

Assessing the Service-Profit Chain

Wagner A. Kamakura • Vikas Mittal • Fernando de Rosa • José Afonso Mazzon

Duke University, Box 90120, Durham, North Carolina 27708

Katz Graduate School of Business, 360 Mervis Hall,

University of Pittsburgh, Pittsburgh, Pennsylvania 15260

University of Brasilia, SQSW 304 Bloco I, Apto. 507, Brasilia-DF-Brazil 70673-409

Universidade de São Paulo, Faculdade de Economia e Administracao, Ave. Prof. Luciano Gualberto,

908 CEP 0558-900, São Paulo-SP-Brasil

kamakura@mail.duke.edu • vmittal@katz.pitt.edu • fernando.rosa@uol.com.br • jmazzon@usp.br

Abstract

The service-profit chain (SPC) is a framework for linking service operations, employee assessments, and customer assessments to a firm's profitability (Heskett et al. 1994). The SPC provides an integrative framework for understanding how a firm's operational investments into service operations are related to customer perceptions and behaviors, and how these translate into profits. For a firm, it provides much needed guidance about the complex interrelationships among operational investments, customer perceptions, and the bottom line.

Implementing the SPC is a pervasive problem among most service firms, and several attempts have been made to model various aspects of the SPC. However, comprehensive approaches to model the SPC are lacking, as most studies have only focused on discrete aspects of the SPC. There is a need for approaches that combine data such as measures of operational inputs, customer perceptions and behaviors, and financial outcomes from multiple sources, providing the firm with not only comprehensive diagnosis and assessment but also with implementation guidelines. Importantly, an approach that is sensitive to and can accommodate the strengths and weaknesses of such data sets is required. We outline and illustrate such an approach in this paper. Our approach has the potential to both identify and quantify the benefits of implementing a service strategy, especially for firms having multiple units (e.g., banks with branches, retail outlets, and so forth).

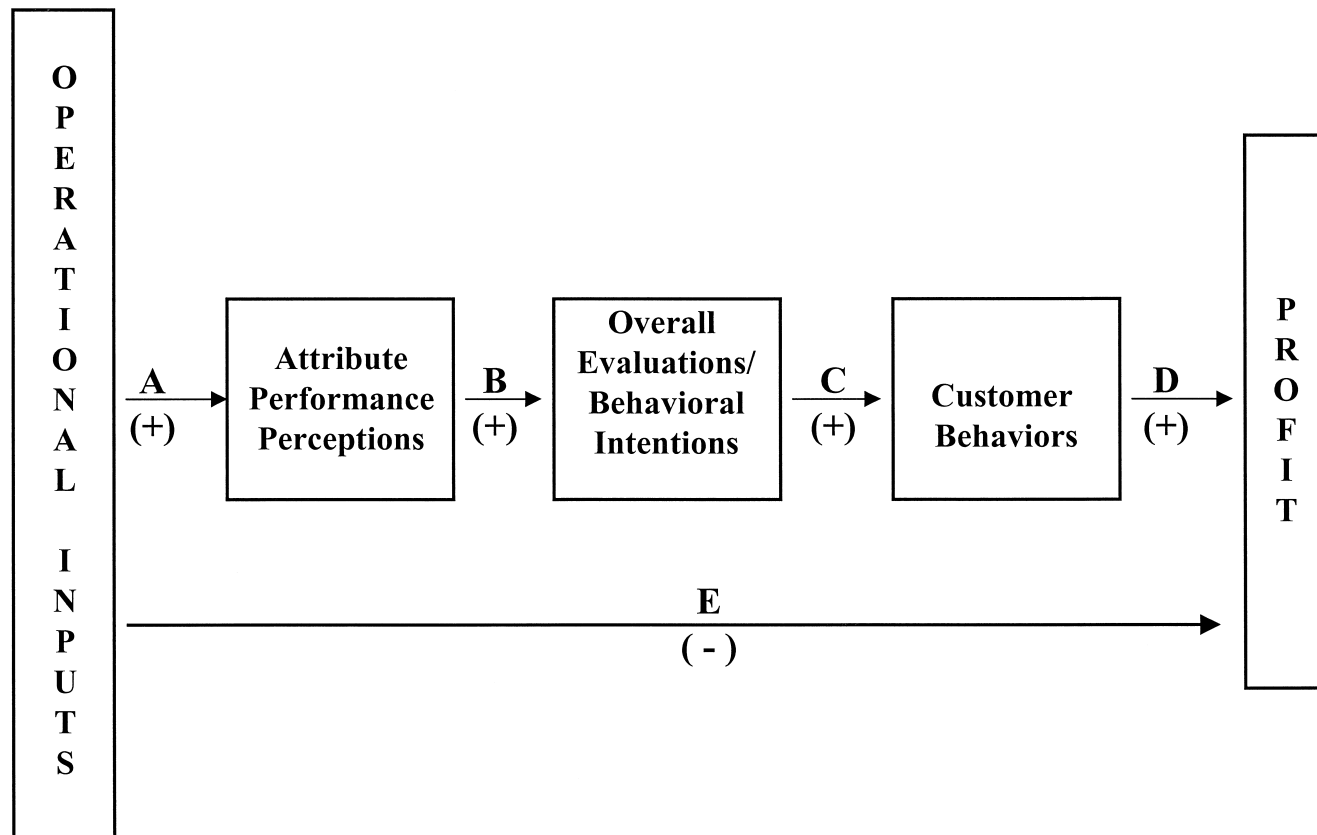
The implementation approach is illustrated using data from a national bank in Brazil. We used customer surveys from more than 500 branches of the bank. Each individual customer's marketing survey data was linked to a number of operational metrics. First, behavioral measures of retention, such as the length of the customer's relation with the bank, the deposit amount, and number of transactions with the bank, were obtained and merged with the survey data. Second, the main branch used by each customer was identified and operational inputs (e.g., number of employ-

ees, number of available automated teller machines (ATMs)) used at that branch were obtained and merged with the data set. This data set was used to model the SPC at a *strategic* and *operational* level.

The *strategic* analysis consisted of a structural-equation model that identified the critical conceptual relationships that parsimoniously articulate the SPC for this bank. For instance, from among a variety of attribute-level perceptions, the bank was able to identify those perceptions that were critical determinants of behavioral intentions. Similarly, from a variety of available behavioral metrics, the bank was able to identify those behaviors most relevant to profitability. The *operational analysis* utilized Data Envelopment Analysis (DEA) and provides customized feedback to each branch in implementing the strategic model. It provides each branch with a metric of its relative efficiency in translating inputs such as employees and ATMs into relevant strategic outcomes such as customer intentions and behaviors. Our illustration shows how top management can use the strategic and operational analysis in tandem. Whereas the strategic model provides the key relationships and metrics that are needed to ensure that all subunits of the firm follow a consistent strategy, the operational analysis enables each branch to benchmark its unique position so that the branch can implement the strategic model in the most efficient way. Thus, *simultaneously implementing the strategic and operational model enables a firm to have a centralized focus with decentralized implementation*. For this bank, the operational analysis shows that for a branch to achieve superior profitability, it is important that the branch manager not only be efficient in achieving superior satisfaction (as indicated in positive behavioral intentions) but also be efficient in translating such attitudes and intentions into relevant behaviors. In other words, superior satisfaction alone is not an unconditional guarantee of profitability.

(Service; Profitability; Service-Profit Chain; Retention; Satisfaction; Banking; Financial Services)

Figure 1 The Service-Profit Chain



Note. Employee perceptions, attitudes, and satisfaction are included as a form of operational input because we view both technological and human factors as operational inputs.

Prior to the 1990s, most firms oriented their operations toward maximizing service quality. Today, the focus is on linking service quality to concrete business outcomes such as retention and profitability (cf. Rust et al. 1995). In essence, the strategic focus has been on *maximizing profitability* by *optimizing* operational resources allocated toward service quality efforts.

However, for most firms, linking operational resources to marketing outcomes has not been easy. As remarked by Bolton and Drew (1994, p. 197):

There is a critical need for *comprehensive* models of customer assessments, service operations, and outcomes, that is, models with multiple, structural equations that recognize

potentially simultaneous relationships. By necessity, these models must be operationalized with measures of service operations and outcomes from within the organization. Unfortunately, many organizations do not systematically collect relevant internal measures. If they do, it can be very difficult to retrieve and match them at the individual level.

The SPC is a framework for linking service operations, employee assessments, and customer assessments to the bottom line (Heskett et al. 1994). As detailed in Figure 1, the SPC provides an integrative framework for understanding how a firm's operational investments into service quality are related to customer perceptions and behaviors and how these translate into profits. Thus, it provides much needed

guidance about the complex interrelationships among operational investments, customer perceptions, and the bottom line.

