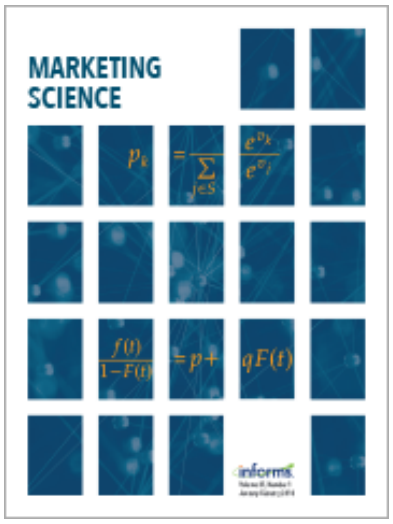

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The Service Revolution and the Transformation of Marketing Science

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The nature of marketing science is changing in a systematic, predictable, and irrevocable way. As information technology enables ubiquitous customer communication and big customer data, the fundamental nature of the firm's connection to the customer changes: better, more personalized service can be offered, from which service relationships are deepened, and consequently, more profitable customers grow the influence of service within the goods sector and expand the service sector in the economy. Marketing is becoming more personalized, and marketing science techniques that exploit customer heterogeneity are becoming more important. Information technology improvements also guarantee the increasing importance and usage of computationally intensive data processing and "big data." Most importantly, these trends have already lasted for more than a century, and they will become even more pronounced in the coming years as a result of the monotonic nature of technology improvement. These changes imply a transformation of marketing science in both the topics to be emphasized and the methods to be employed. Increasingly, and inevitably, all of marketing will come to resemble to a greater degree the formerly specialized area of service marketing, only with an increased emphasis on marketing analytics.

Keywords: service; customer lifetime value; customer loyalty; customer relationship management; customization; information technology; service productivity; customer equity; big data
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1. Introduction

Service is transforming every developed economy, resulting in an expansion of the service sector and the increasing infusion of service into the goods sector. These changes are largely due to the effect of information technology (IT, which, in this article, refers to information, communication, mobile, and networking technologies). We argue that the service revolution and the information revolution are two sides of the same coin and that understanding how advances in IT deepen customer relationships and expand opportunities for service explains the service revolution. All of this has profound implications for marketing science. We describe how the most important topics in the service literature are related to IT and the resulting deepening of customer relationships. We also add to previous attempts to define a research agenda for service (Marketing Science Institute 2012, Ostrom et al. 2010, Rust and Chung 2006) by suggesting promising topics for future research in marketing science, building on these trends.

Our three main objectives are the following:

- to explore the long-term trend of a shift from a goods-based to a service-based economy,
- to explain the trend's relationship to advances in IT, and
- to consider the implications of this trend for marketing science.

This paper contributes to the marketing science literature by concluding a set of promising substantive research topics and methodologies from a comprehensive exploration of the long-term shift from a goods-based to a service-based economy, where IT plays an important role. We have witnessed the power of manufacturing technology in moving an agricultural economy to an industrial economy (the industrial revolution), and now we have seen and will continue to see the essential role of IT in transforming an industrial economy into a service economy (the service revolution). There is current debate about whether the importance of the manufacturing sector is (or should be) diminishing, with politicians often urging more support for the manufacturing sector as the primary means of improving the economy. Our analysis suggests that these policies may be misguided.

Marketing science is being radically transformed because the nature of marketing is becoming more individual customer centered and relationship driven instead of mass market centered and transaction driven. Marketing research methods that were appropriate for a transaction-based initial choice environment may be less appropriate for a relationship-based repeated-choice environment, and they should be supplemented by explicitly dynamic methods. The same IT factors that are growing the service economy also change the relevant toolkit for marketing analytics, leading to an emphasis on computationally intensive data analysis of customer databases. Thus, IT and the service revolution are creating a wealth of new topics to study and new methods with which to study them.

In the remainder of this section, we provide a working definition of service that expands the current conceptualization and has implications throughout the whole of the economy. Section 2 begins with a description of the service revolution and how it is being driven by IT. Section 3 explores how the service revolution is transforming marketing science by enhancing the ability to provide better, more personalized service; deepen customer relationships; and make customers more profitable. We then discuss how these factors expand the service sector and increase the importance of service throughout the economy. Section 4 summarizes the paper, provides substantive and methodological implications, and draws conclusions.

1.1. What Is Service?

Traditional marketing focused on "products," a word which in common usage to this day is assumed to mean physical products (goods), even though service products (e.g., insurance policies, cell phone plans) are now ubiquitous. A realization then emerged that "services" were in many ways different from products (goods) (Shostack 1977), and this realization spawned a stream of research comparing goods and services (e.g., Anderson et al. 1997). In this article we move beyond these earlier conceptualizations to reflect the fact that service permeates our entire economy, and not just the service sector. We also recognize that service is often cocreated by the customer and service provider together (Vargo and Lusch 2004). This leads to the working definition of service that we will use throughout.

Definition. Service is any direct provision or cocreation of value between a provider and a customer.

There are several observations that emerge from this conceptualization:

1. Service does not have to involve customer contact personnel. For example, an ATM machine provides service to bank customers.

2. Because service cocreation often plays out over time, the emphasis expands from "selling a service" (static) to "cocreating service, interactively, over time" (dynamic).

3. Selling a good to a customer is not service, because ownership of a good, in itself, provides no value. Only use of the good results in value. In other words, the "purchase utility" of a good is the expectation of "consumption utility" that will be derived from the service provided by the good.

4. Service is not restricted to the service sector. There is considerable service in the goods sector. For example, auto dealers provide aftersale service, and many business-to-business (B2B) goods manufacturers provide ongoing service (advice, maintenance, etc.) to build customer relationships.

To summarize our viewpoint, we believe that the "products versus services" conceptualization of service is out of date and that service is everywhere, not just in the service sector. *Service* is more than just "services." Our main thesis is that IT is expanding service and is profoundly influencing all of marketing, not just service marketing.

