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Product Customization and Customer Service Costs: An Empirical Analysis

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We conduct a field study in a U.S. health insurance firm to examine how product customization affects the firm's cost to serve customers through its call center. In our setting, the product is a complex health insurance plan. The firm incurs substantial costs in serving the customers through its call center and in adjudicating the claims using its information systems. The firm sells either standard plans or in some instances allows customer groups to customize their plans by adding and modifying certain aspects in active collaboration with the firm. Such a collaboration process is akin to the firm cocreating products with its customers. This cocreation process should increase customers' familiarity with their coverage and improve the fit with their medical needs. Better fit and familiarity in turn, reduces customers' incentives to contact the call center for clarifications regarding the firm's product coverage. In particular, we show that customers with a customized plan call 21% less frequently than customers with a standard plan. Our results account for possible self-selection of customers to customized plans. We also show no difference in the claims adjudication cost between a standard and a customized plan exists. Overall, our results suggest customized plans may be operationally cheaper to serve than standard plans. Thus, our paper provides a link between a growing business concern (customer support cost via call centers) and a prevalent business strategy (product customization via cocreation).

Key words: product customization; product cocreation; health insurance; field study; customer service; product familiarity; call center
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1. Introduction

In today's competitive world, firms are increasingly trying to differentiate themselves by offering customized goods, services, and experiences to their customers. Product customization requires design of new products that begins with firms eliciting customers' needs and then selecting appropriate design parameters to create new products. Traditionally, experts who had professional training and experience to accurately match customers' needs with product design parameters performed this function. However, with the advent of the Internet, product cocreation with active customer collaboration has emerged as an effective method for product customization. The basic philosophy is to shift a part of product design toward customers because (1) customers have the best incentive to choose exactly what they need, and (2) gathering information on customers' needs is costly to the firm (von Hippel 1994, von Hippel and Katz 2002). The product cocreation process is likely to result in customized products whose attributes closely match customer needs. This process also helps customers understand their product well and thus have realistic expectations about its functionalities.

On the one hand, product customization has demand-side benefits. Customized products engender customer loyalty, reduce customer churn, raise customer willingness to pay, and so forth (Murthi and Sarkar 2003, Dewan et al. 2003, Ansari and Mela 2003, Wattal et al. 2011). On the other hand, it also creates supply-side problems such as complex logistics, distribution, and customer support. In the case of services, which tend to be intangible and produced and delivered via computer systems, production-related supply-side challenges such as logistics and distribution may be less relevant, but customer support still remains a major operational challenge. Firms spend a significant amount of money on customer support via call centers. In 2004, more than 50,000 call centers with over 2.65 million workers existed in the United States (*McDaniel Executive Recruiters*' 2004 North American Call Center Report, September 23, 2004). In fact, call centers constitute a major part of the day-to-day operations for continuously delivered services such as insurance, banking and financial services, IT and telecom-related services, and so on. A large academic literature is devoted to studying and analyzing customer service and call centers (Gans et al. 2003).

In this paper, we focus on the supply-side challenges of product customization. In particular, we examine how health insurance plan customization

affects demand for customer services via call centers. A health insurance plan is a complex and elaborate product that contains a number of details on medical coverage, costs, and exclusions. Because health insurance plans are important products to consumers, firms spend considerable resources serving customers via its call centers.

In recent years, Internet-based technologies have made it easy for firms to provide customers with customized products. Firms are able to offer specific coverage and exclusions tailored to different customers. Products such as CDHP (consumer-driven health plans), where customers control the costs of their health plans explicitly by actively participating and monitoring these plans, are becoming common. Unlike personalizing an online newspaper or a search result, where customers are usually passive participants, customizing a health plan requires significant customer participation and thus has a flavor of product cocreation. Previous literature has examined the impact of customization on product demand. However, in this paper, we examine how customizing health plans via product cocreation has an impact on firms' customer support cost, in particular, customer demand for the firm's call center.

The literature, by and large, is silent on the link between product customization and customer service costs. However, researchers generally agree customization leads to higher customer satisfaction (Anderson et al. 1997), and a satisfied customer is less likely to call and hence less costly to serve. In this paper, we provide a link between customization and customer calling behavior. The firm in our setting runs a busy call center (firm's name withheld because of nondisclosure agreements). Because a health insurance plan is a complex product, a significant proportion of calls to the center are customers' inquiries regarding their plan features and coverage. Customers usually call (1) when the plan does not cover the health event satisfactorily, and/or (2) when they are unsure of their coverage and need some clarification. In our setting, certain customer groups customize their plans to cover their salient medical needs. However, unlike many other traditional products where customers are passive participants, customizing a health insurance plan requires customer groups to repeatedly interact with the firm. This process is akin to *product cocreation*. During the cocreation process, customers and the firm go over specific plan details to include or exclude features that fit with customers' needs. In this process, the customers become more familiar with the plan attributes. We argue that a better *fit and familiarity* with customized plans should reduce the number of customer calls related to product characteristics and coverage.

To test our hypothesis, we collect a rich customer group-level data set. In the data set, a group of customers select either standard plans or customized plans. In a customized plan, customers make explicit changes to a standard plan to fit their needs. To control for various unobserved effects, we follow groups over a period of time in which one set of selected groups makes a switch from a standard plan to a customized plan, while the other set of groups continues to remain on the same standard health plan. We use detailed call data and show that, on average, when customer groups move to a customized plan, their calls pertaining to product-related queries drop by about 21%. We see no such evidence of call reduction when customers stay on the same plan or when they switch from one standard plan to another standard plan. We also see no reduction in *non-product*-related calls when switching to a customized plan. We find that our results are not merely driven by specific trends in calls but that the results are consistent over the entire period. We also tested for several possible selection issues and find our results are robust to them.

Another major component of the cost of customer support for the firm is its claims' processing expenditures. The firm employs extensive computer systems for automatic processing of claims filed by doctors and medical facilities. However, the firm incurs significant costs when computer systems suspend claims, which then require manual intervention. We find that customers shifting from standard plans to customized plans do not affect suspension rates. Overall, from a customer service point of view, our results indicate the customized plans are less costly to serve.

Our study is significant in many ways. First, we are aware of little research that has explicitly examined the link between product design and customer service costs. Technology is making it easier and cheaper for firms to offer a wide menu of products to customers of different tastes. We show that the product customization process can later affect customer service costs. Our study provides evidence of the operational benefit of customization in customer support for complex services that require customers to have a clear understanding of the company's product, for example, insurance services, IT and telecom-related services, financial and investment-related services, and so forth. Thus, we show that the process of customization, under certain circumstances, can be a win-win situation for the firm and its customers. Second, even for the empirical work on customization, our study is unique in that we conduct a field study and collect rich customer group-level actual usage data. The panel nature of the data allows us to control for various unobserved effects, providing robust estimates on the impact of customization.

We organize the remainder of this paper as follows. In §2, we provide a literature review of relevant papers in this domain. We describe our study setting in §3. Section 4 outlines our theoretical framework. We describe our data in §5. Section 6 contains econometric specifications and results. Finally, in §7, we conclude and outline future research possibilities and limitations.