Implementing the SPC is a pervasive problem among most service firms, as it provides a clear opportunity for operational improvement. Therefore, several attempts have been made to model various aspects of the SPC. As discussed later, comprehensive approaches to model the SPC are lacking, as most studies have only focused on discrete aspects of the SPC (cf. Zeithaml 2000). As such, approaches and studies that can provide a firm with not only comprehensive diagnosis and assessment but also with implementation guidelines are needed. To accomplish this, data from multiple sources must be melded, including measures of operational inputs, customer perceptions and behaviors, and financial outcomes. Importantly, an analysis approach that is sensitive to and can accommodate the strengths and weaknesses of such data sets is required. We outline and illustrate such an approach in this paper. As shown, the results have the potential to both identify and quantify the benefits of implementing a service strategy, especially for firms having multiple units (e.g., banks with branches, retail outlets, and so forth). By undertaking such an exercise, a clearer picture of the *strategic* and *operational* blueprint of the firm's service strategy emerges. This can be used to set action priorities for top management as well as front-line managers. Such an effort has an illustration and implementation focus and is in sharp contrast with studies aimed at examining specific and isolated pieces of the SPC. Whereas the purpose of these focused studies is to theoretically examine the nature of each link, the purpose of this effort is to illustrate a comprehensive modeling approach from an implementation perspective.

We utilize data from 5055 customers of a national bank in Brazil to illustrate our approach. We also discuss the broader applicability of the approach to other service environments and highlight some interesting conceptual insights that emerge from this analysis. To undertake this issue, we first review the SPC framework by highlighting conceptual and empirical research related to it. We also discuss the ap-

plication of the SPC framework at a *strategic* and *operational* level (Soteriou and Zenios 1999). Next, we develop a testable model emanating from the SPC framework and describe the empirical application in the context of the bank. In doing so, this paper articulates a measurement and modeling approach to this problem area with an illustrative application. Thus, we believe that the contribution of this paper is not the development of a new methodology or modeling technique or the generality of the specific findings. Rather, the contribution is in presenting a comprehensive approach that service firms can use as a blue print for action. In the process, we gain several qualitative insights that shed light on important questions such as: Why are some firms unprofitable despite high-service quality and what is the role of implementation efficiency in moderating profitability?

The Service-Profit Chain

The original SPC framework was proposed by Heskett et al. (1994), who posit that revenues are driven by service quality perceptions, which in turn are driven by operational inputs and employee efforts. The popularity of the SPC framework is evident in the numerous case studies reported by practitioners, the most notable being its application at Sears (Rucci et al. 1998). Another framework proposed by Rust et al. (1995), known as the "Return on Quality" framework, is similar, although it differentiates itself by explicitly modeling the cost and benefits of quality-related investments. Note that in the SPC framework, the cost of quality is not explicitly considered and the focus is on revenue rather than profitability, the focus of the return on quality (ROQ) framework. However, both the SPC and ROQ have several commonalities, the most notable being an emphasis on driving the firm's operations based on statistical analyses of customer surveys. Thus, customer surveys are used to identify key service attributes that impact overall quality and retention, which in turn drive financial outcomes. In this respect, they can provide actionable guidance to management. Both

these frameworks, however, are different from the recently emerging customer equity framework, where the focus is on identifying profitable customers. At the basic level, all of these frameworks are aimed at linking service quality and marketing activities to financial metrics. However, the customer equity framework is more focused in customer identification, whereas the ROQ and SPC frameworks are more focused on improving the firm's operations. Thus, while the former may be useful to manage a firm's customer base, the latter two are more useful to manage the firm's internal operations to service the customer base so identified.

Following Heskett et al. (1994), early SPC conceptualizations and tests were focused on retention and revenue maximization with no explicit consideration of the cost of service quality efforts. Thus, in the SPC application at Sears, the objective was to increase sales and revenues with no explicit regard for profitability (Rucci et al. 1998). At PNC bank, the SPC application was aimed at linking satisfaction ratings to bank balance and not profitability (cf. Carr 1999). Similarly, at Holiday Inn, service quality was explicitly linked to revenue available per room (Kimes 1999). Similar in spirit were academic studies seeking to link consumer perceptions to behavioral outcomes such as patronage duration (Bolton 1998) and repurchase behavior (Mittal and Kamakura 2001). To our knowledge, Loveman (1998) presents the most comprehensive application of the SPC in examining both customer behavior (duration of stay, cross-purchasing) and revenue implications (average balance) of service quality. However, in all of these applications, the *implicit* goal was to *maximize* retention or revenues, and as such the cost of engaging in such strategic objectives is not *explicitly* modeled.

To be sure, some studies have linked satisfaction or service quality to profitability and not just revenues. Even results from such studies have been inconclusive. For instance, Ittner and Larcker (1998) found that satisfaction is positively related to retention and revenues but not to margins. Specifically, they found that bank branches ranking in the lowest customer satisfaction quartile had no different return on sales (margins/sales) than those ranking in the

highest quartile. This was despite the fact that the lower quartile branches had lower revenue than the higher quartile branches. Although they do not address this issue, we believe that this could have occurred because the high-satisfaction branches were overspending to satisfy customers and gain sales. Thus, simply having profits or margins as the dependent variable or objective function is not enough, unless the *simultaneous positive and negative impact of service quality expenditures and investments on profitability is explicitly included* in the analysis. The ROQ framework proposed by Rust et al. (1995) squarely addresses this important point. Here, operational resources directed toward service improvements are posited to simultaneously have a positive and negative effect on profitability. The positive impact occurs because such investments (e.g., more tellers at a bank) in operational resources lead to positive performance perceptions on corresponding attributes (e.g., higher performance perceptions of waiting time), which in turn lead to more favorable behavioral intention toward the service provider, retention, and revenues. The negative impact is directly due to the outlays made toward operational inputs aimed at improving attribute performance perceptions and, eventually, service quality and corresponding consumer behaviors. It is in this regard that we modify the SPC framework proposed by Heskett et al. (1994). By explicitly including their negative impact on profitability, management can make its investments in service quality financially accountable. Thus, the approach we take blends elements of the ROQ framework in the SPC framework.

An additional distinction of our application is its simultaneous *strategic* and *operational* focus. The distinction between strategic and operational focus was first made by Soteriou and Zenios (1999). Accordingly, the *strategic* model is more of a conceptual, analytical model that identifies the key linkages and parameters for management. The *operational* model, on the other hand, has an implementation focus, and the goal is to provide efficiency benchmarks and evaluations to the multiple subunits of a firm in their ability to implement the core elements of the strategic model. As Soteriou and Zenios (1999,

p. 1222) remark, "Strategic benchmarking focuses on the things that really matter and efficiency benchmarks focus on how to do these things well." Consider, for example, the linkage between operational inputs and service quality perceptions among customers. For this link, an attempt to correlate operational inputs to customer perceptions of service quality would constitute a strategic-level analysis. The strategic-level analysis would enable management to identify, from a variety of inputs, that subset of inputs that has the largest impact on customer quality perceptions. Operational analysis, on the other hand, would compare the performance of various subunits (e.g., bank branches) on their efficiency in translating the operational inputs into consumer perceptions. Thus, both strategic and operational analysis is needed to execute and implement the SPC in a firm. In a typical application, the strategic model may first be estimated from aggregate data, and then a subunit level operational analysis may be conducted to compare each subunit on its ability to execute the strategic model.

In implementing the SPC at a firm, several choices must be made, each representing a constraint specific to the firm's unique situation. First, depending on data availability, the SPC may be implemented at the customer level or the subunit level. While some firms collect sufficient customer-level information from each subunit, others do not. Ideally, the customer-level analysis can be used to produce a strategic model that can be implemented at the subunit level to produce an operational model. A second issue concerns the use of cross-sectional or time-series data. Although time-series data provide superior capability in terms of statistical analysis, matching wave-to-wave satisfaction data for each individual customer may be impossible, especially in industries facing low retention rates (e.g., telecommunication). If data for enough time periods are available at the subunit level, causal analysis incorporating heterogeneity may be conducted. In the study we report, data for a single-time period were available. Third, firms must explicitly articulate the time horizon for the application and conclusions. Typically, firms implementing the SPC for the first time will focus on the

short term, although over time, additional analysis can be undertaken. However, it may be useful to consider the present value of financial variables, including customer profitability and service quality investments. The point is that every application of the SPC is unique to the specific situation faced by the firm and the data available to model the SPC. Choices made in this regard typically represent data constraints and these should be delineated up front so that management can understand the limitations of the analysis. Interpretation of the results and implementation of the SPC should then proceed with caution, bearing in mind the limitations of the data available.

