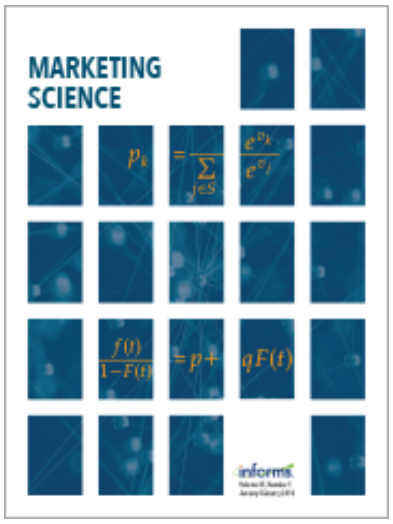

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Turf Wars: Product Line Strategies in Competitive Markets

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In this paper we study product line scope and pricing decisions in a horizontally differentiated duopoly. Past research has shown that a firm may offer a broader product line to attract higher demand or charge a higher price (or both), and benefit at the expense of its competitor. We show that such outcomes may be reversed, especially when consumers have relatively high valuation and low heterogeneity in their preferences for the line extension. We find that an equilibrium exists such that only one firm prefers to expand scope but profits may be higher for both firms, even in the absence of market size expansion. This is because a broader scope permits that firm to effectively price discriminate by raising prices for its core customers. The competitor optimally responds by lowering prices to gain share and earn a higher profit. Thus, higher prices for the firm expanding its product line translate into higher demand for the competing firm, thus increasing profit for both. We show that our results hold when firms deploy generic, offensive or defensive strategies during product line expansion.

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1. Introduction

Developing a distinct and differentiated market position in the minds of target consumers is a core aspect of a firm's marketing strategy. A differentiated position often defines a firm's brand by being strongly associated with certain product characteristics desirable to some consumers in the target market. This helps a firm carve out its dominant space in the overall category and define a "home turf." The degree of competition within the category is then driven by whether each firm respects its competitor's turf or strategically broadens scope to expand beyond its core position.

In practice, we observe firms broadening their product line scope by introducing new products in a variety of different ways. Some line extensions directly attack a competitor on their home turf. Other line extensions are intended to defend a firm's home turf. Yet other types of extensions may seek to be undifferentiated and more generic in their appeal. Additionally, in some markets all competing firms might choose to expand their product lines. In others, only some firms might prefer to do so, and in yet other markets, all firms might prefer to simply stick to their own turf. These strategic choices can give rise to a myriad of competitive market situations, as illustrated by the examples below.

Consider the competition between Kirin and Asahi, two established players in the Japanese beer market. Kirin's market position is an authentic *lager* beer (rich, bitter taste), whereas Asahi's position is an authentic *dry* beer (comparatively less sugar, more alcohol). In this market, Kirin has expanded into Asahi's turf with a product called "Kirin Draft *Dry* Beer," but Asahi has refrained from encroaching on Kirin's lager turf (Aaker 2011). Given its core lager reputation, consumers have been reluctant to accept Kirin's dry beer as an authentic, high quality product. In the U.S. fast foods market, McDonald's is well known for hamburgers and cheeseburgers, positioned strongly on what one might call tasty, *fun* food. Subway, on the other hand, has established a position as a provider of healthy, *fresh* food.[1] Recently, McDonald's expanded its menu scope to offer healthy, fresh alternatives such as salads. Yet Subway, like Asahi, has refrained from broadening its scope.

Similarly, consider the competition between BMW and Lexus in the U.S. premium cars market. BMW is positioned relatively strongly on the *performance* dimension, whereas Lexus is positioned relatively

[1] Subway's "Eat Fresh" campaign played a big role in achieving this position (Ries 2005).

strongly on the *comfort* dimension.[2] In 2007, Lexus announced its scope expansion in the following manner: "*With Lexus solidly established as a luxury leader, it was time to expand the brand's scope by offering unique high-performance models, and the IS-F is the first*" (Lexus 2007). This decision to expand scope has significant strategic importance, as it dictates the specific positioning a firm wishes to achieve, what markets and what set of consumers to pursue, as well as how much to encroach on competitors' territories.[3] It also has tactical implications, in terms of determining exactly what products the firm should carry in its product line to achieve its strategic goals. While BMW continues with its performance position, Lexus seeks a broader focus with its new products.

In the 1980s–1990s among desktop printers, HP enjoyed a dominant position in inkjet technology, and IBM in laser technology (Teisberg and Clark 1994). Both HP and IBM, however, later offered both types of printers. Similarly, in the online video space, YouTube developed a strong position as the website for personal content (individual videos, music singles), and Hulu developed a strong position as the destination for professional content (TV shows, movies). Yet, YouTube now offers professional content (TV shows, movies) and Hulu offers personal content (starting with music videos). Per recent *Wall Street Journal* reports, "the companies dominate two segments of the online video business. Yet Hulu and YouTube are increasingly going after each other's turf" (Vascellaro et al. 2009, p. B6).

Such examples are abundant, and they illustrate the strategic role of a firm's product line scope in orchestrating an active encroachment on competitor territory or a careful defense of own territory. In this paper, we study how key demand side factors influence these product line scope decisions. We study the effect of consumers' valuation for the various products offered as well as the strength of consumer preferences for core and extension products on firms' product line and pricing decisions, and the resulting implications for profits and competition in the market.

In our model, each firm has an established position at one end of a unit line (Hotelling 1929). Consumers towards each end signify the home turf for the respective firms at that end. Consumers are uniformly distributed over the horizontal line, and hence have heterogenous preferences for the distinct market positions. Firms first decide whether to expand their product line scope, and subsequently compete on prices. If a firm expands scope, it offers an additional new product that, for instance, may directly attack the competitor's turf. Under distinct conditions, we show that expansion of product line scope by only one firm, by both firms or by no firm, can all be equilibrium strategies.

The main insight from our analysis is as follows. Extant research (e.g., Anderson and dePalma 1992) argues that in saturated markets, firms expand scope at the expense of their competitors: Product line expansion allows a firm to gain share and higher profits, but increases overall competition in the market. By contrast, we find that under certain conditions product line expansion in a saturated market may reduce overall competition. In other words, we find that when a market is fully covered, in equilibrium, only one firm expands scope but both firms may earn higher profits.

Such outcomes are observed in markets where consumers have relatively high valuation and low heterogeneity in their preferences for the line extension. In such markets, scope expansion allows that firm to better price discriminate among its customers, by charging a higher price for its core product. To support this higher core price, the expanding firm commits to not being too aggressive in pricing its line extension. In fact, the line extension may solely cannibalize sales from its existing product, but enable effective price discrimination. The competitor responds by lowering the price on its core product to gain more share, such that its overall profits rise. Thus, the benefits of price discrimination spill over: Higher core prices for the expanding firm translate to higher demand for the competing firm, increasing its profit despite a drop in its core price. In equilibrium, the nonexpanding firm prefers to maintain narrow scope, so as not to intensify price competition. Thus, a firm may choose to expand its product line to price discriminate within its turf, and it may end up doing it in a way that provides an incentive for its competitor to increase its market share without expanding scope.

We find that our results hold when we analyze product line scope expansion using generic, offensive as well as defensive new product line extensions. Thus, compared to existing research, for certain markets, our analysis provides new insights on the effects of product line scope expansion on profitability and competition.

The rest of this paper is organized as follows. Section 2 positions our work in the context of prior literature. Section 3 introduces our model, and analyzes a simple product line and pricing game to illustrate our main result and its intuition. In §4, we extend this basic model to accommodate offensive product line

[2] *Ad Age* reports that since 1975, BMW's advertising tagline has been "the ultimate driving machine" (Ries 2005); whereas Lexus' tagline since its U.S. launch in 1989 has been "the relentless pursuit of perfection," focused on attributes the automaker considers the heart and soul of the brand, i.e., comfort, quality, and dependability (Halliday 1998). This is echoed on Edmunds.com, an independent and popular automotive information website, which describes the BMW brand as offering "superior levels of driving enjoyment" (www.edmunds.com/bmw) and the Lexus brand as offering "utterly refined luxury vehicles" (www.edmunds.com/lexus).

