because we saw in Appendix A.3. that $\sqrt{v - p_{b1}} < l_{b1}$ at $p_{b1} = \frac{(2 + l_{b1} + l_a)(l_a - l_{b1})}{3}$ whenever $v < l_{b1}^2 + \frac{(2 + l_{b1} + l_a)(l_a - l_{b1})}{3} = \frac{2l_a - 2l_{b1} + l_a^2 + 2l_{b1}^2}{3}$. $l_a > l_{b1}$ ensures that the upper bound of v, $\frac{2l_{b1}l_a - 2l_{b1}^2 + 2l_{b1}^2 l_a + l_{b1}l_a{}^2}{2l_a + l_{b1}} < \frac{2l_a - 2l_{b1} + l_a^2 + 2l_{b1}^2}{3}$.

Appendix A.5: Estimates from Thomadsen (2005)

$V_{i,j} = X\beta - D_{i,j}\delta - P_j\gamma + \eta_{i,j}$
$MC_j = C_k + \varepsilon_j$

Variable Name	Variable	
BK Base utility	β_1	**4.07*** **(2.42)**
McD Base utility	β_2	**6.53**** **(2.69)**
Price sensitivity	γ	**0.91*** **(0.47)**
Distance disutility	δ	**2.58***** **(0.56)**
Playland utility	β_{play}	-0.47 (0.30)
Drive-thru utility	β_{drive}	0.09 (0.32)
Mall utility	β_{mall}	-0.91 (1.05)
Outside utility ages < 18		0.34 (0.27)
Outside utility ages 30-49		0.13 (0.16)
Outside utility ages 50-64		0.38 (0.25)
Outside utility over age 64		**2.11***** **(0.57)**
Outside utility for males		**-0.34***** **(0.13)**
Outside utility for blacks		0.10 (0.26)
Outside utility for workers		**2.46**** **(1.12)**
Marginal Cost BK	$C_{Burger\ King}$	**2.03***** **(0.58)**
Marginal Cost McD	$C_{McDonald's}$	**1.45*** **(0.84)**

Standard errors appear in the parentheses.
*, **, *** denote significance at the 90, 95 and 99% levels respectively.

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Table 1: Changes from when a rival introduces a new product, where Φ as specified in eq. (6).

a. Percentage increase in profits for firm *a*.

		σ^2 (Consumer Heterogeneity)						
		4	8	12	16	20	24	28
γ (mean utility)	0	-0.5	1.4	2.2	2.6	2.7	2.8	2.8
	2	-0.5	2.2	3.1	3.6	3.7	3.9	3.9
	4	-0.6	2.7	4.1	4.6	4.9	5.0	5.1
	6	-1.5	2.7	4.3	5.2	5.5	6.0	5.9
	8	-3.1	1.6	4.0	5.4	6.2	6.3	6.8
	10	-4.3	-0.3	2.7	4.6	5.5	6.3	6.7
	12	-4.3	-1.5	0.4	2.6	3.8	5.3	6.1

b. Percentage increase in p_{b1}.

		σ^2						
		4	8	12	16	20	24	28
γ	0	12.1	11.1	11.1	10.8	10.4	10.5	10.1
	2	15.2	13.8	13.1	12.7	12.0	12.1	11.8
	4	16.0	15.4	14.8	14.1	13.7	13.3	13.3
	6	14.7	15.3	15.0	14.9	14.5	14.5	14.1
	8	12.7	13.8	14.5	14.9	15.1	14.5	14.7
	10	11.8	11.9	13.1	14.2	14.2	14.3	14.5
	12	11.5	10.9	11.3	12.3	12.4	13.5	13.7

c. Percentage increase in p_a.

		σ^2						
		4	8	12	16	20	24	28
γ	0	1.8	1.9	1.7	1.6	1.5	1.4	1.3
	2	3.8	3.8	3.5	2.9	2.6	2.4	2.2
	4	5.5	6.0	5.5	4.8	4.4	3.9	3.6
	6	5.6	7.4	7.3	6.9	6.2	5.8	5.3
	8	4.5	7.3	8.2	8.2	8.0	7.3	6.9
	10	3.6	6.1	7.8	8.8	8.7	8.5	8.3
	12	3.5	5.3	6.5	7.7	8.1	9.0	8.9

d. Percentage increase in units sold by firm *a*.