The SPC: Gaps in Empirical Literature

Systematic empirical investigations of the SPC have emerged only recently. As data needed to empirically test the SPC have started to become available, empirical research assessing the SPC has emerged. Noteworthy is the fact that most studies have been done only within the last 2 to 3 years. Soteriou and Zenios (1999) note that no study has comprehensively modeled the SPC and that most empirical studies have studied specific links in isolation. Thus, there is extensive research linking attribute-level performance perceptions to service quality (Parasuraman et al. 1988), service quality perceptions to customer behaviors (Bolton 1998), and customer behaviors to revenues (Carr 1999). However, these studies tested each link separately rather than as a simultaneous-equation model, leaving three critical gaps in the application of SPC at a firm. First, these studies have been unable to identify the causal and mediating mechanisms that managers need to understand to implement the SPC. Second, an exclusive focus on isolated links has led to mixed and inconsistent findings. Third, unless all of the pieces of the puzzle can be put together in the context of a single firm, it is hard to find acceptance for the SPC framework, thus impeding its application among firms. Regarding the first point, consider a study by Loveman (1998), who sought to examine each of the

SPC links separately. Loveman (1998, p. 30) found results that were equivocal and concluded:

This simple analysis offers no way to exclude other interpretations, including the claim that mediating links render the more distant relationships invalid. Future research will employ more sophisticated multi-equation methods to improve tests of the service profit chain model and better discriminate among competing explanations of equivocal results.

Thus, explicating the various mediating mechanisms, although complicated due to the use of multi-equation models, can resolve issues about causal mechanisms underlying the relationships between more distal constructs in the SPC. Regarding the second point, a comprehensive approach can potentially resolve seemingly inconsistent findings, such as the one found by Ittner and Larcker (1998, Study 2) and discussed earlier. Finally, a common barrier to implementing research findings is their contextual variance. Consider that literature finds a strong link (theoretically and empirically) between overall satisfaction perceptions and customer behavior (Bolton 1998, Mittal and Kamakura 2001). Yet, management at a specific firm needs to put that finding in its own context (i.e., observe it in its own data) and then statistically link it to other pieces of the SPC framework to make meaningful decisions. In other words, despite strong support for isolated links, a comprehensive, "big picture" approach is needed at the firm level to provide management with action priorities.

Past empirical studies tended to have either a *strategic* focus or an *operational* focus but never both. Notably, the focus is driven by the discipline with which the authors of a study are affiliated. Whereas authors in marketing tended to test the SPC at the *strategic* level, authors in operations management have taken an *operational* focus. Studies with a strategic focus identify key links and variables needed to model the SPC at a firm, whereas studies with an operational focus seek to identify the most efficient ways in which the link identified in the strategic model can be implemented. As highlighted by Soteriou and Zenios (1999), the interplay between these two levels of analysis has not been formalized. Yet, for managers implementing the SPC, simultaneous

guidance is needed at both levels. Managers need to be told not only which links of the SPC to focus on (strategic model) but also need to be guided in terms of efficiently implementing each link (operational model).

Thus, from a research perspective, a comprehensive empirical application that *simultaneously* assesses *all* of the links of SPC and examines these links both at the *strategic* and *operational* levels is missing. Such an empirical application can illustrate for most firms how to *simultaneously* assess *all* of the links of SPC at the *strategic* and *operational* levels. More importantly, this application focuses on managing profitability, rather than on only maximizing revenues or retention. In doing so, we gain several qualitative insights. At the strategic level, we demonstrate that operational investments designed to improve service quality perceptions have a positive, indirect effect on profitability, although this positive, indirect effect is offset by their direct negative effect on profitability. Operationally, our results show that superior profitability accrues to those subunits of the firm that are not only efficient in generating the desired level of services but also in translating the service perceptions into customer retention.

We estimate the strategic model using data from 5055 customers of the bank. In addition to the large sample size, the data are unique in three respects. First, customer survey data about quality perceptions and behavioral intentions toward the bank were available. Second, behavioral data on customer retention and profitability were collected at the customer level and merged with the survey data. Finally, data on operational inputs at branch level were also available. We present the results of the study cautioning the reader that the results reported here are based on customized measures available from the database of a single firm. We are well aware that the application of the SPC framework is likely to vary from firm-to-firm, depending on the specific measures and metrics available. We do not claim that ours is the best operationalization, nor do we claim to have provided the definitive test of the SPC. Rather, we view our work to be illustrative in nature, one that demonstrates how the SPC can be comprehensively implemented at

a firm, and in the process, also provide qualitative insights that advance the satisfaction literature. Thus, our work is closer in spirit to that of Simester et al. (2000), who illustrate an implementation approach to cross-cultural, customer satisfaction enhancement.

The SPC: Strategic Model

Our conceptualization of the SPC is shown in Figure 1. Although we follow models previously proposed in the literature (see Bolton and Drew 1994, Heskett et al. 1994), we also incorporate a direct negative link from operational inputs to profitability. This is in line with Rust et al. (1995), such that operational resources directed toward service improvements are posited to simultaneously have a positive and negative effect on profitability. Equations 1–4 posit a general specification of the system described above:

$$\begin{aligned} \text{Link A Attribute performance perceptions} \\ = f(\text{resource investments in operational inputs}), \end{aligned} \quad (1)$$

$$\begin{aligned} \text{Link B Behavioral intentions} \\ = f(\text{attribute performance perceptions}), \end{aligned} \quad (2)$$

$$\begin{aligned} \text{Link C Customer retention} \\ = f(\text{behavioral intentions, competition}), \end{aligned} \quad (3)$$

$$\begin{aligned} \text{Links D and E Profit} \\ = g[f(\text{customer retention}), f(\text{resource investments})] \end{aligned} \quad (4)$$

Each equation represents specific testable hypotheses for an individual firm. Except for Link E (should be negative), all of the relationships are expected to be positive. As specified in Equation (1), the firm's interest is to allocate resources to operations that explicitly affect customer perceptions about performance on specific attributes. At a bank, performance perceptions of an attribute such as "waiting time in line" can be affected by operational inputs such as increasing tellers, modifying the lobby layout, or increasing automation to provide faster service. It is also critical for a firm to allocate resources to inputs that explicitly affect customer perceptions. Unless customers perceive the consequences of the opera-

tional inputs, investments in operational inputs are unlikely to have an impact on overall satisfaction. Although seemingly obvious, empirically linking operational processes and attribute perceptions has not been easy. Bolton and Drew (1994, p. 179) remark that "Most companies are (as yet) unable to link engineering/operations attributes to customers perceptions of service through statistical models." Without an explicit link between the two, firms cannot be sure of their resource allocation strategy for service quality improvements. The goal of a strategic model is to statistically identify, from among the variety of operational inputs, those that affect key attribute perceptions.

As specified in Equation (2), attribute performance perceptions affect global consumer evaluations. These global evaluations¹ can take the form of an overall service quality rating (Bolton and Drew 1994), overall satisfaction rating (Anderson and Mittal 2000), or an overall behavioral intent rating (Rust et al. 2000). The theoretical basis for this link is located in a multiattribute conceptualization of customer satisfaction and service quality (Anderson and Mittal 2000, Parasuraman et al. 1988). In such a conceptualization, the global customer evaluation is a function of attribute-level perceptions and the extent to which a change in attribute performance perceptions leads to a change in the global evaluation determines the importance of that attribute (Anderson and Mittal 2000). Resource allocation to various attributes is based on their relative importance. Thus, the goal in estimating this link in the strategic model is to isolate the "key driver" attributes, or attributes that have the highest importance in determining overall evaluations.

Per Equation (3), global consumer evaluations predict a variety of customer retention behaviors. The theoretical basis for this link is the idea of attitude intention behavior consistency (Morwitz and Schmit-

¹In this paper, we do not address the debate about which of these constructs is an appropriate global evaluation. Our position is that the choice and appropriateness of the construct is dependent on the specific situation faced by a firm.

lein 1992), whereby consumer behavior, on average, follows attitudes and intentions. Empirically, it has been demonstrated that global evaluations such as satisfaction and intentions affect behaviors (e.g., Bolton 1998, Mittal and Kamakura 2001). Note that in any SPC application, the global evaluation used—satisfaction, service quality rating, or behavioral intent—may be specific to the firm. Similarly, the behavioral outcomes and their metrics are expected to vary from firm to firm. For instance, a telephone service provider may be interested in measuring the duration of a customer's stay with it (Bolton 1998). For durable goods such as cars, the actual repurchase of the same brand may be the behavior of interest. However, in the financial services industry where a single customer can have multiple accounts with different providers, firms find it useful to monitor "share of wallet" and duration of the customer's relationship with the firm. The key is to ensure that behaviors monitored should be related to revenues and/or profitability. Furthermore, factors such as industry competitiveness (Anderson and Mittal 2000) can moderate the extent to which global evaluations of service are related to desirable customer behaviors. Thus, instead of *assuming* that higher global evaluations will translate into more desirable behaviors, a firm must specifically test for the existence, magnitude, and functional form of the underlying relationship. Links D and E in Figure 1 are captured in Equation (4). Accordingly, customer retention behaviors have a positive impact on profitability (Link D), and investments made in operational inputs have a direct negative impact on profitability (Link E).

