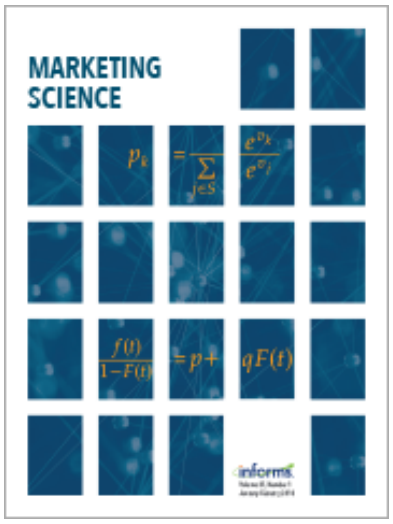

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On Customized Goods, Standard Goods, and Competition

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In this study, we examine firms' incentive to offer customized products in addition to their standard products in a competitive environment. We offer several key insights. First, we delineate market conditions in which firms will (will not) offer customized products in addition to their standard products. Surprisingly, we find that when firms offer customized products they are able to not only expand demand, but can also *increase* the prices of their standard products relative to when they do not. Second, we find that when a firm offers customized products it is a dominant strategy for it to also offer its standard product. This result highlights the role of standard products and the importance of retaining them when firms offer customized products. Third, we identify market conditions under which ex ante symmetric firms will adopt symmetric or asymmetric customization strategies. Fourth, we highlight how the degree of customization offered in equilibrium is affected by market parameters. We find that the degree of customization is lower when both firms offer customized products relative to the case when only one firm offers customized products. Finally, we show that customizing products under competition does not lead to a prisoner's dilemma.

Key words: degree of product customization; mass customization; standard products; competition; game theory
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1. Introduction

Advances in information technology facilitate the tracking of consumer behavior and preferences and allow firms to customize their marketing mix. The practice of firms customizing their products is pervasive. Product categories that have seen a rise in customization include apparel, automobiles, cosmetics, furniture, personal computers, and sneakers, among others. The business press has also accorded a lot of importance to this phenomenon (see, for example, Pollack 2004, Agins 2004, Fletcher and Wolfe 2004).

Extant work on product customization in the information systems literature (e.g., Dewan et al. 2003) has focused on markets where firms customize products completely to match the consumers' preferences. In these models the level of customization is not a decision variable; however, prices of the products are customized. While the idea of customizing prices and products is very appealing, it is a common marketing practice, particularly in spatially differentiated product markets, to charge the same (posted) price for the customized products even if different consumers choose different options while customizing. For example, at LandsEnd.com, consumers can purchase a standard pair of jeans for \$29.95 or a customized pair for \$54. A customer may choose to customize a range of options, but regardless of the options chosen the price of the customized pair of jeans is \$54. The practice of charging the same price for all customized variants is not limited to the apparel industry. Indeed, Reflect.com, a manufacturer of custom-made cosmetics, allows consumers to customize the color and type of finish (glossy or matte) of a lipstick for \$17.[1] Once again the price of all variants is the same regardless of the color or type of finish chosen by different consumers.

In addition, as mentioned in a recent article (Fletcher and Wolfe 2004), the decision of what to customize appears to be a critical strategic decision. For example, Home Depot's EXPO division allows consumers to customize the color of rugs, whereas Rug Rats, a Farmville, VA, manufacturer, will customize both the colors and patterns of its rugs. Similarly, in the home furniture market, Ethan Allen customizes furniture, but will not allow customers to use their own fabric. Crate & Barrel, on the other hand, will upholster furniture from fabric provided by the customer. These examples and the discussion in Fletcher and Wolfe (2004) illustrate the fact that the level of

[1] Similarly, at Timberland.com consumers can get a customized pair of boots for \$200 regardless of the options chosen.

customization is an important strategic variable, and firms operating in the same industry adopt different customization strategies. Extant theory on product customization, however, does not shed much light on how the level of customization offered is affected by market characteristics, or why firms adopt different customization strategies.[2] An additional consideration in offering customized products is the impact they have on the prices and profitability of the firms' standard offerings.

With these institutional practices in mind, we address the following research questions. First, how is the nature of competition between firms, and their profitability, affected when they offer customized products in addition to their standard products? Under what market conditions (if any) can firms benefit from offering customized products in addition to their standard offerings? Second, is it ever profitable for firms to offer only customized products to the exclusion of standard products? Third, when it is optimal to offer customized products, what should the optimal degree of customization be, and how is it related to market characteristics? Fourth, what effect does the strategy of offering customized products have on the intensity of competition between firms' standard products, and on their prices? Finally, we seek to examine whether ex ante symmetric firms can pursue asymmetric strategies as it relates to product customization. The motivation for exploring this issue is to understand the strategic forces that may help explain why competing firms might adopt different customization strategies.

Our work contributes to the scant but growing literature on product customization (Dewan et al. 2003, Syam et al. 2004). Dewan et al. (2003) consider a duopoly in which the competing firms offer completely customized products to match the preferences of a set of consumers, and so the degree of customization is not a decision variable in their model. However, they do allow the prices to be customized. As noted earlier, it is a common marketing practice to charge the same price for the customized products even if consumers choose different options while customizing. Furthermore, firms operating in the same market differ in the degree of customization offered, and in many markets products are not completely customized. We add to extant literature by examining a set-up in which prices of all customized offerings of a firm are the same and the degree of customization is endogenously determined. In doing so we offer several predictions that are new and distinct from those offered by Dewan et al. (2003). First, we identify the role of market parameters on the degree of customization offered in equilibrium. Second, Dewan et al. (2003) find that the standard good prices remain the same independent of a firm's decision to offer customized products. In contrast, we find that the price of the standard good may be higher or lower when firms decide to offer customized products relative to the case when there are no customized offerings. In addition to being a new finding, the fact that under certain market conditions firms are able to increase the price of the standard offerings by adding customized products to their product line is very counterintuitive. Syam et al. (2004) examine a duopoly in which firms compete by offering only customized products. In their set-up the product has two attributes, and firms decide whether and which attribute(s) to customize. Because standard products do not exist in their model in equilibrium, they are unable to make statements about the effects of firms' decision to customize, on the competition between, and pricing of, their standard products. Most importantly, they find that by offering only customized products in equilibrium, firms are unable to increase their profits relative to the case when they only offered standard products. An important contribution of the current paper is to show that firms can increase profits by offering both standard and customized products.

We also see our paper contributing to the growing literature on customizing the marketing mix (Zhang and Krishnamurthi 2004, Gourville and Soman 2005, Liu et al. 2004). There is a rich literature in marketing and economics (Shaffer and Zhang 1995, Bester and Petrakis 1996, Fudenberg and Tirole 2000, Chen and Iyer 2002, Villas-Boas 2003) that examines the effect of customizing prices to individual customers. In general, the finding is that customized pricing among symmetric firms tends to intensify competition as a firm's promotional efforts are simply neutralized by its rival. We contribute to this body of work by examining the effect of offering customized products under competition. We find that when symmetric firms offer customized products it does not lead to a prisoners' dilemma, even though it could intensify price competition. Chen et al. (2001) offer similar conclusions in the context of price customization.