[3] Indeed, inline with Lexus' intentions, critics were quick to acknowledge the IS-F as a potential challenger to the BMW M series (*Automobile Magazine* 2008, *Motor Trend* 2008).

strategies, while in §5 we model defensive product line strategies. There, we also compare outcomes across the offensive and defensive games. In §6, we introduce an a priori asymmetry among firms to investigate which firm expands scope. Section 7 summarizes our key findings and concludes with ideas for future research.

2. Prior Literature

Product line length, positioning, and pricing are critical elements of a firm's marketing strategy. Consequently, this is a well researched topic in marketing, economics, and other disciplines. In this section, we review the related literature on product line strategies, differentiation, and multiproduct competition to place our analysis in context.

A large stream of research on firms' positioning and pricing decisions typically models consumer preferences for a product attribute as being horizontally or vertically distributed (e.g., Hotelling 1929; d'Aspremont et al. 1979; Mussa and Rosen 1978; Moorthy 1984, 1988). In the horizontal differentiation context, past research has shown that firms might offer multiple products to benefit from economies of scope, deter entry, and preempt competition (e.g., Schmalensee 1978, Bonanno 1987). Furthermore, product line decisions are often driven by various types of costs. From a supply side perspective, firms might not offer high variety when facing production costs as well as manufacturing related inventory and holding costs (e.g., Lancaster 1990, deGroote 1994). In the vertical differentiation context, a monopoly may offer too many products than are socially optimal when production costs are low, and too few products when the costs are high (Tirole 1988). From a demand side perspective, Klemperer (1992) analyzed whether multiproduct firms should offer identical or differentiated product lines when consumers seek variety. He showed that when consumers incur shopping costs, firms prefer identical product lines to prevent consumers from shopping around for variety. Kuksov and Villas Boas (2010) studied the impact of consumer search and evaluation costs and showed that firms may shy away from offering too few or too many products if consumers anticipate that it may be quite unlikely or too costly to assess fit and make the right choice. Thus, in many of these studies, costs are an important driver of product line breadth; the normative recommendation is for firms to offer broader product lines in the presence of lower costs. Analyzing the effects of entry and exit costs, Judd (1985) showed that when exit costs are low, an incumbent might be unable to use product line expansion credibly as a deterrent to prevent entry. The key intuition in this analysis is that competition in the noncore turf can depress demand and profit in the incumbent's core turf: Hence with low exit costs, the incumbent would prefer to give up the noncore turf. We show that in the presence of horizontally distributed consumer tastes, a firm may in fact prefer to stake its claim on a competing turf: While doing so may depress demand a la Judd (1985), it can also enable price discrimination across the turfs, effectively improving profits from expanding scope.

More broadly, in our work we abstract away from cost based explanations to investigate whether demand side interactions can motivate firms to choose narrow product lines even if it were costless for a firm to provide or for consumers to consider variety. On the demand side, past research has shown that while a monopoly may offer multiple products to charge higher prices and extract additional consumer surplus, competing multiproduct duopolies do not offer breadth to reduce price competition (Bonanno 1987, Martinez-Giralt and Neven 1988). We investigate whether there are circumstances under which a firm might be motivated to offer breadth in its product line, while still reducing overall competition.

Finally, while past research has extensively analyzed competition between single product firms where consumer preferences for products are heterogenous on more than one dimension (e.g., Vandenbosch and Weinberg 1995, Ansari et al. 1998, Irmen and Thisse 1998, Lauga and Ofek 2011), the analysis of competition between multiproduct firms has been relatively limited. Notable exceptions include past work by Katz (1984) and Desai (2001) investigating optimal product line designs in markets with horizontal and vertical differentiation. Analogous to the analysis by Moorthy (1984), Katz (1984) showed that competing firms may inefficiently serve the consumer segment with lower preference for quality so as to prevent cannibalization, and that this is more likely when location specific preferences among consumers with a higher preference for quality segment are weaker. Desai (2001) generalized Katz's (1984) analysis to identify circumstances when efficient and inefficient quality provisions may arise in a monopoly as well as a duopoly. Because the primary concern in these analyses was to understand whether and to what degree were consumer segments being served efficient quality levels; issues of pricing and product line focus were not central.[4] Doraszelski and Draganska (2006) studied product line decisions for competing multiproduct firms offering general purpose or niche products to two segments of consumers desiring distinct product characteristics. Consistent with the supply side perspective, they found that if the fixed costs of offering a variant are low, firms compete with full product lines. Yet if the fixed costs are high, firms may offer general purpose products or

[4] In fact, Desai (2001, p. 276) concludes by calling for "more research towards studying how firms' price and quality strategies change when they compete . . . occupying multiple locations."

specialize in niche segments, depending on the degree of product fit and competition. Thus, costs become the major driver influencing firms' product line breadth (also see Desai et al. 2001, Krishnan and Zhu 2006, Xia and Rajagopalan 2009). Additionally, asymmetric product line length as an equilibrium consequence of demand side interactions remains is yet to be adequately explored. As illustrated in our earlier examples, Kirin versus Asahi, McDonald's versus Subway, etc., situations wherein one firm chooses a narrow product line focus and the other chooses a broader focus are an important and frequently observed outcome in many product categories.

In this paper, we address this gap. Our objective is to abstract away from costs and other supply side factors, and focus on demand side interactions to contribute to our existing knowledge. We identify conditions under which it is optimal for competing firms that are a priori symmetric to have an asymmetry in their product line scope, and when such scope expansion can in fact reduce competition. We investigate the robustness of our results when expansion in product line scope is of a generic, offensive or defensive nature, and explore the implications for profitability and competition under these three distinct approaches to scope expansion.

Our analysis proceeds as follows: We first analyze a duopoly where firms consider introducing generic line extensions. There, we derive all feasible pure strategy equilibria in product lines and prices in the entire parameter space, and highlight the most interesting outcomes. Subsequently, we explore whether the most interesting results obtained for generic products continue to hold when product line extensions might not be generic, but instead may focus on attacking the competitor's turf or enhancing the defense of one's own turf. We start by outlining our model for generic product line extensions in §3.

3. Product Line Strategy with Generic Extensions

Following the standard horizontal differentiation literature (e.g., Hotelling 1929), consider two firms, $i \in \{1, 2\}$, competing in a market with a continuum of consumers uniformly distributed along a horizontal $[0, 1]$ line with unit density, and where travel costs are linear in distance. Each firm offers a product at one end of the market, i.e., firm 1's core product is at 0, and firm 2's core product is at 1. The location of this core product signifies a firm's established position in the market. It also defines the home turf for the firm as the set of consumers who (all else equal) prefer its core product over the competitor's core product.

Let v denote consumer valuation of the core product and p_{ic} denote the price of the core product offered by firm i. Let t denote the unit travel cost, also equivalent to the strength of consumer preference in this market. Consequently, the ratio t/v represents consumers' *valuation adjusted preference* (much in the spirit of the notion of preference adjusted valuation in Jerath et al. 2010). For a consumer at $x \in [0, 1]$, utility u_{ic} for the core product offered by firm i is specified as

$$u_{1c} = v - tx - p_{1c}, \tag{1}$$

$$u_{2c} = v - t(1 - x) - p_{2c}. \tag{2}$$

Firms play a two-stage game. In the first stage, each firm simultaneously decides whether to extend the scope of its product line by introducing a generic product. In the second stage, having observed the competitor's product line strategy, both firms simultaneously set prices for their products. Let p_{ie} denote the price of the product line extension offered by firm i. For a consumer at $x \in [0, 1]$, utility for the new extension products is specified as

$$u_{1e} = \gamma v - p_{1e}, \tag{3}$$

$$u_{2e} = \gamma v - p_{2e}. \tag{4}$$

The absence of travel cost in Equations (3)–(4) implies that all consumers have the same valuation for the product line extensions, irrespective of their ideal points. In other words, product line extensions do not have any specific *positioning* unlike the core products, and hence are *generic* in their appeal to all consumers. The exogenous parameter γ represents consumers' valuation for generic extensions relative to the core products. We restrict $\gamma \in [0, 1]$, i.e., valuation of generic products to lower than the valuation of core products. If this were not the case, developing core market positions would no longer be a valuable proposition in most markets. This runs counter to observations about firm strategies in many product categories. It also reflects the notion that products developed by a firm with a specific position (e.g., high performance cars) are valued more by consumers who strongly desire that particular position (e.g., drivers interested in high performance cars).