Implementing the SPC: Operational Model and Assessment

Once the strategic model has been estimated and evaluated, a firm can then proceed to examine the relative efficiency with which each subunit is implementing the strategic model. This constitutes the operational analysis. For this, researchers and managers jointly decide on the key links (identified in the strategic model) that must be emphasized and on the basis on which the subunits are to be compared.

Typically, the subunit comparison is based on their *efficiency in translating inputs to desired outputs* using operations management techniques such as Data Envelopment Analysis (DEA). This technique, detailed later, measures the efficiency (ratio of output to inputs) of a bank branch in relation to a virtual branch that represents the "best practice" or benchmark at the same scale of operations. In other words, rather than comparing each branch to the best of all branches within the firm, DEA defines a "virtual" branch as a convex combination of efficient branches that operate at similar scale levels (in terms of inputs utilized and outputs produced), which would be directly comparable to the branch under evaluation. Thus, this efficiency analysis is not focused on output maximization alone and is fully consistent with the SPC and ROQ approaches that focus on *maximizing profitability rather than on service quality*. Moreover, this analysis takes into account potential differences in economies of scale across the multiple units, producing more equitable efficiency assessments.

Empirical research on operational-level assessments of the SPC has been sparse, although some recent studies are relevant (cf. Kimes 1999, Frei and Harker 1999, Simester et al. 2000). Kimes (1999) used an output maximization approach to compare various hotels in the Holiday Inn chain on their quality performance and revenues. Frei and Harker (1999) compared the efficiency of service delivery process but focused only on service design issues. Finally, Simester et al. (2000) compared several units of an international firm using a quasi-experiment. Their assessment only focused on the operational inputs, perceptions of attribute performance, and satisfaction. As such, no assessment of retention or profitability was made. We address all of these issues by comparing different subunits on (1) resource allocation, (2) customer perceptions, and (3) customer retention. We then demonstrate the profit implications of such comparisons.

Strategic and Operational Assessment of SPC

Before discussing the empirical results, it is important to understand how the strategic and operational models fit together. These two models form a two-

step process and should not be treated as substitutes. The focus of the strategic model is on extracting, from a large set of data and variables, key conceptual relationships that can parsimoniously articulate the SPC. For instance, management may ask: Among the 15 attribute performance perceptions measured in our customer survey, which should we focus on? Among the several customer behavior measures available in the accounting database, which should we consider? These questions are answered in the process of estimating the strategic model. In our experience, overly complex models can stymie implementation.

Although the strategic model provides a blue print to top management, it alone is not useful to guide implementation considerations, especially at individual subunits. For instance, think of a bank where management has identified that ATMs positively affect service quality perceptions and retention. However, the extent to which an individual branch can change service quality perceptions and retention in response to installing additional ATMs will vary from branch-to-branch. A branch that caters primarily to college students may witness a stronger relationship than a branch that caters primarily to senior citizens. Thus, each branch needs guidance for implementing the strategic model in an efficient manner. The operational model provides such guidance.

In effect, the operational model “customizes” the strategic model for specific subunits by incorporating the unique situation faced by the particular subunit. Another way of thinking about this is that the strategic model provides the key relationships and metrics that are needed to ensure that all subunits of the firm follow a consistent strategy. In tandem, the operational analysis provides each branch with a snapshot of its unique position so that the branch can implement the strategic model in the most efficient way. Thus, *simultaneously implementing the strategic and operational model enables a firm to have a centralized focus with decentralized implementation*. In summary, the strategic model and operational model are complements rather than substitutes, and both are needed for successfully implementing the SPC at a service firm with multiple subunits.

Research Setting

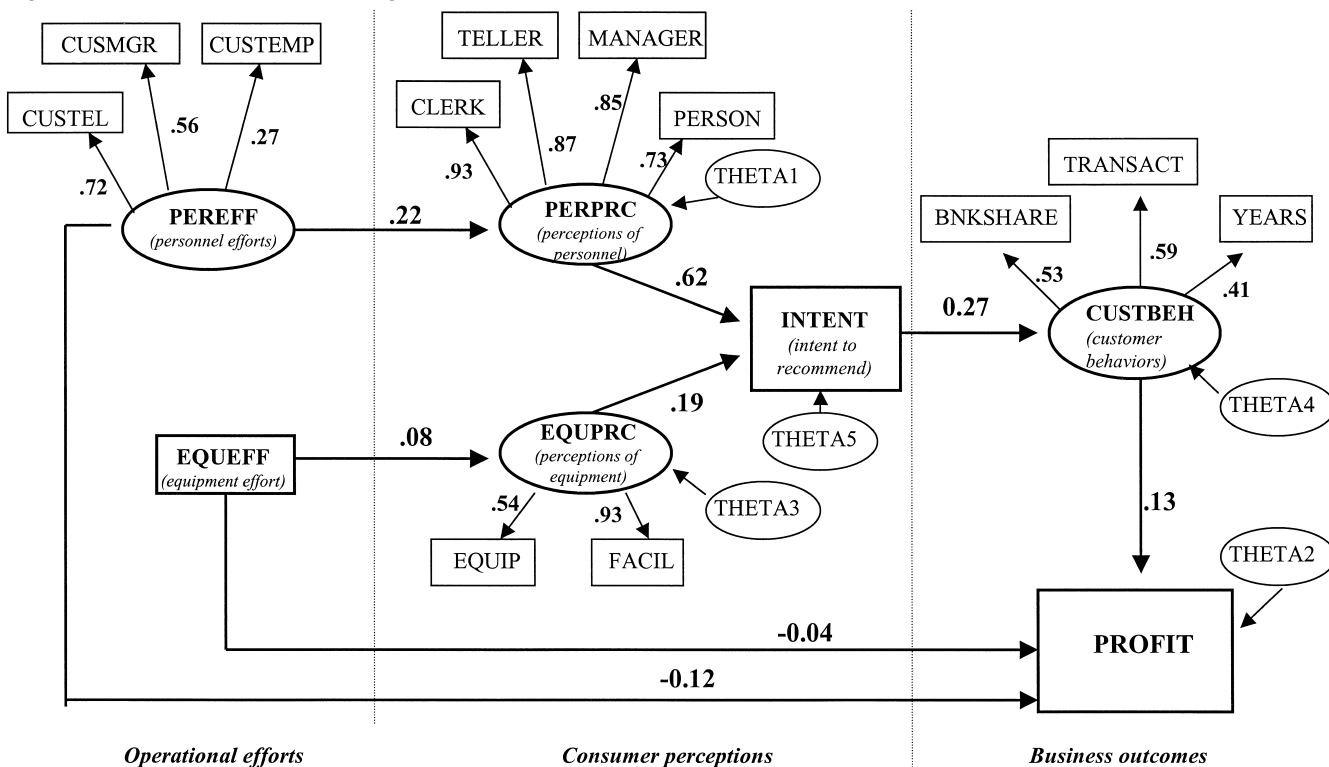
The research was conducted in conjunction with a leading national bank in Brazil whose identity has been disguised for confidentiality reasons. Survey data was compiled as part of a customer satisfaction initiative. A total of 5,055 customers from more than 500 branches were interviewed based on a proportionate sampling plan, such that more customers were interviewed from the larger branches. Each individual customer’s marketing survey data was linked to a number of operational metrics. First, behavioral measures of retention such as the length of the customer’s relation with the bank, the deposit amount, and number of transactions were obtained and merged with the survey data. Second, the main branch used by each customer was identified, and operational inputs used at that branch were obtained and merged with the data set. For instance, variables such as the number of employees and the number of available ATMs at the branch were merged with each customer’s record.

As mentioned earlier, our analysis is somewhat unique, as the variables and their measures are specific to the sponsoring organization. However, the measures used are considered most actionable by this bank’s management. For instance, the two perceptual dimensions on which attributes were measured in these data—equipment and personnel—are unique to this bank, and other banks or organizations may very well focus on other attributes. Similarly, even though retention and profit measures were taken at a later time period than when satisfaction measures were taken, we only had access to single-period data. Thus, although we have a time lag between customer perceptions and measures of retention and profitability, issues such as persistence and unobserved heterogeneity cannot be directly addressed.

Strategic Model (Customer-Level Analysis)

The customer-level analysis used four types of measures: operational inputs to attribute-level percep-

Figure 2 Service-Profit Chain: Strategic Model



Notes. All estimates are significant at $p < 0.05$. Thick lines indicate structural relationships.

tions, survey measures on attribute performance perceptions and overall satisfaction, behavioral measures of retention, and financial measures of profitability. Equations (1)–(4) and Figure 1 provided the framework that guided the empirical testing.