1.2. The Conceptual Framework

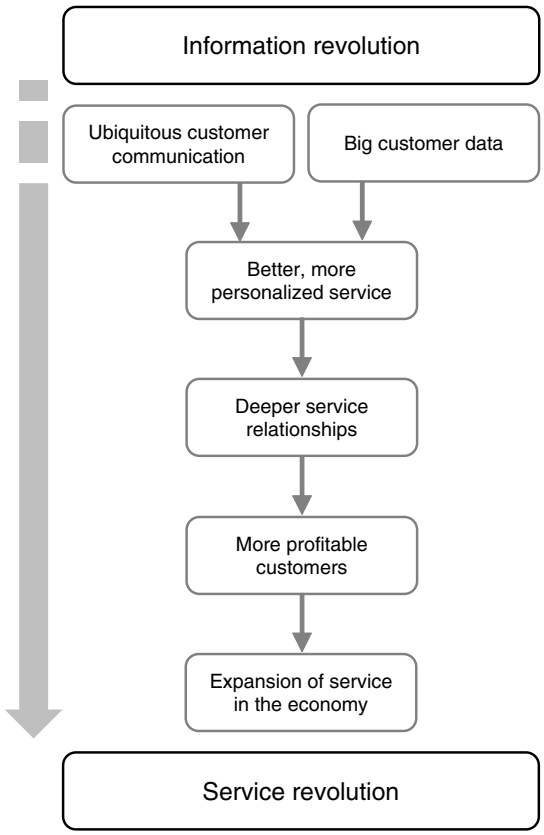
Figure 1 illustrates how advances in IT result in the service revolution. Improved communication technology (e.g., mobile and networking technology) results in enhanced multiple-way information flows. At the same time, data storage becomes cheaper and data processing becomes faster (e.g., big data, cloud computing). Together, these factors facilitate the provision of better, more personalized service, which forges deeper customer relationships and increases customer profitability. We will show in §3 how these deeper relationships serve to expand the service economy and to increase the importance of service throughout the economy. This conceptual framework forms the backbone of our paper. We start by describing the advances in IT, and then we discuss how this advancement results in better service, deeper relationships, and a larger role for service in the economy. We then discuss the ways in which the field of marketing science is transformed by the service revolution.

2. Information Technology and the Service Revolution

2.1. The Service Revolution

One of the longest and most stable economic trends is the shift in employment to the service sector. This trend is seen in all of the developed economies of the world, and the service sector has been steadily growing for almost 200 years. For example, in 1839, only 21% of U.S. nonfarm workers worked in the service sector; by 1900, the percentage increased to 33%

Figure 1 Information Technology and the Expansion of Service



(Gallman and Weiss 1969). Service sector employment in the United States rose to 56% of nonfarm employment by 1940, 67% by 1980, and 84% by 2011 (U.S. Bureau of Labor Statistics 2012). This trend holds even at the firm level, with successful manufacturing firms such as IBM adopting intentional strategies to transition to service (Fang et al. 2008).

As service has become more important in the economy, the service marketing literature has grown correspondingly (Kunz and Hogreve 2011), and the quantitative service literature, in particular, has expanded dramatically in the last 20 years (Rust and Chung 2006, Rust and Metters 1996). It continues to accelerate as new research influences from such fields as computer science and engineering help build an emerging field of "service science" (Spohrer and Maglio 2008).

2.2. The Advance of Information Technology

In the manufacturing economy, it was mass production technology (i.e., the tools that enable production of all manufactured goods) that significantly enabled the industrial revolution. In the service economy, IT plays a key role (Rust and Huang 2011). Much of the radical transformation of the world economy from an industrial to a postindustrial service society comes from the contribution of IT to service and from IT as a service. Service is not new; it is *service plus IT* that transforms service. IT enables service, and its input and output, information, is central to service. IT can play the role of facilitator (e.g., it facilitates access to customer information and customer communication) or enabler (e.g., it enables value cocreation), serves as the context (e.g., mobile phone market or e-commerce), or is itself the service (e.g., social networking sites or information goods) (Huang and Rust 2013).

The advancement of IT—mainly big data, cloud computing, and mobile and networking technology—has transformed the nature of service fundamentally. Data storage capabilities have advanced steadily and dramatically, as typified by Moore's law, which states that electronic storage capacity per unit volume doubles every two years. In the late 1980s, an IBM 3850 mass storage system stored a total of around 100 GB and was used to store the entire 1980 U.S. Census database (Jacobs 2009). Now one can easily store the data on a $10 disk. The world's information storage capacity per capita has roughly doubled every 40 months since the 1980s (Hilbert and López 2011). In 2012, 2.5 quintillion (2.5×10^{18}) bytes of data were created every day (IBM 2012).

In addition to data management techniques, the analytical capabilities and techniques used in marketing have taken advantage of huge increases in data processing speed. Hardware evolution has made all kinds of software run much faster. The Intel Pentium processor, introduced in 1995, achieved a SPECint95 benchmark score of 2.9, whereas the Intel Core 2 Duo achieved a SPECint2000 benchmark score of 3108.0—a 375-times increase in performance in 11 years (Larus 2009). In the 1980s, the average processing speed of the fastest supercomputer was about 2 gigaflops (10^9) of floating-point operations per second; today, a fast consumer desktop computer can easily handle calculation at 50–90 gigaflops (e.g., an Intel Core i7-900 series desktop processor) (Intel 2011).

Mobile and networking technology allows firm-to-customer, firm-to-firm, and customer-to-customer communications online and on mobile devices (e.g., Twitter, Facebook). Such communications provide firms with useful information about individual customers as well as greatly amplify the power of word of mouth.

2.2.1. Ubiquitous Customer Communication. Today, through the use of mobile devices coupled with social networking platforms, the ability of the firm to communicate to its customers and to learn from customer communication (customer-to-firm and customer-to-customer) has been significantly enhanced. This enduring trend of increased mobile

networking allows marketers to interact with customers anywhere at any time to gain a deeper understanding of customer behavior.

Mobile and networking technology strengthens the ubiquitous communication between firms and customers. For example, a service firm's communications with its customers originally mainly involved direct person-to-person communication. The salesperson is the classic embodiment of this link. Remote communication technologies such as the telephone increased the company's ability to aim personalized offers at the customer; this has been further enhanced in recent years by technologies such as the Internet, mobile phones, and smartphones. Researchers have shown that the decreased search costs facilitated by electronic marketplaces such as the Internet can reduce inefficiencies and allow the consumer to take some of the seller's profit (Bakos 1997). Firm-to-customer communications can be beneficial postsale as well as presale, consistent with the iterative view of the firm–customer relationship (Challagalla et al. 2009) and the idea of customer engagement (Brodie et al. 2011, Verhoef et al. 2010).

Customer-to-firm communication has also been enhanced by mobile and networking platforms, where learning about customers has become a central issue in relationship management (Sun 2006). For example, customer interactions and transactions over the Internet provide the firm with rich data on not just customer purchasing but also customer clickstreams and online behavior. Customer-to-customer communications online and on the customers' mobile devices (e.g., Twitter, Facebook) also provide the firm with useful information. The interaction further implies that customer information is useful for not just service/product design (Griffin and Hauser 1993, Hauser and Clausing 1988, Raghu et al. 2001) but also, increasingly, service corrections within the course of a customer relationship (Nakata et al. 2011). The design of service is moving increasingly from static and aggregate (e.g., conjoint analysis)[1] to evolving, iterative, and personalized.

2.2.2. The Availability of Big Customer Data. Data storage capabilities and computing speed have advanced steadily and dramatically, as typified by big data and cloud computing, to handle the massive amount of data from ubiquitous customer communication that are diversified in formats and data models, and are semantically heterogeneous. Big data consolidates many types of data resources with different structures and data models in a massive, distributed storage system. Multiple data sources contribute to the size, variability, and complexity of big data. Examples include social data, large-scale e-commerce, chatroom conversations, clickstream data, and customers' emails to call centers. Cloud computing solutions exist today for handling big data analysis that facilitates greater flexibility, scale, and speed.