2. Related Literature

Our research draws from literature on product design, development, and innovation, literature on customization, and literature on operation management.

The information-processing view of product design says the design process begins with sensing a gap in user experience, which then leads to the planning and production of a new product. For a high-quality design, designers should (1) understand the users' experience gap clearly and accordingly define the problem precisely, (2) select the appropriate solution space to search for solutions, and (3) deliver a product consistent with the design (Ulrich 2007). However, thanks to the Internet, firms can easily and economically gather user needs and configure the product by selecting appropriate design parameters. This access has led to product cocreation with active participation from actual users. Von Hippel and Katz (2002) propose user toolkits for product design, in which the user provides her desired attributes and the system automatically calculates appropriate design parameters at the back end to offer complete product design. Mass customization and marketing literature talks about "collaborative customization" in which experts conduct dialogue with users to discuss the latter's needs and then provide customized products (Pine and Gilmore 1997, Zipkin 2001, Kahn 1998). The approach of product cocreation is especially attractive in complex multiattribute products with heterogeneous demand for different attributes. Thus, the product cocreation process leads to customer involvement in product development, which leads to a better-informed customer who understands the product and has realistic expectations.

Product customization impacts product demand via enhanced customer value, higher customer satisfaction, and hence increased product loyalty. Ansari and Mela (2003) show that customization of e-mail content results in increased click-through rates. Wattal et al. (2011) empirically validate that targeted products generate a significantly positive response from customers. Tam and Ho (2003) found that subjects who received personalized recommendations downloaded the music significantly more than subjects who did not receive personalized recommendations. Srinivasan et al. (2002) conducted an online survey on a sample of online customers with a prominent market research agency. The authors found customization significantly affected customer loyalty in an online B2C (business-to-consumer) context. Note that much of the empirical work on personalization is survey based, experimental, and usually assumes the customer as a passive partner. Our work is a field study in which the customer is an active participant in the customization process.

Product customization and consequent proliferation of product variety leads to operational complexity and productivity decrease. Some studies in the operation management literature suggest product variety leads to a loss of operational productivity (MacDuffie et al. 1996, Fisher et al. 1995, Fisher and Ittner 1999). However, other studies have pointed to the absence of an association between product variety and productivity (Kekre and Srinavasan 1990, Foster and Gupta 1990). Producing greater product variety requires sourcing a larger variety of raw materials and parts, complex production scheduling, higher inventory, higher machine down time, higher stockout situations, and so forth. The operations literature highlights some strategies to mitigate these consequences via flexible manufacturing, modular product architecture, and process standardization (Ramdas 2003, Ulrich 1995). Studies also suggest firms resorting to product customization would achieve higher customer satisfaction and therefore need to allocate fewer resources for handling returns, reworks, warranties, and complaints, which may result in lower costs and higher productivity (Juran 1988, Anderson et al. 1997). This view is consistent with our paper.

However, the literature linking product information or design to customer support is fairly sparse. Goffin and New (2001) provide case studies on how some firms explicitly take into account the cost of customer service when they design their products. Similarly, an article in the *Wall Street Journal* (Lawton 2008) highlights consumers returning products to retailers not because the products are defective but because they do not understand the product's features. Many retailers are taking action (educating consumers, providing better information) to alleviate this problem. Our study also suggests how a lack of product information can lead to more calls.

3. Research Site

Before we outline our theoretical framework, we first provide details of our field study and the research site. Our study setting is a large U.S. health insurance firm (referred to as the firm) that sells several different plans to a customer base of over three million. After the plans are sold, the firm serves its customers

through its operational unit. The operational unit performs three broad activities:

1. Initial set up and routine periodic activities—coding customers and plan details in the computer system, maintaining customer accounts, and issuing regular invoices.

2. Call-center services—resolving customers' queries through telephones calls.

3. Claims processing—automatic processing of claims through computer systems. Only claims the computer system suspended or wrongly processed are processed/adjusted manually.

Activities 1 and 3 are predominantly automated by extensive information systems set up in the firm. Activity 2 requires a customer service representative (CSR) to resolve customers' queries over the telephone, and it accounts for more than 70% of the total operational cost, which was $47 million in 2007. The firm received over three million calls in 2007.

The firm sells health insurance plans to different organizations (referred to as clients) through designated client administrators in those organizations. Normally, members in the client organization, either through their union or through other bodies, apprise the administrator of their specific needs. The administrator accordingly selects appropriate plans and negotiates prices with the firm. Within a client organization, members of similar status (e.g., executives, staff) who purchase the same plan are organized as a group. Therefore, for insurance purposes, members within a client are organized under several groups. For example, one of the firm's clients had 98 groups.

A typical health insurance plan is a bundle of descriptive coverage with quantitative specifications. Descriptive coverage includes broad medical provisions, pharmacies, drugs, a network of providers, and the explicit exclusion in each of these categories. Quantitative specifications include the extent of coverage in terms of coinsurance rates, co-pays, deductibles, and out-of-pocket limits. We highlight these details via the structure of a representative plan in Appendix A (available in the electronic companion). Typical health plans are comprehensive and complicated. For example, a plan benefit booklet is 60 to 70 pages. Over the years, the firm has created hundreds of different plans. Servicing such a large number of different complex plans is difficult for the firm. To overcome this problem, the firm has developed modular standard plan coverage components that can be combined to generate a variety of existing health plans. Such plans are termed standard plans. Sometimes, however, the firm makes deviations from these standard coverage components to accommodate the specific needs of a group of customers they want to attract or retain. The firm terms such plans the *nonstandard* plans. These plans, the result of a group of customers requesting specific changes to a standard plan, are essentially *customized* plans. For example, a consortium of school teachers negotiated to incorporate sterilization reversal procedures in its nonstandard health plan. We will use nonstandard and customized plan interchangeably. We provide more details on plans and their customization process in §4.2.

The firm's management believed the nonstandard plans were operationally more costly, as these not only require additional upfront coding costs but also result in more calls and a higher claims suspension rate. The management therefore decided to start a new service operation environment (hereafter referred to as the new environment) in which it offered only standard plans. In the new environment, the firm streamlined business processes at the call center, cross trained CSRs, and put them all on one floor to achieve operational efficiencies. It also offloaded initial set-up work to the client organizations. Although the new environment helped resolve customer queries more efficiently at the firm's end, it did not affect the reasons for calls at the customer's end. To encourage clients to move to the new environment, the firm initially offered a 2% premium reduction as an incentive. The firm management introduced the new environment in July 2005 with the aim of migrating the entire customer base within three to four years. Initially the firm had been successful in persuading its clients to shift from their earlier nonstandard plans at the old environment to standard plans at the new environment. However, over time, the firm had to introduce nonstandard plans at the new environment to accommodate specific needs of customer groups under different clients.