If the key distinguishing feature of customized products is that they better match customer's preferences (Peppers et al. 1999), then the dichotomy of standard and customized products is hard to sustain. Every standard product is customized for those consumers whose preferences square up with the features embedded in the product. In that sense, "preference fit" is a necessary but not a sufficient condition for a product to be called customized. In this paper, we

[2] The level of customization is not a decision variable in Dewan et al. (2003), so their study does not offer any specific predictions on this issue.

view product customization as firms providing consumers with the option of influencing the production process to obtain a product that is similar to the standard offering, but is individually unique. Clearly, the cost of producing such a customized product would depend on the options that are provided to the consumers and the information that is exchanged between the consumer and the firm. In our model these two features distinguish a customized product from a standard offering. First, customization is expensive, and so the marginal cost of a customized product is increasing and convex in the degree of customization (the options with which consumers are provided), which is endogenously determined. Second, customized products come into existence when customers transmit their preference information, thus allowing firms to match consumers' preferences more closely.

1.1. Overview of the Model, Results and Intuition

We consider a model with two firms competing to serve a market of heterogeneous consumers with differentiated standard products. The standard products are located at the ends of a line of unit length. Each firm can complement its standard product with customized products that are horizontally differentiated from the standard product. If firms decide to offer customized products, they also decide on the degree of customization and its price. Consumers in our model differ both in the location of their ideal product and their intensity of preference for products (or disutility when the product offered does not match their ideal point). The former is captured by assuming that consumers' ideal product is distributed uniformly on a line of unit length, while the latter is captured by assuming the existence of two segments (a high- and low-cost segment) that differ in their transportation cost or disutility parameter. The interaction between consumers' utility and the degree of customization is incorporated by assuming that the transportation or disutility cost of consumers is decreasing in the degree of customization.

We find that firms *can* increase their profits by offering customized products in a competitive setting. This finding is counter to that from the price-customization literature, which finds that with symmetric firms, price customization intensifies competition and leads to a prisoner's dilemma. The main driver of our finding is that when firms compete only with standard products, then serving the marginal consumers whose ideal point is sufficiently removed from the standard products requires firms to lower price, thus implicitly subsidizing the inframarginal consumers. If the intensity of preference of the high-cost segment is sufficiently large, the benefit of reducing price to serve the marginal consumers is less than the cost of subsidizing the inframarginal consumers who are satisfied with the standard product. Under these conditions, firms will set prices of the standard product so that some of the consumers in the high-cost segment are not served. Product customization achieves two objectives. First, it allows firms to grow demand by serving customers that were not served with standard products. Second, it allows firms to extract the surplus from the inframarginal consumers. This is accomplished by using customized products to target those consumers whose preferences are far removed from the standard products, and by using the standard products to target the fringes of consumers whose preferences are close to them. This allows firms to compete efficiently for consumers that are not satisfied with their standard offerings, without having to needlessly subsidize consumers that are. Under certain conditions, firms can *increase* the price of their standard products when they also offer customized products compared to the situation in which they do not. Hauser and Shugan (1983)[3] obtain a similar result in their study of the defensive strategies of an incumbent in response to the entry of a new product.[4] In their model there are discrete consumer segments that do not all value the incumbent's product in the same manner. In such a market, the incumbent's postentry price can go up, especially if the entrant serves the segment that does not value the incumbent's product very highly. In the context of uniformly distributed preferences, both H&S and Kumar and Sudharshan (1988) find that the optimal response to entry is to decrease price. We find that the prices of the standard product can go up even when consumer preferences are uniformly distributed. Another important distinction is that in our model the customized product is offered by the same firm that offers standard products, and so the problem of adjusting the price of a firm's existing product is distinct from adjusting its price in response to another firm's product. The main driver of our result is that by offering customizing products firms are able to serve the needs of customers that do not value the standard products very much. In that sense, the role of the customized products in our model is similar to that of the entrant's product in H&S. Nevertheless, the mere addition of an additional product is not sufficient to increase the price of a standard product. It is important that the additional product(s) be a better match to the preferences of consumers who are not satisfied with the standard offering. We show that this can be accomplished with customized offerings.

We also find that when a firm decides to offer customized products, it is a *dominant strategy* for it to

[3] Henceforth referred to as H&S.

[4] We thank the editor-in-chief for encouraging us to contrast our results with that from this literature.

also offer its standard product. This result highlights the role of standard products and the importance of retaining them when firms offer customized products. Thus, the effect that offering customized products has on the nature of competition between standard products might in itself warrant a closer look at product customization.

While customized products may mitigate the intensity of competition between standard products, this comes at the expense of increased competition between the customized products. Because the customized products in our model compete head-to-head, competition between them can be very intense.[5] Customized products of firms are less differentiated than their standard counterparts, and in the extreme, if both firms offer complete customization, their customized offerings are completely undifferentiated. Because the intensity of competition between firms is increasing in the degree of customization, firms internalize this effect in choosing the degree of customization and choose partially customized products in equilibrium. It is worth noting that partial customization of products is not driven by costs, but is a consequence of firms internalizing the strategic effect of the degree of customization on the nature of price competition. Interestingly, this logic carries through even if only one of the firms offers customized products. The rationale for this finding is that the firm that does not offer customized products is confronted with a vastly superior product line and is forced to drastically lower its price if it is to have any market share. This puts downward pressure on the prices of both the customized and the standard offerings of the customizing firm, and the desire to ease price competition induces it to choose less-than-full customization.

We find that in equilibrium the degree of customization chosen by a firm when its rival does not offer customized products is higher than when both firms offer customized products. While conventional wisdom might suggest the opposite, this intuition does not carry through in our context because firms internalize the effect of customization levels on price competition. Finally, we highlight how the optimal degree of customization varies with market parameters, and we delineate market conditions that are (not) conducive to offering customized products. Interestingly, an equilibrium where ex ante symmetric firms pursue asymmetric product strategies exists where one firm prefers to offer customized products while its rival does not. This finding might help explain why firms such as Home Depot's Expo and Rug Rats (alluded to in the introduction) operating in the same industry offer varying levels of customization.

In our base model, firms charge the same price for all customized products it offers. While this assumption is consistent with institutional practice in markets for spatially differentiated products, we would like to note that our main findings are not sensitive to this assumption. Indeed, we demonstrate that all our findings continue to hold in a setting where firms customize the products as well as the prices of the customized offerings.[6] If firms charge the same price for all customized products, then the inframarginal consumers who purchase the customized product derive positive surplus. If firms are allowed to customize prices, then they are able to extract additional rents from these customers. Nevertheless, the price of the customized offerings must still leave these consumers indifferent between purchasing the customized product of the firm and the standard product of the firm. The customized price is thus the price of the standard product plus the premium the consumer is willing to pay for the reduction in misfit cost as a result of product customization. Because this premium is increasing in the degree of customization, firms have an incentive to offer higher levels of customization. However, higher levels of customization reduce product differentiation and intensify price competition. These two forces are identical to the forces that operate in our base model without price customization, and so the qualitative insights obtained in our base set-up continue to hold even when firms are allowed to customize prices.

