Strategic Implications of Alternative Customization Approaches

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Abstract:

We identify two distinct approaches toward customization: S-customization and H-customization. With S-customization, a firm identifies a customer’s preferences by soliciting information directly from the customer at the time of purchase. With H-customization, a firm uses historical information to deduce customers’ present preferences. We investigate a firm’s incentive to invest in these two alternative elicitation approaches and explore how each approach affects the interactions between the firm and its competitors. We argue that the optimal elicitation approach depends on the relative cost of implementing H-customization and S-customization, the size of its customer base and, most interestingly, the actual and/or anticipated elicitation approach adopted by a rival. In particular, we focus on how the elicitation approach impacts price competition and a rival’s customization strategy. A key insight is that H-customization provides a credible signal to competitors for relaxing price competition, while S-customization does not. Furthermore, we find that S-customization creates a strong disincentive for competitors to invest in either elicitation approach. We survey purchasing managers on the elicitation approaches adopted by their suppliers and find evidence that supports our theory.

Keywords: customization, personalization, acquisition, retention, customer relationship management, elicitation of preferences
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1. Introduction

Recent marketing literature stresses that customization enables firms to meet the heterogeneous needs of customers thus increasing customer value (Brady et. al. 2000) as well as firms’ own profits (Ansari and Mela 2003). Examples of customization can be found in industries ranging from automobiles to clothing to shoes to even coffee (Brady et. al. 2000). Generally speaking, three key capabilities are essential to customization: (1) elicitation – a mechanism for discovering each customer’s specific preferences, (2) process flexibility – the production technology to efficiently produce products to match these preferences, and (3) logistics – a way to distribute the right product to the right customer (Zipkin 2001).

While much has been learned about how to build each of these three required capabilities, little is known about how a firm’s approach towards building these capabilities affects and is affected by competition. In this paper, we focus on how different approaches used in the elicitation process impact inter-firm competition. We are interested in elicitation because to give customers exactly what they want, firms first have to learn what that is. In particular, our objectives are two-fold:

1. We identify two distinct approaches for eliciting customer preferences and, for each approach, explore its impact on customer perceptions and the degree of price rivalry within a market.

2. We investigate firms’ incentives to invest in these elicitation approaches and the strategic implications of these choices.

The following examples help illustrate what we view as two fundamentally different approaches to eliciting customer preferences. At Nikeid.com, a customer designs an athletic shoe to his/her specifications, selecting each element of the shoe from the material of the sole to the
color of the shoelace (Randall, Terwiesch, and Ulrich 2005). At Pandora.com, based on the user’s previous listening pattern, personalized recommendations are made as to which new releases he would most enjoy (Moser 2006). In both examples, the seller helps a customer identify his/her most preferred product. And, both examples required substantial investment on the part of the seller to elicit the customer’s preferences – Nikeid.com designed an interface that solicits information from customers in an efficient and effective manner; Pandora.com created a database to track listening behavior, hired a team to classify new music as it is released, and developed an algorithm to ensure accurate recommendations.

This paper argues that these two companies use distinct elicitation approaches, as defined as $S$-customization and $H$-customization in this paper, for customization, which impact the nature of competition within a market in very different ways. In particular, Nikeid.com is an example of using $S$-customization, where customization is based on “solicited” information, i.e. products are personalized on the basis of information collected at the time of purchase. Solicitation can be done directly – as at Dell.com where the customer designs his own laptop configuration – or indirectly, as Eleuria does by surveying a customer’s preferences for fragrances and then offering a perfume that best satisfies her reported tastes (Randell et. al. 2005).

On the other-hand, $H$-customization, as exemplified by Pandora.com, is based on “historical” information, i.e. information gathered by a firm during previous interactions with that particular customer. For instance, a firm that maintains a database consisting of personal purchase histories and click-stream data can use this knowledge to identify a particular user’s most preferred product offering. Examples of $H$-customization include Amazon.com offering personalized book recommendations and the Ritz-Carlton anticipating a return guest’s preferred snack (Court 2005). It should be noted that previous research does not distinguish between these
two approaches for eliciting preferences. For instance, Ansari and Mela (2003), p. 132, use examples of both $H$-customization – a company customizing a website “based on revealed preferences data” – and $S$-customization – allowing “users to self-customize the site” – to define on-site customization.

To see that $H$-customization and $S$-customization impact the interaction between market competitors very differently, note that $H$-customization does not facilitate customization for “new” customers, i.e. customers for whom the firm does not have any historical information. On the other hand, both old and new customers benefit from $S$-customization. Thus, it is intuitive that $H$-customization, but not $S$-customization, relaxes competition (i.e. each firm focuses on customer retention rather than customer acquisition). However, in our analysis, we find, somewhat surprisingly, that both firms invest in $H$-customization only under a narrow set of parameters. This is true even though our model contrasts the two types of customization approaches in as stark of terms as possible: if both firms invest in $S$-customization (or make no investments at all) pure Bertrand competition leads to each firm pricing at marginal cost in equilibrium; if both firms invest in $H$-customization, perfect segmentation occurs and no attempt is made to poach one another’s customers. Investing in $H$-customization may not be the dominant strategy for two reasons. One, it requires a costly investment to acquire the necessary infrastructure. Two, and more importantly, investing in $H$-customization bestows a positive externality upon one’s rival since the relaxed competition benefits both firms. Since a firm does not capture the entire benefit of an $H$-customization investment, the market may not reach the cooperative outcome.

In the next subsection, we describe the previous literature and outline how our paper differs from previous work, especially in terms of research objectives. Then, we describe our key
results. In section two, we introduce our model, starting with a monopoly to highlight how each elicitation approach used for customization affects value creation. In section three, we introduce duopoly competition. We first derive the pricing equilibrium for all possible investment outcomes. Then, we analyze the reaction decision, i.e. whether firm B should invest in $H$-customization or $S$-customization (or neither) given firm A’s previous decision. Finally, we investigate the first-mover’s decision, i.e. what firm A should do given firm B’s optimal response function. Section 4 offers empirical evidence based on a survey of purchasing managers that is consistent with our analytical results. Section 5 concludes with a summary and suggestions for future research.

**Literature Review**

Prior studies have examined various techniques for soliciting preferences, e.g. attribute-based vs. alternative-based approaches (Huffman and Kahn 1998), interface design (Randall et. al. 2005, 2006), and via prototypes (Tseng, Jiao, and Su 1998; Dahan and Mendelsen 2001; Terwiesch and Loch 2004). There is also an extensive literature on how to most effectively use historical information, e.g. designing recommendation systems based on customer profiles using case-based reasoning, collaborative filtering, dynamic taxonomy hierarchy, or fuzzy logic (see Ryu 1999; Saward and O’Dell 2000; Cho, Kim and Kim 2002; Lee, Liu and Lu 2002; Yager 2003; Srikumar and Bhasker 2004). Generally speaking, customers’ willingness and ability to participate in the elicitation process will affect the optimal form of customization a firm should adopt (Gilmore and Pine 1997).\(^1\) In contrast to these aforementioned papers, we focus on

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\(^1\) Gilmore and Pine (1997) identify several different ways to customize. Their terms collaborative customization and adaptive customization would fall under our definition of $S$-customization. Under collaborative customization, the firm is in a dialogue with individual customers, offering them tools to help articulate their needs. Under adaptive customization, the users can alter the product for themselves. On the other hand, when describing their term transparent customization, Gilmore and Pine (1997) provide several good examples of what we have coined $H$-customization. All these examples are based on the idea that customers “do not want to be bothered with direct
competitive issues. For example, we are interested in how one’s optimal elicitation approach is affected by which elicitation approach has already been adopted by a rival.

Previous studies have considered “how much” customization a firm should do, noting that the choice is not all or nothing, but that there is instead a continuum of varying degrees of customization (Silvestro et al. 1992). In the management literature, a major concern is taking into account the increased production costs associated with offering a greater degree of customization (Selladurai 2004; Sundbo 2002). In the marketing literature, the focus has been on how the amount of customization offered by competing firms will affect the degree of rivalry and thus also profitability (Dewan, Jing, and Seidmann 2003; Syam, Ruan, and Hess 2005). In contrast, our paper is primarily concerned with what approach should be taken in the elicitation stage of the customization process. We demonstrate that the approach used can dramatically impact market interactions, i.e. it matters “what type” of customization is done, not just “how much.”

Finally, a related stream of literature studies the trade-off between efforts to increase customer retention and efforts to enhance customer acquisition. Specifically, Reinartz, Thomas and Kumar (2005) examine how to achieve the right balance between these marketing efforts. Others explore how these decisions depend upon market share (Fruchter and Zhang 2004, McGahan and Ghemawat 1994) and competitive forces (Syam and Hess 2006). Our paper adds to this literature by studying how different elicitation approaches used for customization influence the ability and willingness of a firm to pursue customer retention versus acquisition.

collaboration.” For instance, ChemStation provides soap to businesses. By studying the needs of its customers, it is able to adjust its product (pH level, enzyme concentration, odor, etc.) to meet unvoiced needs.