4. Theoretical Framework and Hypothesis

In the present research setting, we examine whether any significant difference exists in operational costs in administering nonstandard (customized) plans versus the standard plans. We identify key operational cost drivers in the three operational activities as below:

- **Initial set-up**—One-time *coding cost* for a new plan in the computer systems.
- **Call center activity**—*Call volumes* received for each plan category and the *average call-handling time* for CSR response to such queries.
- **Claims-processing activity**—*Claims suspension* (*auto-adjudication failure*) *rate* and the *claims adjustment rate* for each plan category. If the computerized claims auto-adjudication process fails to clear the claims, additional time and cost of manual claims adjudication/adjustment is required.

The initial coding cost for a new plan is fixed; it is incurred once and is relatively straightforward to estimate. In this paper, we focus on how plan customization affects call volume and the claims adjudication rate. We had detail conversations with the CSRs regarding call handling times. CSRs respond to customer queries based on the related information the firm's computer systems provides. As this system is the same for both the standard and customized plans, the CSRs felt the time they spend on a call from a customer on a standard plan and the time they spend on a call from a customer on a customized plan are the same. Although we do not have exact data on the average call handling time to test this.

The plan benefits and claims processing logic are coded in the firm's computer system. Claims processing operation on the computer system requires collation of such coded claims information with the coded admissible plan benefits information. Therefore, the claim adjudication rate at the computer system depends on how correctly information is coded on it. Because the nonstandard plans require adding new code for the plan benefits and the claims processing logic, the firm management expected higher likelihood of claims suspension for nonstandard plans than the already-developed standard plans.

The key focus of this paper is customer call volume. Customers contact the firm's call center for a variety of reasons, for example, for product benefits/coverage information, claims rejection questions, and inaccurate invoice or ID card issues. For the analysis in this paper, we only include *product-related* calls. These include inquiries regarding coverage of medical procedures, facilities, providers, pharmacies, or drugs. The firm categorizes the calls according to their reasons, resulting in a total of 164 reason codes. The CSRs allocate these codes to each received call. Forty-eight percent of the total calls belong to product-coverage inquiries.

4.1. Call Generation Process

We held extensive discussions with the CSRs, operational managers at the call center, and several client administrators to understand what triggers product-related calls from customers (one of the authors spent three months with the firm to facilitate these discussions). We also randomly listened to more than 100 live calls and found that most of the product-coverage ones were "My doctor has prescribed ——— and I was told that my plan does not cover it/Is it covered under my plan?" "I thought my plan allowed for ——— specialist visits but I was told otherwise/How many specialist visits do I have in my plan?" "What are my co-pays for out of network ——— treatment?" "What is my generic drug coinsurance rates/co-pays?" These calls usually come in when (1) health events force customers to visit their doctor or a medical facility; and (2) after receipt of claims, customers are unclear about their liability or the coverage provided by their plans. If their plans adequately cover their medical needs, customers usually do not call. When their plans do not adequately meet their medical needs, customers' understanding of relevant plan coverage plays an important role. If the customer is clear about her plan coverage, she has little reason to call and inquire about it. In contrast, if the customer is uncertain about her plan coverage, she may contact the call center for clarification. The plan's failure to provide the desired coverage can be attributed to the *lack of fit* between the plan coverage and the customer's medical needs. Customers' uncertainties about their relevant plan coverage can be attributed to their *lack of familiarity* with their plan coverage.

Prior research has documented both lack of fit and familiarity with the health insurance coverage. Marquis (1981) and Garnick et al. (1993) document that many families are uninformed about their coverage, and the authors argue that educating consumers regarding their coverage is essential for creating effective plans. Isaacs (1996) notes from a national survey that many users are poorly informed about the range of services their health plans offer (or exclude). He also points out that more than one-third of the consumers would like more information and education regarding their plans and choices.

Researchers have shown how lack of knowledge regarding health coverage leads to users choosing inefficient health plans and hence to significant welfare loss (Parente et al. 2005). Harris-Kojetin and Lubalin (1999) provide a review of how lack of information, complexity of a health plan, and hence bounded rationality on the part of consumers can lead to suboptimal choices. Hanoch and Rice (2006) highlight how complex information needs and too many choices force the elderly to make suboptimal choices in the supplemental Medicare plans, thereby leading to significant welfare loss. These inefficiencies have prompted the government to actively use technology in the form of decision support systems to help patients make the right choices for their Medicare plans (Gruber and Abaluck 2009). Parente and Van Horn (2006) estimate the impact of information on consumer choices and document that better information leads to significant cost savings for society. They suggest Medicare should spend $3 per year per beneficiary on consumer education. Prior research also highlights the role of information systems. Sainfort and Booske (1996) provide results of an experiment in which a computer system aids users in making health-care plan choices.

In summary, a significant body of research highlights how lack of information and awareness leads to suboptimal choices and a poor fit between customers' needs and their selected plans. Firms also recognize the need to provide better information to consumers. Many insurance firms are actively using the Internet to provide detailed information to end users so they have a better understanding of their coverage and can therefore make more informed decisions. Thus lack of fit and familiarity are widely documented constructs in health-care plan choices. From our earlier discussion, we also see consumers are more likely to call when a medical need arises and they are either unclear regarding their plan coverage and/or the plan does not cover their medical needs.

4.2. Product Customization

Before we discuss how customization would impact a consumer's decision to place a phone call, we provide details on the insurance selection process at the firm.

4.2.1. Insurance Choice. To gain insight into the process of insurance plan sales and specifically the process of customized plan creation, we interviewed several of the firm's sales and operational managers as well as several client administrators. The firm's sales managers offer a set of standard plans at tentative prices to the administrator of the client organization. Normally the client administrator negotiates the price and by and large accepts the standard plans or accepts them with minor changes that still fit the standard plan coverage components. However, when the standard plans do not provide adequate coverage for certain common medical needs of a group of employees (customer groups), such groups push the client administrator for inclusion of those needs. This push results in a prolonged negotiation between the firm's sales managers and the group members through their client administrator. The client administrator and group members discuss internally the proposed plan prototype reached at each step of negotiation. The firm's sales manager in turn consults with the operations and product development managers to discuss the feasibility of such plans. After several such iterations, the parties reach an agreement on the plan's final configuration, which often requires the firm to deviate from the standard plan coverage components. As we mentioned, such negotiated products are nonstandard plans. Some examples of such nonstandard plans are (1) an automobile service agency that modified its health plan to include more robust preventive vision care for its mechanics and (2) a graduate student association that received additional mental health and substance abuse procedures in its health plan. Note that including these broad features in the plan would result in changes in several related plan attributes such as co-pays, deductibles, preadmission review requirements, the admissibility of special care units, day limits for inpatient facilities, and a maximum number of specialist visits. We highlight these plan attributes in a electronic representative health plan in Appendix A (available in the electronic companion). Therefore, inclusion of these broad procedures essentially means negotiating a number of plan attributes and reaching a final plan configuration.