It is also reasonable to ask why firms may customize products but not prices. One reason for this observed practice may be that customizing products only requires information on the location of the consumer's ideal point, while customizing prices requires information on the consumers' ideal point as well as their misfit cost or how much they value product differences. In our model, heterogeneity on this dimension is captured by assuming the existence of two discrete consumer segments: one with low and the other with high misfit cost. Furthermore, their preference is assumed to be common knowledge. In practice, there may be a continuum of consumer types, with misfit cost having support over a range of values. Uncertainty over the distribution of consumer types could deter firms in such markets from customizing prices even though they have information to customize the products. With an extension (in the technical supplement) we have demonstrated that even if firms had the information to customize prices, our main findings continue to hold.

[5] In our model, when both firms offer customized products, the marginal consumer that is most dissatisfied with both standard products ends up directly comparing the utilities from the two customized products.

[6] This extension may be found in the online appendix on the journal's website at http://mktsci.pubs.informs@informs.org.

The rest of the paper is organized as follows. In §2 we present the model and derive the demand and profit functions. We characterize the equilibrium decisions and derive the main results in §3. In §§4 and 5 we analyze the implications of relaxing two assumptions of our model. We conclude in §6.

2. Model of Customized Goods and Standard Goods

We develop a model with two firms—A and B, competing to serve a market of consumers with heterogeneous preferences. Each firm offers a standard product that is differentiated from that of its rival's. We assume that firms' standard products are located at the ends of a line AB of unit length, with A at zero and B at one. All consumers are in the market to purchase at most one unit of the product and have a common reservation price of r for their ideal product. The heterogeneity in consumers' preferences in our model is along two dimensions. First, consumers differ in their definition of an ideal product offering. For example, of the consumers in the market for a pair of jeans from Lands' End, some may prefer a short rise while others may prefer a long rise; some may prefer to have a coin pocket; others may not. Heterogeneity in preferences along these (and other) dimensions is represented by assuming that consumers' ideal points are distributed uniformly on the line AB. Second, consumers differ in the intensity of their preference or the transportation cost parameter, independent of the location of their ideal point. For example, of the consumers who prefer a coin pocket in their jeans, some might value this feature more than others. To keep the analysis simple, we assume that independent of the location of their ideal point, a fraction α have a transportation cost parameter of 1, while the remaining fraction $(1-\alpha)$, have a transportation cost of $t > 1$. We label consumers in the former segment as *low-cost consumers* and those in the latter segment as *high-cost consumers* and index them as the l and h segments, respectively. Formally, the indirect utility functions of consumers in the high- and low-cost segments, whose ideal point is x units away from firm i's standard product, are as follows:

$$\begin{aligned} &\text{High-cost consumers: } U_h(p_i \mid x) = r - tx - p_i, \\ &\text{Low-cost consumers: } U_l(p_i \mid x) = r - x - p_i. \end{aligned} \tag{1}$$

In the utility functions specified above, $x \in [0, 1]$ denotes the distance between the ideal point of consumers in either segment and firm i's standard product, and p_i denotes the price of firm i's standard product. Thus, consumers in the high-cost segment value product differences more, and so incur a higher disutility ($tx > x$) when a firm's product does not match their ideal point, relative to the low-cost segment.

By offering customized products a firm can provide an offering that more closely matches consumers' preferences. When firm i decides to complement its standard product with customized products, it chooses the degree of customization. We let $d_i \in [0, 1]$ represent the fraction of meaningful attributes (to consumers) in the product that firms choose to customize. Lands' End offers a consumer the option to customize the *fit, rise, front-pocket style, leg, waist, inseam, thigh shape, seat shape*. Of course, there might be other attributes that a consumer may want customized (for example, the number of loops, the width of the loop, size of the coin pocket, etc.). For simplicity, we assume that attributes that are customized are fully customized to meet the consumers' preferences. If the competing firm j chooses to offer more (fewer) options than firm i for consumers to customize, then its degree of customization will be greater (less) than that of firm i: $d_j > d_i$ ($d_j < d_i$). Clearly, the cost of customizing products would depend on d_i. Furthermore, for any given choice of degree of customization, d_i by firm i, the cost of materials and labor would depend on the options chosen by the consumer. We assume that the cost per unit of the customized product is $d_i^2/2$. In addition to variable costs, a firm that decides to offer customized products also incurs a fixed cost of k.[7] The indirect utility function of consumers in the high- and low-cost segments from consuming firm i's product with a degree of customization, d_i is as follows:

$$\begin{aligned} &\text{High-cost consumers: } U_h(p_i, d_i \mid x) = r - (1-d_i)tx - p_i, \\ &\text{Low-cost consumers: } U_l(p_i, d_i \mid x) = r - (1-d_i)x - p_i. \end{aligned} \tag{2}$$

Notice how a firm's choice of the degree of customization affects the disutility consumers incur in Equation (2). If $d_i = 0$, then the firm does not offer any customization, and so (2) reduces to (1). For any $d_i > 0$, the customized product is closer to the consumers' ideal point than the standard product. Notice also that if $d_i = 1$, the product is completely customized and exactly matches the consumers' ideal point.

The interaction among firms and between firms and consumers is formalized as a three-stage game. In the

[7] Normalizing the fixed cost to zero leads to identical results. Nevertheless, we retain this parameter to reflect the commitment (or lack thereof) by a firm to offer customized products. It also captures the fact that negotiating contracts with third parties is both time consuming and costly. Importantly, a firm that does not commit these resources up-front will not have the ability to offer customized products even if it wanted to. We thank the area editor and an anonymous reviewer for encouraging us to reflect on this issue.

first stage, firms decide whether or not to offer customized products in addition to their standard product. If they do choose to customize, they incur a fixed cost of k, symmetric across the firms. It is helpful to denote the strategy space of firm $i = \{A, B\}$ as $l_i = \{S, SC\}$, where S represents firm i's decision to only offer the standard product and SC represents its decision to offer customized products in addition to its standard product.[8] We let $\langle l_A, l_B \rangle$ denote the first-stage outcome. If they choose to offer the customized product, they set the degree of customization to offer in the second stage. In the third stage, firms set prices given the first- and second-stage decisions: $\langle l_A, l_B \rangle$ and d_A, d_B (if applicable) and consumers make their product choice given the prices set by the firms.

Note that any firm that chooses S in the first stage has essentially committed to a zero degree of customization in the second. The fixed cost of setting up customization capabilities in the first stage acts as a credible commitment device because firms that have not invested in customization technologies cannot provide any customization in the second stage. We let p_{iS} and p_{iC} denote the prices charged by firm $i = \{A, B\}$ for its standard product and customized products (if applicable), respectively. The price of all customized products is the same regardless of the options the consumer indicates. This assumption is consistent with institutional practice.[9] The profits of firms A and B given the first-stage decisions $\langle l_A, l_B \rangle$ are denoted as $\Pi_A^{\langle l_A, l_B \rangle}$ and $\Pi_B^{\langle l_A, l_B \rangle}$. We start by analyzing consumer behavior and the demand for all possible outcomes of the first stage: $\langle l_A, l_B \rangle$.