2 Gilmore and Pine (1997) do allude to an important characteristic of H-customization. Since the customers are not active participants, they do not learn their preferences and thus would incur switching costs to change suppliers. For instance in the ChemStation example, customers do not know the precise soap formula. This is a fundamental feature of our model when firms employ H-customization—a customer gets higher gross utility from staying with its previous supplier rather than switching to a competitor who could not make informed recommendations.
Description of the Model and Summary of Key Results

Customization is defined in differing ways throughout the prior literature. A spatial model is commonly used to capture the idea that customization allows a firm to match products to an individual customer’s taste along a particular dimension (e.g. Dewan et. al. 2003, Syam et. al. 2005). Since our focus is on the elicitation approach, consistent with Zipkin (2001)\(^3\), we believe that a fundamental aspect of customization is that it helps a customer locate her most preferred product. This product could have been found without customization, albeit after a more extensive search. Consider the oft-cited example of Dell allowing customers to design their own computers. Choices are confined to a menu, e.g. memory for notebooks can be 512MB, 1G, or 2G. Although the number of potential configurations is large, it is unlikely a given customer will want an entirely unique notebook, i.e. a configuration that Dell has never produced before. The key advantage of customization in this example is that it provides a desired notebook with minimal effort, i.e. without requiring the customer to visit numerous retailers or just “settling” for the most suitable configuration available at a particular local retailer.

Following this reasoning, and consistent with the idea of customization through personalized recommendations (e.g. Srikumar and Bhasker 2004, Randall et. al. 2006), we introduce a model based on search. Each firm offers an extensive product line. Customers differ in which product from this line that they prefer. In the absence of any effort by the firm to elicit an individual’s preferences, each customer engages in costly search. As in Lippman and McCall (1976) and McCall (1965), at each point in time, the customer faces a decision of whether to stop searching and choose the best alternative she has encountered thus far or to continue searching.

\(^3\) For example, Zipkin (2001) argues that elicitation is an “essential and difficult” component of mass customization. This is because “customers often have trouble deciding what they want and then communicating” this information to the firm. Thus, an effective elicitation process is one that “reduces the costs associated with customers’ laborious searching.”
for a better alternative. We model customization as a way to avoid search costs. If the firm employs $S$-customization, customers can avoid sequential search, but will incur additional effort (e.g. filling out surveys and/or acquiring the expertise needed to design their own products). In contrast, a firm that uses $H$-customization eliminates all transaction costs since the firm already knows what customers want without any additional effort on the part of customers. However, the firm is only able to offer personalized recommendations for customers for whom it has historical data.

Our analysis of a monopoly reveals a number of intuitive results and one somewhat unexpected result. As expected, customization is worth investing in only if search costs are sufficiently large so that the savings from reduced search outweigh the costs of implementing a specific elicitation approach. Furthermore, an elicitation approach is more likely to be preferred as the cost of implementing this approach falls and as the cost of implementing the alternative approach rises. $H$-customization will also be more preferred as the size of a firm’s historical base increases (so the required information can be collected for a greater fraction of the population) and as the customers’ effort requirement under $S$-customization rises. A somewhat surprising result is that a monopolist is biased away from $H$-customization, i.e. there are cases where efficiency would have the firm invest in $H$-customization, but the monopolist would either make no investment or invest in $S$-customization instead.

Allowing for competition, we find that joint revenue is maximized when both firms invest in $H$-customization and that joint profits are lowest when both firms invest in $S$-customization. Several other key results are: 1) a firm facing a rival has a stronger incentive than a monopolist does to invest in $H$-customization$^4$; 2) Investing in $S$-customization eliminates a

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$^4$ This result is roughly consistent with the result from Syam and Hess (2006) that a monopolist, relative to a duopolist, is less inclined to follow a retention strategy as opposed to an acquisition strategy. However, this result
rival’s incentive to invest in that same customization process and, at the same time, reduces the rival’s incentive to invest in $H$-customization; and 3) Investing in $H$-customization reduces, but does not eliminate, a rival’s incentive to invest in either customization processes. Our empirical evidence is consistent with these analytical findings, i.e. $S$-customization deters a rival’s incentive to invest in $S$-customization significantly more than $H$-customization deters a rival’s incentive to invest in $H$-customization.

Furthermore, we identify six potential “strategic” equilibria for our analytical model. The premise behind each strategy is that a firm chooses a particular action in order to induce a desired response from its rival. For example, in “Beat ‘em to the Punch” a firm may be an early adopter of $S$-customization in order to keep a rival from adopting that same elicitation approach. In this case, $S$-customization provides the first-mover with a sustainable competitive advantage. However, this strategy is optimal only if $H$-customization is sufficiently expensive else the rival could narrow or even eliminate this advantage by adopting $H$-customization. Another interesting strategy is “Be My Guest”, which is optimal if $S$-customization is very expensive and $H$-customization is only moderately expensive. Here, the first-mover does best by choosing not to customize and thus inducing the second firm to make the costly, but mutually beneficial, investment in $H$-customization. A final example illustrates the profound effect a market leader’s initial customization choice may have on the evolution of a market. In “Follow Me”, a firm invests in $H$-customization and its rival follows suit with an investment in $H$-customization of its own. In contrast, if the first-mover had chosen $S$-customization, the rival would have responded with no customization investment of its own and thus compete only on price. This suggests that a

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runs somewhat against the findings from Dewan et. al. (2003) that a duopoly under-invests in customization. There are important differences between our model and theirs (e.g. their model allows for customized prices while ours does not). But, this at least raises the possibility that the efficiency of investment incentives depends on the particular type of customization being contemplated.
firm’s choice of its elicitation approach to customization can be an important factor in determining whether a market will be highly profitable for all players in the future or whether price competition will be very fierce in that market.

2. Monopoly Model

The monopoly case serves as a benchmark that can be compared to the duopoly outcome. Such a comparison allows us to identify actions taken for competitive reasons, i.e. the strategic implications of customization, which are the focus of this paper.

Suppose a single firm offers $J$ horizontally-differentiated products, each of which is sold at a price $p$. This is consistent with the observation from Syam et al. (2005) that many customizers do not price discriminate. The unit cost of production is constant across these products and, for analytical convenience, is assumed to equal zero. We restrict our attention to the situation where $J$ approaches infinity. The number of customers is normalized to one. Customer $i$ values good $j$ at $V_{ij}$ and will consume at most one item. For all $i$, $V_{ij}$ is drawn independently from the uniform distribution on the interval $[0, 1]$. Furthermore, assume customers cannot costlessly observe their valuations. Instead, valuations are revealed only as a result of search effort. The required effort depends on the type of elicitation approach used by the firm (if any) and is outlined below.

2.1. No Customization

If the firm does not invest in either elicitation approach, then customers must screen the product offerings on their own. Suppose that each customer incurs a cost $c$ for revealing the valuation of any particular product. Thus, a customer who makes a purchase after sampling $n$...
products will earn a net customer surplus of:  

\[ CS_n = \text{Max} \left[ V_1, V_2, \ldots, V_n \right] - n \cdot c - p \]  

For notational convenience, we have dropped the customer subscripts.

Standard analysis (e.g. Lippman and McCall 1976, McCall 1965) reveals that each customer maximizes his or her expected surplus by following an optimal stopping rule, i.e. continue searching until one receives a value of at least \( \bar{V} \). The optimal threshold is found by equating the cost of searching one more time (\( c \)) to the expected increase in value created by the additional search \( \int_{x=0}^{\bar{V}} (x-\bar{V}) \, dx \). Thus, the optimal stopping rule is:

\[ \bar{V} = 1 - \sqrt{2c} \]  

Following this strategy, each customer earns an expected surplus of \( 1 - \sqrt{2c} - p \).

Customers are willing to search only if \( p \leq 1 - \sqrt{2c} \). The monopolist maximizes its profit by choosing \( p = 1 - \sqrt{2c} \). Since all customers purchase one item at this price, the firm’s profit in the absence of any investment is:

\[ \Pi_M^\otimes = 1 - \sqrt{2c} \]  

For the remainder of the paper, we assume \( c < \frac{1}{2} \) so that positive profits are attainable in the absence of any investment.