This process of nonstandard (customized) plan creation in our setting has a flavor of collaborative customization (Pine and Gilmore 1997) and collaborative prototyping (Terwiesch and Loch 2004, Terwiesch et al. 2007) in which the firm goes over several iterations of product prototypes to help customer groups clearly articulate their needs. Kahn (1998) suggests the personalized/user-designed/cocreated products should match users' needs better and should thus lead to higher satisfaction, higher customer loyalty, and fewer occasions of required reworks, returns, and warranty costs. Anderson et al. (1997) also show that customization leads to higher customer satisfaction. Christianson et al. (2004) study the impact of consumer-driven health plans on expenses and utilization rates and find CDHPs lead to lower expenditure and better utilization. Although CDHPs are not necessarily customized plans, they do require significant participation and active management on the part of their users.

Based on the discussion so far, we can intuitively describe customers' call-generation process. The probability of calling depends on how well the plan fits the medical needs (particularly relevant medical needs) and how well the customer knows her coverage (or plan attributes). In our setting, the customization process involves a group of customers modifying the health insurance plan to suit their salient medical needs through a multistep negotiation process that involves significant interaction between the firm and the customer group. Negotiation improves the fit by adding, modifying, or deleting certain plan attributes. This process is also likely to increase plan familiarity. Moreover, customization usually occurs for plan attributes (features or services) that are highly relevant to the customers' medical needs. Therefore, the customization process results in increased *fit* and *familiarity.* This framework provides us with a testable hypothesis:

Hypothesis 1. *Customers migrating from a standard product to a customized product reduce their product-coverage-related calls*.

5. Data and Methodology

To test our hypothesis, we take advantage of a quasi-natural experiment that occurred in the firm. As we

mentioned earlier, the firm started a new environment in July 2005 for providing efficient customer support. In the trial phase, the firm offered incentives to a few select client organizations to move them to the new environment. After about six months, the firm had moved several clients, accounting for more than 250,000 individual customers. By July 2006, the new environment was stabilized and all clients (not only a select few) were encouraged to migrate to the new environment. Although the goal of the new environment was to promote standardization of plans, the firm was allowing clients to move to the new environment even if they were opting into some nonstandard plans. Thus the July 2006 time frame was appropriate for our study. We could find a large number of clients switching to the new environment along with their plans.

Our goal is to examine how a customer's migration from a standard plan to a customized plan affects her calling behavior. We collect data at the customer group level. As noted earlier, a group is a collection of similar individuals within a client organization that sign up for the same plan. Because our data are such that a change in plan is also associated with change in environment, we need a control group to weed out the changes in call rates due to a change in environment. For example, the firm recoded many marginal call categories into the related major call categories in the new environment to reduce the total number of call categories. Accordingly, the firm recoded many marginal call categories as product-related calls. This recoding led to a general increase in product-related calls in the new environment. Customer groups that did not change their plans after July 2006 but migrated to the new environment provide us with the control group to weed out the effect of such recoding and thus identify the net impact of plan customization.

The argument for our hypothesis rests on the fact that the customization process improves fit and familiarity. Because our data are at the group level, we highlight below salient features of the customization process that explains why fit and familiarity play important roles.

1. The customized plan is created only if a specific group within a client organization has requested it. In our data, the customized plan is offered *only* to this specific client and not to other clients. So we know the plan was created for a specific group.

2. Virtually all members of the group switch from a standard plan to the customized plan in our sample. Put another way, the firm does not offer a customized plan to its employees and different employees then randomly opt into it. In our data, the whole group within the client organization migrates to the customized plan. Although we cannot rule out the possibility that a few employees randomly might have chosen this plan, we know the same core block of employees have switched from a standard plan to the customized plan.

3. Although not all members in the group may have played an active role in creating the customized plan, the process of customization should ensure that any group member who is migrating into the new customized plan is more familiar with the new plan.

5.1. Sample

We identified four major categories of plan migrations to the new environment: (1) standard → nonstandard or customized; (2) nonstandard or customized → standard; (3) one type of standard → another type of standard; and (4) customers who did not change their plans. We randomly selected a sample of 2,000 customer groups migrating from the old to new environment in 2006. Because we wish to compare the post-July 2006 calls for these groups on one plan with their pre-July 2006 calls on another plan, we needed these groups to stick to a plan for the entire pre-July 2006 year and post-July 2006 year. However, not all groups stayed on the same plan for the entire year before or after July 2006. We also want the same customers to remain in these groups in the two periods so we can test the effect of customization (and thus fit and familiarity) on these customers' calls in the new environment. Therefore, we only selected those groups from our sample whose membership count did not change by more than 5% after the plan migration. After applying these screening rules, we determined our final sample of groups in each category of plan migrations was as follows:

- *Standard-to-customized migration*—170 customer groups who migrated from a standard plan in the old environment to a customized plan in the new environment.
- *Standard-to-standard migration*—66 customer groups who remained on the same standard plan after migration from the old to the new environment.
- *One-standard-to-another-standard migration*—34 customer groups who migrated from one type of standard plan in the old environment to another in the new environment.
- *Customized-to-standard migration*—35 customer groups who migrated from a customized plan in the old environment to a standard plan in the new environment.

Note that the standard-to-customized category in our final sample has more groups than the other categories. This higher number is because although the firm allowed migration to the standard plan all year (not just in July), it usually allowed migration to the customized plan only at the beginning of contract year, namely, July. We also had 11 groups that moved from the old to new environment on a customized

Table 1 Category Member Counts for Groups

Migration category	Environment	No. of groups	Mean group size	Std. dev.	Min	Max
Standard–Customized	Old	170	25.391	30.194	1	216
	New	170	24.898	31.912	1	234
Standard–Standard	Old	66	49.173	71.386	1	375
	New	66	50.413	72.457	1	367
One standard–Another standard	Old	34	55.402	75.194	1	386
	New	34	54.272	72.632	1	375
Customized–Standard	Old	35	76.951	113.363	1	518
	New	35	84.473	128.035	1	548

plan. Given the small size of that sample, we did not analyze this migration.

We provide summary statistics for group sizes in Table 1. Group sizes are somewhat different. However, because we normalize the calls by group size, econometrically it should not be a concern. Similarly, we do not have demographic data for the groups. However, because we mostly estimate a fixed-effect difference-in-difference model, lack of demographic information is not an important limitation.

We collected weekly call data for each customer group in our sample from the automatic call distributor (ACD) of the call center. We focus on product-related calls in the present analysis. As noted earlier, the firm recoded many marginal call categories into product-related calls in the new environment. These marginal call categories concerned calls related to either a specific plan attribute or plan attributes in a specific situation. Appendix B (available in the electronic companion) contains the description of a few such calls. Through discussion with the call-center managers, we find that such calls are equally likely from the standard and customized plans. Therefore, we expect the number of product-related calls to increase in general for all categories in the new environment due to recoding. In Appendix C (available in the electronic companion), we run a regression to provide more rigorous evidence of an increase in product-related calls in the new environment. Table 2 presents the summary statistic for the number of annual calls for each category of groups. Despite a general increase in the number of product-related calls with the change in environment (due to recoding of product-related calls), we see a marginal reduction in the mean product-related calls per member in standard-to-customized groups.