Big data has dramatically transformed a firm's capabilities to store and analyze customer information. Facebook handles 50 billion photos from its user base (Johnson 2010). Internet clickstream data become available and accessible for customer analysis as a result of the increased data storage capacity. For example, the comScore Internet clickstream data contain an enormous data quantity, based on the collection of 100,000 panelists' Internet behavior on a daily basis. The data quantity comprises more than 120 MB each day (Danaher 2007). Similarly, the clickstream data in Park and Fader (2004) easily exceeded 10,000 visits, just for book and music site visits.

The availability of big data and marketing analytics on the cloud makes personalization (in terms of both service offerings and marketing communications) increasingly feasible and cost efficient. Firms can collect more accurate and detailed customer information at the individual level and use the information for a very narrow and specific segmentation of customers, thus enabling mass customization of services and personalized marketing communications. This means that personalization has two meanings here: service itself can be tailored to customer's individual needs with the input of big customer data, and marketing communications with customers can be personalized by taking advantage of the personal nature of communication content in many networking platforms—for example, the shared personal lives and views on social networking sites. This new IT trend thus allows firms to tailor service to individual customer needs and to build personal relationships with customers by leveraging personal content (not necessarily personal identity).

2.3. Unanswered Questions

2.3.1. Poor Service. Despite the impetus for an increased emphasis on service in every developed economy, even casual observation quickly confirms that poor service is disappointingly prevalent. Prior research gives some of the reasons that poor service persists (e.g., Gerstner and Libai 2006, Oliva and Sterman 2001), but we need deeper understanding of the causes of poor service and how management can prevent it. Oliva and Sterman (2001) used a systems dynamics approach to investigate this, and the complexity of service provision suggests that an approach such as agent-based modeling may be required to

[1] Conjoint analysis can incorporate service attributes such as speed of service, level of aftersale service, etc., but it is inherently limited to the initial design (static). What are increasingly needed are dynamic design methods that can change the product over time for individual customers.

capture all of the feedback loops resulting from the different agents (customers, service providers, external financial analysts, etc.).

2.3.2. Big Data. Big data is known for its volume, velocity, and variety that together create new challenges in data analysis. The volume of the data very often goes beyond the capacity of most computers, the streaming of the data requires that data analysis be collected and processed in real time, and the variety of the data makes unfit the traditional structured data sets that are typically arranged as a matrix. Data compression and data scalability are two crucial issues to consider. Bickel (2013) looked at how the Fisherian concepts have evolved in response to the new big data environment. He argued that "'sufficiency' has evolved to 'data compression,' 'efficiency' has had to include computational considerations, and issues of scale—'parameters' and procedures such as 'maximum likelihood'—have had to be considered in the context of larger semi- and nonparametric models, as in robustness." In other words, as pointed out by Lazar (2013), we need to reconsider the traditional concept of sufficient statistics as an issue of data compression when determining what data contain the information that is relevant to the parameters of interest and to explore the large-sample behavior of various data analysis techniques, especially when many traditional statistical methods do not scale up well for very big data sets.

3. The Transformation of Marketing Science

The previous section focused on the advances in IT that are profoundly impacting marketing and changing our understanding of marketing science. This section focuses on how marketing is being transformed. In particular, we flesh out Figure 1 by exploring how advances in IT result in better, more personalized service; deeper customer relationships; more profitable customers; and an expansion of service in the economy.

3.1. Better, More Personalized Service

Information technology enables firms to improve service quality by providing better, more personalized service. This has implications for how we think about the relationship between quality and productivity.

3.1.1. From Standardization to Personalization. Standardization implies one segment for all customers, whereas personalization implies that every customer constitutes a separate segment. The relationship between technology[2] and optimal segment size can be described mathematically (Varki and Rust 1998). Interestingly, technology has an inverted-U relationship to segment size. When technology is at a very low level (i.e., no technology in the modern sense), all service is one-to-one (think artisans and craftsmen). When technology improves (i.e., manufacturing technology becomes available), standardization becomes feasible, and a mass marketing approach prevails. Historically, this coincided with the rise of the manufacturing sector of the economy. Then as technology improves further (i.e., information technology becomes dominant), it becomes economically feasible to differentiate more and more, resulting in more personalized service. Past this point, advances in technology imply improved service quality, deepened customer relationships, and consequently, an expanded service sector and greater importance of service throughout the economy. That is where we are now, and the unidirectional nature of technology advancement means the trend will only intensify.

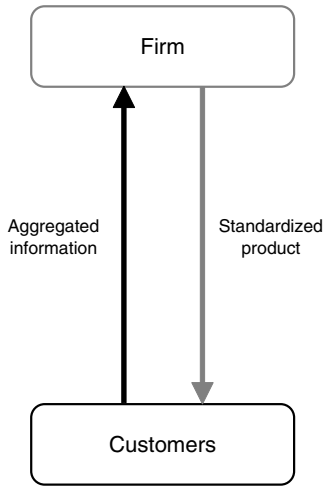
Service quality improves with personalization. That is, as segment sizes decrease, service becomes more targeted and focused, improving service quality and customer satisfaction. All of this is accelerated by developments in IT that advance the service revolution. With IT strengthening iterative, multiple-way customer communication (see Figure 3), firms have a growing opportunity to differentiate their customers more and employ smaller segments. Thus, the service environment implies the increased importance of attention to customer heterogeneity (Danaher 1998). The mass marketing viewpoint (epitomized by Henry Ford's "You can have any color that you want as long as it is black") is rapidly giving way to more personal attention, even to the point of one-to-one marketing (Peppers and Rogers 1993).

As individualized customer information becomes more available over time, a firm often has an opportunity to fully personalize the service provided (Murthi and Sarkar 2003), and IT accelerates this capability (Shugan 2004). The inherent temporal and spatial dimensions make it a great source for personalizing service. Research explores the conditions under which customer input can best result in successful personalization (Franke et al. 2009). The process of personalization and customization—if all it means is how to configure a product—is limited to the product scenario conceptualization of marketing (see Figure 2). In other words, the firm hears what the customer wants once and provides the product (service or physical product) once. If we instead incorporate the thinking of the service scenario (see Figure 3), we see that what is needed is a dynamic process by which the firm adapts its product over time (Oliver et al. 1998).

We term such an approach as *adaptive personalization*. For example, Hauser et al. (2009) built a "website morphing" system that changes the pages shown

[2] In this paragraph, the term "technology" refers to technologies in general.