2.2. S-customization

The monopolist can reduce customers’ search costs by implementing “solicited” customization. This requires a lump-sum investment of \( T_s \). Here, the firm offers customers the

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\(^6\) Technically, this specification assumes search is conducted with recall. However, this is not a critical assumption since no customer will choose to consume a previously rejected option. Thus, the cases of no recall and perfect recall are identical (see Lippman and McCall 1976).
opportunity to identify their preferred item without searching product-by-product. The firm learns a customer’s tastes by having the customer answer a series of questions. See Huffman and Kahn (1998), Randall et. al. (2005), and the papers cited therein for discussion of how best to solicit the necessary information. This current paper is ambivalent as to what type of data is collected, e.g. responses to a series of preference tests, reactions to prototypes, user-specified preferred attribute levels, or surveys of tastes. Suppose that a customer who completes the required tasks incurs a cost of $E$. For a customer to be willing to provide the solicited information rather than searching on her own, we must have:

$$E \leq \sqrt{2c}$$  \hspace{1cm} (4)

Throughout this paper, we assume condition (4) is met so that $S$-customization has potential value. Furthermore, consistent with Dewan et. al. (2003), we assume the collected information allows the firm to identify the customer’s most preferred product. With an infinite number of choices from the value distribution, the firm can find a product that is valued at 1. Thus, the customer earns a net surplus of $1 - E - p$. The profit-maximizing price is: $p = 1 - E$. The firm earns a profit of:

$$\Pi^S_M = 1 - E - T_S$$  \hspace{1cm} (5)

2.3. $H$-customization

A second approach to customization is based on data from the historical observation of customers. The firm uses information it has collected from past shopping behavior (e.g. past purchases of related and unrelated items, browsing behavior) to construct a customer profile that can be used to identify a customer’s most preferred product (as Srikumar and Bhasker (2004)

\footnote{This assumption is based on the idea that $S$-customization requires a significant up-front investment in the appropriate infrastructure, interfaces, and algorithms. This is consistent with Dewan et. al. (2003) which models the cost of “gathering and processing information” as a fixed cost.}
and the literature cited therein describe). Notice that this does not require any effort on the part of the customer.\(^8\) We assume this elicitation approach can be implemented at a cost \(T_H\) without any associated per-customer costs. For example, the process may be entirely automated, thus requiring an elaborate infrastructure, but approximately zero user-specific costs.

Since customers have heterogeneous tastes, recommendations from this type of customization are valid only if the firm has an established relationship with the particular user. We assume such a relationship exists with a proportion \(\alpha_m\) of the population. Furthermore, we assume that predictions based on these relationships are perfect, i.e. they allow the firm to find a product of value 1 for each of these customers. Since \textit{H-customization} requires no effort on the part of customers, a customer’s surplus from purchasing this recommended item equals \(1 - p\).

The firm maximizes profit on this segment by choosing \(p = 1\) and thus earns a profit of:\(^9\)

\[
\Pi_M^H = \alpha_m - T_H
\]

\((6)\)

2.4. The Customization Choice

The monopolist chooses \textit{H-customization}, \textit{S-customization}, or no customization depending on which action yields the highest profit. The profit-maximizing choices are outlined below:

- \textit{No Customization} if \(T_S \geq \sqrt{2c} - E\) and \(T_H \geq \sqrt{2c} + \alpha_m - 1\)
- \text{Choose} \textit{S-customization} if \(T_S < \sqrt{2c} - E\) and \(T_S \leq 1 - \alpha_m + T_H - E\)
- \textit{H-customization} if \(T_H < \sqrt{2c} + \alpha_m - 1\) and \(T_S > 1 - \alpha_m + T_H - E\)

Figure 1 illustrates these results. The location and size of each region is very intuitive.

\(^8\) Similarly, but in a much-different context, Hagel and Singer (1999) argues that electronic agents can make recommendations based on historical information and thus drastically lower customers’ search costs.

\(^9\) If \(\alpha_m\) is sufficiently small, the firm would prefer a price of \(1 - \sqrt{2c}\) (instead of \(p = 1\)) in order to sell to all customers. But, in this case, the \textit{H-customization} increases the firm’s costs without enhancing revenue and thus cannot be the optimal strategy.
For example, a monopolist employs *S-customization* if the implementation cost of *S-customization* is sufficiently cheap, the implementation cost of *H-customization* is sufficiently expensive and the search costs in the absence of either customization approach are sufficiently high. Furthermore, *S-customization* is less likely to be employed as the size of the firm’s database, $\alpha_M$, increases (and thus *H-customization* is more valuable) and as the effort required during the solicitation procedure ($E$) increases (and thus *S-customization* is less valuable).

An interesting result is that a monopolist does not always invest in *H-customization* when it is socially optimal to do so. To see this, note that under *No Customization* and *S-customization* a monopolist is able to extract the entire surplus that is created. For example, when a monopolist has *S-customization*, it offers this tool to all customers, as would be efficient to do, and sets a price equal to customers’ common expected net value. However, the monopoly outcome does not match the welfare-maximizing outcome when *H-customization* is available. Recall that in this case a monopolist only sells to customers with whom it has a historical relationship. However, the social optimum prescribes that the remainder of the population would also purchase the product, but through traditional search. This does not occur under a monopoly because high prices ($p = 1$) discourage purchases by this segment. Specifically, the social optimal would create a total surplus of $W_{SO}^H = \alpha_M \left( 1 - \alpha_M \right) \left( 1 - \sqrt{2c} \right) - T_H$ which exceeds the profit a monopolist earns (eq. (6)). Thus, there are parameters such that the monopolist invests in *S-customization* or no customization, whereas the efficient outcome would utilize *H-customization*.

**3 Competition**

Now suppose a firm faces competition. In particular, there are two firms, $A$ and $B$, both of which sell $J$ items, where $J$ again approaches infinity. Customers purchase at most one item in total. All item valuations are drawn from U[0,1]. Thus, a randomly selected item from firm $A$ has
the same expected value as a randomly chosen item from firm $B$. However, to account for the differences in databases that firms have, we assume that firm $B$ has an historical relationship with a proportion $\alpha_B$ of the population, whereas firm $A$ has previously interacted with the remaining $1 - \alpha_B$ proportion of the population. This is obviously an oversimplification. We employ this assumption to highlight the ability of $H$-customization to mitigate price competition. However, the benefit from reduced rivalry would be lessened if databases partially overlap or if there are customers that are in neither database.

Customization decisions may have a long-term strategic component and cannot easily be adjusted over short time horizons (at least not as easily as prices can be). Thus, consistent with Syam et. al. (2005), we model these decisions in a sequential manner. First, firm $A$ makes its customization decision ($D_A = S, H,$ or $\emptyset$). Second, firm $B$ makes its customization decision ($D_B = S, H,$ or $\emptyset$).\(^{10}\) Third, firms $A$ and $B$ choose prices ($p_A, p_B$) independently and simultaneously. We solve the game backwards, first deriving the pricing equilibrium given the customization decisions and then considering a firm’s choice of which customization approach to take.

3.1. Pricing

Prices depend on the type of customization used by each firm. Table 1 summarizes the equilibrium prices for each possible permutation of ($D_A, D_B$). A full derivation of equilibrium prices is provided in the appendix. For illustration purposes, we examine a few cases in the text:

1. $D_A = D_B = \emptyset$. Since an expected value of a draw from either firm is identical for all customers (regardless of the number and realizations of previous draws), all customers will buy from the firm with the lowest price provided that $p_i \leq 1 - \sqrt{2c}$. This is standard

\(^{10}\) This sequential structure for customization decisions is consistent with the argument in Dewan et. al (2003) that firms differ in “their readiness to adopt new technologies.”
Bertrand competition with the well known unique pricing equilibrium at $p_A = p_B = 0$.

2. $D_A = D_B = S$. Again, all customers view the firms as perfect substitutes, i.e. purchasing from firm $A$ yields an expected surplus of $1 - E - p_A$ and purchasing from firm $B$ yields an expected surplus of $1 - E - p_B$. The unique pricing equilibrium is $p_A = p_B = 0$. Thus, neither firm is able to recover its sunk investment in \textit{S-customization}.

3. $D_A = D_B = H$. Here, customers view the two firm’s product offerings quite differently since only the firm with historical information is able to offer a personalized recommendation and thus allow the customer to avoid costly search. For example, a segment of size $\alpha_B$ earns an expected surplus of $1 - p_B$ if it purchases from firm $B$ and an expected surplus of $1 - \sqrt{2c} - p_A$ if it purchases from firm $A$. There is a pure-strategy equilibrium at the prices $p_A = p_B = 1$ as long as condition (8) is met:

$$c > \frac{(\text{Max}[\alpha_B, 1 - \alpha_B])^2}{2}$$

(8)

Condition (8) ensures that it is not profitable for either firm to try to poach each other’s customers. We are interested in environments where search costs are sizeable enough to warrant investment in customization technologies. Thus, we assume condition (8) holds throughout the remainder of the paper.

In the cases where only one firm invests in \textit{H-customization}, there is not a pure-strategy pricing equilibrium. Instead, the pricing equilibrium involves mixed strategies. The appendix details the derivation of these equilibria. However, it is relevant to note here that the analysis relies on an additional assumption:
Thus, our results only apply when \textit{S-customization} imposes non-trivial costs on customers.