The number of calls is also affected by the medical events a customer encounters. We capture customers' medical issues in our data by the number of claims filed for them. Normally, a medical facility (hospitals, doctors, etc.) that provides treatment to customers file claims on their behalf. We collect the number of claims filed for each category of groups in the old and new environments. Table 2 also presents the summary statistics for the same. Note from the last column of Table 2 that the calls per claim also marginally reduce for the standard-to-customized groups only. This data suggests that even after accounting for the customers' health events, these groups make fewer calls after migration to customized plans. We test this result with more rigorous regression specifications in the following sections.

6. Empirical Model and Results

Our goal is to identify how a change in plan choice affects call volume. However, in our case, a change in plan is also associated with a change in environment. We need to weed out the effect of customer group–related heterogeneity, environment-related heterogeneity, and any effects of time trends or seasonality on call volumes. Given the rich data set, we can estimate the effect of plan customization on call volume in various ways. We now explore these alternatives in detail to provide consistent and robust estimates.

6.1. Econometric Specification

We use difference-in-difference design (see Figure 1) to difference out the effects of environment and time. We have a treatment group, a category of customer groups changing their plans from standard to customized after a change in environment, and a control group, a category of customer groups with the same standard plan after a change in environment. In Appendix D (available in the electronic companion),

Table 2 Mean Number of Calls and Claims

Migration category	Env.	Mean group size	No. of calls per year: Mean	No. of calls per year: Std. dev.	Calls per year per customer	No. of claims per year: Mean	No. of claims per year: Std. dev.	Claims per year per customer	Calls per claim
Standard–Customized	Old	25.390	8.399	12.606	0.331	266.590	304.972	10.500	0.032
	New	24.898	8.220	13.034	0.330	265.728	332.912	10.676	0.031
Standard–Standard	Old	49.173	14.501	21.542	0.295	489.809	695.036	9.961	0.030
	New	50.413	17.273	23.976	0.343	553.150	763.494	10.972	0.031
One standard–Another standard	Old	55.402	15.412	18.012	0.278	575.913	741.523	10.395	0.027
	New	54.272	19.655	21.915	0.362	594.265	773.616	10.950	0.033
Customized–Standard	Old	76.951	19.154	20.007	0.249	694.033	913.793	9.019	0.028
	New	84.473	26.547	27.973	0.314	829.866	1,084.972	9.824	0.032

Figure 1 Difference-in-Difference Design

	Old environment (pre)	New environment (post)	
Treatment group	Calls (standard)	Calls (customized)	Product effect +Time effect Environment effect
Control group	Calls (standard)	Calls (standard)	Environment effect + Time effect

we show how we can further eliminate the time effect by running difference-in-difference estimations. The results, shown in Table D1 in Appendix D, remain unchanged.

In particular, we employ this difference-in-difference design to estimate a pooled regression model:

$$Cvol_{it} = \beta_0 + \beta_1 TG_i + \beta_2 Post_t + \beta_3 TG_i * Post_t + \beta_4 Claims_{it} + \beta_5 Grsize_{it} + \varepsilon_{it}, \quad (1)$$

where i indexes group and t indexes period (two periods are used here, before and after July 2006); $Cvol_{it}$ is the average monthly product-related calls by group i in period t; TG_i equals 1 for the treatment group and 0 for the control group; $Post_t$ is the dummy for the new environment or post-period (0 before July 2006 and 1 after); $Claims_{it}$ is the number of claims group i filed at time t; and $Grsize_{it}$ is the size of group i at time t. The estimate of interest is β_3, which captures the net effect of a plan change on product-related calls.

Notice that in the previous model, we pool all data without worrying about group-level heterogeneity. We next estimate a fixed-effect model with group-level call data. Customers in a group may have some unobserved similarities that are likely to remain constant over the period of study. A fixed-effect model would account for these group-level unobserved effects. The fixed-effect model would also be appropriate if only a few groups are driving the results in the pooled regression model (1).

Thus, we use a difference-in-difference design with group fixed effects to estimate a fixed-effect regression model:

$$Cvol_{it} = \alpha_i + \beta_1 TG_i + \beta_2 Post_t + \beta_3 TG_i * Post_t + \beta_4 Claims_{it} + \beta_5 Grsize_{it} + \varepsilon_{it}, \quad (2)$$

where α_i is the group fixed effects for group i. The remaining variables are the same as in the pooled regression model (1) and thus omitted for brevity. Again, β_3, the coefficient of interaction term $TG * Post$, is of interest, which highlights the net effect of plan change on product-related calls in this model.

Note that in the pooled regression model (1) and the fixed-effect regression model (2), we aggregate the calls over the entire year. Aggregating call volumes for the entire contract year helps avoid the serial correlation problem in the idiosyncratic error term over the 24 months of the study period (Bertrand et al. 2004). However, in this process, we lose the variations in call volumes over time for each group. We also cannot include time trend on aggregated data. So we now disaggregate call volumes by using monthly call volumes for each group. Our dependent variable is the monthly product-related calls per group. Besides fixed effects, we also include time dummies for each month to control for time effects. We estimate a fixed-effect regression model with time dummies:

$$Cvol_{it} = \alpha_i + \beta_1 TG_i + \beta_2 Post_i + \beta_3 TG_i * Post_i + \beta_4 Claims_{it} + \beta_5 Grsize_{it} + \Sigma_{t=1,\ldots,24} \beta_{5+t} T + \varepsilon_{it}, \quad (3)$$

where t indexes months ($t = 1, 2, \ldots, 24$), where $t = 1$ is July 2005, and $t = 24$ is June 2007. Thus, we include 24 monthly time dummies (T). These time dummies should capture any seasonality in the call volumes. Instead of including time dummies, one can potentially also include a continuous time variable that captures the time trend. For example, the calling trend for the treatment group may already be declining before the treatment. We tested this alternative specification and received the same results.

Before we estimate this model, to confirm the selection issues are not driving our results and that the change to customized plans is really the driver for the increase in phone calls, we estimate the fixed-effect regression model (2) on only pre-July 2006 (old environment) data. We split these data into two periods: the first six months (July 2005 to December 2005) and the last six months (January 2006 to June 2006). Note that both categories of groups (standard-to-customized and standard-to-standard) had the standard plan in this period. Therefore, if treatment and control groups are similar in the old environment then we should not expect a significant estimate on β_3. We present these results in Appendix E (available in the electronic companion). The results in Table E1 confirm that indeed β_3 is insignificant (both economically and statistically). This finding indicates no statistically significant difference between the calling behavior of the standard-to-customized group and the standard-to-standard group in the old environment.