Figure 2 The Product Scenario (Static)



on a website in real time, based on choices that the user makes in navigating the site. This is a "one-shot" adaptive system, in that it makes only one change to the product. A more complete example of an adaptive personalization system is the My Mobile Music system for downloading music to mobile devices (Chung et al. 2009). In that system the device presents the listener with a playlist of songs. Based on how the listener responds to the songs (how long he or she listens, whether he or she listens all the way through), the system updates the listener's preferences while taking into account other listeners' behavior; it then presents the listener with a new playlist periodically. In this way, the product improves dynamically over time. This approach is differentiated from traditional recommendation systems in that the system does not make recommendations—rather, it changes the nature of the product itself. With better, more personalized service offered over time, a firm's relationship with customers becomes more personalized, deeper, and longer. Although not all customers may want a close relationship with the firm (Danaher et al. 2008), many customers can benefit from more personalized service.

3.1.2. Productivity and Its Trade-offs. So far, we have argued for the ability of IT to provide better, more personalized service that deepens customer relationships. But it is important to note that IT very often is used to increase productivity and reduce the cost of service, a thought philosophically rooted in manufacturing. In manufacturing, return on quality is often evaluated based on the degree to which costs are cut (e.g., Tennant 2001). Such cost reductions go directly to the firm's bottom line and are reflected immediately on the firm's income statement. In service, on the other hand, quality improvements typically result in increased customer satisfaction and customer retention. This plays out over time (Bolton 1998; Bolton and Drew 1991a, b), and the benefits of service quality (discounted future profits) must be weighed against the increased costs of providing better service.

It is useful to categorize three cases of IT, based on whether the IT deepens relationships by improving service quality and whether it reduces costs by increasing efficiency and productivity.

Case 1. Quality+, Cost−: $dQ/dT > 0$, $dC/dT < 0$.

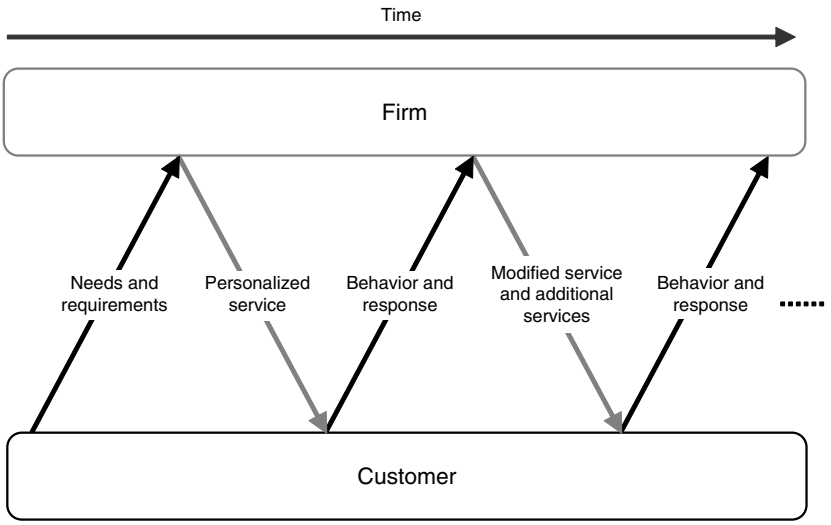
Case 2. Quality+, Cost+: $dQ/dT > 0$, $dC/dT > 0$.

Case 3. Quality−, Cost−: $dQ/dT < 0$, $dC/dT < 0$.

Here, Q is quality, C is cost, and T is level of information technology. There could be a fourth case (Quality−, Cost+), but no firm would have an incentive to adopt such an IT.

Case 1 is the ideal case for IT, in that service is done both better and cheaper. One example is the use of the

Figure 3 The Service Scenario (Dynamic)



Internet for travel reservations. A firm such as Expedia allows customers to make travel arrangements in a way that is both better and cheaper than it would have been otherwise. Cases 2 and 3 involve trade-offs. Case 2 provides better quality at a higher cost. We see this at expensive restaurants, for example, where IT is used to record repeat customers' table and food preferences. Case 3 provides worse quality at a lower cost. Telephone customer service menus are an (irritating) example. This classification suggests that customer satisfaction and productivity may sometimes be at odds.

We see a difference between manufacturing and service with respect to how satisfaction relates to productivity. The traditional manufacturing view of productivity (e.g., Deming 1986) holds that better quality arises from more efficient processes. Greater efficiency leads to both lower costs and higher quality (more standardization), which then satisfies the customer.[3] This is the typical scenario of manufacturing technology-enabled industrial resolution. However, as argued in the previous section, service demands customization rather than standardization, and more customization seldom results in lower costs (the advances of IT have lessened the degree of the trade-off). Also, higher productivity can imply either fewer service personnel or more customers and more crowding (Chen et al. 2009), or even forced customer confinement (e.g., leaving an airliner on the tarmac for hours) (Chen et al. 2012), either way providing a worse customer experience and lower customer satisfaction result. These effects suggest a trade-off between satisfaction and productivity in service, whereas one may not exist in manufacturing.

This trade-off was investigated both analytically and empirically (Anderson et al. 1997), and it was confirmed to be more pronounced for service firms than for goods firms. Subsequent research (Rust et al. 2002) showed that a "dual emphasis" (striving for both satisfaction/revenue expansion and productivity/cost reduction) was less profitable than a "revenue emphasis" that focused primarily on customer satisfaction and revenue expansion. That research was challenged by Mittal et al. (2005), who showed that firms that *achieved* both revenue expansion and cost reduction were more profitable. However, the results of Mittal et al. are actually compatible with those of Rust et al. when we realize that the dual-emphasis managerial strategy often fails (in essence, the Mittal et al. research eliminates the failed cases).

Recent research investigates the satisfaction–productivity trade-off in more depth. In service, the satisfaction–productivity trade-off generally focuses on the use of labor versus the use of service technology that substitutes for employee labor. Such technology is often of the self-service variety (Meuter et al. 2000), in effect substituting some combination of customer labor and technology for employee labor. Substituting for human employee labor may sometimes be accomplished with the use of virtual agents (Köhler et al. 2011). Effectiveness of self-service and other technological methods of service delivery may depend on the tendency of the customer to accept technology (Parasuraman 2000) and whether the use of that technology is forced on the consumer (Reinders et al. 2008), the customer's evaluation of service quality on the Internet and other technology-mediated venues may involve different factors from non-technology-mediated service (Parasuraman et al. 2005), and electronic service provision ("e-service") may involve different principles (Rust and Kannan 2003, Rust and Lemon 2001).

Using both analytical theory and empirical analysis of hundreds of U.S. service firms, Rust and Huang (2012) showed that there is an optimal level of service productivity that depends on the level of technology. The research shows that factors that encourage the firm to provide good service (e.g., higher profit margins, higher price) motivate the firm to provide better customer satisfaction and lower productivity, whereas factors that discourage the firm from providing good service (e.g., fewer competitors, high employee wages) motivate the firm to provide worse customer satisfaction and higher productivity. Tentative empirical results indicate that large U.S. service firms may tend to be overproductive, suggesting that it may be more profitable to trade off some productivity and efficiency to provide better customer satisfaction. From a broader view, these findings may imply that marketing should play a larger role in service provision relative to operations. This is because marketing is closer to the customer than is operations, meaning a shift of emphasis from productivity to satisfaction may also imply a shift of emphasis from operations to marketing.

