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Incorporating the Dual Customer Roles in e-Service Design

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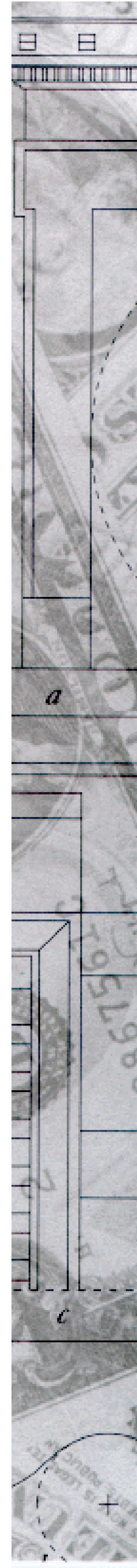

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Abstract

E-service involves the delivery of useful services through information technology based service delivery channels such as the Internet. A distinguishing feature of e-service is the active and significant participation of customers in the service co-production process. With increasing customer participation in the e-service co-production process, it is important to incorporate customers' needs both as a co-producer and as a patron into the design of e-service systems. However, these dual customer roles create a complex decision problem during e-service design. In the current paper we present a customer orientation strategy for e-service design, and propose a corresponding two-stage decision model based upon the customer orientation strategy to evaluate the efficiency and effectiveness of e-service design when the focus of the design is to meet customers' needs as both co-producers and patrons. The decision model is then applied in an empirical study of the design of e-services of Internet food retailers.

Key Words: Service Operations, E-Service, Co-production, Efficiency Analysis, Data Envelopment Analysis

1. Introduction

Electronic services have undergone rapid development and dramatic transformation in a relatively short period of time. In the process, many service sectors have changed forever. While brick-and-mortar stores still hold the major portion of market share, electronic services have experienced significant gains during the past several years. A survey conducted by PricewaterhouseCoopers in January 2000 showed that nearly half of the primary shoppers in households with Internet access had already made purchases on-line, up from 27 percent in 1998 (Fortune 2000). The Census Bureau (2002) estimates that total retail e-commerce sales for 2001 had grown to $35.9 billion, maintaining year-to-year percent changes above 20% into 2002. Of this amount, consumers are estimated to have spent approximately $675 million during 2001 on digital goods and services, not counting revenues from adult services (Richtel 2002). Even though there has been an ebb and flow in the pace of development of e-service, it is clear that e-service, or service delivered mainly through electronic channels in the form of self-service, will not go away. E-service has become an integral part of service delivery in more and more service industries. From the self-check-in kiosks at airports and the self-checkout counters at grocery stores, to their counterparts on the Web, self-service has become part of consumers' everyday lives.

The implications of customers "going online" are significant. With the development of electronic service technologies and new business models featuring self-service, customers' roles in service delivery processes have been transformed from passive recipients of the service product into active co-producers who can effectively influence the quality and efficiency of the service delivery processes. Using electronic service delivery channels such as the Internet, customers have been taking over an increasing proportion of the labor involved in services. For example, Ameritrade.com's (an Internet brokerage company) customers, instead of the employees of the company, trade their stocks using the company's website as the self-service facility. In another example, customers use the website of Travelocity.com (an Internet travel agent) to make travel related transactions such as ticket purchases, hotel reservations, and car rental. In each example, consuming the e-service typically does not require any direct involvement of the live employees of the company. As a result of this substitution of employee labor with customer self-service, and the reduced direct encounters between customers and service employees, the necessary workforce levels and physical storefronts may decrease for many service companies, creating the potential for cost-savings. Considering many service industries are labor-intensive, the transformation from being more employee-service-based to being more self-service-based poses a strong appeal for executives across service industries.

The changes in service delivery brought about by this customer role transformation go far beyond the implementation of new technologies. As we have seen over the past several years, it has led to the birth of new business models such as e-retailing, e-health care, e-banking, e-brokerage, and e-travel agents. In some companies, it has led to the overhaul of the whole service delivery system. The role transformation of the customer has also had a profound impact on many aspects of service management in regard to e-service. Consequently, strategic and tactical changes of service management in response to such transformations have become necessary. In response to this customer role transformation, researchers need to consider what kind of perspective managers now need to take in regard to designing service delivery systems that customers use during the service co-production process. In the past, employees' needs were often taken into consideration in designing the service delivery system, but they were typically not a strategic focus. However, focusing mainly on employees' requirements only works when little or no customer participation is involved in the service delivery process. When customers, instead of employees, are primarily involved in the service delivery process, or serve as the primary workforce using the system, a different perspective is necessary because of customers' dual roles as both patrons and co-producers.

Compared to employees, customers are generally less skillful at operating information technology involved in an e-service, and consequently demand a more user-friendly interface of the system. In practice, the designs of many e-service systems have until recently been technology-driven. The lack of skills or knowledge may be of less concern when employees are the major users, since this gap usually can be filled through employee training or targeted recruiting. However, when customers, rather than employees, are the primary users of the facility, a company is very much limited in terms of its control or influence over its customers' skills or knowledge. This makes a user-friendly interface highly important for successful service delivery. Meanwhile, the issue is also important because customers' judgments of service quality are heavily influenced by their experiences in the service delivery process. That is, customers' evaluations of service quality are not only based on their consumption of the end product, but also on their "working" experiences during the service co-production process. Unlike employees, customers have the choice to exit the service co-production process at almost any time. Thus, an efficient and smooth service delivery may project positive impressions and attract customers to return for repeat purchases, while the frustration caused by a poor design can turn customers away.

The dual customer roles of patron and co-producer create a complex dilemma during the design of e-service delivery systems such as websites. The dilemma involves the tradeoff of the need for simplicity and standardization against the need for flexibility and customization. Given the fact that customers are relatively more limited in terms of their skills and knowledge compared to professionally trained employees, a standardized and simplified design of an e-service delivery system might seem to be more appropriate. However, as a patron, customers also have other needs to be met during the service delivery process such as the desire for "fun" and the social need for customization and personalization. Customers often want more flexibility and a higher ability to personalize or customize the service product when they are involved in the service co-production process. As a result, the design of an e-service needs to find an appropriate balance between the two directions.

The goal of this study is to develop a means to assist managers in solving the dilemma described above: the appropriate balance between simplicity and flexibility in the e-service delivery system. Thus, we develop a customer orientation strategy and a related two-step decision model to provide general guidance for the design of e-services. We then apply our decision model in a two-phase empirical analysis of e-retailers in the retail food industry. Since websites on the Internet are at the present time the primary self-service facility for e-service, in the current paper, we investigate how a customer orientation perspective can be applied for their design. However, we must note that the focus herein is not to provide a technical guide for the design of a commercial website. Rather, our goal is to explore how the customer orientation decision model can be used to guide the design and analysis of an information-technology-based service facility featuring self-service. Although the empirical study focuses on the design of commercial websites, the implications of this customer orientation strategy can be extended to the design of other self-service facilities.