Table 3 Estimation Results

Dependant variable: *Call volume*	Pooled regression model (1)	Fixed-effect regression model (2)	Fixed-effect regression model with time dummies (3)
Treatment (*TG*)	−0.035 (0.087)	Dropped	Dropped
Post	0.202* (0.094)	0.207* (0.091)	0.193* (0.086)
TG ∗ *Post*	**−0.204* (0.101)**	**−0.212* (0.092)**	**−0.201* (0.092)**
Group size	0.023** (0.003)	0.017* (0.007)	0.012** (0.004)
Claims	0.003 (0.003)	0.012^ (0.006)	0.004* (0.002)
Constant	0.071 (0.065)	0.092 (0.182)	0.327** (0.112)
Time dummies	Not applied	Not applied	Applied
N	472	2 observations each for 236 groups	24 observations each for 236 groups
R^2	0.696	0.663	0.436

Note. Standard errors are in parentheses.
**, *, ^ denote statistically significant at the 1%, 5%, and 10% levels (two-sided test), respectively.

6.2. Results

6.2.1. Results on Calls. Table 3 presents the results of all three regression models. In all specifications, the standard-to-customized groups are the treatment group and the standard-to-standard groups are the control group. We cluster corrected standard errors to account for the fact that some groups in our sample belong to the same client. (In our sample, 170 treatment groups belonged to 106 different clients and 66 control groups belonged to 28 different clients.) We also checked that the residuals from our fixed-effect regression model (2) are approximately normally distributed and thus the standard errors of our coefficient estimates are unbiased. We also used log form and higher polynomial form of variable group size and claims to account for their possible nonlinear relationship with calls and found similar results. Because our dependant variable in the fixed-effect regression model with time dummies (3) is count data (monthly calls), we also tested our results with a Poisson model and a negative binomial model. The results are similar.

First notice the *Post* dummy is positive and significant in all models. This finding is consistent with our raw data that higher numbers of product-related calls are being observed (mostly due to the way the firm recoded this category) in the post-migration period.

As expected, the estimate on group size is positive. An increase of 100 group members leads to approximately two more calls. The estimate on claims indicates an increase in one call for an increase in 100 claims for the group. A higher number of claims signals more medical needs of a group and thus leads to a higher number of product-related calls. This finding is consistent with our theory model. A key estimate of interest, the interaction term β_3 that captures the net effect of plan customization on product-related calls, is negative and significant in all three models. This estimate indicates that controlling for other factors that affect calls; customers migrating from standard to customized plans make 0.212 fewer calls. When applied over the average 0.96 calls per month in the old environment, this estimate translates into a 21% reduction in calls—an economically significant reduction in product-related calls. These estimates are consistent across three models and thus robust to the aggregation problem and any group-level unobserved effects. Thus we find support for our hypothesis.

A 21% decline in calls is a significant reduction for a call center. In fact, call centers invest heavily in interactive voice response systems (IVRs) and automatic call distributor systems (ACD) to reduce incoming calls to CSRs. The firm in our setting had a customer base of about three million members and received about one and a half million product-related calls from April 2006 to March 2007. Even if 20% of the members selected customized plans, this number translates to about 60,000 fewer product-related calls per year. The call duration with call wrap-up time for a typical call in the firm is about 15 minutes (average call duration of 10.43 + 40% call wrap-up time = total call handle time of approx 15 minutes). With six productive hours a day, a CSR can handle 24–25 calls per day. Assuming five days a week and 48 weeks of work per year, a CSR can handle about 6,000 calls per year. A decrease of 60,000 calls per year suggests the possibility of a reduction of ten CSRs. A fully loaded CSR costs the firm about $60,000 per year. Therefore, our data suggest an operational cost savings of about $600,000 per year. (This finding is consistent with industry numbers on costs per call averaging around $10; Yankee Group Research Inc. 2006). This calculation, however, does not include other savings such as needing fewer desks, computers, and training costs. One of the key challenges to running a call center is cutting costs without losing efficiency. In that regard, savings of more than half a million dollars per year due to product design changes is a nontrivial amount. Our calculations do not include the benefits to customers of not having to spend time talking to CSRs. Fewer phone calls also suggest a more satisfied customer, and our calculations do not include other nontangible benefits such as increased customer loyalty.

The implications of these findings go beyond this sample. Firms are aggressively encouraging customers to manage their health plans and self-serve themselves via Web portals. The firm under study is considering offering user toolkits/product configurators to customers over the Internet. These configurators would allow customers (or clients) to pick and choose various modular features to create a healthcare plan for their own needs. However, much of

the empirical work has ignored how these offerings impact customer service costs. If anything, our results point out that these offerings will reduce the demand for call-center services as customers are more involved in creating plans that suit their needs and increase their awareness regarding plan features. Customized plans, however, may still increase other costs, which we discuss in subsequent sections.

6.2.2. Results on Claims Suspension Rate. Another aspect of customer service cost is the claims suspension rate. As pointed out earlier, if the computer system does not automatically adjudicate claims, they require costly manual intervention. One of the challenges of nonstandard plans is that they are not widely distributed and need to be coded in the system properly. So the firm's management worried the claims suspension rates on such plans may be higher.

We collected data on claims suspension rates and estimated how migration from a standard to a customized plan affected them. We estimate the fixed-effect regression model (2) with the standard-to-customized groups as treatment group and the standard-to-standard groups as control group. The dependent variable is the claims suspension rate. Table 4 shows the results.

We find an insignificant coefficient for interaction term $TG * Post$, which indicates a lack of statistically significant difference in the claims suspension rate because of a change from standard to customized plans.

6.3. Robustness

Our theoretical framework underscores that customization of a health plan with customer involvement reduces misfit and increases awareness and hence leads to fewer product-related calls. Our empirical analysis indeed suggests a reduction in calls for customized plans. However, because we do not directly measure plan *fit* or *familiarity*, we may still have some concern regarding the underlying mechanism at play. In the following, we consider and rule out some potential explanations for a reduction in product-related calls.

Table 4 Estimates on Claims Suspension Rate

Dependant variable: *Claims suspension rate*	Fixed-effect regression model (2)
Post	0.012 (0.014)
TG ∗ *Post*	**−0.006 (0.017)**
Constant	0.851** (0.003)
N	2 observations each for 236 groups

Note. Standard errors are in parentheses.
** denotes statistically significant at the 1% level (two-sided test).

1. Large client organizations may be able to influence the firm more and thus are more likely to customize plans for their customer groups. Moreover, large clients may have more resources for internally resolving their members' queries. If so, we should see a higher proportion of large clients in our treatment group. However, we find a similar proportion of customer groups from large clients: 48% in the treatment group and 53% in our control group. Further, if our treatment-group clients were somehow internally resolving their members' queries, we should see fewer product-related calls there even before plan customization. We test this fact by aggregating the calls at the client level in the pre-July 2006 period for the two groups and comparing the product-related calls for our treatment-group and control-group clients. We find no difference in the calling propensities for clients in the two groups (see details in Appendix F, available in the electronic companion). Therefore, differences across clients on issues such as better internal resolution are not driving our estimates.