3.2. Deeper Service Relationships

Customer communications and purchases with the firm, with competitors, and with other customers are captured by the firm and stored in customer databases. This information, known as *big data* (discussed in §2.3.2), is then processed and analyzed both locally and remotely, often using cloud computing. Because of the size of the data management task, information systems and database management are playing an increasingly important role in managing customer data—and computationally intensive statistical methods are increasingly used to analyze it.

[3] The causal direction can also work the other way, with satisfaction leading to greater efficiency because of less time lost to complaint management and rework.

Based on the analysis of customer data, personalized services and marketing actions are implemented for each customer (Blattberg and Deighton 1991). These individualized marketing actions supplement, or in some cases replace completely, the traditional mass marketing actions. The customers then respond to these actions, to the firm directly (e.g., buying more), to competitors (e.g., switching to competitors), and/or to other customers (e.g., word of mouth, referrals). This ability to communicate and deliver service, anytime and anywhere, is facilitated by mobile and social networking technology.

3.2.1. Dynamic Customer Interaction. One of the main results of this trend has been to change the way firms typically interact with customers. In a goods-driven economy, the traditional method of interacting with customers is typified by Figure 2. In this *product scenario*, the firm collects aggregate information from customers and then uses that information to produce manufactured products. Traditionally, these products are standardized, often in an assembly-line sort of environment. In a service-driven economy, the method of interacting with customers changes, as seen in Figure 3. In this *service scenario*, the interaction with the customer is individualized. The customer presents the firm with personal information (wants, desires, etc.), and the firm responds with personalized service. Given this service, the customer then gives the firm feedback (behavior and/or communication) that the firm can then use to fine-tune the service (Khan et al. 2009, Lewis 2005, Luo and Kumar 2013). This feedback loop can go back and forth for many iterations. This implies a long-term orientation by the firm with respect to its customers, and it increases the importance of customer retention in relation to customer attraction. Note that the service scenario is not new—personalized service has been provided by doctors, haircutters, B2B marketers, and others for many years. What is new is the degree to which IT facilitates the service scenario.

Service quality and customer satisfaction are already well understood from the standpoint of individual transactions, or even strings of transactions. In the service transformation, the focus moves to understanding the value of service, as perceived by the customer, over time.

3.2.2. Customer Relationship Management. With service being driven by repeated interactions with the customer (see Figure 3) and firm actions being informed by big customer data, there has been increasing attention paid to customer relationship management (CRM) models. At the micro level, models describe the effectiveness of specific marketing actions to specific customers. At the macro level, models describe the effectiveness of different types of relationship investments (Palmatier et al. 2006, Reinartz et al. 2004).

Estimation of the effects of firm–customer interactions on subsequent customer behavior is a complex problem. One approach adopted by researchers is to assume the existence of a finite number of relationship states, from low to high, with movement from state to state modeled by a hidden Markov model (Netzer et al. 2008). Subsequent research has generalized the discrete states to a continuous state space with improved estimation performance and computational efficiency (Aravindakshan et al. 2008).

Ultimately, if addressed in its full complexity, the CRM problem is an estimation problem relating managerial actions to sales, followed by a dynamic programming problem to determine the optimal marketing actions. The estimation problem is plagued by the endogeneity of marketing actions. That is, prior marketing actions were typically not done randomly—they were instead done based on some prior behavior exhibited by the customers. Another complexity is that the impact of CRM can take the form of customer retention, increased usage rates, up-selling, and cross-selling (Li et al. 2011, Shah et al. 2012, Verhoef et al. 2001), all of which would need to be modeled in a comprehensive CRM model. The complexity of the optimization problem often forces the researcher to employ simplifying heuristics to obtain practical solutions (Bitran and Mondschein 1996).

To investigate this, we would need to collect customer-specific data over the course of a customer's relationship with a service provider, measuring the degree to which value was perceived as well as the resulting attitudes and behaviors. Ideally, these data would be augmented with information from the service provider's side with respect to quality efforts. The data would be analyzed econometrically.

With dynamic customer interaction over time and appropriate CRM models that can incorporate customer heterogeneity and marketing action endogeneity, service relationships can be deepened. This means that the value of service, as perceived by customers, can increase over the course of the relationship.

3.3. More Profitable Customers

When the economy is increasingly made up of relationship-intensive firms, a firm typically builds its profit not only by attracting an initial sale but also by building subsequent additional sales; cumulatively, this forms a customer's customer lifetime value. Additional sales depend on deepening the customer relationship—satisfying the customer enough to motivate repurchase and cross-selling. The more relationship intensive the firm is, the greater the

importance of deepening customer relationships in order to be profitable. Thus, the firm pays increasing attention to customer profitability (not just product profitability) and to getting returns on investment from expenditures intended to grow the value of the customer base.

3.3.1. Profitability of Service Relationships. By deepening customer relationships, IT changes the way we need to think about the profitability of products and customers. Generally speaking, the emphasis shifts from product profitability to customer profitability as relationships deepen. To see this, let us explore where a firm's sales come from. The firm's total sales, S, can be written as

$$S = IS + AS, \tag{1}$$

where IS is initial sales from customers marketed to in a transaction way (e.g., through mass advertising), and AS are the additional sales from repeat purchases, cross-selling or up-selling.

A mass-produced goods firm cannot easily deepen its customer relationships, which means initial sales, IS, are of primary importance. Customers are essentially anonymous, meaning that the most important thing is the immediate effect of marketing efforts on sales. At the extreme, this means that the firm closely monitors

$$S = IS = f(M), \tag{2}$$

where M refers to mass marketing expenditure. In practice, the firm typically considers lag effects and (implicitly or explicitly) the cumulative value of the brand. Estimation becomes an econometric/time-series issue, with aggregate data over time:

$$S_t = f(M_t, M_{t-1}, M_{t-2}, \ldots). \tag{3}$$

This is the typical marketing mix scenario, with M typically being a vector of expenditures across the marketing mix.[4] The firm seeks to find the marketing expenditures that maximize

$$\Pi_{jt} = \sum_j \left[S_{jt}(P_{jt} - MC_{jt}) - M_{jt}\right], \tag{4}$$

where Π_{jt} is the contribution to profit of product j at time t, P_{jt} is the price, and MC_{jt} is the marginal cost. Note that this equation could be rewritten as

$$\Pi_{jt} = \sum_j \sum_i \left[S_{ijt}(P_{ijt} - MC_{ijt}) - M_{ijt}\right] \tag{5}$$

with an i subscript for the customer, but there would be no good reason to do so if all marketing effort is at the aggregate level and the relationship with the customer is not developed enough to enable personalization.