Consumers observe all products and prices offered, and purchase a single product that provides the highest non-negative utility. Any consumer who derives negative utility from all products offered prefers an outside good whose utility U_{oo} is set to 0. Let d_{ij} denote demand for product $j \in \{c, e\}$ offered by firm i. Let π_i denote profits for firm i. Then, $\pi_i = \sum_{j \in \{c,\, e\}} p_{ij} d_{ij}$, contingent on product e being offered by firm i.

Depending on whether each firm maintains a narrow product line scope (N) or introduces a new product line extension (E) in the first stage, there are four subgames in the second stage $\{NN, NE, EN, EE\}$. Our analysis begins with deriving pure strategy equilibria in prices in these second stage subgames. We then characterize the distinct subgame perfect pure strategy Nash equilibria in product line scope in the first stage.

3.1. Pricing Generic Products

Price selection, market coverage as well as realized consumer surplus is often "at the heart of the strategic problem for firms" (Wauthy 1996, p. 352; also see Desai 2001 and He et al. 2012). Hence we begin by summarizing the equilibria in prices in the *NN* subgame when each firm offers only its core product. As is well known, equilibrium outcomes in horizontal differentiation models such as ours depend on the values of t/v. When t/v is high ($t/v > 1$), consumers have relatively strong preferences (for their ideal points), making the market inherently less competitive. In equilibrium the market is not fully covered and equilibrium prices are $p^*_{ic} = v/2$, equilibrium demand is $v/(2t)$, and equilibrium profit for each firm is $v^2/(4t)$. Some consumers in the middle of the market prefer the outside option.

On the other hand, when t/v is low ($0 < t/v < \frac{2}{3}$), consumers have relatively weak preferences, making the market inherently more competitive. In equilibrium the market is fully covered and equilibrium prices are $p^*_{ic} = t$, equilibrium demand is 1/2, and equilibrium profit for each firm is $t/2$. The consumer indifferent between the core product of either firm is at the center of the market, and earns a positive surplus from consumption in this market.

Finally, intermediate values of t/v ($\frac{2}{3} \le t/v \le 1$) represent markets that are moderately competitive, a region of significant interest in our analysis of product line scope. In this region, as is well known, there exist multiple equilibria in prices. Each of these equilibria corresponds to a location of the consumer indifferent between purchasing either firm's core product, $\bar{x}_i$, in the range $[1 - v/(2t), v/(2t)]$. Furthermore, this indifferent consumer is indifferent between choosing either firm's core product as well as the outside good: In other words, this consumer earns zero surplus from consumption in this market. For each $\bar{x}_i$, equilibrium prices are $p^*_{1c} = v - t\bar{x}_i$ and $p^*_{2c} = v - t(1 - \bar{x}_i)$, equilibrium demand is $d^*_{1c} = \bar{x}_i$ and $d^*_{2c} = 1 - \bar{x}_i$, and equilibrium profit is $\pi^*_1 = (v - t\bar{x}_i)\bar{x}_i$ and $\pi^*_2 = (v - t(1 - \bar{x}_i))(1 - \bar{x}_i)$.

Because multiple equilibria exist in this region ($\frac{2}{3} \le t/v \le 1$), and since firms are a priori symmetric in this market, we first focus only on the symmetric equilibrium (a la Varian 1980, among others) such that the consumer indifferent between buying from either firm is at $\bar{x}_i = \frac{1}{2}$.[5] With this assumption, in this region equilibrium prices are $p^*_{ic} = v - t/2$, equilibrium demand is 1/2, and equilibrium profit for each firm is $(v - t/2)/2$.

In the rest of the subgames where at least one firm introduces a generic product, clearly the market is always covered. In these subgames, equilibrium outcomes depend on the relative values of t/v and γ. Pricing equilibria for these subgames are derived along the same lines as the analysis for subgame *NN* above, and the outcomes are summarized in Appendix A.

3.2. Product Line Equilibria with Generic Products

As a tie-breaker, assume that firms prefer not to expand scope when they are indifferent between expanding scope or not. Comparing profits across subgames, the pure strategy equilibria in product line scope for the first stage are as follows:

Proposition 1. *In the product line game with generic extensions, in equilibrium*:

(a) *For* $1 \le t/v$ *and* $0 < \gamma \le 1$, *only one firm expands scope. The firm that expands scope is better off, while its competitor is no worse off compared with the subgame when no firm expands scope.*

(b) *For* $\sqrt{3} - 1 < t/v < 1$ *and* $(2 + \sqrt{3})(1 - t/v) < \gamma \le 1$, *only one firm expands scope. Both firms are better off compared to the subgame when no firm expands scope, even though scope expansion does not attract new consumers into the market.*

(c) *In the rest of the region, neither firm expands scope.*

Figure 1 illustrates the various equilibrium outcomes.[6] In regions (a) and (b), in equilibrium, only one firm expands scope and the other firm maintains a narrow scope.[7] Interestingly, in the central unshaded region (b) where only one firm prefers to expand scope, both firms are better off compared to when neither firm expands scope, despite the market always being fully covered. This is surprising, since extant knowledge suggests that expansion in product lines increases competition and reduces profits in the market (e.g., Anderson and dePalma 1992).[8] The intuition behind our result becomes clear when we compare equilibrium prices and demands across the various subgames. In region (b), the firm that expands scope sets the price for its product line extension at its valuation ($p^*_{1e}|_{EN} = \gamma v$).[9]

[5] This is analogous to applying a refinement based on focal point arguments (Schelling 1960, Fudenberg and Tirole 1991, Myerson 1991) that leverages the natural symmetry among players in this game. We argue that the unique equilibrium in this subgame, subject to the focal point refinement, is one where $\bar{x}_i = \frac{1}{2}$. This is the most natural choice given the shared understanding of the environment by both firms. Subsequently, we will relax this assumption/refinement, and derive equilibrium in the product line game while considering all possible equilibria in prices for this subgame.

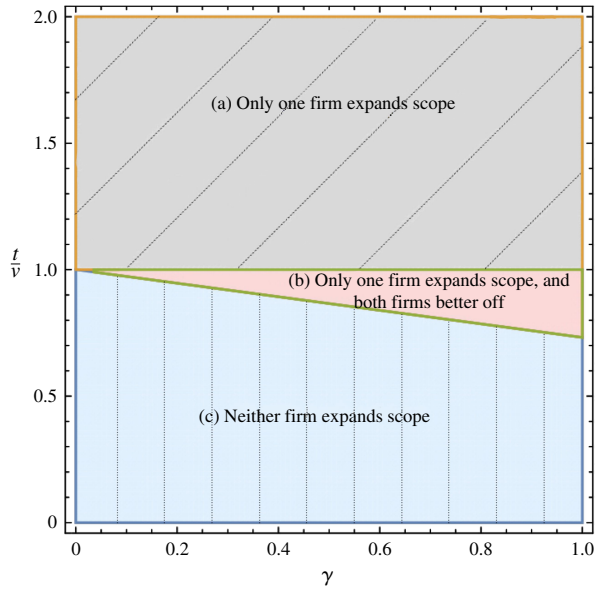
[6] The y-axis in Figure 1 can be extended to any values as desired, without any qualitative change in the observed equilibrium outcomes.

[7] Given the symmetric nature of the game, this leads to two pure strategy equilibria, in each of which only one firm expands scope.

[8] Thomadsen (2012) shows that adding a product to a product line of one of two competing firms can increase profit by expanding the size of the served market. We show that an increase in profits for both competing firms can be an equilibrium outcome even without market expansion, and even when both firms have the ability to expand scope.

[9] Since $\sqrt{3} - 1 > 2/3$, region (b) lies strictly within the range of intermediate values for t/v.