3.2. The Reaction Decision

Now, we consider the second stage of the game: firm \( B \)'s customization decision given \( D_A \). Firm \( B \) chooses \( D_B \) to maximize its profit, anticipating what the pricing equilibrium will be given \( D_A \) and \( D_B \). Table 1 provides the expected profit, net of investment costs, for each possibility. For example, for \( D_A = \emptyset \), focus on column 1 of Table 1. Firm \( B \) will choose \textit{No Customization} if both conditions (10a) and (10b) are met:

\[
T_s \geq \sqrt{2c} - E \quad (10a)
\]

\[
T_H \geq \alpha_b \left(1 - \alpha_b \left[1 - \sqrt{2c} \right]\right) = \hat{H}_\emptyset \quad (10b)
\]

Firm \( B \) will choose \textit{S-customization} if both conditions (11a) and (11b) are met:

\[
T_s < \sqrt{2c} - E \quad (11a)
\]

\[
T_s \leq T_H + \sqrt{2c} - E - \alpha_b \left(1 - \alpha_b \left[1 - \sqrt{2c} \right]\right) \quad (11b)
\]

Firm \( B \) will choose \textit{H-customization} if both conditions (12a) and (12b) are met:

\[
T_H < \hat{H}_\emptyset \quad (12a)
\]

\[
T_s > T_H + \sqrt{2c} - E - \alpha_b \left(1 - \alpha_b \left[1 - \sqrt{2c} \right]\right) \quad (12b)
\]

On the other hand, if firm \( A \) invested in \textit{S-customization} (2\textsuperscript{nd} column of Table 1), it is never optimal for firm \( B \) to also invest in \textit{S-customization}. Instead, \( B \) will invest in \textit{H-customization} only if condition (13) is met:

\[
T_H < \alpha_b \left(1 - \alpha_b \left[1 - E \right]\right) = \hat{H}_S \quad (13)
\]
If this inequality is violated, firm B will choose not to invest in either customization approach.

Finally, if firm A has invested in *H-customization*, firm B will choose *No Customization* if both conditions (14a) and (14b) are met:

\[ T_s \geq \alpha_B \left( \sqrt{2c} - E \right) \]  
\[ T_H \geq \alpha_B \sqrt{2c} \equiv \hat{H}_H \]  

Firm B will choose *S-customization* if both conditions (15a) and (15b) are met:

\[ T_s < \alpha_B \left( \sqrt{2c} - E \right) \]  
\[ T_s \leq T_H - \alpha_B E \]  

Firm B will choose *H-customization* if both conditions (16a) and (16b) are met:

\[ T_H < \hat{H}_H \]  
\[ T_s > T_H - \alpha_B E \]  

**Discussion**

The presence of a rival and that rival’s ability to offer customized recommendations dramatically affects what approach to customization will be optimal for a firm. Consider the case where firm A does not customize. Figure 2 illustrates the optimal response by firm B. The key characteristic to note is that, holding the availability of historical information constant, a firm that faces a rival is more likely to invest in *H-customization* than it would in the absence of competition.\(^{11}\) To see this, note that \( \hat{H}_\otimes > \hat{H}_M \) (as defined in equations (7) and (10b), respectively) when \( \alpha_M = \alpha_B \). If neither firm customizes, price competition is intense since the

---

\(^{11}\) This suggests that incentives for investing in *H-customization* are more closely aligned to the socially-efficient conditions when there is competition. However, this effect is counter-balanced by the fact that competition leads to inefficiencies in distribution, i.e. there is a positive probability that customers who are offered a customized recommendation will engage in costly search in order to purchase from firm A at a significantly lower price.
firms sell undifferentiated products. Investing in \textit{H-customization} not only allows a firm to reduce customers’ search costs, it also provides a credible mechanism to mitigate competition by creating distinct segments of the population. Note that this advantage exists even though perfect segmentation cannot be achieved, i.e. the resulting pricing equilibrium involves mixed strategies in which firm \( A \) sells to \( B \)’s historical customer base with some positive probability. Thus, \textit{H-customization} reduces the degree of rivalry but does not eliminate it altogether. This benefit does not apply to investments in \textit{S-customization}. This type of customization also reduces customers’ search costs and thus allows firm \( A \) to sustain higher prices. However, all customers view the trade-off between purchasing from firm \( A \) and purchasing from firm \( B \) in the same way. Therefore, no finer segmentation of the population occurs.

Figure 3 illustrates the optimal response by firm \( B \) if firm \( A \) possesses \textit{S-customization}. The most glaring observation is that firm \( B \) should never respond by also investing in \textit{S-customization}. Such an investment would create fierce competition that drives prices down to marginal cost. Firm \( B \) would strictly prefer not to make any investment (and thus avoid the investment cost \( T_S \)). Furthermore, \( A \)’s investment in \textit{S-customization} also discourages \( B \) from investing in \textit{H-customization} since \( \hat{H}_S < \hat{H}_\phi \). To see this inequality is true, calculate

\[
\hat{H}_\phi - \hat{H}_S = \alpha_b^2 \left( \sqrt{2c - E} \right) > 0
\]  

(17)

The implication of this result is quite interesting. Firm \( A \) is very formidable if it has \textit{S-customization}. Often, the best response is to remain still, thus allowing firm \( A \) to maintain a competitive advantage. It is only prudent for firm \( B \) to invest in \textit{H-customization} if this customization approach is cheap and its historical base is sufficiently large.

Figure 4 illustrates the optimal response by firm \( B \) if firm \( A \) possesses \textit{H-customization}. A
critical feature of this graph is that the size of the “Invest in S-customization” region is smaller in Figure 4 than in Figure 2. To see this, compare conditions (11a) and (15a). Choosing S-
customization will require smaller $T_S$ for the case when the firm faces a rival who has H-
customization. Furthermore, such an investment by a rival also expands the No Customization region downward since $\hat{H}_\emptyset - \hat{H}_H = \alpha_B (1 - \alpha_B) (1 - \sqrt{2c}) > 0$. Thus, firm A’s investment in H-
customization reduces, but does not eliminate, B’s incentive to invest in S-customization.

Furthermore, firm B is less likely to invest in H-customization if firm A has already made such an investment (rather than if it had done nothing). The reason for this is as follows. Firm A’s investment in H-customization, has a first-order effect of mitigating cutthroat competition by creating two distinct segments of customers. A second investment in H-customization by firm B could crystallize this segmentation, i.e. move the market from a mixed strategy equilibrium in which leakage between segments may occur to a pure-strategy equilibrium in which each firm only sells to its historical base at their reservation value. But, the benefit of this second investment is not as large as the value from the initial investment. Thus, when such investments involve substantial costs, firm B may “settle” for imperfect segmentation.

3.3. Strategic Motivations for Customization

Having characterized the outcome of the second and third stages of the game, we can now consider the first stage, i.e. firm A’s investment choice. In particular, firm A chooses $D_A = S$, H, or $\emptyset$ to maximize its profit, anticipating B’s best response, $D_B(D_A)$. In this section, we outline several “strategies” that may be optimal for firm B given various sets of parameters. We should be clear that we are not attempting to describe all possible equilibrium outcomes. For example, we will not examine “non-strategic” parameter configurations. By “non-strategic”, we mean those situations where firm A’s investment choice is not meant to affect B’s investment decision.
in the second stage. For instance, if \( T_S \) is sufficiently large and \( T_H \) is sufficiently small, firm \( B \) will invest in \textit{H-customization} regardless of firm \( A \)’s decision in the first stage (see Figures 2-4) and thus \( B \)’s action does not influence \( A \)’s subsequent choice.\(^{12}\)

Table 2 presents six strategic motivations for customization. In the appendix, we outline the conditions required for each of these respective strategies to be optimal. In the text, we provide numerical examples to illustrate these six strategies and to serve as verification that the prescribed parameter spaces are non-empty.

**Strategy\#1: “Take Your Pick”:** Firm \( A \) uses its first-mover advantage to secure the most cost efficient customization approach for itself.

\[ \text{Example: } \alpha_B = .5 , \, c = .2 , \, E = .5 , \, T_S = .05 , \, T_H < .3 . \]

Under these parameters, both customization approaches are relatively cheap. Firm \( B \) will invest in whichever approach firm \( A \) does not choose. Thus, the final outcome will involve one firm investing in \textit{S-customization} and the other investing in \textit{H-customization}. By moving first, firm \( A \) can choose whether to be the \textit{S-customization} player or the \textit{H-customization} player.\(^{13}\) In this particular example, the \textit{S-customization} firm earns a net profit of .2 and the \textit{H-customization} firm earns a net profit of .375 - \( T_H \). Thus, firm \( A \) chooses \( D_A = S \) if \( T_H > .175 \) and chooses \textit{H-customization} if \( T_H < .175 \).

**Strategy\#2: “Beat ‘em to the Punch”:** Firm \( A \) takes a dominant industry position by adopting \textit{S-customization} before firm \( B \) does.

\[ \text{Example: } \alpha_B = .5 , \, c = .2 , \, E = .5 , \, T_S < .066 , \, T_H > .342 . \]

For these parameters, \textit{S-customization}

\(^{12}\) Such non-strategic decisions have already been analyzed in section 3.2.

\(^{13}\) Strategy \#1 is similar to the result in Syam and Hess (2006) that the first mover can benefit by forcing a rival to adopt the less profitable strategy. However, in the current model, depending on the parameters, either customization approach may be the preferred one. And, one is only assured that the rival will choose the opposite strategy only under a constrained set of market situations.
is viable (for one firm). The firm that adopts $S$-customization earns a positive net profit while the non-adopter earns zero profit. Firm $A$, by moving first, secures positive profit for itself and, in the process, puts firm $B$ at a severe competitive disadvantage.

**Strategy#3: “Beat ‘em to the Punch with a Helping hand”**: Firm $A$ prevents an attack by firm $B$ by adopting $H$-customization, which actually improves the profit of Firm $B$.