By contrast, a service firm is typically more relationship intensive because of the heterogeneity and inseparability of services. Equation (4) implies a continuing relationship with the customer, involving additional sales. Thus, each customer relationship is viewed as an asset of the firm, and the profitability of the *customer*, both now and in the future, becomes paramount. The static profit function, analogous to Equation (4) in the product focus, is

$$\Pi_{it} = \sum_i \left[\sum_j \left[S_{ijt}(P_{ijt} - MC_{ijt})\right] - M_{it} \right]. \tag{6}$$

The notable differences between this and the product-focused version is that the contribution is now summed across products for each customer, and the individual-specific marketing efforts may include relationship-building efforts that are not product specific.

3.3.2. Returns from Customers. Deep customer relationships play out over time, so the long-term profitability needs to be considered. This means consideration of customer lifetime value. The concept of returns from customers involves the calculation of individual customer lifetime value (CLV) and the aggregate customer equity, both reflecting that the customer is the profit center, not the product. Customer lifetime value is the expected discounted profit stream that will result from the relationship with a customer (Dwyer 1989). The sum of customer lifetime values across the firm's current and future customers is known as the firm's customer equity (Blattberg and Deighton 1996). Accurately predicting an individual's future profitability, and hence CLV, is not easy, but progress has been made (e.g., Rust et al. 2011).

In a transaction world, the profitability of the transaction is what matters. In a relationship world, the future value of the relationship becomes important. IT now provides many firms with both the large customer databases and the computational firepower necessary to compute CLV for individual customers on a routine basis. This facilitates the use of CLV scores to decide which customers are worth the efforts to offer improved individualized service. For example, IBM maintains large databases that keep track of customer purchases and customer-related marketing efforts, enabling the calculation of CLV for each of its business customers.

The customer lifetime value of customer i can be written as

$$\text{CLV}_i = \sum_t (\Pi_{it}(1+d)^{-t}), \tag{7}$$

where t is time and d is the discount rate. We note that this estimation is at the individual level and that

[4] Practical marketing mix models may be somewhat more complicated than this, but this simplified equation captures their essence.

we are dealing with individual customer profitability. We may decompose the profit, Π_{it}, into its constituent parts:

$$\Pi_{it} = S_{it} - MC_{it} - M_{it}, \tag{8}$$

where S_{it} is revenue from customer i (across all the firm's products) in time t, MC_{it} is the marginal cost, and M_{it} is the marketing expenditure directed toward customer i. Other customer relationship expenditures could also be included.

The preceding discussion considers CLV at the individual customer level, but we can also obtain insights from considering this at the aggregate level (e.g., see Gupta and Lehmann 2005 for a discussion of some models along these lines). For example, let us consider a firm that has C customers, an acquisition rate of A customers per period, a profit per customer of Π, a retention rate r,[5] and discount rate d. Under those conditions, the value of the existing customer base is

$$\begin{aligned}&\text{Value of customer base}\\ &\quad = C\Pi + \big((rC\Pi)/(1+d)\big) + \big((r^2C\Pi)/(1+d)^2\big) + \cdots\\ &\quad = C\Pi((1+d)/(1+d-r)).\end{aligned} \tag{9}$$

We can then calculate the value of future acquired customers by noting that A replaces C in the above equation and each subsequent cohort discounts by an additional factor of $(1+d)$. This leads to a value of future customers:

$$\begin{aligned}&\text{Value of future customers}\\ &\quad = (A\Pi/(1+d-r)) + (A\Pi/((1+d)(1+d-r)))\\ &\qquad + (A\Pi/((1+d)^2(1+d-r))) + \cdots\\ &\quad = (A\Pi/(1+d-r))((1+d)/d).\end{aligned} \tag{10}$$

The total customer equity of the firm is thus the sum of the value of the current customer base plus the value of the firm's future customers, as determined in Equations (9) and (10). From these equations, we can see the various ways in which service can grow the customer equity of the firm. Service can drive retention rate r through better service quality; acquisition rate A through word of mouth, resulting from better service quality; and profit per customer Π through deepening customer relationships and more cross-selling.

A deep customer relationship evolves from repeatedly satisfactory transactions and communications with the firm, by which individually tailored service and personalized marketing communication play a key role. Service is essential in the two aspects for long-term customer value. As modern economies become predominantly service based, firms increasingly derive revenue from the creation and sustenance of long-term relationships with their customers. Returns from service quality come from increasing the future value of these relationships (Rust and Zahorik 1993, Rust et al. 1995). At the firm level, customer equity can be managed strategically as a means of evaluating return on marketing investments (Rust et al. 2004, 2000), and it has been shown to link closely to the value of the firm (Gupta et al. 2004, Kumar and Shah 2009, Rust et al. 2004, Schulze et al. 2012).

3.4. Expansion of Service in the Economy

From the preceding sections, we see that IT can deepen customer relationships, but what effect does that have on the size and importance of the service economy? In particular, could that explain the expansion of the service sector?

The typical service is more relationship intensive than the typical goods business is. To see this, let us consider two extreme cases. One is a consumer packaged goods firm that sells cookies. The customer goes to the store, chooses from among many possible cookie choices, and purchases the cookies on a transaction basis. Repurchase is not assured, and there are few switching costs to glue the customer to that cookie brand. A relationship is largely nonexistent.

The second case is a retail bank. The customer has a checking account at that bank that continues, by default, month after month and year after year. The bank can learn from the customer's past transactions to make service suggestions (maybe a different kind of account with a better interest rate) or to try to cross-sell the customer to expand the relationship (maybe a small business loan, car loan, or home equity loan).

Not all services are relationship intensive, and some goods firms *are* relationship intensive (many B2B firms would fit that description). Nevertheless, the typical service firm is more relationship intensive than is the typical goods firm because services tend to be more labor intensive and involve more continuing customer contact.

If we assume that IT's effect of deepening customer relationships will have a greater impact on relationship-intensive businesses, and services tend to be more relationship intensive, this will have a predictable and systematic effect on the importance of the service sector in the economy.

To illustrate this, let us build a simple model. First, we separate a firm's sales into "initial sales," which are those from initial selling transactions (e.g., a cookie firm sells a bag of cookies, a bank signs up a new customer) and "additional sales," which are those from relationship-induced repurchase and cross-selling. Let IS denote initial sales, and let AS denote additional sales. The total sales, S, is then

[5] Managers often refer to the "churn rate," the proportion of customers lost per period, which is equal to $1-r$.