We first characterize the demand conditional on first-stage outcomes that induce four subgames in the second stage, corresponding to the cases when (a) both firms offer only standard products denoted $\langle S, S \rangle$; (b) when both firms offer standard and customized products denoted $\langle SC, SC \rangle$; (c) when firm A offers both standard and customized products while firm B only offers its standard product denoted $\langle SC, S \rangle$; and finally, (d) when firm B offers both standard and customized products while A only offers its standard product, denoted $\langle S, SC \rangle$. Consumer behavior and the demand characterization in these subgames are presented in the following subsections.

2.1. When Both Firms Offer Only Standard Products

For any given p_{AS}, p_{BS}, following (1), consumers in the low-cost segment located at x will purchase firm A's standard product iff:

$$r - x - p_{AS} \geq \max\{0, r - (1 - x) - p_{BS}\}.$$

The left-hand side (LHS) of the above inequality denotes the net utility from purchasing firm A's standard product, and the right-hand side (RHS) that from buying firm B's standard product, or choosing not to buy at all, whichever is higher. Given this choice rule, consumers in the low-cost segment located at $x_l^{\langle S, S \rangle} = (p_{BS} - p_{AS} + 1)/2$ are indifferent to buying either firm's standard product (superscripts are used to distinguish between the different subgames). Hence, consumers located at $x \in [0, x_l^{\langle S, S \rangle}]$ will purchase firm A's product, while those located at $x \in [x_l^{\langle S, S \rangle}, 1]$ will purchase firm B's standard product.

Similarly, consumers in the high-cost segment located at x will purchase firm A's standard product iff:

$$r - tx - p_{AS} \geq \max\{0, r - t(1 - x) - p_{BS}\}.$$

If t is sufficiently large so that this segment is not fully served, then $x_{Ah}^{\langle S, S \rangle} = (r - p_{AS})/t$ represents the identity of marginal consumers in the high-cost segment who are indifferent to purchasing firm A's standard product and not purchasing at all.[10] Similarly, $x_{Bh}^{\langle S, S \rangle} = 1 - (r - p_{BS})/t$ denotes the identity of consumers in the high-cost segment indifferent to purchasing firm B's standard product and not purchasing at all. Therefore, in the high-cost segment consumers located at $x \in [0, x_{Ah}^{\langle S, S \rangle}]$ will purchase firm A's standard product, while those located at $x \in [x_{Bh}^{\langle S, S \rangle}, 1]$ will purchase firm B's standard product. Consumers located in the interval $x \in [x_{Ah}^{\langle S, S \rangle}, x_{Bh}^{\langle S, S \rangle}]$ do not purchase either firm's product. The profit functions of firms A and B in this subgame are:

$$\Pi_A^{\langle S, S \rangle} = \left(\alpha x_l^{\langle S, S \rangle} + (1 - \alpha) x_{Ah}^{\langle S, S \rangle}\right) p_{AS}; \quad (3)$$

$$\Pi_B^{\langle S, S \rangle} = \left(\alpha\left(1 - x_l^{\langle S, S \rangle}\right) + (1 - \alpha)\left(1 - x_{Bh}^{\langle S, S \rangle}\right)\right) p_{BS}. \quad (4)$$

2.2. When Only One Firm Offers Both Standard and Customized Products

Suppose firm A offers customized products in addition to its standard product, while firm B only offers its standard product. In this case, consumers in the low-cost segment located close to zero (A) may still purchase the standard product if: $r - x - p_{AS} \geq r - (1 - d_A)x - p_{AC}$. Consumers located at $x_{Al}^{\langle SC, S \rangle} = (p_{AC} - p_{AS})/d_A$ are indifferent to purchasing firm A's standard and customized product, so that consumers

[8] See §5 for an analysis of a model where firms can offer customized products without having to offer their standard products.

[9] As noted earlier, allowing firms to customize the prices of the customized products does not qualitatively change our results. For a formal analysis of this set-up, please see the Technical Appendix on the journal's website at http://mktsci.pubs.informs.org.

[10] We find that if both segments are fully covered, then firms will not offer customized products in equilibrium. Given our focus, we therefore assume that the high-cost segment is not covered. We establish this in Proposition 1.

located at $x \in [0, x_{Al}^{\langle SC,S\rangle}]$ will purchase firm A's standard product. Consumers located at $x \geq x_{Al}^{\langle SC,S\rangle}$ will purchase firm A's customized product iff:

$$r - (1 - d_A)x - p_{AC} \geq r - (1 - x) - p_{BS}.$$

Given this choice rule, consumers located at $x_{Bl}^{\langle SC,S\rangle} = (1 - p_{AC} + p_{BS})/(2 - d_A)$ are indifferent to purchasing firm A's customized product and firm B's standard product.[11] Consequently, consumers in the low-cost segment in the interval $x \in [x_{Al}^{\langle SC,S\rangle}, x_{Bl}^{\langle SC,S\rangle}]$ will purchase firm A's customized products while those in the interval $x \in [x_{Bl}^{\langle SC,S\rangle}, 1]$ will purchase B's standard product. Using the same procedure, we can identify the location of consumers in the high-cost segment indifferent to purchasing firm A's standard and customized products ($x_{Ah}^{\langle SC,S\rangle}$) and that of consumers indifferent to purchasing firm A's customized product and firm B's standard product ($x_{Bh}^{\langle SC,S\rangle}$). Given this behavior, the profit functions of firms in this subgame are:

$$\begin{aligned}\Pi_A^{\langle SC,S\rangle} &= \big(\alpha x_{Al}^{\langle SC,S\rangle} + (1-\alpha)x_{Ah}^{\langle SC,S\rangle}\big)p_{AS} \\ &\quad + \big(\alpha\big(x_{Bl}^{\langle SC,S\rangle} - x_{Al}^{\langle SC,S\rangle}\big) + (1-\alpha) \\ &\quad \cdot \big(x_{Bh}^{\langle SC,S\rangle} - x_{Ah}^{\langle SC,S\rangle}\big)\big)\left(p_{AC} - \frac{(d_A)^2}{2}\right) - k, \quad (5)\end{aligned}$$

$$\Pi_B^{\langle SC,S\rangle} = \big(\alpha\big(1 - x_{Bl}^{\langle SC,S\rangle}\big) + (1-\alpha)\big(1 - x_{Bh}^{\langle SC,S\rangle}\big)\big)p_{BS}. \quad (6)$$

The demand and profits in the subgame $\langle S, SC\rangle$ is similarly derived.