*Example:* $\alpha^A = .35$, $c = .2$, $E = .5$, $T_S = .1$, $T_H = .4$. Because of the skewed amount of historical data – a necessary condition is $\alpha^A < .5$ – $H$-customization is viable for firm $A$ but not for firm $B$. If firm $A$ does not invest in either customization approach, firm $B$ will choose $S$-customization and take the dominant position in the industry. Firm $A$ can prevent this investment by choosing either type of customization. It chooses the one that yields the highest profit for itself, which is $H$-customization for these parameters. This choice has a positive spillover effect on Firm $B$ because it relaxes competition. Firm $B$ may even receive a disproportionate share of the net benefit, e.g. with these particular parameters, equilibrium profit (net of investment costs) is .095 for firm $A$ and .129 for firm $B$.

**Strategy#4: “Be My Guest”**: Firm $A$ foregoes the opportunity to adopt $H$-customization, leaving it for firm $B$ to adopt.

*Example:* $\alpha^B = .5$, $c = .2$, $E = .5$, $T_S = 1$, $T_H = .35$. $S$-customization is prohibitively costly, but $H$-customization is of moderate expense – low enough to be warranted by one firm but high enough to dissuade a second firm from investing in it. Thus, either firm $A$ or firm $B$ will invest in $H$-customization. In a somewhat counterintuitive move, $A$’s best strategy is to remain still and let firm $B$ “be its guest” to this customization approach. This accommodating move is advantageous because it allows $A$ to avoid paying $T_H$ while still benefiting from the segmentation that arises when firm $B$ employs $H$-customization.
Strategy#5: “Ride My Coattails”: Firm A takes a leading industry position by adopting H-customization first, but this action allows Firm B to be a free-rider.

Example: $\alpha_B = .35, c=.2, E = .5, T_S = 1, T_H = .25$. Similar to “Be My Guest”, S-customization is prohibitively costly and H-customization is only viable for a single firm. But, for these parameters, firm A achieves higher profit by investing in H-customization (rather than leaving this customization approach to its rival). Firm B benefits from the ensuing reduction in price rivalry without making an investment of its own. Although this may seem like an “expected” result (in contrast to “Be My Guest”), we should stress that this strategy is only optimal for a more stylized setting. For example, it requires a skewed amount of historical data, i.e. $\alpha_B < .5$, and a lower range of $T_H$.

Strategy#6: “Follow Me”: Firm A guides the industry to a cooperative outcome by adopting H-customization first.

Example: $\alpha_B = .5, c=.4, E = .5, T_S = .3, T_H = .4$. Firm A essentially has two choices: 1) play aggressively by choosing $D_A = S$ and thus discouraging any investment (and associated profit) by $B$; or 2) play accommodating by choosing $D_A = H$ and thus inducing firm $B$ to also invest in H-customization. For these specific parameters, the second choice leads to higher profits for firm $A$. $A$’s decision has a dramatic impact on the evolution of the market. The “Follow Me” strategy guides the market to a conciliatory outcome in which each firm earns a profit of .1; whereas choosing $D_A = S$, which would be optimal for $T_S < .294$, leads the market down a path of fierce competition in which firm $B$ earns zero profit.

4. Empirical Results

Since our focus is on the competitive implications of customization approaches, most
aspects of our analytical model are related to the dynamics of the choices between $H$-
 customization and $S$-customization by competing firms. Testing all aspects of our analytic model
 would involve collecting extensive survey and archival firm-level data that is well beyond the
 scope of the current paper. For example, note that our model predicts that the choice of which
 customization approach, if any, to invest in should depend on the relative cost of implementing
 each approach, the amount of historical information one (and one’s rival) has amassed, the effort
 required under solicited customization, the sequence of customization approaches chosen by
 competitors, and the level of investment by rivals on these respective customization approaches.
 Collecting data to measure each of these factors for different firms in different industries over
 time can be a fruitful avenue for future empirical research. For this paper, as a compromise
 between offering a full test of the theory and remaining a purely theoretical paper, we offer an
 empirical test to examine the main theoretical results.

 In particular, we survey purchasing managers to test how $S$-customization and $H$-
 customization differ in influencing a rival’s incentive to invest in customization. Our analytical
 model suggests that an investment in $S$-customization precludes a rival’s investment in $S$-
 customization. In contrast, an investment in $H$-customization reduces but does not eliminate a
 rival incentive to invest in $H$-customization. Together these two results imply that a firm is less
 likely to emulate a rival firm's $S$-customization approach than the rival firm's $H$-customization
 approach. This leads to the following proposition that can be tested at the cross-sectional level:

 **Proposition:** The difference between the levels of $H$-customization between two competitors
 is likely to be lower than their difference in $S$-customization.

 This proposition is a fundamental outcome of the dynamic postulates of our analytical model
 and, prior to this current paper, would not have been expected. For instance, extant research
 might have predicted that customization decisions would be correlated across firms within a
particular industry, e.g. due to industry-specific costs and/or demand characteristics\(^{14}\), or that customization decisions would be inversely correlated among rivals, i.e. one firm’s customization crowds out a rival (consistent with Dewan et. al. 2003). However, prior to this current paper, it would not be clear why a rival would emulate one approach to customization more frequently than another approach to customization.

To test our proposition, we surveyed a random cross-section sample of 2000 purchasing managers.\(^{15}\) Perceptions of purchasing managers are particularly relevant for our research objectives because observations from purchasing managers can reflect how much information is solicited from them by different suppliers when they make purchases (thus enabling us to measure \textit{S-customization}). In addition, purchasing managers normally are well informed about alternative suppliers since they are fully responsible for the purchase of a particular product or product line (thus enabling us to also construct measures of \textit{S-customization} for rival suppliers).

Each purchasing manager was contacted by email and directed to complete an online survey via a website link. They were asked to list the products that they were responsible for purchasing and to provide information about two suppliers of each product. After accounting for the undeliverable email addresses, the response rate was 10.4\% and we received a total of 189 responses with information on 398 pairs of buyer-supplier relationships (consisting of 216 different product types). For each relationship, the purchasing manager assessed both the amount of total customization and the amount of \textit{S-customization} employed by each supplier using a

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\(^{14}\) Even the degree of \textit{S-customization} would be correlated across firms within a given industry if investing in \textit{S-customization} were simply a cost of doing business (as would be predicted by the model if \(c > \frac{1}{2}, T_S \) is relatively small and \( T_H \) is relatively large). As a side-note, this implies that we cannot test our model with simple correlations of \textit{S-customization}, \textit{H-customization}, or total customization among market participants, i.e. one would need to control for industry-level characteristics.

\(^{15}\) These industrial buyers were drawn from the two-digit Standard Industrial Classification codes 20-23 (Manufacturing), 24-34 (Material), and 35-39 (Equipment), and 52-59 (Retail Trade).
Table 3 gives the descriptive statistics of our data. The “focal” supplier refers to the supplier identified by a buyer as his/her current supplier of a particular product. The “alternative” supplier refers to the supplier identified by a buyer as “any other supplier” that supplies the same products as the focal supplier. The relative degree of \textit{S-customization} reported by the purchasing manager is used as the appropriate ratio of the two customization approaches. For example, if the total customization is reported as 3 (on a scale of 5) and the extent of \textit{S-customization} is reported at 4 (on a scale of 5), then \( S_i \) is calculated as \( 4/5 \) of 3, i.e. 2.4. \textit{H-customization} is calculated as the difference between total customization and the amount of \textit{S-customization} employed, i.e. we implicitly assume that all customization involves either \textit{S-customization} or \textit{H-customization}. Therefore, in the above example, \( H_i \) is 0.6.

For each complete buyer-product pair, we calculate the following construct:

\[
    z = |H_{\text{focal}} - H_{\text{alternative}}| - |S_{\text{focal}} - S_{\text{alternative}}|
\]  

(18)

Based on our proposition, we expect \( z < 0 \), i.e. we expect more variation in the degree of \textit{S-customization} employed by a focal supplier and alternative supplier than we do for \textit{H-customization}. Consistent with this conjecture, this difference score was significantly negative (\( z = -.29 \), t-value = -5.28, \( p < .001 \)). Thus, the survey results strongly support the proposition.

\[\text{\textsuperscript{16}}\]

\[
\text{\textsuperscript{16}}\text{Specifically, respondents were given a definition of customization: “efforts made by suppliers to reduce buyers' efforts to shop and purchase their (buyers') ideal products. Based on this definition, your suppliers can sell tailor-made products/services and/or standard products/services to your company as long as they make efforts to reduce your company's efforts to locate the desired products;” Then, respondents assessed the degree of customization from “No (or very little) Customization” to “A very high amount of Customization.” Respondents were then told: “Suppliers can design their customization strategies based on different types of information they have obtained. For example, information can be obtained directly from asking/surveying buyers at the time of sale, or indirectly through various other resources prior to the time of sale (e.g., suppliers can ascertain indirect information from previous interactions and/or from third parties).” Finally, respondents were asked “Generally speaking, how much information does Supplier 1 directly ask or survey your company at the time of sale?”}
\]
5. Concluding Remarks

This paper explores how competitive factors affect whether a firm should attempt to offer customized recommendations and what type of approach should be chosen to elicit preferences. We find that customization approaches already adopted by one’s rivals have important impact upon one’s current decisions. In particular, a firm has less incentive to invest in customization if a rival has already done so (consistent with the results from Dewan et. al 2003). One is particularly discouraged from investing in customization if a rival’s customization process relies on information collected at the time of sale (rather than from a historical database).