The rest of the paper is organized as follows: In Section 2, related literature is reviewed. In Section 3, a customer orientation strategy for the design of information technology based self-service facilities is presented. In Section 4, a two-stage decision model using DEA and post-DEA analysis is developed for the evaluation and analysis of the efficiency and effectiveness of the design of the e-service delivery system. In Section 5, an empirical investigation of the design of retailing websites using the proposed customer orientation decision model is described. Section 6 concludes the paper by summarizing the major results and discussing the limitations and potential directions for future research.

2. Literature Review

The design of an e-service determines the key features of a service, the ease of maintaining and improving a service, and the qualities of service experiences delivered through this channel. Yet, in practice, many e-services have been designed according to common sense or common practice (Conallen 2000), with little thought given to quality as defined by the customer. Practitioner methodologies for web application design and service design are available (Conallen 2000; Dubé et al. 1999), yet informal and sometimes even contradictory suggestions remain the common means of describing appropriate electronic service design (Greenspun 1999; Hanson 1999; Nielsen 2000; Siegel 1996). The academic literature also has approached the electronic service design problem, but typically with an eye toward being more descriptive than prescriptive. Prior research has focused on building conceptual frameworks (Hoffman, et al 1995**;** Hanson 1999; Kaplan and Sawhney 1999; Heim and Sinha 2001; Boyer, et al. 2002) or an empirical taxonomy of e-service designs (Spiller and Lohse 1998; Heim and Sinha 2002). Many open service strategy and design issues exist that require further research to identify best practices for e-services (Boyer, et al. 2002).

Studies have only recently considered the performance implications of such models of e-service. Business performance metrics of interest are summarized in Steyaert (2002). Researchers have empirically examined drivers of e-service performance such as website design and interface characteristics (Te'eni and Feldman 2001; Hong et al. 2002; Palmer 2002; Shim, et al. 2002), website usability (Agarwal and Venkatesh 2002; Palmer 2002), website architectural qualities (Kim, et al. 2002), Keeney's means objectives and fundamental objectives (Torkzadeh and Dhillon 2002), and SERVQUAL (Deveraj, et al. 2002; Gefen 2002). Rajgopal, et al. (2001) studied whether the quality of online customer experiences was related to sustainable competitive advantage for e-services.

With the transition from person-to-person service delivery to computer-based e-service delivery, ample data have become available for analyzing the effectiveness of e-service designs. While it was close to impossible to monitor and record data on the second-by-second actions and interactions of customers within traditional physical service environments, e-services now enjoy the luxury of being able to collect data 24 hours a day about customer activities from the second customers enter an e-service website to the point when they exit the service. Supplemental ratings of e-services are also being made available through several online customer ratings companies. Field, et al. (2002) provides a comprehensive review of the breadth of these ratings available to e-services. However, the literature has only begun to consider the issues related to how e-services should make use of such data related to their operations.

Further, to the best of our knowledge, little has been done to examine the co-production aspects of e-service, even though there is a sizable body of related literature for traditional services. In Chase (1978), customer roles in service delivery processes were explored and their influence on service quality were discussed. Lovelock and Young (1979) pointed out that customers could be potential sources for productivity improvement as their labor can replace employee labor. Mills and Morris (1986) proposed the "partial" employee view for customers' roles and explored the potential managerial tools for managing customers as "partial employees". Heskett, *et al.* (1997) noted that by encouraging customers to share responsibility, the firms could not only reduce their costs but also improve service quality.

Prior work has also focused on the relationship between self-service technology and customer satisfaction. Dabholkar (1996) examined the factors that influence customers' evaluations of self-service technology service quality through an attribute model and an overall effect model. Moon and Frei (2000) pointed out that self-service may become a burden to the customer without an appropriate service design. Meuter *et al.* (2000) used the "Critical Incident Study" method to investigate the sources of satisfaction and dissatisfaction with self-service technology. Finally, Xue and Harker (2002a) presented the concept of customer efficiency and a related service management strategic framework, called Customer Efficiency Management (CEM), in response to customers' increasing participation in the service co-production process, which has been enhanced by the development of information technology such as the Internet. Customer efficiency characterizes the customer's role as a co-producer by measuring her productivity. Customer efficiency management is a strategy that focuses on actively involving customers in the co-production process and developing an efficient customer base through the integration of service delivery process management, customer relationship management, and information system management, in order to achieve high productivity, profitability, and customer equity.

Another stream in the literature that our work is built on is Data Envelopment Analysis (DEA) (Charnes et al 1994, Xue and Harker 2002b), which has increasingly been employed to analyze the performance and the quality of service operations. The managerial goals of a DEA analysis include identification and classification, performance evaluation, and resource allocation (Metters, et al 1999). Thanassoulis et al. (1995) included service quality as an output in their DEA model used in a health care setting. Soteriou and Zenios (1999) developed and analyzed a conceptual model of service quality efficiency in banking services based on the Heskett et al. (1997) service profit chain. DEA studies of service quality have employed both single-stage and two-stage empirical methods. The single-stage methodology allows researchers and managers to identify which services are efficient in their transformation of inputs into service outputs such as service quality. Soteriou and Stavrinides (1997) employed a single-stage approach to analyze the service quality of bank branches. Two-stage methods can help to explain or to improve upon first-stage empirical analyses, to potentially provide insights about why services are efficient. For example, Athanassopoulos (1997) used a latent variable regression approach to analyze the relationship between the perceived quality of service processes and DEA efficiency scores for bank branches. The two-stage model and empirical analysis we present in this paper is a development along this direction.

3. Customer-Orientation E-Service Design: the Dilemma and the Strategy

The dilemma described in Section 1 highlights the challenge facing e-service design as a result of customers' increasing involvement in service co-production. As with any challenge, this one poses both risks and potential benefits. On one hand, with an appropriate design, it is possible to create a win-win situation for both the customer and the service provider. For a service provider, e-service has the potential for lower labor cost, a less expensive facility cost, and the potential of reaching much bigger or new customer segments. For consumers, e-service offers unprecedented flexibility and control of the service delivery process, and often a less expensive alternative to the service product delivered mainly through service employees. On the other hand, an e-service delivery system having an inappropriate design may lose customers to either traditional service providers or other e-service providers who are able to deliver their service both more efficiently and effectively.

In this section, we explore the nature of the e-service delivery system and the source of the design dilemma and present a customer orientation strategy for the design of the e-service system. Figure 1 depicts the structure of a typical e-service delivery system, representing the flow of information between the customer and the service provider, which presently takes place primarily across the Internet. If the e-service offers merchandise such as a tangible good, then delivery of the physical merchandise, represented by the dotted arrow, must be included to complete the service delivery process.