Model Specification

The model specification shown in Figure 2 can be expressed using the following structural equations:

$$PERPRC_i = w_{01} + w_{11}PEREFF_i + \varepsilon_{i1}, \quad (5)$$

$$EQU PRC_i = w_{02} + w_{12}EQU EFF_i + \varepsilon_{i2}, \quad (6)$$

$$INTENT_i = w_{03} + w_{13}PERPRC_i + w_{23}EQU PRC_i + \varepsilon_{i3}, \quad (7)$$

$$CUSTBEH_i = w_{04} + w_{14}INTENT_i + \varepsilon_{i4}, \quad (8)$$

$$PROFIT_i = w_{05} + w_{15}PEREFF_i + w_{25}EQU EFF_i + w_{35}RETEN_i + \varepsilon_{i5}. \quad (9)$$

The construct and variable definitions along with the measures corresponding to these equations are shown in Appendix 1. Note that the specific variable definitions and measures are unique to this application and each firm may need to adapt them to its particular situation.

Analysis Plan

The expected weight for each structural path testing the SPC links is summarized below.

- The bank invests operational resources in two main areas: equipment (*EQUEFF*) and personnel (*PEREFF*). These two constructs are measured based on operational inputs. For instance, *PEREFF*, is measured as a latent construct comprising of number of customers per manager, number of customers per teller, and number of customers per employee (with inverted signs).

Table 1 Key Sample Characteristics

Sample Characteristics	Percent/Average (%/avg)
Age	
30 years or less	14
31–50 years	50
51–60 years	19
More than 60 years	17
Education	
Elementary or less	13
High school	32
College or more	55
Gender	
Female	35
Male	65
Phone Ownership	
Yes	83
No	17
Average number of years using this bank	13.5 years
Average percentage of funds at this bank	44.4
Number of branches represented in the sample	521
Average number of respondents per branch	9.9

- *Link A*: $w_{11} > 0$; $w_{12} > 0$. For this bank, the two key areas of performance evaluations measured in the survey pertain to customer perceptions of personnel (*PERPRC*) and equipment (*EQUIPRC*). For instance, performance ratings of various front-line employees (e.g., *CLERK*, *TELLER*, etc.) constitute the latent variable *PERPRC*. Similarly, consumers' assessments of equipment (*EQUIP*) and facilities (*FACIL*) constitute the latent construct perceptions of equipment (*EQUIPRC*).
- *Link B*: $w_{13} > 0$; $w_{23} > 0$. According to this link, perceptions of personnel (*PERPRC*) and equipment (*EQUIPRC*) affect consumers' behavioral intentions (*INTENT*).
- *Link C*: $w_{14} > 0$. According to this link, customer's overall evaluation affects retention. For this bank, customer behavior is a latent construct (*CUSTBEH*) comprising three outcomes. These were a percentage of their funds that a customer

keeps at this bank or share of wallet (*BNKSHARE*), number of transactions per month (*TRANSACT*), and customer's tenure with the bank (*YEARS*).

- *Link D*: $w_{35} > 0$. This hypothesis specifies a positive effect of retention on profitability. Profitability (*PROFIT*) is measured as the monthly average profits generated by customers.
- *Link E*: $w_{15} < 0$; $w_{16} < 0$. Finally, a direct negative impact of investments in operational inputs on profitability is hypothesized. For this bank, operational efforts in personnel (*PEREFF*) and equipment (*EQUEFF*) have a direct negative effect on profitability.

The analytical plan consisted of specifying the structural equation model and testing the structural path pertaining to each hypothesis.

Results

Due to missing data, an effective sample of 3489 customers was used to compute rank order correlations among the variables. This reduction in sample occurred due to listwise deletion (when data for a single variable are missing, the entire observation is deleted). To ascertain the extent of bias in the sample with missing data, we compare the mean for each variable for the 3489 observations with the mean from the original sample using a *t*-test. For all of the variables, the means are statistically identical (all *ps* > 0.10). Table 1 provides some demographic information on the sample which, when examined by the bank's management, was considered representative of its customer base.

The correlations were used to estimate the model shown in Figure 2. The model is estimated using the AMOS module in SPSS software and it uses a maximum likelihood estimation procedure. A key benefit of this software is its ease of use in applied settings due to its graphical interface. All estimates shown in Figure 2 are standardized estimates and are statistically significant at the 0.05 level. The model- $\chi^2_{(df=85)}$ is 4244.28 and is significant at $p < 0.001$. However, chi-square is not an appropriate-fit statistic due to

the unusually large sample size. The Goodness-of-Fit Index (GFI index) for the model is 0.904 with a root-mean-square residual (RMSR) of 0.14, indicating that the model fits well with the data. Furthermore, the AIC criterion for the estimated model was 4,344.28, compared to 12,359.49 for the naïve (independence) model.

All of the links in the SPC framework are supported. Supporting Link A, resource investments in terms of personnel have a positive effect on customer perceptions of personnel ($w_{11} = 0.22$, $t = 9.28$, $p < 0.01$) and resource investments in terms of equipment have a positive effect on customer perceptions of equipment ($w_{12} = 0.08$, $t = 4.89$, $p < 0.01$). In support of Link B, customer perceptions of personnel ($w_{13} = 0.62$, $t = 49.01$, $p < 0.0001$) and equipment ($w_{23} = 0.19$, $t = 16.19$, $p < 0.001$) have a positive impact on customer's overall behavioral intentions. In support of Link C, we find that customer intent to recommend the bank to others has positive impact on consumer behaviors ($w_{14} = 0.27$, $t = 9.33$, $p < 0.01$), and in support of Link D, we find a positive relationship between customer retention and profitability ($w_{35} = 0.13$, $t = 6.74$, $p < 0.01$). Most importantly, as postulated in Link E, profitability of the customer to the firm is directly and negatively influenced by resource investments in the area of equipment ($w_{25} = -0.04$, $t = -2.77$, $p < 0.05$) and personnel ($w_{15} = -0.12$, $t = -6.11$, $p < 0.01$).

The results of this strategic model show top management the key linkages on which to focus their effort. However, one might ask: Would it not be more parsimonious to directly link customer attribute perceptions to customer behaviors? Stated differently: Is there any value added by including customer intentions in the model? Theoretically, it can be argued that it is only through intentions (or other such global evaluations) that attribute perceptions affect behaviors. Statistically, we tested an alternative model in which attribute performance perceptions (*EQUIPRC* and *PERPRC*) also had a direct impact on customer behavior (*CUSTBEH*). This model was rejected in favor of the proposed model (AIC = 5,762.19 compared to 4,244.28 for the proposed model). Thus, for this firm, inclusion of intention is warranted. Moreover, from a continuous

tracking perspective, intention data are useful to the firm.

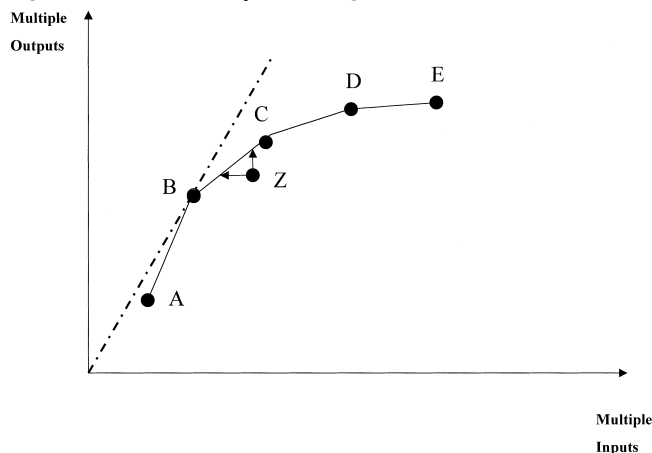
This strategic model confirms that, with respect to profitability, managers at this bank must carefully balance the *positive indirect* effect of resources invested to increase service quality and retention with their *negative direct* effect. The results also reveal unique insights for the bank providing the data. At the strategic level, the bank wanted to decide the relative emphasis it would put in technology versus human factors. The results suggest that, perceptions related to personnel are more consequential than equipment for behavioral intentions. However, resources allocated to personnel are more consequential for profitability than resources allocated to equipment. At an overall level, this suggests that management should carefully evaluate the extent to which it emphasizes human versus technology factors in its service and profitability strategy. Still, these results are specific to this bank and are unlikely to be universally applicable. For instance, it could be that customers of this Brazilian bank are not as technologically oriented, hence the higher importance given to human factors. More importantly, when deciding whether to emphasize human factors or technology at a particular branch, top management needs to be sensitive to the specific conditions and need for the branch. Information regarding branch-level decisions can be gleaned from the operational analysis described next.