2.3. When Both Firms Offer Standard and Customized Products

For any given degree of customization offered by forms A and B, d_A and d_B consumers in the low-cost segment located close to firm A will purchase its standard product iff: $r - x - p_{AS} \geq r - (1 - d_A)x - p_{AC}$. Similar to the earlier case, consumers located at $x_{Al}^{\langle SC,SC\rangle} = (p_{AC} - p_{AS})/d_A$ are indifferent to purchasing firm A's standard and customized products, and so consumers located at $x \in [0, x_{Al}^{\langle SC,SC\rangle}]$ will purchase firm A's standard product. Consumers located at $x \geq x_{Al}^{\langle SC,SC\rangle}$ will purchase firm A's customized product iff:

$$r - (1 - d_A)x - p_{AC} \geq r - (1 - d_B)(1 - x) - p_{BC}.$$

Given this inequality, consumers located at $x_{ABl}^{\langle SC,SC\rangle} = (1 - d_B - p_{AC} + p_{BC})/(2 - d_A - d_B)$ are indifferent to purchasing the customized products of the two firms. Finally, consumers located at $x \geq x_{ABl}^{\langle SC,SC\rangle}$ will purchase firm B's customized products iff:

$$r - (1 - d_B)(1 - x) - p_{BC} \geq r - (1 - x) - p_{BS}.$$

Given the above inequality, consumers located at $x_{Bl}^{\langle SC,SC\rangle} = (d_B + p_{BS} - p_{BC})/d_B$ will be indifferent to purchasing firm B's customized and standard products. Using the same procedure, we can determine $x_{Ah}^{\langle SC,SC\rangle}$, $x_{ABh}^{\langle SC,SC\rangle}$, and $x_{Bh}^{\langle SC,SC\rangle}$ representing the corresponding marginal consumers in the high-cost segment, and obtain the profit functions of firms A and B in this subgame:

$$\begin{aligned}\Pi_A^{\langle SC,SC\rangle} &= \big(\alpha x_{Al}^{\langle SC,SC\rangle} + (1-\alpha)x_{Ah}^{\langle SC,SC\rangle}\big)p_{AS} \\ &\quad + \big(\alpha\big(x_{ABl}^{\langle SC,SC\rangle} - x_{Al}^{\langle SC,SC\rangle}\big) + (1-\alpha) \\ &\quad \cdot \big(x_{ABh}^{\langle SC,SC\rangle} - x_{Ah}^{\langle SC,SC\rangle}\big)\big)\left(p_{AC} - \frac{(d_A)^2}{2}\right) - k, \quad (7)\end{aligned}$$

$$\begin{aligned}\Pi_B^{\langle SC,SC\rangle} &= \big(\alpha\big(1 - x_{Bl}^{\langle SC,SC\rangle}\big) + (1-\alpha)\big(1 - x_{Bh}^{\langle SC,SC\rangle}\big)\big)p_{BS} \\ &\quad + \big(\alpha\big(x_{Bl}^{\langle SC,SC\rangle} - x_{ABl}^{\langle SC,SC\rangle}\big) + (1-\alpha) \\ &\quad \cdot \big(x_{Bh}^{\langle SC,SC\rangle} - x_{ABh}^{\langle SC,SC\rangle}\big)\big)\left(p_{BC} - \frac{(d_B)^2}{2}\right) - k. \quad (8)\end{aligned}$$

Notice that in (7) and (8) the fixed cost k that firms need to incur to acquire customization capabilities is reflected.

3. Equilibrium Analysis

The first-stage outcomes induce four subgames corresponding to $\langle S, S\rangle$, $\langle SC, SC\rangle$, $\langle SC, S\rangle$, and $\langle S, SC\rangle$. Because firms in our model are symmetric, it is sufficient to analyze only the first three subgames.

3.1. Pricing and Customization Strategies

We characterize the pricing strategies and choice of degree of customization (if applicable) in the following sections. In the remainder of our paper we set α to $\frac{1}{2}$. Our results are qualitatively unaffected for any $\alpha \in (0, 1)$.

3.1.1. When Both Firms Only Offer Standard Products: $\langle S, S\rangle$. We start with an analysis of the case where there is incomplete coverage of the high-cost segment. In this subgame the profits of the two firms are as defined in Equations (3) and (4). Optimizing these profits with respect to p_{AS} and p_{BS}, respectively, we obtain the equilibrium prices and profits in this subgame, which are summarized in the following lemma.

Lemma 1. *Let $r \geq 2$. There exists $t^*(r) = r + \sqrt{r^2 - 2r + 9} - 3$, such that when $t > t^*(r)$ there is complete market coverage of the low transportation cost segment and*

[11] Note that the demands in the $\langle SC, S\rangle$ case have been obtained under complete coverage of the high-cost segment. This is not an assumption, but rather an equilibrium outcome. We find that when at least one firm offers customized products, it is in the firm's interest to cover the high-cost segment. The same is true with incomplete coverage in the $\langle SC, SC\rangle$ subgame. We demonstrate this formally in the technical supplement.

incomplete market coverage of the high transportation cost segment. The optimal prices are $p_{AS}^{\langle S,S\rangle} = p_{BS}^{\langle S,S\rangle} = (2r+t)/(4+t)$ *and the optimal profits are*

$$\Pi_A^{\langle S,S\rangle} = \Pi_B^{\langle S,S\rangle} = \frac{(2+t)(2r+t)^2}{4t(4+t)^2}.$$

Proof. See an online appendix.[12]

When firms compete to serve consumers with only their standard products, they are faced with the following trade-off. On the one hand, there are consumers (located on either ends of the line) whose preferences are adequately met with the standard product. On the other hand, there are consumers (those located in the middle of the line) whose ideal product is sufficiently different from the standard offerings. The latter group of consumers limits the firms' ability to extract surplus from consumers who are satisfied even with the standard offering. To ensure nonnegative surplus for the marginal consumer in the low-cost segment, firms will need to lower price. Consumers whose preferences are close to the standard product derive higher surplus than the marginal consumers. This surplus goes up even further when firms attempt to serve all consumers in the high-cost segment, as this would require a further reduction in price. Furthermore, the extent of price reduction required to serve all the consumers in the high-cost segment is increasing in t. Indeed, when t exceeds the threshold identified in the lemma, firms would prefer not to serve all consumers in the high-cost segment. The profits characterized in this subgame serve as a useful benchmark, as firms will have an incentive to offer customized products only if profits can be increased relative to this case (Proposition 1).

3.1.2. When Only One Firm Offers Both Standard and Customized Products: $\langle SC, S\rangle$. Consider the subgame in which firm A offers both standard and customized products, while firm B offers only its standard product. In this case, the profits of the firms A and B are as defined in (5) and (6), respectively. In characterizing the equilibrium solution, we first solve for prices chosen by the firms in the third stage for any given d_A and then optimize firm A's profits with respect to d_A to obtain the degree of customization offered by firm A in equilibrium.

Lemma 2. *When only one firm (say firm A) offers customized products in addition to its standard product while its rival (firm B) only offers standard products, then in equilibrium the prices and the degree of customization (offered by firm A) are*:

$$p_{AS}^{\langle SC,S\rangle} = \frac{d_A^{\langle SC,S\rangle^2} + \left(24 - \left(8 - d_A^{\langle SC,S\rangle}\right)d_A^{\langle SC,S\rangle}\right)t}{12(1+t)},$$

$$p_{AC}^{\langle SC,S\rangle} = \frac{d_A^{\langle SC,S\rangle^2} + \left(6 - \left(2 - d_A^{\langle SC,S\rangle}\right)d_A^{\langle SC,S\rangle}\right)t}{3(1+t)},$$

$$p_{BS}^{\langle SC,S\rangle} = \frac{d_A^{\langle SC,S\rangle^2} + \left(6 - d_A^{\langle SC,S\rangle}\right)\left(2 - d_A^{\langle SC,S\rangle}\right)t}{6(1+t)},$$

$$d_A^{\langle SC,S\rangle}:\ r - t\left(1 - d_A^{\langle SC,S\rangle}\right)x_{Bh}^{\langle SC,S\rangle} - p_{AC}^{\langle SC,S\rangle} = 0.$$

The optimal profits in this subgame are obtained by substituting the above values in (5) *and* (6).