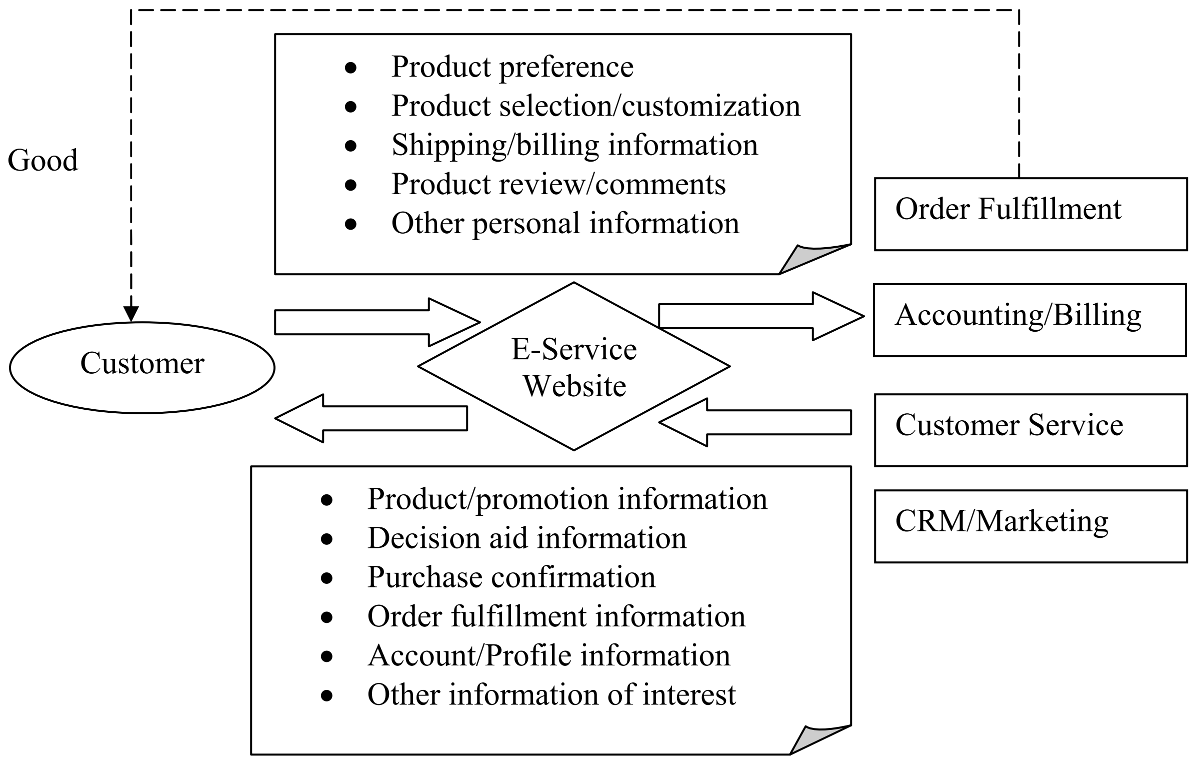

Figure 1 E-Service Delivery System

In Figure 1, the information flow between the customer and the service provider constitutes the major content, or core attributes, of the e-service. Successful delivery of the e-service relies on an efficient and effective exchange of the relevant information, which is realized via customer interactions with the service provider through website transactions. Thus, in addition to successful back office operations including order fulfillment, accounting and billing, customer service, and self-service support and so on (Janenko 2002), it is important to have an appropriate design of the service product.

However, a customer's dual roles as a co-producer and a consumer of the service product create complexity and even conflicting goals during the design of the e-service. Customers are co-producers or "amateur employees" who, without being professionally trained, use the self-service facility to serve themselves. Thus, to ensure efficient delivery of the service content, standardization and simplification in the design of the e-service delivery system are necessary. However, on the other hand, unlike the actual service employees, customers also have other needs and objectives that they want to fulfill during the service delivery process. These needs and objectives may include the so-called "fun" factor and the social needs for flexibility and personalization. As a result, customers require a certain degree of flexibility and the ability and freedom to customize or personalize the service content. These conflicting needs create a dilemma for the design of an e-service delivery system: should managers focus on co-production activities by simplifying and standardizing, or should they focus on consumption activities via a flexible, customized e-service? We argue that they inevitably must do both. Essentially, a tradeoff must take place between these to determine the nature of the e-service co-production process.

To further illustrate this dilemma, we analyze the functional orientation of different digital content modules. In Figure 2, we classify the typical content of an e-service according to (i) the extent to which they are related to customization and standardization, and (ii) their task orientation relative to two types of functional modules: marketing modules and operational modules. The marketing modules involve information transactions that are not essential for the completion of service delivery itself but are important for order procurement, customer relationship management, improving customer satisfaction, and leveraging customer lifetime value. The operational modules involve the core information transactions that are essential and indispensable for the completion or fulfillment of the service delivery. Some information transactions can serve both operational and marketing purposes, and are thus positioned more toward the middle of Figure 2. The designs of both types of functional modules can be standardized or customized, as shown in Figure 2. In the case of marketing modules, modules such as those related to a registration procedure and frequently asked questions (FAQ) are standardized, while others such as an individualized wish list and targeted on-site promotions are customized. Similarly, from an operational perspective, the delivery of the service product can take place through both standardized and customized process technologies (Heim and Sinha 2002).

Marketing modules are associated with customers' roles as co-producers, but they must also take a customer's role as a patron into consideration as well. Marketing modules perform electronic transactions substituting for traditional customer service transactions, such as inquiring about personal needs, and tracking of personal account, shipment, and other product related information. Marketing modules also include customer relationship management transactions such as membership programs, product reviews written by customers, and Internet chat rooms. Finally, marketing modules perform configuration of the service product during the order procurement stage, performing tasks such as configuration of orders for goods, configuration of a personalized e-service interface, and configuration of targeted product promotions. In many cases, the design of these modules addresses a customer's need for efficiency as a co-producer. For example, storage of purchase history and wish list helps a customer to speed the configuration of repeat purchases. However, even while the co-production is occurring, the consumer is also consuming the result of these systems in their role as patrons. As a result, marketing modules require a delicate balance between standardization and customization, and essentially, the balance between simplicity and flexibility.

Operational modules also must take account of both customer roles. Operational modules both fulfill, and assist the customer in fulfilling, the marketing module processes as well as the order that was configured by the marketing modules. Some tasks that operational modules fulfill include product information searches, purchase transactions at a retailing website, and stock trade transactions at an Internet trading website. With regard to the functioning of operational modules, customers as co-producers are concerned about the efficiency and accuracy of the content fulfilled, and therefore may prefer the operational module to be user-friendly and straightforward. Customers, in their role as patrons, view the delivery as a service experience, and thus may prefer to have certain flexibility to customize or personalize the service product by themselves during the fulfillment process, even though it may increase the degree of complexity for the completion of the service delivery.