Operational Model (Branch-Level Efficiency Analysis)

The strategic model formalizes a conceptual model for top management that can be followed throughout the bank at all its branches. However, the relative efficiency with which each branch is able to translate the inputs for each link to its outputs is likely to vary. Thus, each branch manager needs to understand how well the branch is doing relative to others. This question is answered using *Data Envelopment Analysis* (DEA) (Charnes et al. 1994).

DEA has been applied in a variety of contexts, such as evaluation of school districts (Grosskopf et al. 1999), university departments (Post and Spronk

Figure 3 Data Envelopment Analysis



1999), power plants (Athanasopoulos et al. 1999), and bank branches (Sherman and Gold 1985, Schaffnit et al. 1997, Soteriou and Stavrinides 1997, Thanassoulis 1999, Zenios et al. 1999). DEA measures the relative efficiency of multiple decision-making units (DMUs) (bank branches in this case) producing multiple outputs from multiple inputs. Efficiency for a DMU is measured by comparing the inputs it needs to those needed by a combination of the most efficient units operating under similar conditions to produce the same levels of outputs. Rather than evaluating a DMU in relation to all other DMUs, DEA identifies a set of efficient units operating similarly to the unit under analysis. These efficient units (or branches) operating *under similar conditions* comprise one facet of the production efficiency frontier. DEA compares the inputs and outputs of all DMUs, identifies the most efficient set of DMUs to which a particular one will be compared, and creates a “virtual” production unit as a convex combination of the units in the efficiency frontier. This “virtual” production unit serves as a benchmark against which the relative efficiency of a unit can be determined. An advantage of DEA is that it accommodates economies, as well as diseconomies, of scale by only comparing units operating at similar levels, identifying a piecewise linear efficiency frontier. With this piecewise linear frontier relating inputs to

outputs at the branch level, the DEA model accommodates the nonlinearities in the relationships between service perceptions, intentions, and actual behavior (Anderson and Mittal 2000).

These concepts are illustrated in Figure 3, which depicts the inputs utilized and outputs produced by six DMUs. A simple comparison of outputs and inputs ratios would indicate B as the only efficient DMU. In contrast, DEA identifies the Pareto frontier across all units and evaluates each unit in relation to the relevant facet of the frontier. Unit Z in this illustration would be deemed inefficient because a convex combination of DMU’s B and C could produce more outputs than Z, using the same level of inputs or the same level of outputs and utilizing less inputs.

For this bank we chose an approach similar to the multistage DEA proposed by Soteriou and Zenios (1999). These authors conceptualize a service firm (e.g., a bank) as consisting of systems of operations, service quality, and profits. They propose a three-stage model for assessing the operations, quality, and profit efficiency of bank branches. Their three-stage model includes the following:

- “Operational Efficiency” DEA Model. This uses the resources (labor and equipment) available to the branch manager, as well as the number of accounts serviced by the branch, as inputs of the production process and the workload (number of transaction hours at various accounts) as outputs.
- “Service Quality” DEA Model. This model uses essentially the same inputs as the “Operational Efficiency” model (labor, equipment, and number of accounts serviced). However, the output consists of perceptions of service quality by employees (as proxies for customer perceptions) of the bank.
- “Profitability Efficiency” DEA Model. This stage of the Soteriou and Zenios (1999) model uses similar inputs to the other two models, but profits as outputs.

For our purposes, a different formulation is needed. First, we combine the operational and ser-

vice quality stages into a single model. We do this to consider service quality (as perceived by customers) as a direct output from the production process and to use the volume of transactions and customers served as outputs from the process, rather than inputs. We label this first stage as the “Operational Efficiency Model,” because it measures the efficiency of the branch in producing service quantity and quality. Next, we use a second-stage process that has measures of customer behavior as outputs, instead of profits. This second-stage model is called the “Customer Behavior Model.”

Our choice of customer retention (as opposed to profitability) as the final output in our two-stage model is motivated by an interest in marketing-related outcomes and by a concern that a focus on profits alone will lead to a short-term orientation in the assessment of branch managers. Second, as an output, profit already embeds the impact of all inputs, in the form of costs, which might render a measure of profit efficiency invalid. Third, as argued by Bolton and Drew (1994, pp. 176–177) service quality and retention are better “output” measures than profitability for comparing subunits, as they are less likely to be volatile. Profitability alone could be more sensitive to factors such as accounting changes and competitive situation. However, to the extent that profitability is the ultimate goal of increasing service quality and retention, it is imperative to validate the model by relating the efficiency classification of different branches to profitability. For instance, is it indeed the case that more efficient branches are more profitable? If such is the case, then management has been able to identify the “right” strategic model to guide branch-level implementation efforts. Thus, we use profits as an external criterion to validate the efficiency assessments obtained through our two-stage model.

Operational Efficiency Model

In this first stage, we consider a process in which the branch manager uses the firm’s resources to serve customers, producing service transactions and

favorable overall customer evaluations (behavioral intentions in this data set). We want to assess the branch manager’s efficiency in allocating the firm’s resources, relative to other branches within the bank, operating at similar levels. This first stage of our model is similar to the model previously used to assess the productivity of bank branches (Sherman and Gold 1985, Berger et al. 1997, Zenios et al. 1999). A key distinction of our formulation, however, is that we include overall evaluations as one of the outcomes in the production of services. We consider the following production factors in this process:

Inputs

$TELLERS_n$ = number of full-time-equivalent tellers working in branch n during the planning period.

$MANAGERS_n$ = number of managers working in branch n during the planning period.

$EMPLOYEES_n$ = number of full-time equivalent hourly employees in branch n .

$ATMS_n$ = number of ATM units located within branch n . The allocation of ATMs is not under direct control by the branch manager. Therefore, this factor is taken as an *allocative input*.

Outputs

$CUSTOMERS_n$ = number of customers using branch n as their primary branch.

$TRANSACT_n$ = number of transactions produced by branch n during the planning period.

$INTENT_n$ = proportion of respondents (to the customer satisfaction survey) from branch n who would “highly recommend” the branch to friends. This “top-box” measurement of behavioral intentions is needed because the DEA model requires ratio-scaled measurements.

Operational efficiency is measured by solving the following linear programming problem:

$$\min \left\{ \tau_o + \sum_{i=1,3} \varepsilon \alpha_{io} + \sum_{j=1,3} \varepsilon \beta_{jo} + \sum_{k=1,3} \varepsilon \delta_{ko} \right\}$$

s.t.

Input Constraints

$$\begin{aligned}
 -TELLERS_o \tau_o + \alpha_{1o} + \sum_n \lambda_n TELLERS_n &= 0, \\
 -MANAGERS_o \tau_o + \alpha_{2o} + \sum_n \lambda_n MANAGERS_n &= 0, \\
 -EMPLOYEES_o \tau_o + \alpha_{3o} + \sum_n \lambda_n EMPLOYEES_n &= 0.
 \end{aligned}$$

Allocative Input Constraints

$$-ATMS_o + \delta_o + \sum_n \lambda_n ATMS_n = 0.$$

Output Constraints

$$\begin{aligned}
 -CUSTOMERS_o - \beta_{1o} + \sum_n \lambda_n CUSTOMERS_n &= 0, \\
 -TRANSACT_o - \beta_{2o} + \sum_n \lambda_n TRANSACT_n &= 0, \\
 -INTENT_o - \beta_{3o} + \sum_n \lambda_n INTENT_n &= 0,
 \end{aligned}$$

$$\sum_n \lambda_n = 1,$$

$$\lambda_n \geq 0, \quad n = 1, 2, \dots, N,$$

$$\alpha_{io} \geq 0, \quad i = 1, 2, 3,$$

$$\beta_{jo} \geq 0, \quad j = 1, 2, 3,$$

$$\delta_{ko} \geq 0, \quad k = 1, 2, 3,$$

where

α_{io} = input slack for factor i , indicating the amount of overutilization of input i

β_{jo} = output slack for factor j , indicating the underproduction of output j

δ_o = allocative input slack indicating the amount of overutilization of the allocative input.

Customer Behavior Model

This second DEA model evaluates the branch manager's efficiency in transforming customers' behavioral intentions into retention-related behavioral metrics for customers who use the bank as their

main provider of financial services. The following production factors are considered in this model:

Inputs

$INTENT_n$ = proportion of respondents (to the customer satisfaction survey) from branch n who would "highly recommend" the branch to friends.

Outputs

$SHARE_n$ = average share of respondent's funds at the bank. This is the average reported proportion of funds kept in this particular bank among respondents using branch n as their main branch.

$YEARS_n$ = average number of years among respondents using branch n as their main branch.

$FUNDS_n$ = average volume of funds kept in the bank among respondents using branch n as their main branch.

Customer retention efficiency is measured by solving the following linear programming problem:

$$\min \left\{ \tau_o + \varepsilon \alpha + \sum_{k=1,3} \varepsilon \delta_{ko} \right\}$$

s.t.