Figure 1 (Color online) Product Line Equilibria with Generic Products



For this firm, equilibrium price for its core product when it expands scope is higher compared to the equilibrium price for that core product when no firm expands scope ($p^*_{1c}|_{EN} = (v/2)(1+\gamma) > v - t/2 = p^*_{1c}|_{NN}$). Thus, scope expansion enables this firm to serve the middle market with the product line extension and to extract higher surplus from its core consumers via the higher price on its core product. In other words, product line extension allows this firm to effectively price discriminate among its core consumers and the middle market, leading to higher profits. The benefits of this extension, interestingly, spill over to the competing firm with narrow scope, via changes in its market share. Comparing demand across subgames, in equilibrium, the firm that maintains narrow scope earns a higher market share when its competitor expands scope compared to the case when both firms maintain a narrow scope ($d^*_{2c}|_{EN} = v/(2t) > \frac{1}{2} = d^*_{2c}|_{NN}$). Hence, even though the equilibrium price on its core product drops ($p^*_{2c}|_{EN} = v/2 < v - t/2 = p^*_{2c}|_{NN}$), the gain in demand compensates for the loss in pricing power due to increased competition, allowing the narrow scope firm to earn a higher profit compared to the subgame where both firms have a narrow scope.[10]

As a technical note, the result in Proposition 1(b) weakly holds even when we relax the second-stage symmetric equilibrium assumption for the *NN* subgame discussed towards the end of §3.1:

Corollary 1. *For* $\sqrt{3}-1 < t/v < 1$ *and* $(2+\sqrt{3})\cdot(1-t/v) < \gamma \le 1$, *only one firm expands scope, and neither firm is worse off compared with any feasible pricing equilibrium in the subgame when no firm expands scope.*

Note the robustness of Corollary 1. When we allow for any possible equilibrium in the *NN* subgame, both firms are still always better off when only one firm expands scope compared with where no firm expands scope, except for one specific equilibrium in the *NN* subgame. This specific equilibrium in the *NN* subgame corresponds to the case wherein $\bar{x}_i = 1 - v/(2t)$: When this particular equilibrium is selected, the firm that expands scope is still better off, but the firm maintaining the narrow scope does no worse in terms of its profits. For all other $\bar{x}_i \in (1 - v/(2t), v/(2t))$, both firms are always better off when one firm expands scope compared with their profits when no firm expands scope.

In the top region (a) in Figure 1, while the firm that expands scope is better off in doing so, the firm that maintains a narrow scope is no worse off than before when both maintained a narrow scope. Here, since t/v is high, markets are inherently less competitive, and the firm that expands scope simply picks up the middle unserved market with its new product extension, leading to demand expansion. It also better price discriminates using its core product to charge a higher price to its core customers, leading to overall higher profit due to expansion in scope. In doing so, it does not infringe on the customers served by its competitor's core product, hence profit remains unchanged for the competitor. In either regions (a) or (b), the competitor that maintains a narrow scope has no incentives to expand scope, since scope expansion by both firms intensifies competition between the extension products, leading to lower profit for all in the market.

Finally, in region (c), markets are relatively more competitive, and product line extension by even one firm elicits a strong pricing response from the competitor, making resulting profits unattractive to the firm considering expansion. Hence, in this region, neither firm prefers to expand scope.

4. Offensive Product Line Strategies

Having established the main results above in a simple model with generic products, we now analyze whether similar outcomes might be observed when firms extend their lines with products that directly attack their competitor's turf. We do this by revising the model from §3 such that the product line extension directly attacks a competitor on its home turf.

[10] When γ is high, some consumers in the middle of the [0, 1] market would have a higher willingness to pay for the generic product than either firm's core product, due to travel costs associated with core products. Conceptually, this implies that the product line extension is a better fit than either core product for these middle consumers. For example, car consumers who are not hardcore performance seekers but who desire both performance and comfort to some extent may find Lexus's product line extension to be a better fit for their preferences, than either Lexus's or BMW's core product.

We modify the game with generic product line extensions as follows. In the first stage, each firm simultaneously decides whether to extend the scope of its product line by introducing an attacking product (instead of a generic product) which is exactly at the same location as the competing firm's core product. In the second stage, having observed the competitor's product line strategy, both firms simultaneously set prices for all of their products. Let p_{ia} denote price of the *attacking* product line extension offered by firm i. For a consumer at $x \in [0, 1]$, utility for the new extension products is specified as

$$u_{1a} = \gamma v - \alpha t(1 - x) - p_{1a}, \quad (5)$$

$$u_{2a} = \gamma v - \alpha t x - p_{2a}. \quad (6)$$

The introduction of travel cost in Equations (5) and (6) implies that firm 1's attacking product is at 1, right on firm 2's home turf, and vice versa. In other words, product line extensions here have a very specific *positioning*, aligned with the competitor's core products, and hence are *offensive* in terms of their intended target customer base. The exogenous parameter α represents the extent to which line extensions are generic in nature, in terms of their appeal to consumers. We restrict $\alpha \in (0, 1)$, i.e., as $\alpha \to 0$, the attacking products are generic in their appeal, whereas $\alpha \to 1$ suggests that consumers find the attacking products to be very similar to the core products in terms of their strength of preference.

Let d_{ij} denote demand for product $j \in \{c, a\}$ offered by firm i. Let π_i denote profits for firm i. Then, $\pi_i = \sum_{j \in \{c,a\}} p_{ij} d_{ij}$, contingent on product e being offered by firm i. The four second-stage subgames in this game are denoted as $\{NN, NA, AN, \text{and } AA\}$. The rest of the model setup is similar to the model with generic extensions. The pricing equilibria for the NN subgame remain the same given no change in this subgame. Similar to §3.1, when multiple equilibria exist in the NN subgame, we focus only on the symmetric equilibrium.[11]

For the rest of the subgames, compared to the previous analysis with generic products, the analysis with attacking products bears some semblance and some differences. Here, under certain conditions, even with one or both firms introducing extensions, the market may remain uncovered. For instance, when the valuation adjusted preference is strong, and extensions are not too generic, travel costs across the market for all products are high. One could observe regions where despite the introduction of line extensions by both firms, some consumers in the middle still remain unserved and prefer the outside option. The derivations for pricing equilibria for each of these subgames follow along the same lines as in §3.1. Analogous to the results observed earlier for generic products, we find that:

Proposition 2. *In the offensive product line game, under moderate levels of valuation adjusted preferences* (t/v) *and moderate to high relative valuation for line extensions* (γ)*, when the attacking products are close to generic products in their appeal* (*low* α)*, in equilibrium only one firm expands scope, and both firms are better off compared with the subgame when no firm expands scope.*[12]

Proposition 2 generalizes our previous finding that product line expansion by one firm can benefit the competing firm, even for the case when the extension product makes a direct attack on the competitor's home turf. The conditions outlined in Proposition 2 indicate that as long as the attacking product is close to a generic product, as shown in the strength of consumer preference, line expansion by one firm can benefit both firms. The intuition for this result is similar to earlier intuition: Scope expansion allows that firm to benefit from effective price discrimination, whereas the competitor benefits from demand expansion.

Furthermore, in the equilibrium above, profits for either firm are decreasing in α: In other words, as the attacking product becomes less generic, and more "similar" to the firm's core product, profits decrease for either firm. This outcome is not surprising, since more similarity between the original and attacking product leads to intensified price competition, thus eroding firms' profits.

Finally, with attacking products we find that there exist conditions when scope expansion is optimal for both firms:

Proposition 3. *When valuation adjusted preferences in the market are high* $(t/v > (2\alpha + 4\gamma)/(4\alpha(1 - \alpha)))$*, and attacking products are relatively generic* $(0 < \alpha < 2\gamma/(1 + \gamma))$*, both firms expanding scope is the unique subgame perfect Nash equilibrium.*[13]

In markets where valuation adjusted preferences are high, in all subgames some consumers prefer the outside option, leaving the market always uncovered. If a firm maintains a narrow scope, it can charge a high price for its core product and target only the core consumers in its turf. Yet this leaves the intermediate consumers unserved. This unserved segment is irresistibly attractive to its competitor, who targets it with an expansion in its product line. For instance, consider firm 2's incentives. Having served its core consumers with its core product, it now considers whether it should attack firm 1's turf and gain additional revenue.

[11] We adopt the same approach for the rest of the analysis in this paper.

[12] For a proof of this proposition and the exact conditions for existence, see Appendix D.

[13] See Appendix E for the proof.