$IS + AS$. Furthermore, AS is a function of the degree to which the firm is relationship intensive and the degree to which IT has deepened customer relationships. Let R denote the relationship intensity of the firm, T represent the level of IT, and $\theta(T)$ represent the effect of IT on relationships ($d\theta/dT > 0$). Normalizing additional sales on the level of initial sales, we may assume the following relationship:

$$AS = R \cdot IS \cdot \theta(T). \quad (11)$$

Using the subscript s to refer to the service sector and g to refer to the goods sector, for simplicity, we characterize the two sectors based on two representative firms. From our previous discussion, we further assume that $R_s > R_g$. The relative size of the service sector, SS, is

$$SS = S_s/(S_s + S_g). \quad (12)$$

We now explore the impact of IT advance on the size of the service sector. Simple algebra shows that

$$dSS/dT = [(d\theta/dT)/(S_s+S_g)^2][(R_s-R_g)IS_gIS_s] > 0. \quad (13)$$

Thus, under some quite reasonable assumptions, IT that deepens customer relationships also enlarges the service sector. An equivalent argument based on reinterpreting the above equations also implies that the more relationship-intensive parts of the goods sector should grow faster.

3.5. Unanswered Questions

3.5.1. Personalization. What is the best way to use the mountains of available customer data to determine how best to personalize marketing communications and marketing offers? What data should be gathered, and how should they be best used? Big data implies that many spurious patterns will be found. How can we tell what is spurious and what is not? We need methods for determining when we can confidently glean customer insights without capitalizing too much on chance. This calls for an analytical theory of managing big data, deriving tests for spuriousness and generalizability.

There is also a privacy implication with respect to personalizing service. The customer typically must forfeit some privacy to give the service provider enough information with which to personalize service (Rust et al. 2002). Luckily, it is unlikely that most customers would prefer total privacy. To determine the optimal level of personalization that customers feel comfortable with will be a key issue in managing big data CRM. Better service is not always optimal. Big Brother-like intrusive data collection may facilitate better service, but the loss of privacy may be something the customer cannot tolerate. Firms will benefit from finding out how customers make this important trade-off.

Although many recommendation systems exist, there are fewer true adaptive personalization systems—systems that actually morph the product (typically an information service product) over time in response to customer behavior. A general analytical theory of optimal morphing is called for, as well as development of adaptive personalization systems for an expanding array of applications, such as news and entertainment. A huge hole in the existing literature relates to adapting the product in real time with respect to context. That is, a person may want to listen to fast music in the morning to get going and soothing music at night to settle down. What is needed is a system that can quickly figure out the contextual needs of the user and adapt to the appropriate context.

3.5.2. Service Quality. We also need theoretical and empirical models of how customers react to being called upon to play more of a role in their own service provision. The logical way to investigate this is to assemble a data set in which customer cocreation is measured, along with customer attitudes and behavior. Ideally, the firm's own effort would also be measured and the interaction estimated in a two-sided structural model. Then the degree of cocreation could be empirically related to business outcomes.

3.5.3. Service Productivity. Given that the satisfaction–productivity trade-off is particularly salient in a service-dominant business environment, we need longitudinal research about the business performance of firms that change that trade-off over time. What kinds of productivity improvements incur the least penalty with respect to customer satisfaction and produce the best business results? Econometric time-series models would be appropriate here.

Customer Interactions. The issue of communication intensity between the firm and the customer needs to be considered. The existing literature tends to treat communications and other behavior (both directions) as though they were advertisements or other marketing actions. However, our conceptual framework implies it is likely that the *interaction* between firm communications and customer communications that is important. What's more, timing matters. Communications or behavior should be viewed in a time-ordered way as responses to the other side's communications or behavior. Dynamic models that model both the firm's and customer's response would be required, perhaps using a structural model framework.

Relationship Intensity. It would be helpful to have a measure of how relationship intensive a firm is. Some candidates for this measure might include the number of customer contacts per customer, the number of customer contact personnel per customer, or customers' or managers' subjective estimates of relationship intensity. An appropriate measure would need

to include automated relationship contacts (e.g., Internet contacts) as well as direct personal contacts (e.g., phone calls with customer service personnel).

It would be helpful to conceptualize and measure the relationship/transaction continuum, deriving analytical results about how businesses should operate differently depending on where they are on the continuum; we could also measure the relationship/transaction continuum empirically, testing the effectiveness of different marketing practices and strategies at different points on the continuum. Perhaps the relationship/transaction continuum could be viewed as heterogeneous across customers, with individualized marketing actions dependent on the customer's position on the continuum.

The firm-specific measure could be used to aggregate to specific sectors, or even nations. For example, the analysis above would imply that relationship-intensive goods businesses should be expanding as a proportion of the goods firm. This would have important societal implications, if true, and could be tested.

Relationship Depth. Our previous analysis suggests the usefulness of breaking out initial sales from additional sales. Along with a relationship-intensity measure, this would enable, using Equation (11), an analysis of the degree to which IT is deepening relationships over time. One might substitute time t for IT (T in Equation (11)) to explore the time trends of the shift to the service economy (given the monotonic relationship between time and IT) and perhaps make projections about the nature of the future service economy (and the relationship-intensive goods economy).

Competition and Customer Data. CRM data analysis typically uses only the firm's own database. This may result in nonoptimal decision making because customer-to-customer data (e.g., social data) and customer-to-competitor data are not considered. Previous authors have shown that it is necessary to model consumer-browsing behavior on multiple websites (e.g., head-to-head competitors such as Amazon.com and Barnesandnoble.com) to explain customer behavior on competitive sites (Park and Fader 2004). More recent authors have shown that competition can have an impact on decisions about how much to invest in a customer relationship—the most valuable customers may not always be the best investment if competitors have equal access to them (Musalem and Joshi 2009). The wide availability of social and user-generated data today suggests that customer-to-customer communications will be an important source of CRM data, as they can capture customer decision processes before and after purchases (though maybe not during, which can be captured by the firm's CRM system). In essence, these issues are missing data problems, and methods employed for analyzing incomplete information might prove helpful in addressing them (Chen and Steckel 2012).

Service Expansion. If IT can facilitate customer relationships and grow the service economy, does this mean that every firm should emphasize service more? Could there be cases in which a firm's move to become more service-oriented would be unprofitable? For example, one can speculate that firms in industries with little repeat business (e.g., restaurants along interstate highways) or businesses for which customer information gathering is very costly might be exceptions. A useful empirical investigation would explore the conditions under which a firm should become more of a service firm, given the existing IT level. There may be an optimal balance for any firm between being service or customer focused and being product focused. Empirical work that investigates the variables that determine that optimal point would be useful.

4. Discussion and Conclusions

Marketing is undergoing a profound transformation as IT deepens customer relationships, expanding the relationship-intensive part of the economy and the service sector in particular. These forces have resulted in the steady and monotonic growth of the service sector in every developed economy for more than 100 years. This has resulted in important substantive implications concerning the topics which will assume greater importance in the future. It also has resulted in important methodological implications regarding research methods that are likely to become more widely used.