2. To more rigorously control for any possible selection, we used propensity score matching to match our treatment groups with the control groups (Rosenbaum and Rubin 1983). We computed the probability of migrating to a customized plan (or propensity score) for each group based on their claims, group sizes, and whether they belonged to large clients. We find an average treatment effect of −0.192 based on one-to-one propensity score matching of treatment groups with the control groups (see details in Appendix G, available in the electronic companion). This finding is similar in sign and magnitude to the treatment effect (coefficient estimate for the interaction term) we got in Table 3. This result indicates that even after controlling for selection on such observables as health conditions and client type, the product-related calls go down with the treatment of plan customization.

3. One concern is that simply changing plans induces these effects. To test this possibility, we use customer groups that change from one standard plan to another standard plan as the treatment group and the standard-to-standard groups as the control group. To avoid clutter, we only report the estimate on interaction dummy in Table 5. An insignificant estimate indicates we fail to find a reduction in calls because of a mere change from one standard plan to another standard plan (see row 1). Similarly, we also compare the customers who migrate from standard to customized plans with the customers who migrate from one standard plan to another standard plan. We still find migration to customized plans leads to fewer calls (see row 2).

4. If groups moving to customized plans reduce calls due to better *fit* and *familiarity*, we expect the

Table 5 Estimates for Different Treatment and Control Groups

Coefficient estimates for interaction term $TG * Post$	Fixed-effect regression model (2)
Treatment group: one standard to another standard Control group: standard to standard	0.096 (0.075)
Treatment group: standard to customized Control group: one standard to another standard	−0.378** (0.071)
Treatment group: customized to standard Control group: standard to standard	0.170* (0.075)

Note. Standard errors corrected to account for groups belonging to the same client.

**, * denote statistically significant at the 1% and 5% levels (two-sided test), respectively.

groups who migrate from a customized to a standard plan to accordingly make higher calls due to the loss of *fit* and *familiarity*. We test this hypothesis by comparing the calls for customized-to-standard groups with standard-to-standard groups. Row 3 of Table 5 reports the results. We find that migration from a customized to a standard plan leads to an increase in product-related calls. This finding is in line with our theory's intuition.

5. Another strong support to our theory comes from non-product-related calls. Our theory says the product cocreation process should reduce product-related calls. However, customers make a variety of non-plan-related calls, such as claim-related calls, insurance card-related calls, billing-related calls, and change-in-address-related calls. We do not expect these calls to reduce with plan customization. We now reestimate our model with the non-product-related calls. To reduce clutter, we only report coefficient estimates for the interaction term ($TG * Post$) in Table 6. We fail to find any statistically significant change in the number of non-product-related calls due to product customization. Combined with our result of reduced product-related calls, this result negates the possibility that the customer groups moving from standard to customized plans are somehow making fewer calls, independent of product customization. This finding also alleviates selection concerns for standard-to-customized groups. If these groups were reducing product-related calls for reasons other than product customization, we would expect them to also reduce the non-product-related calls.

Table 6 Estimates for Non-Product-Related Calls

Coefficient estimates for interaction term $TG * Post$	Fixed-effect regression model (2)
Treatment group: standard to customized Control group: standard to standard	0.332 (0.586)

Notes. Standard errors are in parentheses. Standard errors corrected to account for groups belonging to the same client.

Table 7 Estimates When Post-Period Is Split Into Four Quarters

Dependant variable: *Call volume*	Fixed-effect regression model (2)
$TG * Q1$	−0.252* (0.121)
$TG * Q2$	−0.123 (0.172)
$TG * Q3$	−0.226* (0.113)
$TG * Q4$	−0.283^ (0.122)

Note. Standard errors are in parentheses.

*, ^ denote statistically significant at the 5%, and 10% levels (two-sided test), respectively.

6. To test whether the reduction in calls is temporary, we split the post-period into four quarters and estimate the impact for all four quarters. To avoid clutter, we only report the estimates for the interaction with post-quarter dummies in Table 7. All of the estimates are negative and significant (except Q2). Note that the quarterly split in data increases standard errors due to fewer data points, but the sign remains consistent and significant for three of the four quarters. This finding indicates the effect of customization persists for the whole year.

7. Conclusions, Managerial Implications, Limitations, and Future Work

We show through actual usage data in a field study that customizing a complex product like a health insurance plan significantly impacts customer demand for a call center and thus customer service costs. Customization of such a product is usually an interactive exercise and acts as an educational tool to familiarize the customers with their plan coverage. This customization in turn reduces product uncertainty and improves fit, reducing the need to contact the call center for product-coverage clarifications. In the present empirical setting, we find customers migrating from a standard to a customized plan make an average of 21% fewer product-related calls because of this change. This percentage translates into a significant savings for the firm. We find the results are not a short-term blip but an effect that persists for the whole year. We also provide various robustness checks to test the validity of our results under alternative explanations and specifications. In addition, we find the claims suspension rate is not different for the customized and standard plans, which suggests an overall reduction in customer support costs due to customization. Although other researchers have documented many direct benefits of customization, we provide evidence of a less obvious benefit of customization: lower customer service costs.

A key academic contribution of our study is the provision of a link between product design and

customer service costs. Our results highlight that the process of customization is seemingly important. Therefore, although our setting is a health-care product, we believe our results would be applicable to any such setting where the product is complex, for example, other insurance services, IT and telecom-related services, and financial and investment-related services. Product complexity can lead to customer dissatisfaction and higher customer service costs (Lawton 2008). Educating customers is one effective process for reducing product uncertainties and customer service costs. For example, Dell Computer deliberately avoided selling to low-end customers who need a lot of hand-holding (Magretta 1998). As firms' offer more complex and varied products, they cannot ignore its implications on the customer service costs (Knowledge@Wharton 2006). Lack of awareness and lack of understanding regarding health-care plans also leads to significant welfare losses. Many researchers explicitly push policymakers to improve educational efforts to improve user knowledge. Our results highlight that although better product understanding may lead to many direct benefits, it generates substantial indirect benefits to both customers and the firm in the form of lower customer service costs—a potential win-win scenario.

Despite a rich data set and robust empirical tests, our study is not without limitations, one of which is our inability to directly measure fit and familiarity. Although we have used many robustness checks to rule out alternative explanations for our results, we cannot claim definitively that calls are going down because of fit or familiarity, or both, without explicitly measuring these latent constructs. Similarly, although we document the benefits of customization and believe customization in our setting provides indirect benefits as well (e.g., higher customer retention or higher pricing), the interactive nature of customization may also increase firm's costs. A firm may require more time to sell such plans or the plan may increase the complexity of the firm's operations. Because of the lack of data availability, we cannot measure these issues more directly in our present study.

Despite limitations, we believe our study takes a step forward in examining a link between an iterative customization process and customer service costs. We believe this line of investigation is underinvestigated and highly promising and will benefit from future research. One obvious extension is to measure the latent construct of fit and familiarity and estimate separately how each one of these help cut customer service costs. This analysis would also indicate which is more important in reducing customer service cost: the tool itself (plan fit) or the process of creating the tool (plan familiarity). Our paper also highlights the role of "learning before doing"—another promising line of inquiry.