With high valuation adjusted preferences, when firm 2 attacks firm 1's turf, it can gain additional market share and profit while still leaving some consumers choosing the outside option. Thus, broadening its product line has no effect on prices or demand in its home turf, and any revenue that firm 2 generates from expanding scope is solely incremental. Hence, it is unilaterally optimal for firm 2 to broaden scope. Firm 1 faces similar incentives; consequently, offering broad product lines is a dominant strategy for both firms.

5. Defensive Product Line Strategies

So far, we have analyzed strategic product line and pricing decisions when firms consider expanding scope by introducing generic new products or new products that attack a competitor on its turf. An alternative strategic action for firms may be to expand product line scope to defend its own turf, rather than attack the competitor's turf. For instance, in the automotive sector, Lexus introducing a lower quality car on the *comfort* dimension (e.g., the ES series, in addition to its flagship LS series) or BMW introducing a lower quality car on the *performance* dimension (e.g., the 3 series in addition to the M3) are examples of defensive product line extensions compared to offensive line extensions (e.g., the IS-F by Lexus).

Following similar steps as in our previous analysis, in this section we analyze strategic product line and pricing decisions when a firm chooses between a narrow scope or expanding scope by introducing another product on its own turf, to better defend against its competitor. We show that our main results continue to qualitatively hold when considering defensive strategies as well. Furthermore, our key result that scope expansion can lead to decreased competition is strengthened with defensive products. This is primarily because defending one's own turf is inherently less confrontational than attacking a competitor's turf, as we show below.

To analyze defensive strategies, the key change to the previous model setup is that instead of an attacking product (a) each firm considers introducing a defending product (d), which is at the same end of the market as its core product. Similar to the previous game, in the first stage firms simultaneously determine whether to maintain a narrow scope (N) or expand scope to defend their own turf (D). In the second stage, both firms observe the product line choices from the first stage, and simultaneously set prices for all products offered on the market. Let p_{id} denote the price of the *defending* product line extension offered by firm i. For a consumer at $x \in [0, 1]$, utility for the new extension products is specified as

$$u_{1d} = \gamma v - \alpha t x - p_{1d}, \tag{7}$$

$$u_{2d} = \gamma v - \alpha t(1-x) - p_{2d}. \tag{8}$$

The rest of the analysis is analogous to that of §§3 and 4. Consistent with prior propositions, we find that:

Proposition 4. *In the defensive product line game, under moderate levels of valuation adjusted preferences* (t/v) *and moderate to high relative valuation for line extensions* (γ), *when the defending products are not too dissimilar to generic products in their appeal* (*low to moderate* α), *in equilibrium only one firm expands scope, and both firms are better off compared with the subgame when no firm expands scope.*[14]

Similar to the offensive product lines analysis, with defensive product lines, our key result that both firms can be better off with only one firm expanding scope, holds when firms defend their turf.[15] The intuition behind the result in Proposition 4 is similar to the previous results: Scope expansion allows that firm to benefit from effective price discrimination, whereas the competitor benefits from demand expansion.

In terms of differences, when a firm expands scope to defend its turf rather than attack the competitor's turf, competition in the market is inherently lower. To illustrate, consider the situation wherein only firm 1 expands scope. Core consumers in firm 2's turf (in the extreme, the consumer at $x = 1$) would have a higher effective valuation (i.e., baseline valuation minus travel costs) for the attacking product as compared to a defending product. Consequently, competition between the new product and firm 2's core product is more intense with an offensive rather than defensive expansion.

Under the equilibrium conditions of Proposition 4, profits for either firm are increasing in α: In other words, as the defending product becomes less generic, and more similar to the firm's core product, profits increase for either firm. More similarity between the original and defending product allows the expanding firm to extract more as it leads to stronger valuation-adjusted preference on the part of consumers. This softens price competition, which in turn helps increase profits for both firms.

Finally, with defensive products we observe that there exist conditions when scope expansion is optimal for both firms:

Proposition 5. *When valuation-adjusted preferences in the market are high* ($t/v > \gamma/\alpha$), *and defending products are not too similar to the core products* ($0 < \alpha < \gamma < 1$), *both firms expanding scope is the unique subgame perfect Nash equilibrium.*[16]

[14] For a proof of this proposition and the exact conditions for existence, see Appendix F.

[15] Hauser and Shugan (1983) have demonstrated the possibility of such an effect in their seminal work on defensive marketing strategies. Here we show that such an outcome can arise in equilibrium when product line scope is also a firm decision.

[16] See Appendix G for the proof.

Similar to the offensive game, for the defensive product line game, when valuation adjusted preferences are high, some consumers are unserved in all subgames, and in equilibrium both firms find it unilaterally optimal to expand scope. Comparing the minimum thresholds for valuation-adjusted preferences across Proposition 3 (i.e., $t/v > (2\alpha + 4\gamma)/(4\alpha(1-\alpha))$) and Proposition 5 (i.e., $t/v > \gamma/\alpha$), we find that the minimum threshold is higher for the offensive product line game. Thus, valuation-adjusted consumer preferences need to be much stronger with offensive product line expansion, compared to defensive product line expansion, before the markets become uncovered across all subgames. This is consistent with our prior observation that competition tends to be lower with defensive product line expansion compared to offensive expansion: With lower competition, markets are likely to be uncovered sooner in the defensive game.

We now compare firm profits under offensive versus defensive product line expansion. Under the equilibrium conditions outlined in Propositions 2–5, the profit for each firm under a defensive product line expansion is never lower than its profit under a similar offensive product line expansion.[17] Thus, flanking the core product with an extension is likely to be more profitable when the extension is aligned with your core product position, as compared to being aligned with your competitor's core position. Intuitively, when a firm expands scope defensively, its extension is more substitutable with its own core product compared with the case when it expands scope offensively (Brandor and Eaton 1984). Hence, expanding scope defensively is inherently less confrontational, leading to lower price competition and hence better profits for both firms, compared to the case of offensive product line expansion.[18]

6. The Impact of Firm Asymmetry

We now analyze the impact of firm asymmetry on the equilibrium product line strategy. The primary question here is: If firms are a priori asymmetric, in that one firm has a stronger turf advantage than its competitor, then which firm should expand scope? To analyze this question, we modify our model with generic product line extensions presented in §3 to incorporate turf asymmetry. Without loss of generality, let firm 1 be the firm with an a priori turf advantage. For a consumer at $x \in [0,1]$, the utility u_{ic} for the *core* product offered by firm i is now specified as

$$u_{1c} = v - \beta t x - p_{1c}, \tag{9}$$

$$u_{2c} = v - t(1-x) - p_{2c}, \tag{10}$$

where $\beta \in [0,1]$. As shown in Equations (9) and (10), β represents the a priori turf advantage for firm 1, manifest as a lower unit travel cost for firm 1's core product. When markets are covered and both firms charge the same price for their core products, the consumer indifferent between buying either firm's core product is at $1/(1+\beta)$. When $\beta = 1$, firm 1 has no a priori turf advantage, and this model reduces to the symmetric setup discussed earlier in §3. However, as β decreases, the a priori turf advantage of firm 1 over firm 2 increases.[19] Thus, β allows us to capture the idea that all things equal, one firm can have a larger home turf than its competitor. Furthermore, consumer utility as specified in Equations (9) and (10) allows us to capture the idea that strength of preference varies by consumer location within any home turf, as is commonly the case. Indeed, research on product line competition by Thomadsen (2005, 2007) provides empirical support that asymmetry can exist in consumers' baseline valuations for competing firms. In our modeling context this can further translate into an asymmetric size for the home turfs of competing firms.

Consumer utility for the generic line extensions introduced by either firm remains the same as specified in §3. Given our findings from §3 and to illustrate our main point, in this section we restrict our attention to the region where consumers' valuation adjusted preferences are moderate.[20] In this region, we find that:

Proposition 6. *In the asymmetric product line game with generic extensions, in equilibrium*:

(a) *For* $0 < \gamma \le 1$, $0 < \beta \le 1$, *and* $(1+\beta)/(2\beta) - \gamma(2-\sqrt{3}) < t/v < (1+\beta)/(2\beta)$, *only one firm expands scope, and both firms are better off compared with the subgame when no firm expands scope, even though it does not attract new consumers to the market.*

(b) *For* $0 < \gamma \le 1$, *when* $0 < \beta \le 4 - 2\sqrt{3}$ *and* $(1+\beta-\beta\gamma)/(2\beta) < t/v < (1+\beta)/(2\beta) - \gamma(2-\sqrt{3})$, *or when* $4 - 2\sqrt{3} < \beta < 1$ *and* $(1+\beta)/(2\beta) - (\gamma/\beta)(2-\sqrt{3}) < t/v < (1+\beta)/(2\beta) - \gamma(2-\sqrt{3})$, *only the stronger turf firm (i.e., firm* 1*) expands scope, and both firms are better*

[17] This follows immediately from a direct comparison of the corresponding equilibrium profits.