4.1. Substantive Implications

As customer relationships take on even more central importance, the expansion of service in the economy means that the field of marketing is likely to take on more of the characteristics of the formerly niche field of service marketing. The substantive areas most central to the service revolution are (1) how best to understand big customer data, (2) how best to personalize service, (3) service quality–productivity tradeoffs in the application of IT, (4) the impact of IT on customer relationships, and (5) the impact of deeper customer relationships on the expansion of service at both the firm and economy levels. We outline each area below:

- *How Best to Understand Big Customer Data.* This topic is central to the service revolution because of the potential for predicting new service provision and personalizing service. An upcoming special issue of *Marketing Science* focuses on this topic.

• *How Best to Personalize Service.* What is the optimal level of personalization? If there is a trade-off between personalization and privacy, how does customer heterogeneity on that trade-off affect the firm's service practices? How can the concept of adaptive personalization be applied in more contexts? Answering these questions will require both analytical modeling (responding to customer heterogeneity in the personalization–privacy trade-off) and fast computational approaches such as machine learning (adaptive personalization).

• *Service Quality–Productivity Trade-offs in the Application of IT.* Which kinds of IT innovations have the biggest impact (positive or negative) on customer satisfaction and productivity? Under what conditions do satisfaction and productivity trade off? We anticipate that unbalanced panel data, merging innovation incidence, customer satisfaction, and productivity measurements, perhaps analyzed using panel vector autoregressive models, may be used to explore these issues.

• *The Impact of IT on Customer Relationships.* The firm–customer relationship is now a dance. We need two-sided models to explore how this dance evolves over time. How should the firm respond to the customer over time, viewed as a dynamic optimization problem? How should the rational customer behave? What patterns of interaction will result?

• *The Impact of Deeper Customer Relationships on the Expansion of Service.* Which sectors of the economy will be most stimulated by deeper customer relationships? To what extent do deeper customer relationships constitute a competitive advantage for a firm? Under what circumstances do deeper customer relationships matter more? With appropriate measures of relationship intensity, cross-firm and cross-sector research can answer these questions.

4.2. Methodological Implications

The service revolution, driven by advances in IT, calls for greater use of computationally intensive and data-intensive research methods. The following are several modeling techniques, already in use in marketing and even more widespread in other fields, that are likely to become increasingly used in marketing science in the coming years because of the nature of the service revolution. In general, these methods take on much more of a computer science and information systems flavor.

• *Data/Text Mining.* How to manage, search, and make sense of structured and unstructured big data is a central problem for marketing researchers. Data mining methods from information systems will be used more widely, as will methods for searching the Internet and mining its patterns. The 2012 *Marketing Science* special issue on user-generated content was an early recognition of the importance of these methods. In academic research, techniques such as data mining (Drew et al. 2001) and text mining (Lee and Bradlow 2011, Netzer et al. 2012) have become invaluable for exploring the very large amounts of data, both structured and unstructured, that now exist on each customer. Text mining is starting to be used in marketing but is not yet widely used on big data. Lee and Bradlow (2011) text-mined six years of customer reviews for digital cameras to support the analysis and visualization of market structure in a period of rapid market evolution. This method is considered to be scalable to large data sets. Netzer et al. (2012) text-mined user-generated content in blogs, forums, and chat rooms and combined it with semantic network analysis to monitor market structure.

Adaptive learning of customer preference is also facilitated by data (text) mining techniques (Sun 2006). For example, Ghose et al. (2012) analyzed location-based user-generated content from various social media sources using techniques from text mining, image classification, social geotagging, human annotations, and geomapping.

Other than market structure analysis and monitoring, CRM is another area that has seen some preliminary application of the text-mining techniques. For example, unstructured, textual information (e.g., customers' emails to call centers) can be added to improve predictive analytics models for customer churn (customer attrition) (Coussement and Van den Poel 2008). Many of the customer data nowadays are unstructured and text-based (e.g., social networking data), and text mining provides a useful tool for monitoring these activities.

• *Machine Learning.* When there is a lot of data, it has to be processed quickly and automatically. That is what machine learning does. Methods such as machine learning from computer science have been brought into marketing to try to cope with big data in real time (Cui and Curry 2005), and an active-machine-learning method has been developed and tested with synthetic data in marketing that is demonstrated to be able to adapt better to customer use of heuristic decision rules (Dzyabura and Hauser 2011). Machine learning will increasingly be used to analyze customer information because of the sheer amount of data that will have to be analyzed.

• *Agent-Based Models*. Marketing increasingly involves networks of relationships and feedback loops. Another computationally intensive method that is gaining popularity in modeling complex service systems and can benefit from big data is agent-based modeling (Goldenberg et al. 2010, Rand and Rust 2011). This research approach captures emergent aggregate phenomena by modeling a large number of agents that typically follow simple decision rules.

Agent-based modeling has proven to be very useful for understanding dynamic complex systems that evolve over time such as those often encountered in marketing. For example, a researcher can create a model in which customers use a set of decision rules about how they respond to business offers and make choices, and then firms make decisions about how to respond to customers. Thus, the complexity of the dynamic service scenario, as seen in Figure 3, can be addressed by this method.

- *Fast Bayesian Methods.* Perhaps the greatest contribution of Bayesian models to marketing is their ability to develop market response estimates that are specific to each customer (Rossi and Allenby 1993). This enables marketing efforts to be fully personalized. Thus, the increases in computation speed and power seen in the last few decades have made Bayesian models computationally feasible and accelerated the movement toward personalized marketing. For example, the Bayesian approach has facilitated marketing decision making for fully personalized CRM (Gönül and Ter Hofstede 2006, Rust and Verhoef 2005).

Bayesian methods such as Markov chain Monte Carlo (MCMC) are now practical for academic research and increasingly for commercial marketing research use as well. The big drawback of many Bayesian models is their prohibitively long computation time. Marketers can benefit from developing approximate Bayesian methods that are faster (e.g., Miller et al. 2006) or do not involve MCMC estimation (Braun and Damien 2012). Such methods can be more useful to practitioners, who often need answers quickly. As in computer science, marketing will likely begin to trade off exact solutions for computational tractability and speed. Many marketing scientists who apply their models in the business world are already making this trade-off, and the journals should become more accepting of such approaches.

4.3. Conclusions

The service revolution and information revolution are two sides of the same coin. Improvements in IT enhance the ability of firms to deepen relationships with customers, laying the foundation for a dramatic and ongoing expansion of the service sector as well as of service in the goods sector. This trend, more than a century old, is irreversible and will only become more pronounced with time. This service revolution is profoundly transforming marketing. Marketing science is also being radically transformed, because the nature of marketing is becoming more individual customer centered and relationship driven instead of transaction driven and mass market centered. Marketing research methods that were appropriate for a transaction-based initial choice environment may be less appropriate for a relationship-based repeated choice environment, and they thus should be supplemented by explicitly dynamic methods. The same IT factors that are growing the service economy also change the relevant toolkit for marketing analytics, leading to an emphasis on computationally intensive data analysis of customer databases. Thus, IT and the service revolution are creating a wealth of new topics to study and new methods with which to study them.

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