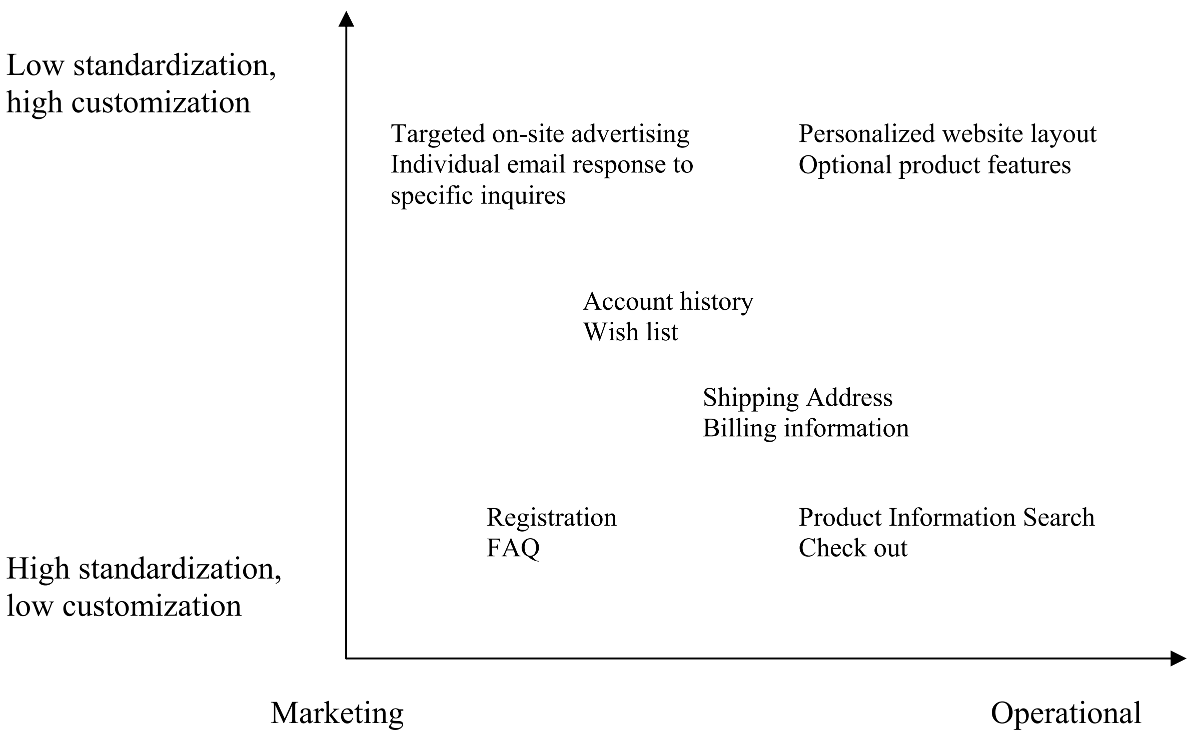

Figure 2 Functional Modules of E-Service Content

In summary, neither the marketing nor the operations modules are strictly related to the co-producer role alone or the patron role alone. Instead, the patron and co-producer roles permeate both types of functional activities that take place in an e-service. Again, one can observe that it is difficult to relate them specifically to individual functional modules. Thus, to have a successful e-service design, and in particular to have the appropriate balance between simplicity and flexibility, requires a design strategy with the right focus. As discussed before, since customers are central figures in the co-production process of an e-service, it is important to address their needs in the design of e-service. Either as a marketing tool or an operational facility, a website or any information technology based self-service interface requires a design strategy focusing on customers' complex needs as both a co-producer and a patron. Thus, we propose the following for a customer orientation strategy:

> *A customer orientation strategy for e-service design is a plan about how to use resources available to develop a system of functional modules that meets the service requirements efficiently and effectively by focusing on customers' needs both as co-producers and as consumers.*

The design of e-service essentially involves planning how to use resources available to develop a system of functional modules that meet the service requirements. We develop a process for approaching this issue next.

4. A Two-Stage Customer Orientation Decision Model for E-Service Design

We next translate our customer orientation strategy into a two-stage decision tool for managing e-service design. In particular, a two-stage model oriented toward performing both efficiency analysis and effectiveness analysis is presented. As stated in Section 3, the design of an e-service is essentially a plan about how to use resources to develop a system of functional modules that meet the service requirements. Electronic services consist of digital service content designed to replace the traditional front office service experience. Various service modules, whose output is the digital content, generate the digital service. These modules represent the resources available for the design of an e-service. In a general sense, the digital content presented in an electronic service essentially can be classified into two types: static content and dynamic content (Heim and Sinha 2001). Through the e-service system, static and dynamic digital content are manipulated by different functional modules and sent to the e-service consumer, constituting the fulfilled attributes of an e-service. The outputs of the e-service delivery system can be measured both quantitatively and qualitatively. The quantitative measures, such as the number of products offered, measure the scope of the service. The qualitative measures, such as the customer satisfaction toward the overall experience, indicate the intangible aspects of the service.

Static content is simply downloaded to the customer, containing whatever information and graphics were designed for a page. In contrast, dynamic content is created by programs or scripting languages that can accept program arguments based on user requests made at the time the customer is consuming the electronic service. Consequently static content and dynamic content serve different segments of customer needs. Static content typically fulfills customers' needs that don't change over time or across customers. Dynamic content is often used to satisfy idiosyncratic or time-critical needs. Static content is often used when the service is largely standardized or fixed, while the use of dynamic content is necessary if the functional module requires a higher degree of customization and flexibility. However, the cost of the two resources, in terms of both development effort and maintenance effort, are not the same. The decision about how to use the two types of resources to build the contents of e-service product needs to be made with all these tradeoffs considered. Service designers must consider the development and maintenance cost, and more importantly, the resulting balance between standardization and customization as well as simplicity and flexibility.

The decision model illustrated in Figure 3 can aid such decision-making as it can be used to analyze the efficiency and effectiveness of the use of different digital content to satisfy customers' needs. Figure 3 suggests a managerial approach that focuses on efficiency first, followed by focusing on effectiveness. The top of Figure 3 represents the transformation process presented in an e-service. This transformation process accepts certain inputs to the process, and produces certain outputs from the process. The two arrows in Figure 3 suggest the order of the activities in the decision process. The first activity is an efficiency analysis, which examines how well an e-service allows customer to "get things done" efficiently, relative to one's peers (competitor e-services). Essentially, the manager should ask whether his service system is efficient – relative to peer services – in its process of turning inputs into valued customer experiences. The second activity is to analyze the relationship of functional modules to the system efficiency. Essentially, the manager would like to identify which modules are related to having an efficient position relative to peer services. In the case where functional modules are not related to efficiency, one potentially can arbitrarily choose to offer customized or non-customized modules to customers, without having to worry about whether the module will affect service efficiency. In the case where a module is found to be negatively related to efficiency, the manager can then carefully consider a trade off between whether to offer a standardized or customized module of that type, so as not to adversely affect the service efficiency. Finally, if a service module is found to exhibit a positive association with efficiency, the manager can focus on enhancing those models to improve service effectiveness, without needing to worry about a deleterious impact on service efficiency.