[18] While this finding is robust under our model formulation, we speculate that under alternative market conditions, e.g., nonuniform distribution of consumer preferences in the market for core and extension products, it could be profitable for firms to pursue product lines that attack competitor locations rather than defend their own locations. We leave this as an interesting possibility to explore in future research.

[19] An alternative approach to modeling turf asymmetry, instead of making unit travel costs asymmetric by firm, would be to consider asymmetric valuations by firm, e.g., v_1 and v_2 for firm 1 and firm 2 core products, respectively. Through analysis not reported in this paper, we verify that our main results are qualitatively robust to this alternative model specification. We thank an anonymous reviewer for highlighting this observation.

[20] We define this region precisely in Appendix H, where we also provide a proof for the results stated in Proposition 6.

off compared with the subgame when no firm expands scope, even though it does not attract new consumers to the market.[21]

Proposition 6 demonstrates that our earlier results generalize to the case wherein firms might be a priori asymmetric such that one firm has a turf advantage. It further shows that when valuation adjusted preferences are moderate, a unique equilibrium exists such that only firm 1, the stronger turf firm, expands scope. Given the nature of asymmetry in this market where consumers have a higher willingness to pay for firm 1's core product, firm 1 is better positioned to more effectively price discriminate with a product line extension than its competitor. Hence, conditions exist when firm 1 finds it optimal to engage in such price discrimination, but firm 2 does not. In other words, the firm with the stronger market position has the incentive to expand scope, while the firm with the more vulnerable market position prefers to maintain a narrow turf.[22] Interestingly, such price discrimination also benefits firm 2, whose profits are higher because of the higher demand it generates in the market.

Next, we analyze the impact of turf asymmetry (β) on equilibrium profit for the two firms, as well as their profit gain compared with the outcome when no firm expands scope. We find that as the turf advantage increases (i.e., β decreases), equilibrium profit for the stronger turf firm always increases, whereas that for the weaker turf firm never increases. Interestingly, when an equilibrium exists such that only one firm expands scope, we find that the profit gain for the firm that expands scope decreases with turf advantage; yet this gain increases for the firm that maintains a narrow scope. In other words, the most anti-competitive effect of product line expansion (i.e., the profit gain for the firm not expanding scope) occurs when turf asymmetry is at its highest. To explain, consider the equilibrium where only firm 1 expands scope. With higher turf asymmetry, firm 1 profit, even when it does not expand scope, increases. This increase is stronger compared with the increase in profit with turf asymmetry when firm 1 expands scope because, with a product line extension, the gains to firm 1 from turf asymmetry are tempered by the gains from price discrimination. On the other hand, when neither firm expands scope, with higher turf asymmetry profits for firm 2 are lower. Yet when only firm 1 expands scope, firm 2 is not faced with a profit loss with higher turf asymmetry, since its core product is competing with an extension priced at its valuation. Consequently, the profit gain for firm 2 is higher with higher turf asymmetry.

[21] In addition, similar to Corollary 1, when compared with the multiple equilibria in the *NN* subgame, neither firm is worse off in the *EN* subgame.

[22] This is similar in spirit to Shaffer and Zhang's (2000) analysis of preference-based price discrimination.

7. Conclusions and Future Research

In this paper, we have analyzed product line scope and pricing decisions for firms competing in a market with horizontally distributed consumer tastes. Firms have established core positions, i.e., home turfs, based on attributes, and consumers are heterogenous in their preferences for these attributes. A firm chooses between offering a narrow product line that maintains its core focus or broadening to a full product line that expands its existing focus. Our main contribution to the literature on competitive product line strategies is twofold: (i) We demonstrate how key demand side forces interact leading to distinct symmetric and asymmetric product line scope decisions in equilibrium even when firms might be symmetric a priori. (ii) We demonstrate that product line expansion might not always increase marketplace competition: There exist conditions where expansion in scope by one firm might also improve profits for the competing firm, without any market expansion. Our results are robust to the nature of the product line expansion, be it with generic, attacking or defending products. They are also robust to the presence or absence of a priori symmetry between competing firms; we show that the firm that finds its market position vulnerable may often find it less attractive to expand scope. Thus, we provide normative recommendations for product line strategy in the presence of consumer heterogeneity, product differentiation, and potential asymmetry in brand power for competing multiproduct firms.

Consistent with prior literature, we find that stronger consumer preferences (for ideal points) can lead firms to offer increased variety. When consumer preferences are especially strong, such as a prisoners' dilemma, the lure of gaining share from consumers in the competitor's turf dominates the potential margin loss due to increased competition in the home turf. YouTube and Hulu, competing against each other's established positions of short-form, personal content versus long-form, professional content, respectively, arguably find themselves in a highly differentiated entertainment market. In such markets with strong consumer preferences, our model predicts that each firm should find it optimal to attack the competitor on their turf to gain new customers. Such a prediction is consistent with observations that Hulu and YouTube offer both types of entertainment content.[23] Likewise for desktop printers, if some consumers highly value inkjet benefits while others value laser benefits, HP and IBM should find it unilaterally optimal to serve the other's turf

[23] To be clear, these examples simply illustrate the feasibility of proposed firm strategies, and are not intended to serve as validation of model predictions. Such validations would require extensive empirical research, which is beyond the scope of the current work, but an important avenue for future research in this area.

and gain more share, perhaps to the detriment of monopolistic margins that could exist in the absence of scope expansion by either firm.

We contribute to the existing literature by identifying circumstances wherein even in saturated markets, it might be wise for one firm to expand its product line scope without hurting its competitor. Such equilibrium outcomes are a result of a careful trade-off between the firms' strategic pricing moves aimed towards high margin core customers vis-á-vis volume driven approaches aimed at garnering market share by selling to as many customers as possible across turfs. When the strength of consumer preferences is moderate, a rush to expand product lines by all is unwise. With turf asymmetry, the weaker firm might prefer to maintain a narrow scope to keep competition in the market to a minimum, and gain as much share as possible by aggressively pricing its sole product. The stronger turf firm, however, might find it optimal to offer a broad scope and leverage the expanded product line in two ways: Use the additional product as a "flanker" to ward off an aggressive attack from its competitor; and better price discriminate between the core and noncore customers in its turf by offering them a choice of products. Consistent with this rationale is the action of McDonald's, the larger player against Subway, introducing fresh salads to hold on to the customers being attracted by Subway's fresh options. Such a rationale is also consistent with the 2007 announcement and the subsequent actions from Lexus as to encroaching on BMW's performance turf.[24]

A surprising finding from our research is that the benefits from enhanced price discrimination to the firm expanding scope can spill over to the competing firm that maintains a narrow scope: Given overall higher prices set by the firm expanding scope, the competing firm can lower its price and gain more market share. Consequently, profits for both firms increase in the presence of scope expansion by only one firm. This leads to softening of the overall competition in the market, even without market size expansion.

When the strength of consumer preferences is low, markets are intensely competitive, and expansion in scope becomes detrimental to either firm. Consequently, both firms maintain a narrow scope and respect their competitor's territory. Such restraint is practically quite difficult to implement. Thus it would not be surprising to observe firms suboptimally expanding product lines especially when markets are intensely competitive. Our model warns that from a demand side perspective, it may be unwise to do so.

We find qualitatively similar results when firms use a generic product to expand scope or use a product that directly attacks their competitor or a product that simply defends their own core position. We also observe some interesting differences. For instance, when a firm expands scope in equilibrium, its profits under a defensive product line expansion are higher compared to those under an offensive product line expansion; defending one's own turf is inherently less confrontational than attacking the competitor's turf. Additionally, profits are higher for its competitor as well, when considering defensive moves instead of the equivalent offensive moves during product line expansion.