Input Constraints

$$-INTENT_o \tau_o + \alpha_o + \sum_n \lambda_n INTENT_n = 0,$$

Output Constraints

$$-SHARE_o - \beta_{1o} + \sum_n \lambda_n SHARE_n = 0,$$

$$-YEARS_o - \beta_{2o} + \sum_n \lambda_n YEARS_n = 0,$$

$$-FUNDS_o - \beta_{3o} + \sum_n \lambda_n FUNDS_n = 0,$$

$$\sum_n \lambda_n = 1,$$

$$\lambda_n \geq 0 \quad n = 1, 2, \dots, N,$$

$$\alpha_o \geq 0,$$

$$\delta_{ko} \geq 0, \quad k = 1, 2, 3,$$

Table 2 DEA Evaluations of Branch #154

DEA1: Service Operations (Efficiency = 0.495)								
DMU	Frontier	Inputs				Outputs		
		Tellers	ATMs	Managers	Employees	Transact	Customers	Intent
564	0.431	52.5	13.5	6.0	148.5	1,577.3	30,238.5	13.3
56	0.013	42.0	9.0	9.0	24.0	458.8	15,403.5	51.2
331	0.243	22.5	6.0	6.0	78.0	906.3	16,930.5	37.0
29	0.314	22.5	4.5	6.0	73.5	905.9	7,365.0	90.0
	Virtual	35.7	8.8	6.0	106.3	1,189.3	19,639.5	43.6
	#154	72.0	19.5	19.5	214.5	1,189.3	19,639.5	22.1
	Slacks	0.0	10.7	3.6	0.0	0.0	0.0	21.5

DEA2: Customer Retention (Efficiency = 0.783)						
DMU	Frontier	Input (Intent)	Outputs			
			Share	Years	Funds	
123	0.464	8.8	51.0	22.4	4,980.2	
136	0.355	21.4	72.1	28.5	5,736.9	
568	0.181	30.8	51.2	29.2	43,581.2	
	Virtual	17.3	58.5	25.8	12,229.6	
	#154	22.1	49.3	25.8	12,229.6	
	Slacks	0.0	9.2	0.0	0.0	

where

α_o = input slack indicating the amount of over-utilization of the input.

β_{jo} = output slack for factor j , indicating the under-production of output j

Results

We apply the two-stage DEA model to a sample of 162 branches for which we had at least 10 complete customer satisfaction surveys. For confidentiality reasons, each variable from internal banking records is disguised by a constant factor. Aside from the measurement of efficiency at each stage, the DEA model also provides diagnostics to the branch manager, indicating the degree of underproduction for each output and overutilization of each input. A customized implementation plan can be devised for each branch as these efficiency metrics are produced for each branch. A detailed discussion of results for

each branch would be beyond the scope of this study, so we discuss the results for a single branch in detail for illustrative purposes. Table 2 shows the results for branch #154, a relatively *inefficient* branch.

DEA1 for Branch #154 (Operational Efficiency Model). Branch #154 is inefficient in its utilization of labor and equipment in the production of positive behavioral intentions and services transactions (its efficiency index is 0.495). According to the results in Table 2, a “virtual” branch formed by combining branches #564, 56, 331, and 29 with weights 0.431, 0.013, 0.243, and 0.314, respectively, would produce the same levels of outputs, utilizing only a fraction of the inputs required by branch #154. This virtual branch would produce the same volume of transactions, serve the same number of customers, and produce 21.5% more customer giving the “top-box score” on the behavioral intention scale (43.6% top-box score as opposed to the observed 22.1%). This would be accomplished while consuming only 0.495

Table 3a Analysis of Variance for Branch-Level Profitability

Model	Mean Square Error (df)	F-Statistic	P-Value
DEA1: (Efficient versus Inefficient)	72,833.9 (1)	23.70	0.001
DEA2: (Efficient versus Inefficient)	81,368.7 (1)	26.48	0.001
DEA1 x DEA2	68,531.9 (1)	22.30	0.001
Error	3,072.9 (158)		

Note. Branch profit is average profits per customer, measured in local currency after a linear transformation (for confidentiality reasons).

Table 3b Profitability Comparison Between Efficient and Inefficient Branches

DEA1 Levels	DEA2: Inefficient	DEA2: Efficient	Total
DEA1: Inefficient	115.81 (122)	123.60 (5)	116.11 (127)
DEA1: Efficient	118.49 (30)	300.24 (5)	144.45 (35)
Total	117.11 (152)	211.92 (10)	122.24 (162)

Note. Parentheses include number of branches in each cell.

of the *TELLERS*, *MANAGERS*, and *EMPLOYEES* utilized by branch #154. For instance, regarding *MANAGERS*, the virtual branch would use only 0.495 of the levels utilized by branch #154 and still have a “slack” to spare. Even if the “virtual branch” used only 9.6 *MANANGERS* or 49.5% of 19.5 managers that branch #154 uses, it would still have a slack of 3.6 *MANAGERS* to spare. Thus, branch #154 has room for improvement in utilizing managers. Finally, with respect to *EMPLOYEES*, branch #154 uses 214.5 employees, whereas the virtual branch would need 49.5% fewer, or 106.3 employees. Finally, this virtual branch would also need 10.7 fewer *ATMs* than branch #154. Note that, because *ATMs* is an allocative input, not under direct control of the branch manager, it does not directly affect the efficiency index of the branch.

DEA2 for Branch #154 (Customer Behavior Model). With an efficiency index of 0.783, branch #154 is also inefficient in the second stage though to a lesser extent than the first stage. This inefficiency is compared to the virtual branch comprised of branches #123, 136, and 568 with respective weights of 0.464, 0.355, and 0.181. With only 78.3% of the top-box score (17.3%, as opposed to 22.1%), the “vir-

tual” branch is able to generate the same level of customer tenure (*YEARS* = 25.8) and deposit levels (*FUNDS* = 12, 229.6) as branch #154. With regard to share-of-wallet, the virtual branch would use only 78.3% of the resources used by branch #154 and produce 9.2 units more shares-of-wallet.

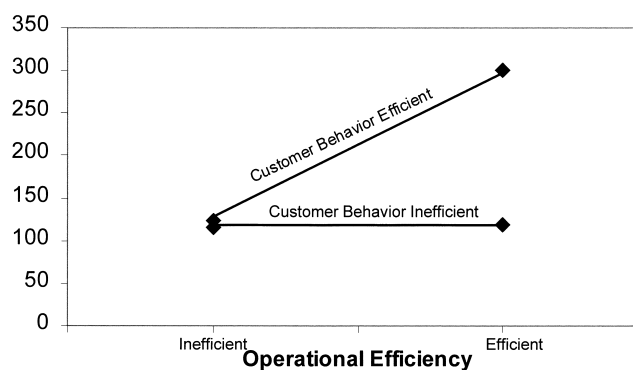
Overall Results. Similar to branch #154, customized results are obtained for each branch. These results are coupled with a qualitative assessment of the unique situation in which the branch operates—a customer, capabilities, and competition audit—to identify reasons that may be inhibiting the branch from reaching a high level of efficiency. Thus, a decision-calculus type approach where the branch managers work in close cooperation with top management is required to ensure that the strategic model is being fully implemented. A key advantage of this approach is that while the core strategic model is common across all branches, branch managers retain the flexibility of adapting it to their unique situation.

From top management’s perspective, it is also instructive to validate the operational implementation. The logic is as follows: If, indeed, the operational model is able to classify branches based on their efficiency in implementing the strategic model, and if

efficiency matters for profitability, then efficient branches should be more profitable. To test this idea, the branches are compared based on their profitability. Table 3 summarizes the two-stage model across all 162 branches: 35 were at the efficiency frontier for “operational efficiency” and 10 were at the efficiency frontier for “customer behavior.” A cross-classification of the branches shows that 5 branches are efficient in both respects, whereas 122 branches are inefficient in both respects. Next, we compared the branches to test if efficiency, indeed, moderates the relationship between implementation and profitability. This comparison of profitability among efficient and inefficient branches identified by the two-stage DEA model provides an additional test of the external validity of the DEA analysis.