Our suggested empirical approach for managers to apply the decision model in Figure 3 also involves a series of two stages. The empirical approach involves Data Envelopment Analysis (DEA) in the first stage, followed by a bootstrapping regression approach for analyzing the relationship of the service modules to service efficiency. Each of the two stages is now described in detail.

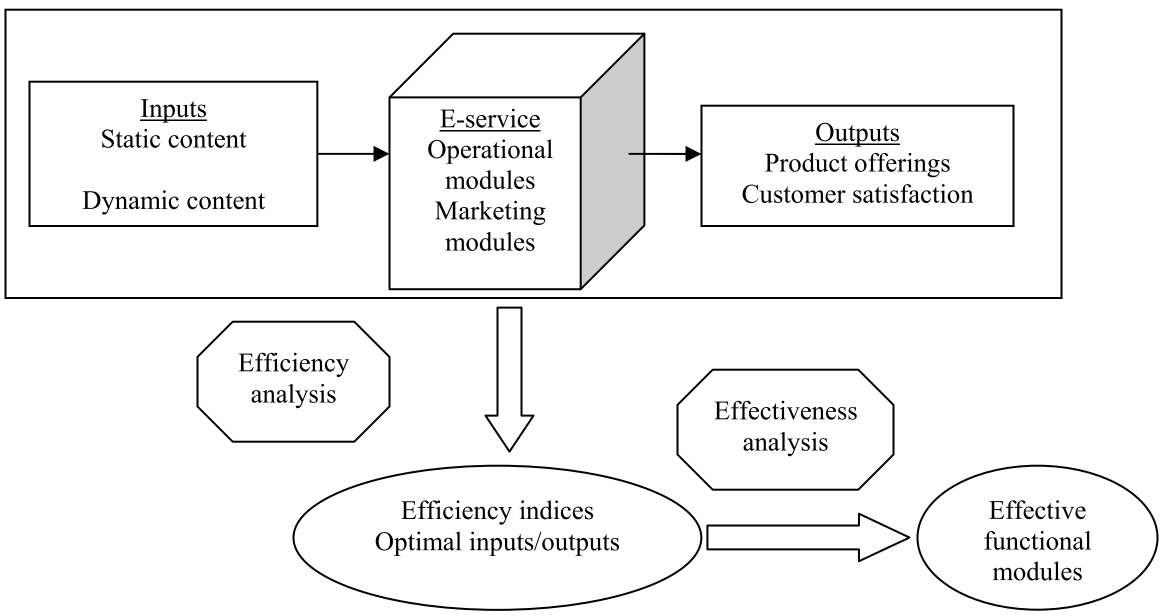

Figure 3 A Decision Model for E-Service Design

Stage 1: Efficiency analysis

In this stage, one can use efficiency analysis tools such as Data Envelopment Analysis (DEA) to evaluate whether the e-service design, based on each type of input, can efficiently produce the service outputs, relative to peer e-services. In order to perform such an analysis, we assume that there is a population of other e-services that we can benchmark against. The service inputs are those things which the customer has available as resources for their co-production activities. In the online e-service environment, these resources can be boiled down into their most basic forms as static digital content and dynamically generated digital content. The service outputs can also include several different items, including both product offerings (tangible) and customer satisfaction (intangible). Product offerings relate to the scope and scale of the e-service, while customer satisfaction dimensions reflect how well customers' complex needs are being met by the content delivered in the e-service.

Data Envelopment Analysis, a multidimensional benchmark method based on mathematic programming, is a suitable tool for this purpose because of the straightforward managerial implications of its results. Data Envelopment Analysis (DEA) has been widely applied to analyze the performance and the quality of service operations. The efficiency indices generated by DEA indicates its relative efficiency level compared to the best players on the efficiency frontier. The results from the analysis also specify the adjustment plan for the inputs and outputs for the individual decision-making unit to become efficient, essentially to be on the efficiency frontier. These results provide significant managerial insights that help decision makers to make the resource allocation decisions in regard to the balance between static contents and dynamic content, and to set up the specific output target to achieve efficiency.

Stage 2: Effectiveness Analysis

In the second stage, one can use statistical analysis tools such as regression analysis to investigate the association of different functional modules to e-service efficiency. As shown in Figure 3, static and dynamic content are transformed into different functional modules within the "black box" of the e-service delivery system in order to deliver the e-service. It is of managerial importance to explore what happens inside the "black box": Which functional module(s) can meet the service requirement of effectiveness, without harming service efficiency? The answer to this question has a significant impact on the design of an e-service, especially when resources are limited. In fact, there always exists an upper bound for the amount of the resources or the digital content that can be used in a particular e-service delivery system. The limits are imposed by either financial considerations or technology considerations. Though digital resources appear to be a quite flexible resource to use, excessive use of digital content makes the development and maintenance of the system costly and sometimes can even lower the efficiency of the service delivery process because of an overload of information.

In short, the proposed two-stage model helps one to make decisions with regard to how to use the resources available to address customers' complex needs as both a co-producer and a consumer both efficiently and effectively. In the next section, the model is used in an empirical study of the designs of e-services provided by Internet food retailers.

5. An Empirical Study of E-Service Design

In this section, we present an empirical study of e-service designs of Internet food retailers using the two-stage model from Section 4. We first review the data set and the study background. Next, the methods and the models used in the two stages of the empirical study are described and the results are discussed at length.

5.1 Data and Background

Food retailing constitutes a significant segment of the retailing industry. Changes happening in the retail food industry historically have had a profound impact on consumers' everyday life, and have provided many rich implications for the managerial practices of other retailing businesses. The food industry is highly diversified because of the variety of merchandise sold. The Internet has posed both challenges and opportunities for the retail food industry. First, food retailers now can use the Internet to reach consumer segments that could not be reached before, and can now expand their potential consumer market base beyond the limitations imposed by store times and physical locations. The Internet also has the potential to lower labor costs and other expenses as those customers shopping through the Internet no longer go through the physical check-out counter in the store and their other direct interactions with the store employees are also minimized. However, to make Internet food retailing successful is not an easy task. Because of the food retailing industry's diversity and the closeness to consumers' everyday life, the challenges and opportunities facing it are representative of those facing all types of e-service.