The current analysis has limitations. Below we discuss some of these and suggest potential avenues for subsequent research in this area. As discussed above, our analysis shows that defensive product line expansion is more attractive compared to an offensive expansion. Yet sometimes we observe firms engaging in offensive line extensions. Here, our analysis relies on assumptions commonly made in the literature on horizontal differentiation. However, some of these assumptions might not hold under certain conditions. For example, the distribution of consumer preferences might be nonuniform such that more consumers prefer one location over another. This is likely to make one location more attractive for an offensive product line expansion. Hence, an interesting avenue for future research might be a comparison of outcomes across games involving offensive, generic, and defensive line extensions under alternative preference distributions.

In our analysis, consumer valuation for the extension product was exogenously specified. Future research could investigate endogenizing this valuation, potentially as a quality decision for the firm introducing the extension. A choice of assumptions on the supply side, e.g., as to the costs of introducing quality, would be associated with endogenizing this decision. Costs can provide an additional avenue for asymmetry between competing firms. Distinct firms could have differences in the steepness of their cost functions at certain quality levels (e.g., cost for a fast food restaurant to develop a strong reputation as a fresh foods alternative might be different from that for the fresh foods restaurant to become a fast food alternative). Based on these differences, one may observe competing firms investing differently in expanding their product lines. Our work here with exogenous valuation for line extensions is simply a first step in this direction.

Another limitation is in terms of the nature of the product offered by a firm when engaging in product line expansion. Our work has considered three types of extensions: a generic product, a product that attacks its competitor directly on the competitor's location or a product that defends one's own product line by co-locating with the core positions. Future research can investigate location of the line extension as an

[24] *Automotive News* (2007) reports that in the five year period between 2002–2006, U.S. light vehicle sales for Lexus exceed those for BMW.

endogenous decision. Along with location, consideration of alternative travel cost specifications, and perhaps an endogenous choice of travel cost might be an interesting area to explore in the future.

Our approach does not seek to explain the dynamics of how market positions are established (see Selove 2014a, b for the treatment of such an approach). Also, in the current model, the act of expanding the product line does not change a firm's core positioning. For some product categories, this may not be the case, e.g., when brand dilution effects or reference group effects (Amaldoss and Jain 2010) are a significant concern. Furthermore, a firm's ability to effectively expand scope might be constrained by how strong its position is in its core turf. While our current model subsumes all these effects exogenously in the willingness to pay for the attacking product, it might be worthwhile to make explicit some of these interactions to analyze their implications on equilibrium product line scope decisions. Following Ansari et al. (1998), one might more generally analyze implications of product line scope expansion on competition when products vary across multiple attributes. Despite its limitations, we hope that this work provides some insight on the profit enhancing implications of various types of product line expansions in competitive saturated markets.

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Appendix A. Pricing Equilibria with Generic Products

Consider subgame *EN*, i.e., only firm 1 expands scope. Let x_L denote location of the consumer indifferent between buying firm 1's core product and its extension product: $v - tx_L - p_{1c} = \gamma v - p_{1e}$. Let x_R denote location of the consumer indifferent between buying firm 1's extension product and firm 2's core product: $\gamma v - p_{1e} = v - t(1-x_R) - p_{2c}$. Firm profits are $\pi_1 = p_{1c}x_L + p_{1e}(x_R - x_L)$ and $\pi_2 = p_{2c}(1-x_R)$. Equilibrium outcomes for this subgame are as follows:

When $t/v > 1$ and $0 \le \gamma \le 1$ or $\frac{1}{2} < t/v \le 1$ and $2(1 - t/v) < \gamma \le 1$, firm 1 prices its extension product so as to make its whole customer base for this extension indifferent between buying and not buying (i.e., a boundary solution for p_{1e}). Consequently, equilibrium prices are $p^*_{1c} = (v/2)(1+\gamma)$, $p^*_{1e} = \gamma v$, and $p^*_{2c} = v/2$; and equilibrium profits are $\pi^*_1 = (v^2/(4t))(1 - 4\gamma(1 - t/v) + \gamma^2)$ and $\pi^*_2 = v^2/(4t)$.

When $\frac{1}{2} < t/v < \frac{5}{6}$ and $1 - 4t/(5v) < \gamma \le 2(1 - t/v)$ or $0 < t/v \le \frac{1}{2}$ and $1 - 4t/(5v) < \gamma \le 1$, equilibrium prices are $p^*_{1c} = \frac{1}{6}(4t + v(1-\gamma))$, $p^*_{1e} = \frac{1}{3}(2t + v(1-\gamma))$, and $p^*_{2c} = \frac{1}{3}(t + v(1-\gamma))$; and equilibrium profits are $\pi^*_1 = (13v^2(1-\gamma)^2 - 16v(1-\gamma)t + 16t^2)/(36t)$ and $\pi^*_2 = (v(1-\gamma) + t)^2/(9t)$.

In the rest of the region, in equilibrium, firm 1's extension product does not earn positive demand even at zero price, and firms' payoffs are identical to those for subgame *NN*.

Given the symmetric nature of the game, equilibrium outcomes for subgame *NE* are analogous to those in subgame *EN* above.

In subgame *EE*, when both firms expand scope, competition between identical generic products drives their equilibrium prices down to 0. When $t/v > 1$ and $0 \le \gamma \le 1$ or $0 < t/v \le 1$ and $1 - t/v < \gamma \le 1$, equilibrium prices for core products are $p^*_{1c} = (v/2)(1-\gamma) = p^*_{2c}$ and equilibrium profits are $\pi^*_1 = (v^2/(4t))(1-\gamma)^2 = \pi^*_2$. In the rest of the region, in equilibrium, firm payoffs are identical to those for subgame *NN*.

Appendix B. Proof for Proposition 1

Comparing profits across subgames, where equilibrium profits are as stated in §3.1 and Appendix A:

(a) For $t/v \ge 1$ and $0 < \gamma \le 1$, we have $\pi^*_1|_{EN} > \pi^*_1|_{NN}$, $\pi^*_2|_{EN} > \pi^*_2|_{EE}$, and $\pi^*_2|_{EN} = \pi^*_2|_{NN}$. Given symmetry in firm types, this implies that either but only one firm expanding scope constitutes a pure strategy equilibrium in product line decisions. Furthermore, the firm that maintains a narrow scope is never worse off in this equilibrium compared with the outcome where no firm expands scope.

(b) For $\sqrt{3} - 1 < t/v < 1$ and $(2 + \sqrt{3})(1 - t/v) < \gamma \le 1$, we have $\pi^*_1|_{EN} > \pi^*_1|_{NN}$, $\pi^*_2|_{EN} > \pi^*_2|_{EE}$, and $\pi^*_2|_{EN} > \pi^*_2|_{NN}$, where profits in the subgame where no firm expands scope are for the symmetric equilibrium in that subgame. Given firm symmetry, either but only one firm expanding scope constitutes a pure strategy equilibrium in product line decisions. Furthermore, the firm that maintains a narrow scope is also better off in this equilibrium compared with the outcome where no firm expands scope.

(c) In the rest of the region, assuming infinitesimal costs of introducing a line extension, a firm is never better off expanding scope compared with the subgame where neither firm expands scope.

Appendix C. Proof for Corollary 1

Comparing profits across subgames, where equilibrium profits are as stated in §3.1 and Appendix A, for $\sqrt{3} - 1 < t/v < 1$ and $(2 + \sqrt{3})(1 - t/v) < \gamma \le 1$, we have $\pi^*_1|_{EN} > \pi^*_1|_{NN}$, $\pi^*_2|_{EN} > \pi^*_2|_{EE}$. Furthermore, $\pi^*_2|_{EN} > \pi^*_2|_{NN}$ for any of the multiple equilibria in prices observed in stage 2 for the *NN* subgame, as discussed in §3.1, except for the one outcome which corresponds to $\bar{x}_i = 1 - v/(2t)$, where instead we have $\pi^*_2|_{EN} = \pi^*_2|_{NN}$.