Recall that in the previous subgame some consumers in the high-cost segment were not served by the standard products. In the equilibrium characterized in Lemma 2, firm A's customized products serve these consumers. The number of such people served depends on the degree of customization, and firm A chooses it such that all consumers in both the high- and low-cost segment are served. An additional benefit is that firm A can now charge a higher price (under certain conditions) for its standard product, without compromising its ability to compete (with the customized product) for the marginal consumers. Firm B, on the other hand, offers only the standard product and is forced to lower price to compete with its rival's customized offerings. Because prices in our model are strategic complements, firm A is forced to keep the price of its customized products low, which in turn affects the price of firm A's standard product. When the intensity of preference (t) of the high-cost segment is sufficiently small, the strategic effect on prices may offset any benefit from increased market coverage. Consequently, the benefit of offering customized products depends critically on the intensity of preference of the high-cost segment.

To understand the effect on firm B's profits, note that to compete with its rival's customized products it is forced to lower price. While this lowers margins, it will increase firm B's demand. Hence, the net effect on firm B's profits will depend on the elasticity of demand. If the demand expansion that results from lowering prices is large enough to offset the reduction in margins, firm B's profits can be higher in this subgame relative to that in the $\langle S, S\rangle$ subgame. Can firm B also benefit from offering customized products?

3.1.3. When Both Firms Offer Standard and Customized Products: $\langle SC, SC\rangle$. In this subgame, we characterize the prices for any given d_A, d_B using Equations (7) and (8), and then optimize the second-stage profits of both firms simultaneously with

[12] All proofs are in the online appendix. In the remainder of this paper we assume that $t > t^*(r)$, the condition for incomplete coverage of the high-cost segment. In Proposition 1 we show that this condition is necessary for customization to occur.

respect to d_A, d_B to obtain the degree of customization offered by both firms in equilibrium.

LEMMA 3. *When both firms offer customized products in addition to their standard products, then in equilibrium the prices and the degree of customization offered are*:

$$p_{AS}^{\langle SC,SC\rangle} = p_{BS}^{\langle SC,SC\rangle} = \frac{d^{\langle SC,SC\rangle^2} + \left(8 - \left(8 - d^{\langle SC,SC\rangle}\right)d^{\langle SC,SC\rangle}\right)t}{4(1+t)},$$

$$p_{AC}^{\langle SC,SC\rangle} = p_{BC}^{\langle SC,SC\rangle} = \frac{d^{\langle SC,SC\rangle^2} + \left(2 - d^{\langle SC,SC\rangle}\right)^2 t}{2(1+t)},$$

$$d^{\langle SC,SC\rangle}:\ r - t\left(1 - d^{\langle SC,SC\rangle}\right)x_{ABh}^{\langle SC,SC\rangle} - p_{AC}^{\langle SC,SC\rangle} = 0.$$

The optimal profits in this subgame are obtained by substituting the above values in (7) *and* (8).

In this subgame firm B also insulates its standard products from direct competition by offering customized products. There are two competing forces. Competition is more focused; firms compete for the marginal consumers with their customized products while insulating their standard products from price competition. However, as customized products are less differentiated than the standard products, competition between them is more intense and increases in the transportation cost parameter (t) of the high-cost segment. Conventional wisdom would suggest that when t is sufficiently high, price competition would be less intense. This intuition does not survive in our context, as the degree of customization is endogenous and increasing in t, decreasing the level of differentiation between the customized offerings of the two firms. Despite the increased competition between customized products, the counterweighing forces, that of mitigating the intensity of competition between the standard products and demand expansion, are beneficial to firms. We find that for moderate values of t the benefit from reduced competition between standard products offsets the cost of increased competition between customized offerings. In contrast, when t is sufficiently high this does not hold, and one firm would prefer not to offer customized products. These ideas are formalized in Theorem 1.

3.2. Choice of Product Strategy

Before characterizing the equilibrium outcome in the first stage of the game, in Proposition 1 we first identify market conditions under which firms will *not* find it profitable to complement their standard offerings with customized products. We then restrict our attention to market conditions in which firms may benefit from offering customized products in addition to their standard offerings, and characterize the equilibrium strategies in Theorem 1. In Proposition 2 we compare the equilibrium degree of customization chosen by firms when both offer customized products to that when only one firm offers customized products.

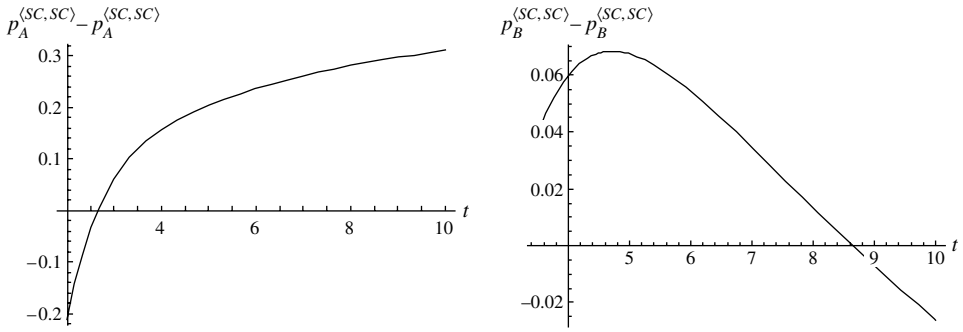
PROPOSITION 1. *If both the high- and low-cost segments are fully covered when firms only offer standard products, then neither firm has an incentive to offer customized products.*

Proposition 1 implies that a necessary condition for firms to offer customized products in equilibrium is incomplete coverage of the market when firms offer only standard products. When the intensity of preference of consumers in the high-end segment (t) is not too large, then firms will find it profitable to serve all consumers in both the segments. Recall that in order to serve the marginal consumers with standard products firms will need to lower the price of the standard product, implicitly subsidizing the inframarginal consumers. Consequently, the key trade-off facing firms when deciding to serve the marginal consumers is the cost of the implicit subsidy to the inframarginal consumers versus the benefit of additional consumers served. When t is not too high, the latter dominates the former, and so in equilibrium firms set the price of the standard goods so that all consumers in the market are served. This price-volume trade-off is well understood and is not a new result. However, what is new and interesting is that if the market is covered, firms would not benefit from offering customized products in addition to their standard products. The intuition behind this is as follows. Consider a deviation by a firm from $\langle S, S\rangle$ to $\langle SC, S\rangle$. The degree of customization offered in equilibrium is increasing in t, and so when t is small the deviating firm does not offer very high levels of customization. The firm that only offers the standard product can drop its price because the price reduction that is required to counter its rival's attempt to gain market share is not too high. Therefore, the benefit from offering customized products is readily voided by the rival, and neither firm benefits from offering customized products. Said differently, when consumers in the high-cost segment do not value product differences sufficiently (t is sufficiently small), the need to offer customized products does not arise because their preferences are adequately satisfied with the standard offerings. Given our interest, in the remainder of the paper we assume that t is larger than the threshold identified in Lemma 1, so that the high-end segment is not completely covered. Specifically, we will assume that $t > t^*(r)$. This condition is necessary, but not sufficient, for customized products to be offered in equilibrium. In the next theorem, we identify the equilibrium product strategies under different market conditions.