This suggests that there is an opportunity to behave strategically, i.e. with the intent of influencing subsequent choices by rivals, when deciding what customization technologies to pursue (e.g. developing more efficient ways to utilize click-stream data or developing more efficient surveys to solicit customer preferences). Such investments could be made for defensive purposes. For example, one may benefit from trying to preempt a rival’s investment in customization technology based on time-of-sale information. Customization can also be used as an offensive strategy in order to secure a long-term competitive advantage (either because rivals will then forego customization – as in “Beat ‘em to the Punch” and “Beat ‘em to the Punch with a Helping Hand” – or because rivals will then adopt the less cost-efficient customization approach – as in “Take Your Pick”). Not customizing may also be a viable strategy. For example, as the technology to conduct $H$-customization becomes available to an industry, a firm may want to “play dumb”, e.g. by sending signals that it is unprepared or unwilling to adopt this new technology, in an effort to lure rivals into undergoing the costly investment instead (as in

\[ \alpha_B = .45 , c = .2 , E = .5 , T_S < .132 , T_H > .349 \] and \[ .243 < T_H - T_S < .306 \].

\[ 17 \text{ For instance, in the “Beat ‘em to the Punch” strategy, } H\text{-customization may be more cost-effective than } S\text{-customization. Still, one chooses to invest in } S\text{-customization in order to prevent one’s rival from adopting this approach (because } S\text{-customization, but not } H\text{-customization, dissuades a rival from adopting } S\text{-customization). An example for which this occurs is: } \alpha_B = .45 , c = .2 , E = .5 , T_S < .132 , T_H > .349 \text{ and } .243 < T_H - T_S < .306 . \]
“Be My Guest”). Finally, investing in customization can be an opportunity to shepherd an industry in a desired direction. For instance, adopting customization based on historical information from existing customers can encourage rivals to follow suit and thus lead to less price rivalry (as in “Follow Me”).

The model in this paper could be extended in a number of directions. First, the current paper assumes that firms cannot customize prices. In some circumstances, it may be possible to vary prices according to the degree to which customization is possible, e.g. a firm with \textit{H}\text{-customization} charging high prices to customers for which it has extensive information about their preferences (and thus can make more accurate recommendations), moderate prices to customers for which it has less extensive information, and low prices to new customers. It is unclear how price customization will affect the incentive to adopt \textit{H\text{-customization}}. On the one hand, a firm with \textit{H\text{-customization}} no longer necessarily forfeits its appeal to novice customers. But, on the other hand, it seems that \textit{H\text{-customization}} becomes less able to mitigate price competition.

Second, a greater degree of dynamics could be added to the current model. For example, a firm that employs \textit{S\text{-customization}} may be able to reduce the required effort ($E$) in future interactions, as less information needs to be solicited (Brady et. al. 2000). Furthermore, if a firm had the ability to do both forms of customization – which is ruled out in the current paper – then it may be possible to follow evolving strategies, e.g. attract new customers with \textit{S\text{-customization}} and then utilize \textit{H\text{-customization}} once sufficient history with those customers has been accumulated.

Third, many other issues ignored in the current model may affect the incentive to adopt \textit{H\text{-customization}} or \textit{S\text{-customization}}. For instance, privacy issues may arise under \textit{H\text{-customization}} or \textit{S\text{-customization}}.
customization. Thus, it would be important to consider whether customers are willing to have historical information collected and used. Implementation through third party may be a potential solution (Hagel and Singer 1999). Finally, customers may prefer to be more involved in the process, rather than being simply told what their preferred product is (Huffman and Kahn 1998). In practice, it seems likely that customers need some assurance that the recommended product is indeed more preferred to the available alternatives.

The empirical study presented in this paper should be viewed as preliminary. As such, there are many directions left for future research. First, in the present survey, we are unable to track the dynamics of customization choices. It would be very interesting to use field experiments and/or longitudinal data to track the impact of firms’ investment decisions on subsequent prices, profit and/or customization choices of rivals. Second, the survey collected a limited amount of data. It would be interesting for future research to look for commonalities and asymmetries that arise across industries. In particular, the model predicts that the cost of each type of customization, the effort required from customers under $S$-customization, and a firm’s historical market share will impact customization choices. A more extensive data set may be able to test for these hypothesized relationships and uncover new ones.
Appendix

Derivation of the Pricing Equilibrium

The pricing equilibria reported in Table 1 are derived below. We only present the results for the cases on or above the diagonal because the cases below the diagonal are symmetric to the cases above the diagonal.

\[ D_A = D_B = \emptyset \]

A customer earns a surplus of \(1 - \sqrt{2c} - p_A\) by purchasing from firm A and a surplus of \(1 - \sqrt{2c} - p_B\) by purchasing from firm B. Assuming ties split demand equally, the demand faced by firm A is:

\[
D(p_A) =
\begin{cases} 
0 & \text{if } p_A > p_B \text{ or } p_A > 1 - \sqrt{2c} \\
\frac{1}{2} & \text{if } p_A = p_B \text{ and } p_A \leq 1 - \sqrt{2c} \\
1 & \text{if } p_A < p_B \text{ and } p_A \leq 1 - \sqrt{2c}
\end{cases}
\]  
(A1)

Firm A’s profit is \(p_A D(p_A)\). Thus, A’s best response is \(p_A(p_B) = p_B - \varepsilon\) where \(\varepsilon\) is an arbitrary small number. As is well-known, the equilibrium of this duopoly game converges to \(p_A = p_B = 0\) and each firm earns zero profit.

\[ D_A = D_B = S \]

A customer earns a surplus of \(1 - E - p_A\) by purchasing from firm A and a surplus of \(1 - E - p_B\) by purchasing from firm B. Thus, firm A faces demand:

\[
D(p_A) =
\begin{cases} 
0 & \text{if } p_A > p_B \text{ or } p_A > 1 - E \\
\frac{1}{2} & \text{if } p_A = p_B \text{ and } p_A \leq 1 - E \\
1 & \text{if } p_A < p_B \text{ and } p_A \leq 1 - E
\end{cases}
\]  
(A2)

A’s best response is \(p_A(p_B) = p_B - \varepsilon\). Again, the equilibrium of this duopoly game converges to \(p_A = p_B = 0\). Each firm earns a profit of \(-T_S\).

\[ D_A = D_B = H \]

Customers for which firm A has historical information, a segment of size \(1 - \alpha_a\), earn a surplus of \(1 - p_A\) if they purchase from firm A and a surplus of \(1 - \sqrt{2c} - p_B\) if they purchase from B. For the remaining segment (of size \(\alpha_a\)) surplus equals \(1 - \sqrt{2c} - p_A\) if they purchase from A and \(1 - p_B\) if they purchase from B. In the case of ties, we assume the customer stays with the firm with which they have had a previous relationship. Firm A’s demand is:

\[
D(p_A) =
\begin{cases} 
0 & \text{if } p_A > p_B + \sqrt{2c} \text{ or } p_A > 1 - \alpha_a \\
1 - \alpha_a & \text{if } p_B - \sqrt{2c} \leq p_A \leq p_B + \sqrt{2c} \\
1 & \text{if } p_A < p_B - \sqrt{2c}
\end{cases}
\]  
(A3)

The pure-strategy equilibrium is \(p_A = p_B = 1\) if condition (8) is met. To see this, note that firm A earns a profit of \(1 - \alpha_a\) and firm B earns a profit of \(\alpha_a\) in this pricing outcome. For this to be an equilibrium neither firm can earn higher profit by deviating from these prices. From (A3), it is obvious that the best deviation for each firm would be to the price of \(1 - \sqrt{2c} - \varepsilon\), which would result in a profit of \(1 - \sqrt{2c} - \epsilon\). Such a deviation is not profitable for firm A if \(1 - \alpha_a \geq 1 - \sqrt{2c} - \varepsilon\) and a deviation is not profitable for firm B as long as \(\alpha_a \geq 1 - \sqrt{2c} - \varepsilon\).

\[ D_A = S, D_B = \emptyset \]

Customers obtain a surplus of \(1 - E - p_A\) by purchasing from firm A and a surplus of \(1 - \sqrt{2c} - p_B\) by purchasing from B. Assuming ties are settled by buying from the firm with the customized offer, firm A’s demand is:

\[
D(p_A) =
\begin{cases} 
0 & \text{if } p_A > p_B + \sqrt{2c} - E \text{ or } p_A > 1 \\
1 & \text{if } p_A \leq p_B + \sqrt{2c} - E
\end{cases}
\]  
(A4)

29
Each firm maximizes profit by pricing just low enough to attract the entire market, i.e. $A$’s best response is $p_A(p_B) = p_A + \sqrt{2c} - E$. $B$’s best response is $p_B(p_A) = p_A - \sqrt{2c} + E$, with the constraint that firms never choose negative prices. This constraint is first to bind firm $B$. Thus, the equilibrium price is for firm $B$ to choose $p_B = 0$, to which firm $A$ responds with $p_A = \sqrt{2c} - E$. All sales go to firm $A$. Thus, $\Pi_A = \sqrt{2c} - E - T_s$ and $\Pi_B = 0$.