Appendix D. Proof for Proposition 2

For the games with offensive and defensive product line extensions, we offer a proof of equilibrium existence by construction. Consider moderate levels of valuation adjusted preference, i.e., $\frac{2}{3} \le t/v \le 1$. Here, we focus on the symmetric equilibrium for the *NN* subgame where consumers are indifferent between buying from either firm or not buying in this market. The proposed equilibrium holds when $\pi^*_1|_{AN} > \pi^*_1|_{NN}$, $\pi^*_2|_{AN} > \pi^*_2|_{AA}$, and $\pi^*_2|_{AN} > \pi^*_2|_{NN}$. These conditions

are satisfied when in the subgame where only one firm attacks its competitor, the consumer is indifferent between that firm's core product and its attacking product is also indifferent between buying or not buying in this market; and in the subgame where both firms expand scope, all consumers earn positive surplus. The conditions under which this happens are: $2(1-t/v) < \gamma \le ((1-t/v)^2+(t/v)^2)/(t/v)$ and $0 \le \alpha < (2(1-t/v)-\gamma)/(1-2(t/v))$, or $((1-t/v)^2+(t/v)^2)/(t/v) < \gamma < 1$ and $0 \le \alpha \le (4(t/v)-3)/(2(t/v)) + 1/(2(t/v))\sqrt{16(t/v)^2-8\gamma(t/v)-16(t/v)+9}$; i.e., moderate γ and low α. When only firm 1 expands scope, equilibrium profits in this subgame are

$$\begin{aligned}
\pi_1^*|_{AN} &= \Bigg((\alpha^3-4\alpha+4)\gamma^2-16\gamma+\alpha\Bigg(9\alpha+(1-\alpha)\frac{t}{v} \\
&\quad \cdot\Bigg(8(3-\alpha)+\alpha^3\Bigg(1-\frac{t}{v}\Bigg)+8\alpha\frac{t}{v}-16\frac{t}{v}\Bigg)-12\Bigg)\Bigg) \\
&\quad \cdot\Bigg((1-\alpha)(4-\alpha^2)^2\frac{t}{v}\Bigg)^{-1} \\
&\quad +\Bigg(\gamma\Bigg(\alpha(16-\alpha(2-\alpha^2+\alpha))-2(1-\alpha)(8+4\alpha-\alpha^3)\frac{t}{v}\Bigg)+4\Bigg) \\
&\quad \cdot\Bigg((1-\alpha)(4-\alpha^2)^2\frac{t}{v}\Bigg)^{-1}, \\
\pi_2^*|_{AN} &= \frac{(2-2\alpha^2(1-t/v)+\alpha(1-\gamma-2(t/v)))^2}{(1-\alpha)(4-\alpha^2)^2(t/v)}.
\end{aligned}$$

Given symmetry, equilibrium profits for the subgame where only firm 2 expands scope follow immediately from the above. Finally, when both firms expand scope

$$\begin{aligned}
\pi_1^*|_{AA} &= \Bigg((1+\alpha)(1+3\alpha)(1-\gamma)^2+\alpha(2+3\alpha)(1-\alpha)^2\Bigg(\frac{t}{v}\Bigg)^2 \\
&\quad -2\alpha(1-\alpha^2)(1-\gamma)\frac{t}{v}\Bigg)\cdot\Bigg(4(1-\alpha)(1+2\alpha)^2\frac{t}{v}\Bigg)^{-1} \\
&= \pi_2^*|_{AA}.
\end{aligned}$$

Given subgame profits as derived above, note that imposing the requirements of $\pi_1^*|_{AN} > \pi_1^*|_{NN}$, $\pi_2^*|_{AN} > \pi_2^*|_{AA}$, and $\pi_2^*|_{AN} > \pi_2^*|_{NN}$ yields a nonempty set.

Appendix E. Proof for Proposition 3

With $t/v > (2\alpha+4\gamma)/(4\alpha(1-\alpha))$ and $0 < \alpha < 2\gamma/(1+\gamma)$, the market is uncovered in all subgames. Each firm has a unilateral incentive to expand scope, since if only that firm expands scope, there is no impact on price, demand or profit in its home turf, and gains in the competitor turf are entirely incremental.

Appendix F. Proof for Proposition 4

The proof follows analogous to Appendix D. For $\frac{2}{3} \le t/v \le 1$, the equilibrium proposed herein holds when $\pi_1^*|_{DN} > \pi_1^*|_{NN}$, $\pi_2^*|_{DN} > \pi_2^*|_{DD}$, and $\pi_2^*|_{DN} > \pi_2^*|_{NN}$. These conditions are satisfied when in the subgame where only one firm introduces a defensive extension, the consumer indifferent between buying this extension and the competitor's core product is also indifferent between buying or not buying in this market; and in the subgame where both firms expand scope, all consumers earn positive surplus. This happens with moderate γ and low α; specifically $2(1-t/v) < \gamma \le (6(t/v)(1-t/v))/(2-t/v)$ and $0 \le \alpha < (\gamma+2(t/v)-2)/(2(t/v)-1)$, or $(6(t/v)(1-t/v))/(2-t/v) < \gamma < 1$ and $0 \le \alpha \le (2\gamma)/(3(t/v))$.

When only firm 1 expands scope, equilibrium profits in this subgame are

$$\begin{aligned}
\pi_1^*|_{DN} &= (4(1-\alpha)tv(\alpha+\gamma)+v^2(\alpha^2+\alpha(2\gamma-1)+\gamma^2-4\gamma+1) \\
&\quad -4(1-\alpha)\alpha t^2)\cdot(4(1-\alpha)t)^{-1}, \\
\pi_2^*|_{DN} &= \frac{v^2}{4t}.
\end{aligned}$$

Given symmetry, equilibrium profits for the subgame where only firm 2 expands scope follow immediately from the above. Finally, when both firms expand scope

$$\pi_1^*|_{DD} = \frac{2(1-\alpha)\alpha t^2+(1-\gamma)^2v^2}{4(1-\alpha)t} = \pi_2^*|_{DD}.$$

Given subgame profits as derived above, note that imposing the requirements of $\pi_1^*|_{DN} > \pi_1^*|_{NN}$, $\pi_2^*|_{DN} > \pi_2^*|_{DD}$, and $\pi_2^*|_{DN} > \pi_2^*|_{NN}$ yields a nonempty set.

Appendix G. Proof for Proposition 5

With $t/v > \gamma/\alpha$ and $0 < \alpha < \gamma$, the market is uncovered in all subgames. Each firm has a unilateral incentive to expand scope, since if only that firm expands scope, there is no impact on price, demand or profit in its home turf, and gains in the competitor turf are entirely incremental.

Appendix H. Proof for Proposition 6

The proposed equilibrium outcomes are observed when in the subgame where no firm expands scope the consumer is indifferent between purchasing either firm's core product and is also indifferent between buying and not buying in the market; in the subgame where only one firm expands scope the consumer is indifferent between buying the extension and is also indifferent between buying and not buying in this market; and in the subgame where both firms expand scope, consumers buying the extension enjoy a positive surplus. The proof follows similar steps as in earlier proofs, and the relevant profits from the various subgames are as follows:

The symmetric equilibrium refinement of the main model is adapted to refine the equilibria for this asymmetric case. Thus, for the *NN* subgame, with the indifferent consumer being at the midpoint of the marginal consumers were each firm to sell monopolistically

$$\begin{aligned}
\pi_1^*|_{NN}^{asym} &= \frac{((1-\beta)v+2\beta t)((\beta+3)v-2\beta t)}{16\beta t}, \\
\pi_2^*|_{NN}^{asym} &= \frac{(2\beta t-(1-\beta)v)(v-2\beta t+3\beta v)}{16\beta^2 t}, \\
\pi_1^*|_{EN}^{asym} &= \frac{v(4\beta\gamma t+v(-2(\beta+1)\gamma+\gamma^2+1))}{4\beta t}, \\
\pi_2^*|_{EN}^{asym} &= \frac{v^2}{4t}, \\
\pi_1^*|_{NE}^{asym} &= \frac{v^2}{4\beta t},
\end{aligned}$$

$$\pi_2^*|_{NE}^{asym} = \frac{v(4\beta\gamma t + v(\beta(1-\gamma)^2 - 2\gamma))}{4\beta t},$$

$$\pi_1^*|_{EE}^{asym} = \frac{(1-\gamma)^2 v^2}{4\beta t},$$

$$\pi_2^*|_{EE}^{asym} = \frac{(1-\gamma)^2 v^2}{4t}.$$

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