THEOREM 1. *For a given r there exist critical values $t^{**}(r)$ and $t^{***}(r)$ of the transportation cost, such that*:

(i) *if $t < t^{**}(r)$, then the pure-strategy Nash equilibrium is $\langle S, S\rangle$ and both the firms offer only standard products*;

Figure 1 Product Strategies and Intensity of Preference



(ii) *if* $t^{**}(r) < t < t^{***}(r)$, *then the pure-strategy Nash equilibrium is* $\langle SC, SC\rangle$ *and both the firms offer standard and customized products*;

(iii) *if* $t^{***}(r) < t$, *then the pure-strategy Nash equilibrium is* $\langle SC, S\rangle$ *or* $\langle S, SC\rangle$ *and only one firm offers standard and customized products*.

When t is large enough so that the high-end segment is not fully covered with standard products alone, but still not too large, then in equilibrium firms only offer standard products. In contrast, when t is moderately large both firms offer customized and standard products in equilibrium. However, when t is very large only one firm offers customized products in equilibrium. To better understand the parameter space over which different equilibria arise, please refer to Figure 1.[13]

The difference in firm A's profits between subgames $\langle SC, S\rangle$ and $\langle S, S\rangle$, $\Pi_A^{\langle SC,S\rangle} - \Pi_A^{\langle S,S\rangle}$ is represented on the y-axis of the panel on the left. The difference in firm B's profits between subgames $\langle SC, SC\rangle$ and $\langle SC, S\rangle$, $\Pi_B^{\langle SC,SC\rangle} - \Pi_B^{\langle SC,S\rangle}$ is represented on the y-axis of the panel on the right. Consider first the panel on the left. The value of t where this difference is zero is $t^{**}(r)$ in Theorem 1. Note that for all $t < t^{**}(r)$, $\Pi_A^{\langle SC,S\rangle} < \Pi_A^{\langle S,S\rangle}$ so that firm A prefers not to offer customized products if firm B does not offer customized products, and vice versa.

If $t > t^{**}(r)$, firm A prefers to offer customized products if firm B offers only standard products. In the panel on the right in Figure 1, we examine the incentives of firm B. The value of t where the difference $\Pi_B^{\langle SC,SC\rangle} - \Pi_B^{\langle SC,S\rangle}$ is zero is $t^{***}(r)$ in Theorem 1. Notice that for $t \in [t^{**}(r), t^{***}(r)]$, $\Pi_B^{\langle SC,SC\rangle} > \Pi_B^{\langle SC,S\rangle}$ so that firm B prefers to offer customized products if firm A offers customized products. Consequently, for $t \in [t^{**}(r), t^{***}(r)]$ both firms offer customized products. Note that for $t > t^{***}(r)$, $\Pi_B^{\langle SC,SC\rangle} < \Pi_B^{\langle SC,S\rangle}$ and so firm B prefers not to offer customized products when firm A offers customized products. Hence, for $t > t^{***}(r)$ only one firm offers customized products in equilibrium.

The main driver of this finding is the effect market parameters have on firms' choice of degree of customization and its ensuing effect on price competition between standard and customized products. Specifically, we find that the degree of customization is increasing in t (see proof of Theorem 1). This in turn has two effects on the prices of the customized products. The direct effect of higher levels of customization is higher prices resulting from better fit between the customized products and consumers' preferences. The strategic effect, however, works in the opposite direction as higher levels of customization make the customized products offered by the competing firms less differentiated and intensifies price competition. Offering customized products, however, has a very interesting effect on the price of the standard products. In contrast to the findings of Dewan et al. (2003), we find that the price of the standard products can be higher or lower relative to their prices when neither firm offers customized products.[14] As shown in Figure 2 below, for small-to-moderate values of the intensity of preference parameter (t) we find that the price of the standard good is higher in the $\langle SC, SC\rangle$ subgame relative to the $\langle S, S\rangle$ subgame. The finding that offering customized products allows firms to increase the price of the standard goods relative to the $\langle S, S\rangle$ subgame is both interesting and counterintuitive.

In the absence of customized products, competition for the marginal consumer who is most dissatisfied with the standard products forces firms to leave money on the table with the inframarginal consumers. When firms have both standard and customized products, they can use the former to target the inframarginal consumers and the latter to target the marginal consumer. As a result, firms can charge higher prices for the standard products. For moderate

[13] For the illustration in Figures 1–3, the model parameters are set to the following values: $\alpha = \frac{1}{2}$, $k = 0$, and $r = 3$, and t is varied over a range of values.

[14] As noted earlier, Dewan et al. (2003) find that the price of the standard goods are unaffected by firms' decision to offer customized products (please see Proposition 2, p. 1062).

Figure 2 **Prices in the $\langle S, S\rangle$ and $\langle SC, SC\rangle$ Subgames and Intensity of Preference t**

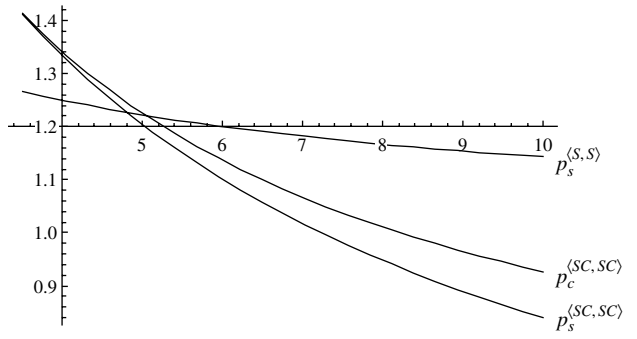
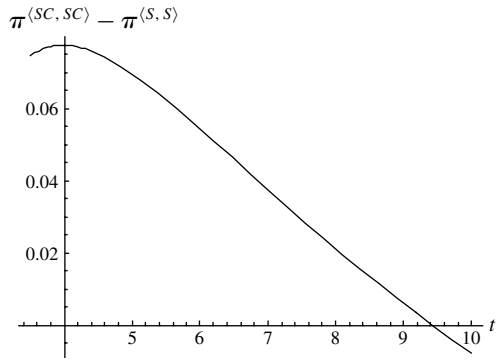


Figure 3 **$\langle SC, SC\rangle$ Equilibrium Is Not a Prisoners' Dilemma $\forall t \in [t^{**}(r), t^{***}(r)]$**



values of t, the optimal response of the firms is to offer moderate levels of customization. This reduces the differentiation between the customized products only slightly, and thus moderately increases the competition between the firms. However, the higher prices of the standard products and demand expansion due to the customized products are sufficient to offset this competitive effect, making customization by both firms profitable compared to offering only standard products. When t is sufficiently high, $t > t^{***}(r)$, the optimal response of the firms is to offer very high levels of customization, and this intensifies competition between customized products. In addition to lowering prices of the customized products, this also depresses the prices of the standard offerings. Competition with high levels of customization erodes profits to such an extent that it cannot be offset by the reduced competition between standard products or by demand expansion. Under this condition, one firm will prefer not to offer customized products, and the equilibrium outcome is one where ex ante symmetric firms adopt asymmetric product strategies (and hence different levels of customization). This might explain the differences in strategies (noted in the introduction) pursued by Home Depot's Expo and Rug Rats in the rugs market and Ethan Allen and Crate and Barrel in the furniture market.