Our data were collected from a study sample of 255 Internet food retailers. At the time the sample frame for this study was collected (late 1998), this sample represented approximately one third of the food retailers that could be identified via search engines and interest sites. Out of the study sample of 255 Internet food retailers, 46 Internet food retailers were finally included in our study mainly because their customer satisfaction levels were reported by BizRate.com, one of the major Internet services dedicated to ranking electronic businesses based on actual customer reviews or expert reviews.

No directory of electronic food retailers existed prior to the study. Hence, we first pooled addresses of electronic food retailers from several sources, including Internet search engines and sites that maintained address lists. This process led to a preliminary list of food-related sites on the World Wide Web. Each site was visited and classified as a retailing site, a non-retailing site, or non-operational. The non-retailing and non-operational sites were removed, leaving approximately 650 electronic food retailing sites. As additional food retailers appeared, they were added to the address database, leading to a slightly larger candidate set of electronic food retailers. The sample was randomly chosen from this list of retailers, along with a convenience sample of 52 retailers for whom data were available from Bizrate.com.

Data were collected for a broad set of variables. The data for the variables were collected via direct observation of each electronic food-retailing site. During the visit to a site, the architecture of the site was mapped and relevant features were noted or printed out for future reference. For each site, all observable content was downloaded and counted. Pages were noted to be static pages or dynamically generated pages, and counts were made of the number of each type of page. This procedure transformed each retailer's site into a set of variables representing the electronic service processes implemented at the sites. In the end, data were collected from food retailers that offered between 1 and over 10,000 goods for sale, and spanned many different food types, such as beverages, meats, seafood, fresh produce, dairy products, candy, desserts, and gift baskets.

The 46 food retailers in the present study are a subset of the 52 retailers for whom data were also available from BizRate. For these retailers, we collected publicly reported online customer survey data on measures of customer satisfaction and customer loyalty. BizRate.com (http://www.bizrate.com), a marketing research company, surveys customers and reports customer survey data on their actual online shopping experience. BizRate's ratings of electronic retailers are considered to be among the most credible online ratings. The customer satisfaction data employed in this study come from Bizrate.com's 1998 survey. Table 1 contains the items in BizRate's 1998 online customer survey and their description.

Table 1 Items in BizRate's 1998 Online Customer Survey and Their Description

Items	Description
Web Site Aesthetics	Consider not just how attractive the site was, but how appropriately graphics were used to enhance your shopping experience, not only slow it down. (1 = Poor, 10 = Excellent)
Web Site Navigation	Consider the overall layout/organization, movement around the site, and missing/non-functional links. (1 = Not Very Easy, 10 = Very Easy)
Product Selection	Consider the breadth of product selection that the merchant has made available, keeping in mind the merchant's stated area of focus. (1 = Poor, 10 = Excellent)
Product Information	Consider the quality, quantity, and relevance of information provided for making your purchase decision an informed one. (1 = Poor, 10 = Excellent)
Price	Consider the price of products relative to other merchants' prices in this category. (1=Very Expensive, 10 = Very Inexpensive)
Product Availability	Consider how many of the items that you wanted to order were immediately available. Do not include items not yet released by the manufacturer. (Leave blank if "Not Applicable.") (1 = Had no items, 10 = Had all items)
Timeliness of Delivery	Consider timeliness in the context of the promised delivery date. (Leave blank if "Not Applicable.") (1 = Poor, 10 = Excellent)
Customer Support	Consider the steps this merchant took to make sure you were informed of your order status and happy with the transaction. Also, consider how available and effective the merchant was in resolving any questions, complaints or problems that you encountered. (Leave blank if "Not Applicable.) (1 = Poor, 10 = Excellent)
Ease of Return/ Cancellation	If you found it necessary to return/cancel any of the merchandize that you purchased, please rate how easy the return/cancellation process was. (Leave blank if "Not Applicable.") (1 = Very Difficult, 10 = Very Easy)
Customer Loyalty	The next time you are going to buy such products, what is the likelihood that you will purchase from this merchant again? (1 = Poor, 10 = Very Likely)

In the empirical analysis presented below, we utilized a subset of the total number of variables collected. In particular, for e-service input variables, we employed counts of the number of static pages employed by the e-service, and the number of dynamically generated pages used in the e-service. The total set of dynamic and static pages essentially represents the total system that the customer must operate during their service co-production activities. We also used service output variables that measured the total product offering and the customer satisfaction. The customer satisfaction variable was constructed by averaging together the customers' evaluations of website performance along four dimensions reported by Bizrate – product information, website aesthetics, website navigation, and customer support – since these four dimensions are among the most important ones that affect consumers' website shopping experiences according to a survey conducted by PricewaterhouseCoopers (Fortune 2000). Sample statistics for each of these variables are shown in Table 2.

Table 2 Data Summary Statistics

Variable	Mean	Standard Deviation
Static contents	56.1087	104.6495
Dynamic contents	306.3043	1070.1551
Product offering	468.6739	994.3160
Customer Satisfaction	6.6087	0.8804

5.2 Stage 1: Efficiency Analysis

In the first stage of our decision process, we identified those food retailers who were efficient in transforming their inputs into service outputs. That is, we investigate what happens inside the "black box" of e-service modules shown in Figure 3. The service inputs for this analysis are the number of static and dynamic pages available for customers to utilize. The final output of the e-service delivery system is measured both quantitatively and qualitatively. The quantitative measure, the number of products offered, measures the scope of the service. The qualitative measure, customer satisfaction toward the overall experience, indicates the quality of the service. To investigate the efficiency of the e-service delivery system, we use the following output-oriented DEA model to measure the efficiency of each decision-making unit, an Internet food retailer in the sample. For example, the DEA efficiency score of DMU t (Internet Food Retailer t) in the observed set, where $t \in \{1, 2, ..., 46\}$, is calculated by solving the following linear programming model:

$$Max\ \theta_t \qquad (1)$$

$$s.t.$$

$$A_t \geq \sum_{i=1}^{46} \lambda_i A_i \tag{2}$$

$$\theta_t B_t \leq \sum_{i=1}^{46} \lambda_i B_i \tag{3}$$

$$\lambda_i \geq 0,\ \ i = 1,...,46. \tag{4}$$

In this model, A_i denotes the input vector of DMU i which includes two dimensions: the amount of static contents and the amount of dynamic contents. B_i denotes the output vector of DMU i which also includes two dimensions: product offerings and customer satisfaction. λ_i is the weight of DMU i.