		σ^2						
		4	8	12	16	20	24	28
γ	0	-2.3	-0.4	0.5	1.0	1.2	1.4	1.5
	2	-4.2	-1.6	-0.3	0.7	1.0	1.5	1.7
	4	-5.7	-3.1	-1.3	-0.3	0.5	1.0	1.5
	6	-6.7	-4.4	-2.8	-1.6	-0.6	0.2	0.6
	8	-7.3	-5.3	-3.9	-2.6	-1.7	-1.0	-0.1
	10	-7.6	-6.1	-4.8	-3.8	-2.9	-2.0	-1.5
	12	-7.6	-6.5	-5.7	-4.8	-4.0	-3.3	-2.6

Table 2: Meta-Analysis for Mixed-Logit
Dependent variable: Percentage Increase in *a*'s profits from *b2*'s entry

Variable	(1)	(2)
constant	-13.3	-12.0
$\Phi_{a,b1}$	4.7	4.7
$\Phi_{a,b2}$	-20.4	-20.4
$\Phi_{b1,b2}$	10.7	10.8
γ	-1.17	-1.7
σ^2	0.23	0.2
$\gamma*\sigma^2$		-0.006
$\gamma*\gamma$		0.041
$\sigma^2*\sigma^2$		0.005
$\Phi_{a,b1}*\varphi_{a,b1}$		1.0
$\Phi_{a,b2}*\varphi_{a,b2}$		-6.9
$\Phi_{b1,b2}*\varphi_{b1,b2}$		0.7
R^2	0.925	0.938

Table 3: Percentage Increase in Profit for Geographic Mixed-Logit Model

Constant	-18.
dist(*a*,*b1*)	-0.09
dist(*a*,*b2*)	0.89
dist(*b1*,*b2*)	-0.13
γ	-1.0
σ	0.8
φ	-2.
R-square	0.63

Table 4: Percentage Increase in Profits for a Burger King Located at location "50."
Every 10 units = 1 mile.

Original McDonald's Location	Location of New McDonald's Outlet								
	20	23	26	29	32	35	38	41	44
20	-0.5	-1.4	-2.8	-5.2	-9.2	-15.3	-24.3	-36.6	-50.9
23	-0.1	-0.9	-2.3	-4.6	-8.3	-14.1	-22.8	-34.9	-49.4
26	0.6	-0.1	-1.5	-3.7	-7.1	-12.6	-21.0	-33.0	-47.7
29	1.6	1.0	-0.2	-2.4	-5.7	-10.8	-18.9	-30.7	-45.5
32	2.9	2.5	1.6	-0.4	-3.6	-8.6	-16.3	-27.8	-42.8
35	4.3	4.4	3.9	2.3	-0.6	-5.5	-13.0	-24.2	-39.2
38	5.9	6.5	6.6	5.7	3.3	-1.2	-8.5	-19.3	-34.0
41	7.2	8.4	9.2	9.2	7.7	4.0	-2.5	-12.5	-26.4
44	7.1	8.8	10.1	10.7	10.1	7.7	2.9	-5.0	-16.6
47	5.2	6.6	7.8	8.3	8.0	6.3	2.9	-2.3	-9.8
50	2.4	2.9	3.1	2.6	1.3	-1.2	-4.9	-9.4	-14.3
53	0.1	-0.3	-1.2	-2.9	-5.7	-9.8	-15.2	-21.4	-27.2
56	-1.2	-2.2	-3.9	-6.6	-10.5	-16.0	-23.0	-31.1	-39.1
59	-1.8	-3.2	-5.3	-8.6	-13.3	-19.7	-27.8	-37.2	-46.6
62	-1.9	-3.4	-5.8	-9.3	-14.4	-21.3	-30.0	-40.3	-50.6