Despite its effect on price competition, under the conditions identified in Theorem 1(ii), and for small values of k, the profits of firms are higher in the $\langle SC, SC\rangle$ case relative to the case where neither firm offers customized products; so when $\langle SC, SC\rangle$ is an equilibrium, offering customized products is *not* a Prisoners' Dilemma. This is an important finding, because as noted in the introduction, in the context of price customization by symmetric firms, it has been well established that the intensity of competition invariably goes up and profits go down. We show that this need not be the case with product customization. We illustrate this in Figure 3, where the difference in profits between the subgames $\langle SC, SC\rangle$ and $\langle S, S\rangle$ is on the y-axis, and the preference intensity t is on the x-axis. Notice that from the right panel in Figure 1, $t^{***}(r) < 9$ for the parameter values chosen for this illustration. Observe in Figure 3 that for all $t < t^{***}(r) < 9$ firms' profits in the $\langle SC, SC\rangle$ subgame are higher than that in the $\langle S, S\rangle$ subgame. Consequently, in the region $t \in [t^{**}(r), t^{***}(r)]$, $\langle SC, SC\rangle$ is not only the equilibrium strategy; it is also more profitable relative to the case in which neither firm offers customized products.

We now turn our attention to the comparison of the degree of customization offered when both firms offer customized products to that when only one firm offers customized products.

Proposition 2. *The equilibrium degree of customization when only one firm offers customized products is higher relative to the case when both firms offer customized products*: $d^{\langle SC, S\rangle} = d^{\langle S, SC\rangle} \geq d^{\langle SC, SC\rangle}$.

One might expect that competitive pressures would force firms to offer higher levels of customization. In Proposition 2 we find the opposite because in our model firms decide on degree of customization, recognizing its strategic effect on price competition. When both firms offer customized products, offering high levels of customization intensifies price competition. Internalizing this effect, firms keep the equilibrium degree of customization low. When only one firm offers customized products, its customized product competes with the rival's standard product. Increasing the degree of competition *does* put downward pressure on prices, but the magnitude of this effect is not the same as in the case when both firms offer customized products.

In the next two sections we analyze the implications of relaxing two assumptions of our model.

4. Only One Segment of Consumers

Suppose that there is only one segment of consumers in the market—a segment with preference intensity, or transportation cost t. The demand and profit functions for the three subgames can be derived as in

§§2.1–2.3. In Proposition 3 below we state the main result of this section.

PROPOSITION 3. *When the market consists of only one segment of consumers with preference intensity t, then*:

(i) *if $t < r$, then the pure-strategy Nash equilibrium is $\langle S, S\rangle$ and both the firms offer only standard products*;

(ii) *if $t > r$, then the pure-strategy Nash equilibrium is $\langle SC, SC\rangle$, and both the firms offer standard and customized products*.

Notice that the asymmetric equilibria $\langle SC, S\rangle$ or $\langle S, SC\rangle$ does not arise with only one segment of consumers. Proposition 3 highlights the critical role that the segment of consumers with low preference intensity plays in the existence of the asymmetric equilibrium. As mentioned earlier, when the intensity of consumers' preference (t) is very high, firms offer a high degree of customization, which in turn intensifies price competition. In the presence of two segments of consumers, one of the firms "gives up" and focuses on the low-cost segment. This option does not exist with only one segment, and consequently, the equilibrium with asymmetric customization strategies does not arise in this setting.

5. Firms Can Choose Not to Offer Standard Products

In this section we analyze a situation where firms can choose not to offer their standard products if they decide to offer customized products. Each firm can offer a standard product, a customized product, or both, and the strategy set is denoted $\{S, C, SC\}$. Given the subgames analyzed in §§2.1–2.3, we need only analyze three additional subgames: $\langle C, S\rangle$, $\langle C, C\rangle$, and $\langle SC, C\rangle$. The profit functions can be derived by standard methods presented in §2. The following proposition shows that when firms decide to offer customized products, it is always better for them to also offer their standard products.

PROPOSITION 4. *If a firm chooses to offer customized products, it is a* dominant strategy *for it to also offer its standard product with it*.

As noted earlier, customized products offered by firms are less differentiated relative to the standard products, and this serves to intensify price competition. This is the main driver of the result summarized in the above proposition. The presence of the standard product allows firms to mitigate the intensity of competition between the customized products and vice versa, so that firms find it profitable to offer standard products together with their customized offerings. In the base model we had assumed that firms do not have the option of eliminating the standard product from their product line. In this extension, we show that, even if this assumption is relaxed, when it is profitable to offer customized products it is a dominant strategy to retain the standard products. The findings of our base model are therefore sufficiently robust.

6. Concluding Remarks

In this paper, we examine a market where firms decide whether or not to offer customized products in addition to their standard products. If customized products are offered, firms decide on the level of customization. Customized products allow firms to compete for consumers who are dissatisfied with their standard products, without having to subsidize consumers who are not. Thus, an important strategic effect of offering customized products is the impact that it has on firms' ability to extract higher surplus from buyers of standard products. Under certain conditions, offering customized products can allow firms to increase the price of their standard products relative to the case when neither firm offers customized products. This counterintuitive finding is distinct from extant work on product customization.

We show that the strategic effect of the degree of customization offered on price competition is critical in determining the equilibrium outcomes. We identify market conditions under which only one firm, both firms, or neither firm will offer customized products. When the intensity of preference of consumers in the market is not high, then the need to offer customized products does not arise, and in equilibrium firms offer only their standard products. When the intensity of preference is moderately large, then in equilibrium both firms offer customized and standard products. When the intensity of preference is sufficiently high, then only one firm offers customized and standard products, while its rival only offers standard products. The analysis highlights the dependence of the equilibrium degree of customization on consumer and market characteristics. We find that the degree of customization goes down when both firms customize relative to when there is a monopoly customizer. Furthermore, offering customized products leads to higher equilibrium profits relative to the case when neither firm offers customized products. Thus, the equilibrium is not a prisoners' dilemma.

Finally, with the extensions in §§4 and 5 we have relaxed some assumptions that may appear to be driving our findings and show that our results are robust. In another extension, we show that even if firms were allowed to customize prices, our main findings continue to hold.

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