The result of the DEA efficiency analysis shows that five of the 46 Internet food retailers included in our study sample are on the efficiency frontier with their efficiency scores equal to one. Therefore, these five retailing websites are the most efficient in delivering satisfying service to their consumers among their peers in the observation set. Given the model orientation, a lower DEA efficiency score indicates a higher efficiency with the lowest possible efficiency score equal to one. The average DEA efficiency score is 5.02, which suggests that the most efficient websites are about five times as efficient as an average level food retailing website in the sample. The summary statistics for the DEA efficiency scores are shown in Table 3.

Table 3 Summary Statistics for the DEA Efficiency Scores

	DEA score
Minimum	1
First Quartile	1.25
Mean	5.0226
Median	2.65
Third Quartile	6.7675
Maximum	22.68
Total N	46
Standard Deviation	5.3063

5.3 Stage 2: Effectiveness Analysis

After identifying the efficient food retailers, we focused on the search for the functional modules that are associated with retailer efficiency, and thus can influence the efficiency of the e-service design significantly. While the analysis in Stage 1 indicates what kind of quantity combinations of different inputs is the optimal design to produce the maximum outputs, the analysis in this stage provides the specific information about the appropriate design structure of the e-service by identifying the functional modules having significant effects on the efficiency. Knowing which functional modules are related to efficiency, and how to change them to facilitate customization, is critical for decision-making in e-service design. In order to perform this stage, we had to generate a set of indexes related to the functional activities performed in online food retailing. First, according to their different functions, we classified some of the food retailers' website features into six categories, and each category represents one functional module, as shown in Table 4.

Table 4 Retailing Website Features

No. (k)	Module	Website Features	Function Type
1	Website Navigation	Site uses image maps Site search system Site sort system Site includes a site map	Operational
2	Shopping Tool	Shopping cart Cost calculator	Operational
3	Order Fulfillment	Shipment tracking system integrated into the website Product in-stock level listed on the website	Operational/marketing
4	Customer Support	Nutritional information posted on the website Decision tool or expert system included Direct link between recipes and the order system Customer service representative phone number posted	Operational/marketing
5	Customer Relationship Management	Membership program Customer registration procedure required Customer information collected Customers are invited to post on the website	Marketing
6	Customization and Variations	Number of shipping options Number of payment options Shipping product as a gift Product/service customization	Marketing

To investigate whether these website functional modules have a significant association with the efficiency of the e-service delivery system or not, we test the following hypotheses:

H1: The website navigation functional module has a significant association with the efficiency of the e-service delivery system.

H2: The shopping tool functional module has a significant association with the efficiency of the e-service delivery system.

H3: The order fulfillment functional module has a significant association with the efficiency of the e-service delivery system.

H4: The customer support functional module has a significant association with the efficiency of the e-service delivery system.

H5: The customer relationship management (CRM) functional module has a significant association with the efficiency of the e-service delivery system.

H6: The customization/variations functional module has a significant association with the efficiency of the e-service delivery system.

The test of these hypotheses involved principal component analysis and bootstrapping a Tobit regression analysis. To test each of these six hypotheses, we fit a series of regression models shown as below:

$$\theta_i = \pi_k + \lambda_k Z_{ik} + \delta_{ik} \qquad (5) \text{ for } k = 1,2,...6$$

Here θ_i is the DEA efficiency score of the i th food retailer's website (i = 1, 2, …, 46). Z_{ik} is the value of the i th website's first principal component corresponding to the k th functional modules of website features (k =1,2,…,6) in Table 4. λ_k is the corresponding regression coefficient.

We first conducted principal component analysis for the website features in each of the functional modules, the results of which are shown in Appendix A. Next, we conducted a Tobit regression analysis in which the DEA efficiency score of each Internet food retailer is the dependent variable, and the first principal component of each functional module is the dependent variable. The reason for using a Tobit regression model is to eliminate the ceiling effect of the DEA efficiency scores (i.e., the efficiency scores generated by the output-oriented DEA model are bounded by one from below), which may cause bias in the regression results if not eliminated (Maddala 1992). The potential impact of this problem is that the efficiency score for each decision-making unit is not independent of the scores of others in the sample. Consequently, direct regression analysis of the DEA efficiency scores may generate biased estimates (Goldberger 1991, Xue and Harker 1999). Thus, we actually applied a Bootstrap regression procedure (Xue and Harker 1999, Efron and Tibshirani 1993), as described in Appendix B. In our analysis, we used 200 Bootstrap replications in the regression analysis in order to deal with the inherent dependency problem of DEA efficiency scores. As shown in the DEA model (Model 1), the computation of each decision-making unit's efficiency score involves all the other decision-making units in the observation set by using the inputs and outputs data of all the decision making units in the observation set. The regression analysis results with 200 bootstrap replications are shown in Table 5.

Table 5 Results of Regression Analysis

Functional Module	Coefficient	Standard Error	t statistic	p-value
Website Navigation	-1.0653	0.4522	-2.3559	0.023*
Shopping Tool	-0.0441	0.6302	-0.0700	0.9445
Order Fulfillment	0.3520	2.7993	0.1258	0.9005
Customer Support	2.1036	0.6646	3.1651	0.0028**
Customer Relationship Management	0.1280	0.6803	0.1881	0.8516
Customization and Variations	0.1171	0.1326	0.8825	0.3823

Note: * indicates p-value less than 0.05 and ** indicates p-value less than 0.01.

The results in Table 5 show that that both Z_1, the first principal component of the website for the website navigation functional module, and Z_4, the first principal component of the customer support functional module, appear to exhibit a significant influence on the efficiency of the e-service delivery system for the Internet food retailing. With 200 Bootstrap replications, the p-value of the t-test for Z_1 is 0.023, which is less than 0.05. Thus, we can conclude that the overall influence of the website features included in the navigation functional module on the efficiency of the e-service delivery system is significant. Similarly, since the p-value of the t-test for Z_4 is only 0.0028, we also conclude that the overall influence of the website features included in the customer support functional module on the efficiency of the e-service system is significant.

In summary, hypotheses H1 and H4 are supported by the empirical study while the other hypotheses are not. Notice that since a lower efficiency score actually indicates higher efficiency, the results indicate that increasing the value of the first principal component of the website navigation module has a significant association with the improvement of efficiency of the e-service delivery. Within our study sample, having a powerful navigation system incorporated into the e-service enables customers to co-produce the service efficiently. This suggests that managers in our study sample might implement more features that enhance navigability, without having to worry about their impact on efficient delivery of the e-service. However, with a significant positive coefficient, customer support is shown to have a negative association with the efficiency of the e-service system. This suggests that providing a lot of customer support tools may negatively affect efficiency, depending upon the customer support tools that are used in a specific service segment. One potential explanation for this finding may be the non-positive marginal value of redundant or irrelevant information. For example, if customers already know nutritional information or do not care about reading it on the food retailer's website, being provided with a lot of such information won't boost a customer's satisfaction, and may make them feel overwhelmed. In any case, the results of this empirical study should be used with caution, as they mainly apply to our study sample, and are subject to further investigation with different samples from different e-service sectors.