$D_A = H, D_B = \emptyset$

The customers for which firm $A$ has historical information, a segment of size $1 - \alpha_A$, earn a surplus of $1 - p_A$ if they purchase from firm $A$ and a surplus of $1 - \sqrt{2c} - p_B$ if they purchase from $B$. For the remaining segment of size $\alpha_A$, surplus equals $1 - \sqrt{2c} - p_A$ if they purchase from $A$ and $1 - \sqrt{2c} - p_B$ if they purchase from $B$. In the case of ties, we assume the customer stays with the firm with which they have had a previous relationship. Thus, demand faced by firm $A$ equals:

$$D(p_A) =
\begin{cases}
0 & \text{if } p_A > p_B + \sqrt{2c} \text{ or } p_A > 1 \\
1 - \alpha_A & \text{if } p_B \leq p_A \leq p_B + \sqrt{2c} \\
1 & \text{if } p_A < p_B
\end{cases} \quad (A5)$$

On the other hand, the demand faced by firm $B$ is:

$$D(p_B) =
\begin{cases}
0 & \text{if } p_B > p_A \text{ or } p_B > 1 - \sqrt{2c} \\
\alpha_A & \text{if } p_A - \sqrt{2c} \leq p_B \leq p_A \\
1 & \text{if } p_B < p_A - \sqrt{2c}
\end{cases} \quad (A6)$$

A pure-strategy equilibrium does not exist in this scenario. To see this, note that firm $A$’s best response to $p_B$ is either $p_B + \sqrt{2c} - E$ or $p_B - E$. In either case, firm $B$ could cause a discrete jump in its demand by cutting its price by $2 \varepsilon$. One might expect an equilibrium at $p_B = 0$. Such a price would induce $A$ to choose $p_A = \sqrt{2c} - E$. But, firm $B$ could make positive profits by setting $p_B = \sqrt{2c} - 2E$, thus demonstrating that $p_B = 0$ is not an equilibrium.

Thus, we must look for a mixed-strategy equilibrium. Suppose $p_A$ are drawn from the interval $[p_A^L, p_A^H]$ and continuously distributed according to the density function $f(p)$, where $p_A^L > p_A^H$. Firm $B$’s prices are distributed according to the density function $g(p)$ for the interval $[p_B^L, p_B^H]$ where $p_B^H > p_B^L$. Furthermore, we allow for the possibility that there is a mass point at $p_B^L$. Finally, assume that the following condition holds:

$$p_A^H \geq 1 - \sqrt{2c} \quad (A7)$$

This condition drastically reduces the complexity of the problem. After calculating the exact specification of $p_A^L$, we will be able to show that condition (8) guarantees that (A7) is satisfied.

If (A7) is met, firm $A$ will never sale to customers for whom it does not have historical information.

Furthermore, personalized recommendations lead to sales only if $p_A \leq p_B + \sqrt{2c}$. One immediate result is that:

$$p_A^L = p_A^H - \sqrt{2c} \quad (A8)$$

It is not optimal for Firm $B$ to put any weight on $p_B < p_A^L - \sqrt{2c}$ since all prices strictly below $p_A^L - \sqrt{2c}$ result in one unit of sales (with a probability of one). Thus, profit is strictly increasing in $p_B$ until this threshold is reached. Furthermore, it is not optimal for Firm $A$ to put any weight on $p_A < p_B^L + \sqrt{2c}$ since all prices strictly below $p_B^L + \sqrt{2c}$ result in $1 - \alpha_B$ of sales.

The expected profit for each firm is given by the following two equations:

$$E[\Pi_A] = p_A \left(1 - \alpha_B\right) \left[1 - G\left(p_A - \sqrt{2c}\right)\right] - T_H \quad (A9)$$

$$E[\Pi_B] = p_B \left[\alpha_B + (1 - \alpha_B) \left(1 - F\left(p_B + \sqrt{2c}\right)\right)\right] \quad (A10)$$
where $F(\cdot)$ and $G(\cdot)$ are the cumulative density functions of $f(\cdot)$ and $g(\cdot)$ respectively. All prices in the support must yield the same expected profit for a mixed strategy equilibrium to exist. In particular, we know that $p_{A} = p_{L}^{\alpha}$ and $p_{A} = p_{H}^{\alpha}$ must yield the same profit: $p_{L}^{\alpha}(1-\alpha_{b})\big(1-G\left(p_{L}^{\alpha}-\sqrt{2c}\right)\big)-T_{H} = p_{H}^{\alpha}(1-\alpha_{b})\big(1-G\left(p_{H}^{\alpha}-\sqrt{2c}\right)\big)-T_{H}$.

Furthermore, from (A8) we know that $G\left(p_{L}^{\alpha}-\sqrt{2c}\right) = 0$. Substituting this into the preceding equality and canceling:

$$p_{L}^{\alpha} = p_{H}^{\alpha}\left(1-G\left(p_{L}^{\alpha}-\sqrt{2c}\right)\right)$$

(A11)

Note that this implies $G\left(p_{L}^{\alpha}-\sqrt{2c}\right) < 1$. In other words, there must be a mass point above the interval $[p_{L}^{\alpha}, p_{H}^{\alpha}]$.

denoted by $p_{b}$, for which firm $B$ does not sell to $A$’s historical customers with any positive probability. To maximize profit, given that sales will only be made to $A$’s non-historical customers, firm $B$ must choose $p_{b} = 1-\sqrt{2c}$. This earns a profit of:

$$\Pi_{b} = \alpha_{b}\left(1-\sqrt{2c}\right)$$

(A12)

All other $p_{b}$ in the relevant range must earn the same profit. Specifically, at $p_{b} = p_{L}^{\alpha}$, firm $B$ will make one unit of sales and will earn the profit given in (A12). Thus, we have:

$$p_{L}^{\alpha} = \alpha_{b}\left(1-\sqrt{2c}\right)$$

(A13)

Combining (A8) and (A13) we see that $p_{L}^{\alpha} = \alpha_{b}\left(1-\sqrt{2c}\right)+\sqrt{2c}$. Substituting this equality into equation (A9) and recalling that $G\left(p_{L}^{\alpha}-\sqrt{2c}\right) = 0$, we see that firm $A$ earns an expected profit of:

$$E[\Pi_{s}] = (1-\alpha_{a})\left(1-(1-\alpha_{s})\left[1-\sqrt{2c}\right]^2\right)-T_{H}$$

(A14)

Finally, recall that throughout this derivation we assumed (A7) was satisfied. Substituting in our result that $p_{L}^{\alpha} = \alpha_{b}\left(1-\sqrt{2c}\right)+\sqrt{2c}$, (A7) reduces to the condition that $c \geq \frac{(\alpha_{b})^2}{2(1+\alpha_{b})\sqrt{2c}}$. It is easy to see that this is a weaker restriction than condition (8) since $\alpha_{b} > 0$. Thus, condition (A7) is met over the entire relevant range of parameters.

$D_{A} = H, D_{B} = S$

This scenario is very similar to the preceding case. In effect, the expected search cost associated with purchasing from firm $B$ has fallen from $\sqrt{2c}$ to $E$. Thus, the analysis proceeds exactly as above except that every $\sqrt{2c}$ that appears in equations (A5)-(A14) and the associated text should be replaced with an $E$. However, an important point to note is that condition (A7) now becomes $p_{L}^{\alpha} \geq 1-E$ where $p_{L}^{\alpha} = \alpha_{b}(1-E)+E$. Thus, the analysis assumes condition (9) is met.

**Strategic Motivations for Customization**

Here, we provide the conditions under which the six strategies identified in the text are subgame-perfect. The numerical examples in the text demonstrate that the prescribed parameter space is non-empty for each of these strategies. In addition to the conditions listed below, all examples also satisfy conditions (4), (8), and (9).

"Take Your Pick"

This strategy requires $D_{A} (D_{A} = H) = S$ and $D_{B} (D_{A} = S) = H$. Thus, we need conditions (13), (15a), and (15b) to hold. Table 1 reports firm $A$’s profit under these two scenarios. Firm $A$ chooses $D_{A} = H$ if $(1-\alpha_{b})(1-(1-\alpha_{b})(1-E))-T_{H} > (1-\alpha_{b})(1-E)-T_{s}$ or:

$$T_{s} > T_{H} + (1-\alpha_{b})\left[(1-\alpha_{b})(1-E)-E\right]$$

(A15)

If condition (A15) is not met, then $D_{A} = S$.
“Beat ‘em to the Punch”

This strategy is valid when \( D_b (D_A = S) = \emptyset \) and \( D_b (D_A = H) \neq H \). Thus, we need conditions (11a) and (11b) to hold, condition (13) to be violated, and either condition (16a) or condition (16b) to be violated. Firm A’s profit is maximized at \( D_A = S \) only if \( \sqrt{2c - E - T_s} > (1 - \alpha_b)(1 - (1 - \alpha_b)(1 - E)) - T_H \).