Electronic Companion

An electronic companion to this paper is available on the *Manufacturing & Service Operations Management* website (http://msom.pubs.informs.org/ecompanion.html).

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References

Anderson, E. W., C. Fornell, R. T. Rust. 1997. Customer satisfaction, productivity, and profitability: Difference between goods and services. *Marketing Sci.* **16**(2) 129–145.

Ansari, A., C. F. Mela. 2003. E-customization. *J. Marketing Res.* **40**(2) 131–145.

Bertrand, M., E. Duflo, S. Mullainathan. 2004. How much should we trust differences-in-differences estimates? *Quart. J. Econom.* **119**(1) 249–275.

Christianson, J. B., T. Parente, R. Feldman. 2004. Consumer experiences in a consumer-driven health plan. *Health Services Res.* **39**(4, Part 2) 1123–1140.

Dewan, R., B. Jing, A. Siedmann. 2003. Product customization and price competition on the Internet. *Management Sci.* **49**(8) 1055–1070.

Fisher, M., C. D. Ittner. 1999. The impact of product variety on automobile assembly operations: Empirical evidence and simulation analysis. *Management Sci.* **45**(6) 771–786.

Fisher, M., A. Jain, J. P. MacDuffie. 1995. Strategies for product variety: Lessons from the auto industry. B. Kogut, E. Bowman, eds. *Redesigning the Firm*. Oxford University Press, New York, 116–154.

Foster, G., M. Gupta. 1990. Manufacturing overhead cost driver analysis. *J. Accounting Econom.* **12**(1) 309–337.

Gans, N., G. Koole, A. Mandelbaum 2003. Telephone call centers: Tutorial, review, and research prospects. *Manufacturing Service Oper. Management* **5**(2) 79–141.

Garnick, D. W., A. M. Hendricks, K. E. Thorpe, J. P. Newhouse, K. Donelan, R. J. Blendon. 1993. How well do Americans understand their health coverage? *Health Affairs* **12**(3) 204–212.

Goffin, K., C. New. 2001. Customer support and new product development: An exploratory study. *Internat. J. Oper. Production Management* **21**(3) 275–301.

Gruber, J., J. T. Abaluck. 2009. Choice inconsistencies among the elderly: Evidence from plan choice in the medicare part D program. NBER Working Paper 14759, National Bureau of Economic Research, Cambridge, MA.

Hanoch, Y., T. Rice. 2006. Can limiting choice increase social welfare?: The elderly and health insurance choice. *Milbank Quart.* **84**(1) 37–73.

Harris-Kojetin, L., J. S. Lubalin. 1999. What do consumers want and need to know in making health-care choices? *Medical Care Res. Rev.* **56**(1) 67–102.

Isaacs, S. L. 1996. Consumers' information needs: Results of a national survey. *Health Affairs* **15**(4) 31–41.

Juran, J. M. 1988. *Juran's Quality Control Handbook*, 4th ed. McGraw Hill, New York.

Kahn, B. E. 1998. Dynamic relationship with customers: High variety strategy *J. Acad. Marketing Sci.* **26**(1) 45–53.

Kekre, S., K. Srinavasan.1990. Broader product line: A necessity to achieve success? *Management Sci.* **36**(10) 1216–1231.

Knowledge@Wharton. 2006. From retailers to manufacturers, complexity in products begs the question: How much is too much? March 1, http://knowledge.wharton.upenn.edu/article.cfm?articleid=1380.

Lawton, C. 2008. The war on returns. *Wall Street Journal* (May 8), http://online.wsj.com/article/SB121020824820975641.html.

MacDuffie, J. P., K. Sethuraman, M. L. Fisher. 1996. Product variety and manufacturing performance: Evidence from the international automotive assembly plant study. *Management Sci.* **42**(3) 350–369.

Magretta, J. 1998. The power of virtual integration: An interview with Dell Computer's Michael Dell. *Harvard Bus. Rev.* (March–April) 73–84.

Marquis, M. S. 1981. Consumers' knowledge about their health insurance coverage. The Rand Corporation, Santa Monica, CA. Accessed March 3, 2011, http://www.rand.org/content/dam/rand/pubs/reports/2007/R2753.pdf.

Murthi, B. P. S., S. Sarkar. 2003. The role of the management sciences in research on personalization. *Management Sci.* **49**(10) 1344–1362.

Parente, S. T., R. L. Van Horn. 2006. Valuing hospital investment in information technology: Does governance make a difference? *Health Care Financing Rev.* **28**(2) 31–43.

Parente, S. T., D. S. Salkever, J. DaVanzo. 2005. The role of consumer knowledge of insurance benefits in the demand for preventive health care among the elderly. *Health Econom.* **14**(1) 25–38.

Pine, B. J., II, J. H. Gilmore. 1997. The four faces of mass customization. *Harvard Bus. Rev.* **75**(1) 91–101.

Ramdas, K. 2003. Managing product variety: An integrative review and research directions. *Production Oper. Management* **12**(1) 79–101.

Rosenbaum, P. R., D. B. Rubin. 1983. Central role of the propensity score in observational studies for causal effects. *Biometrika* **70**(1) 41–55.

Sainfort, F., B. C. Booske. 1996. Role of information in consumer selection of health plans. *Health Care Finance Rev.* **18**(1) 31–54.

Srinivasan, S., R. Anderson, K. Ponnavolu. 2002. Customer loyalty in e-commerce: An exploration of its antecedents and consequences. *J. Retailing* **78**(1) 41–50.

Tam, S. Y., S. Y. Ho. 2003. Web personalization: Is it effective? *IT Professional* **5**(5) 53–57.

Terwiesch, C., C. H. Loch. 2004. Collaborative prototyping and the pricing of custom designed products. *Management Sci.* **50**(2) 145–158.

Terwiesch, C., K. Ulrich, T. Randall. 2007. User design of customized products. *Marketing Sci.* **26**(2) 268–280.

Ulrich, K. 1995. The role of product architecture in the manufacturing firm. *Res. Policy* **24**(1) 419–441.

Ulrich, K. 2007. Users, experts, and institutions in design. *Design: Creation of Artifacts in Society*. Pontifica Press, http://www.pontifica.com/.

von Hippel, E. 1994. "Sticky information" and the locus of problem solving: Implications for innovation. *Management Sci.* **40**(4) 429–439.

von Hippel, E., R. Katz. 2002. Shifting innovation to users via toolkit. *Management Sci.* **48**(7) 821–833.

Wattal, S., R. Telang, T. Mukhopadhyay, P. Boatwright. 2011. Examining the impact of personalization: An empirical investigation with e-mail advertisement. *Inform. Systems Res.* Forthcoming.

Yankee Group Research Inc. 2006. Great expectations: Self-service success can happen. Accessed March 3, 2011, http://www.ccng.com/files/public/Yankee_SelfService.pdf.

Zipkin, P. 2001. The limits of mass customization. *MIT Sloan Management Rev.* **42**(3) 81–86.