6. Summary and Discussions

The topic of e-service design involves many issues in service management as well as those in information systems management. In the current paper, rather than to provide a technical guide for the design of e-service delivery systems, we approach the issue from a service management perspective and present a customer orientation strategy for e-service design. In response to the increasing participation of customers in the e-service co-production process, we propose a design strategy that focuses on addressing customers' complex needs associated with their dual roles as both co-producers and service patrons.

To aid decision makers, we develop a two-stage decision model for finding an appropriate design that can lead to efficiency and effectiveness within the e-service delivery system. An empirical study of Internet food retailing is conducted using this two-stage model. The empirical study finds that the website navigation functional module has a significant association with an e-service system's ability to meet customers' needs. The relationship between the customer support functional module and the efficiency of the e-service delivery system was found to be negatively significant. While the results are insightful, they are not intended to provide any final conclusions about these relationships, but rather to illustrate how the two-stage model can be applied to aid e-service design.

There are certain limitations existing with our study. For example, the sample size for the empirical study is relatively small, although within the range found in many other DEA-based studies. Although it was the best available data set at the time we collected the data, it is limited to the context of the Internet food retailing industry. Future research is necessary with larger sample sizes and across different e-service segments. Meanwhile, as our study has only made the first step in this area of customer orientation strategy and e-service design, to further explore the design of e-service, more research work devoted to a variety of issues related to this topic is needed. For example, though we present a general framework for a customer-orientation e-service design strategy, much remains to be done with regard to how this strategy can be used effectively for analyzing a particular e-service industry. The diverse nature of service offerings in different e-service segments means that different e-service industries may require different tradeoffs in e-service design as they value customers' complex needs differently. As a result, the strategy and the decision model may have to be customized to reflect the specific criteria of a particular e-service industry. In closing, we view the present study to provide some interesting findings that we hope will motivate other academics to further explore the emerging issues inherent in managing e-service operations.

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Appendices

Appendix A Principal Component Analysis of Website Features

$$Z_1 = -0.2033 \times V_1 - 0.9011 \times V_2 - 0.0169 \times V_3 - 0.3826 \times V_4 \quad \text{(A1)}$$

$$Z_2 = 0.6537 \times V_5 + 0.7567 \times V_6 \quad \text{(A2)}$$

$$Z_3 = -0.9824 \times V_7 + 0.1869 \times V_8 \quad \text{(A3)}$$

$$Z_4 = 0.8508 \times V_9 + 0.1376 \times V_{10} + 0.1233 \times V_{11} + 0.4919 \times V_{12} \quad \text{(A4)}$$

$$Z_5 = 0.5033 \times V_{13} + 0.7163 \times V_{14} + 0.44 \times V_{15} + 0.2 \times V_{16} \quad \text{(A5)}$$

$$Z_6 = 0.9993 \times V_{17} + 0.0014 \times V_{18} + 0.0061 \times V_{19} + 0.0337 \times V_{20} \quad \text{(A6)}$$

Appendix B The Bootstrap Approach for Hypothesis Testing

Step 1: Construct the sample probability distribution $\hat{F}$ by assigning probability of 1/n at each DMU in the observed sample: ($x_1, x_2, ..., x_n$).

Step 2: Draw c (c is a constant) random samples of size n with replacement from the original sample ($x_1, x_2, ..., x_n$):

$$S_k = (x_{k1}, x_{k2}, ..., x_{kn}),\ k = 1, ..., c, \quad \text{(B1)}$$

where $x_{ki} = (u_{ki}, v_{ki}),\ i = 1, ..., n$. S_k is the so-called *Bootstrap sample*.

Step 3: For each Bootstrap sample S_k, $k = 1, ..., c$, run the DEA model or a variant of such models to recalculate the efficiency scores for all n DMUs:

$$\theta_{ki} = \phi_i(u_k),\ i = 1, ..., n, \quad \text{(B2)}$$

where ϕ_i represents the DEA model or extended DEA model of choice for DMU i.

Step 4: For each Bootstrap sample S_k, $k = 1, ..., c$, evaluate the *Bootstrap replication* $\hat{\beta}_{kj}, k = 1, ..., c,\ j = 0, 1, ..., m$ by fitting the regression model of choice where the DEA efficiency scores are the dependent variables:

$$\theta_{ki} = G(\beta_k, v_{ki}) + \varepsilon_{ki},\ i = 1,...,n\ ,\beta_k = (\beta_{k0}, \beta_{k1},..., \beta_{kj},..., \beta_{km})\,; \qquad \text{(B3)}$$

Note that any transformation of the DEA efficiency scores (e.g. the logarithmic transformation) can also be used as the dependent variables:

$$\pi(\theta_{ki}) = G(\beta_k, v_{ki}) + \varepsilon_{ki},\ i = 1,...,n,\ \beta_k = (\beta_{k0}, \beta_{k1},..., \beta_{kj},..., \beta_{km})\,. \text{ (B4)}$$

Step 5: Estimate the standard error $se(\hat{\beta}_j)$ by the sample standard deviation of the c Bootstrap replications of $\hat{\beta}_j$:

$$\hat{s}e_c(\hat{\beta}_j) = \left\{ \sum_{k=1}^{c} (\hat{\beta}_{kj} - \overline{\beta}_j)^2 \Big/ (c-1) \right\}^{\frac{1}{2}},\ j = 0,1,...,m, \qquad \text{(B5)}$$

where

$$\overline{\beta}_j = \frac{\sum_{k=1}^{c} \hat{\beta}_{kj}}{c}, j = 0,1,...,m\,. \qquad \text{(B6)}$$

We call $\hat{s}e_c(\hat{\beta}_j)$ the *Bootstrap estimator* for the standard error of $\hat{\beta}_j$.

Now, we are ready to use a t-test to evaluate the following hypothesis:

$$H_0 : \beta_j = 0,\ vs.\ H_a : \beta_j \neq 0.$$

Calculate the test statistic according to:

$$t = \frac{\hat{\beta}_j}{\hat{s}e_c(\hat{\beta}_j)}, \qquad \text{(B7)}$$

and compare t to the critical value $t_{\alpha/2}$ from the student t distribution with (n-m-1) degrees of freedom. If $|t| > t_{0.025}$, reject the null hypothesis $H_0 : \beta_j = 0$ in favor of $H_a : \beta_j \neq 0$, at the $\alpha = 0.05$ significant level. Otherwise, the null hypothesis $H_0 : \beta_j = 0$ is tenable at the $\alpha = 0.05$ significant level. Note that the Bootstrap method is a large sample method and, therefore, a Z-test can be substituted by t-test in practice.

Authors' Vitae

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