“Beat ‘em to the Punch (with a Helping hand)”

This strategy is valid if \( D_b (D_A = S) = \emptyset \) and \( D_b (D_A = H) \neq H \). Thus, we need condition (13) to be violated and conditions (11a), (11b), (14a), and (14b) to hold. Firm A’s profit is maximized at \( D_A = H \) only if \( \sqrt{2c - E - T_s} < (1 - \alpha_b)(1 - (1 - \alpha_b)(1 - \sqrt{2c})) - T_H \).

“Be My Guest”

This strategy requires \( D_b (D_A = \emptyset) = H \) and \( D_b (D_A = H) \neq \emptyset \). Thus, we need conditions (12a) and (12b) to hold and either condition (15a) or (15b) to be violated. Firm A’s profit is maximized at \( D_A = \emptyset \) only if (13) is violated and conditions (16a), and (16b) are met. Firm A selects \( D_A = H \) only if condition (A16) is violated. These conditions can be met only if \( \alpha_b < \frac{1}{\sqrt{2}} \). To see this, note that satisfying (14b) and violating (A16) simultaneously requires
\[
\alpha_b \sqrt{2c} < T_H < (1 - \alpha_b)\left(\sqrt{2c(2 - \alpha_b) + \alpha_b - 1}\right),
\]
which is non-empty only if:
\[
(1 - \alpha_b)\left(\sqrt{2c(2 - \alpha_b) + \alpha_b - 1}\right) - \alpha_b \sqrt{2c} > 0
\]
(A17)

This relationship is violated at \( \alpha_b = \frac{1}{2} \) since at this parameter value the LHS of (A17) becomes: \(-\frac{1 - \sqrt{2c}}{4} < 0 \).

Furthermore, taking the derivative of (A17) and evaluating at \( \alpha_b = \frac{1}{2} \) we find:
\[
\frac{\partial \text{LHS}(A17)}{\partial \alpha_b}_{\alpha_b = \frac{1}{2}} = 1 - 3 \sqrt{2c}
\]
(A18)

(A18) is negative for all \( c \) that satisfy (8). Therefore, condition (A17) cannot be satisfied for \( \alpha_b \geq \frac{1}{2} \).

“Ride My Coattails”

This strategy is valid if \( D_b (D_A = H) = \emptyset \) and \( D_b (D_A = H) = H \). Thus, we need condition (13) to be violated and conditions (16a), (16b) to be violated. Firm A chooses \( D_A = H \) only if condition (A16) is violated. These conditions can be met only if \( \alpha_b < \frac{1}{\sqrt{2}} \). To see this, note that satisfying (14b) and violating (A16) simultaneously requires
\[
\alpha_b \sqrt{2c} < T_H < (1 - \alpha_b)\left(\sqrt{2c(2 - \alpha_b) + \alpha_b - 1}\right),
\]
which is non-empty only if:
\[
(1 - \alpha_b)\left(\sqrt{2c(2 - \alpha_b) + \alpha_b - 1}\right) - \alpha_b \sqrt{2c} > 0
\]
(A17)

This relationship is violated at \( \alpha_b = \frac{1}{2} \) since at this parameter value the LHS of (A17) becomes: \(-\frac{1 - \sqrt{2c}}{4} < 0 \).

Furthermore, taking the derivative of (A17) and evaluating at \( \alpha_b = \frac{1}{2} \) we find:
\[
\frac{\partial \text{LHS}(A17)}{\partial \alpha_b}_{\alpha_b = \frac{1}{2}} = 1 - 3 \sqrt{2c}
\]
(A18)

(A18) is negative for all \( c \) that satisfy (8). Therefore, condition (A17) cannot be satisfied for \( \alpha_b \geq \frac{1}{2} \).

“Follow Me”

This strategy requires \( D_b (D_A = S) = \emptyset \) and \( D_b (D_A = H) = H \). Thus, we need condition (13) to be violated and conditions (16a), (16b) to be violated. Firm A chooses \( D_A = H \) over \( D_A = S \) only if
\[
1 - \alpha_b - T_H > \sqrt{2c - E - T_s}
\]
We also need to verify that firm A would not want to choose \( D_A = \emptyset \). For the example in the text this is easily verified since \( D_b (D_A = \emptyset) = S \) and thus this option would result in \( \Pi_A = 0 \).
Table 1 The Pricing Equilibrium and Expected Profit with Competition

<table>
<thead>
<tr>
<th>Firm A</th>
<th>No Customization</th>
<th>S-customization</th>
<th>H-customization</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No Customization</strong></td>
<td>$p_A = p_B = 0$</td>
<td>$p_A = \sqrt{2c} - E$</td>
<td>Mixed Strategy Equilibrium in prices</td>
</tr>
<tr>
<td></td>
<td>$\Pi_A = \Pi_B = 0$</td>
<td>$p_B = 0$</td>
<td>$\Pi_A = (1-\alpha_b)(1-(1-\alpha_b)(1-\sqrt{2c}) - T_H$</td>
</tr>
<tr>
<td><strong>S-customization</strong></td>
<td>$p_A = 0$</td>
<td>$p_A = p_B = 0$</td>
<td>$\Pi_A = (1-\alpha_b)(1-\alpha_b)(1-E) - T_H$</td>
</tr>
<tr>
<td></td>
<td>$p_B = \sqrt{2c} - E$</td>
<td>$\Pi_B = -T_S$</td>
<td>$\Pi_B = \alpha_b (1-E) - T_S$</td>
</tr>
<tr>
<td><strong>H-customization</strong></td>
<td>$\Pi_A = (1-\alpha_b)(1-\sqrt{2c})$</td>
<td>Mixed Strategy Equilibrium in prices</td>
<td>Mixed Strategy Equilibrium in prices</td>
</tr>
<tr>
<td></td>
<td>$\Pi_B = \alpha_b (1-\alpha_b(1-\sqrt{2c})) - T_H$</td>
<td>$\Pi_A = (1-\alpha_b)(1-E) - T_S$</td>
<td>$p_A = p_B = 1$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$\Pi_B = \alpha_b (1-\alpha_b(1-E)) - T_H$</td>
<td>$\Pi_A = 1-\alpha_b - T_H$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$\Pi_B = \alpha_b - T_H$</td>
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</table>
Table 2  Six Strategic Motivations for Customization

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Firm B’s Best Response</th>
<th>Firm A’s Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1: Take Your Pick</td>
<td>(S, H, S)</td>
<td>S if $T_H$ is high, H if $T_H$ is low</td>
</tr>
<tr>
<td>#2: Beat ‘em to the Punch</td>
<td>(S, $\emptyset$, $\emptyset$ or S)</td>
<td>S</td>
</tr>
<tr>
<td>#3: Beat ‘em to the Punch with a Helping Hand</td>
<td>(S, $\emptyset$, $\emptyset$)</td>
<td>H</td>
</tr>
<tr>
<td>#4: Be My Guest</td>
<td>(H, $\emptyset$ or H, $\emptyset$ or H)</td>
<td>$\emptyset$</td>
</tr>
<tr>
<td>#5: Ride My Coattails</td>
<td>(H, $\emptyset$, $\emptyset$)</td>
<td>H</td>
</tr>
<tr>
<td>#6: Follow Me</td>
<td>(S, $\emptyset$, H)</td>
<td>H</td>
</tr>
</tbody>
</table>

Table 3  Descriptive Statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Definitions</th>
<th>Number of Observations</th>
<th>Mean*</th>
<th>Standard Error</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>$H_{\text{focal}}$</td>
<td>Purchasing manager’s perception of focal supplier’s $H$-customization</td>
<td>216</td>
<td>1.13</td>
<td>.04</td>
<td>.64</td>
</tr>
<tr>
<td>$H_{\text{alternative}}$</td>
<td>Purchasing manager’s perception of rival supplier’s $H$-customization</td>
<td>182</td>
<td>1.16</td>
<td>.03</td>
<td>.46</td>
</tr>
<tr>
<td>$S_{\text{focal}}$</td>
<td>Purchasing manager’s perception of focal supplier’s $S$-customization</td>
<td>216</td>
<td>2.16</td>
<td>.08</td>
<td>1.21</td>
</tr>
<tr>
<td>$S_{\text{alternative}}$</td>
<td>Purchasing manager’s perception of rival supplier’s $S$-customization</td>
<td>182</td>
<td>1.75</td>
<td>.08</td>
<td>1.10</td>
</tr>
</tbody>
</table>

* Each variable is computed on a scale of 1 to 5.
Figure 1 Monopolist’s Choice of Customization Strategy

This figure is drawn assuming $\alpha_m < 1 - E$.

Figure 2 Firm B’s best reaction when neither type of customization is offered by firm A
Figure 3 Firm B’s best reaction when firm A has $S$-customization

![Figure 3 Diagram]

Figure 4 Firm B’s best reaction when firm A has $H$-customization

![Figure 4 Diagram]
References


*Omega* 32(4) 295-300.