A 2×2 analysis of variance with profitability as the dependent variable and efficiency on DEA1 and DEA2 as independent variables was conducted. Results are summarized in Tables 3a and b. In this analysis, efficiency for the DEA is coded as a two-level factor. Thus, DEA1 is a two-level factor (efficient, inefficient) as is DEA2 (efficient, inefficient). The overall model is significant ($F_{3,158} = 17.78, p < 0.0001$, adjusted $R^2 = 24\%$), and there is a main effect for efficiency at DEA1 ($F_{1,158} = 23.70, p < 0.0001$) and DEA2 ($F_{1,158} = 26.48, p < 0.0001$). More interestingly, there is a significant interaction ($F_{1,158} = 22.3, p < 0.0001$) between DEA1 and DEA2 (see Figure 4). Branches that are efficient at both stages produce *higher* average profits per customer than branches that are efficient on one stage alone. Also, branches that are inefficient in both stages are no worse than branches that are efficient in only one stage. This implies that *units focusing on operational efficiency or customer retention alone are less effective in terms of profitability*. Branch managers who focus on operational efficiency alone may drive costs down and, therefore, have higher profitability. However, if they combine such efforts with retention management, profitability almost doubles. For the bank’s management this is a key test of the success of the strategic model and also indicates that additional profitability gains are possible via proper implementation. This also indicates that branch managers have

Figure 4 Profit Comparison Across Groups with Different Efficiency



substantial leverage in affecting profitability, although some of that may be related to the unique situation in which the branch operates. Top management can take that into account and reward branch managers accordingly (e.g., based on their efficiency in translating certain inputs into outputs rather than on raw satisfaction scores alone).

Note that this analysis does not discern *why* some branches are more efficient than others. To shed light on such issues, additional data on the context (customer, capabilities, competition) may be gathered, which may explain some of the variability in the relative efficiency of the branches. For now, only qualitative assessments can be made to determine reasons for relative performance differences. For instance, management at branch #154 may conduct a situation analysis and find that the lower level of retention in response to behavioral intent is driven by the fact that its customer base consists of younger college students and/or because there are many other banks operating in that area. Based on such a decision calculus-type approach (combining managerial judgment and statistical modeling), better decisions can be made. Note that if this bank had only relied on the strategic model, it may simply have concluded that all branches having a certain level of global evaluation must have the corresponding level

of customer behaviors without paying attention to the branch's ability to translate intent into corresponding behaviors.

Discussion

The strategic-level analysis reported here advances the growing body of empirical research investigating the viability of the SPC framework to managing profitability. First, at the strategic level, we *simultaneously* investigate *all* of the key links in the SPC. This simultaneous investigation not only clarifies the mediated nature of relationships among distal constructs but also explicates the dual mechanism by which investments in operational inputs affect profitability. Thus, the strategic model reported here advances past research documenting only a positive relationship between satisfaction quality and financial outcomes. Managers may keep making operational expenses to increase satisfaction and service quality, believing that it will positively affect financial outcomes. Our formulation of the SPC shows that, *for an individual firm, higher service quality is not an unconditional guarantee of profitability* and explains why some firms remain unprofitable despite high levels of quality. Conceptually, then our contribution lies in linking the SPC to the ROQ framework proposed by Rust et al. (1995).

Second, the operational-level analysis using DEA provides specific implementation guidance to individual subunits of a firm. The "input-output" focus of the DEA approach explicitly forces management to classify its subunits based on their efficiency in specific stages of the SPC. Firms that restrict themselves to only the strategic-level analysis may mistakenly take an output-maximization approach when comparing its subunits. For instance, as yet employee compensation in many firms is based only on the overall satisfaction score achieved (cf. Hauser et al. 1994) without regard to the level of resources utilized to achieve the score. As such, employees may focus only on satisfaction or service quality maximization with no regard to the operational expenses made toward achieving the high scores. Such

an output-oriented approach may be one additional reason why many firms remain unprofitable despite high scores on perceived satisfaction and quality.

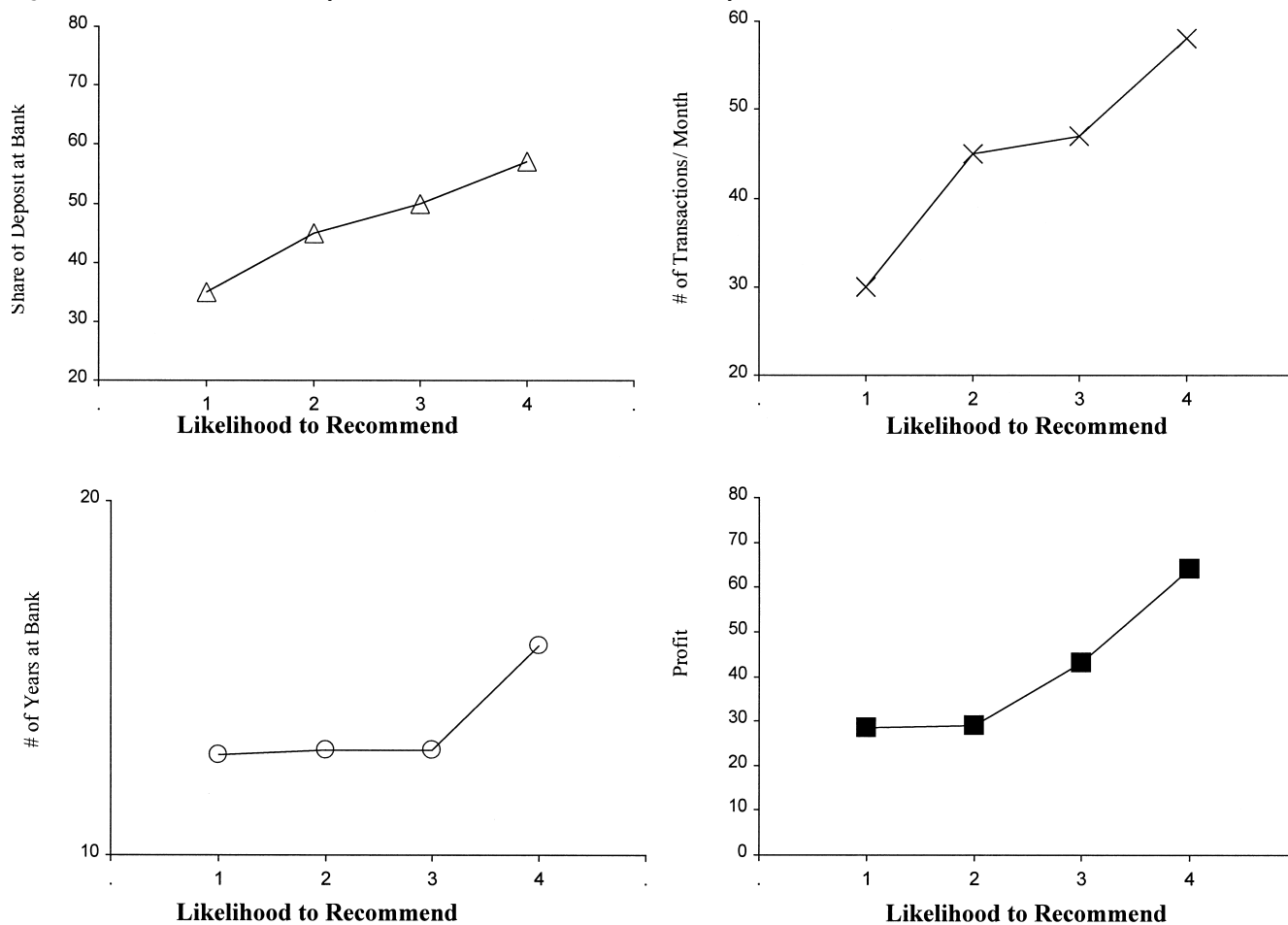
Qualitatively, the operational-level analysis of the branches shows that unless firms are efficient on *both* frontiers—operational efficiency and customer retention—higher gains in profitability are unlikely to emerge. A firm that is *only* focused on the inputs of service quality (e.g., how to increase attribute performance) or on its outputs (e.g., how to increase quality perceptions or retention) is unlikely to be as profitable as a firm that manages *both*. This is evident in the interactive effect of efficiency on both stages of the DEA model on profitability.

Finally, this research addresses a larger concern about the extended role of marketing in a firm. Our study points to the important and expanding role of the marketing manager in the knowledge management domain of a firm. However, significant resources in terms of technology and personnel must be invested to enable marketing to accomplish this role. These investments, to some degree, may contain the knowledge and technological leadership components that Roth and Jackson (1995) found to be significant predictors of service quality.

Research and Application Issues

The results reported here are based on data provided by a single firm and, therefore, we do not claim to have provided a universally applicable test of the SPC framework. Rather, the claimed contribution is in demonstrating a comprehensive approach that can provide strategic guidance to top management, and specific operational guidance to each branch manager in implementing the service-profit chain. From an empirical perspective, the results reflect data limitations and subjective choices made by the bank's management and the research team involved. All of these are avenues for improving further empirical tests of the SPC framework. We discuss some aspects of the SPC evaluation that require further elaboration in empirical research.

Figure 5 Nonlinear Relationship Between Behavioral Intent and Its Consequences



Nonlinear Nature of the Links. Many authors have documented the nonlinear nature of the links of the SPC (Anderson and Mittal 2000, Soteriou and Zenios 1999). In our work, we incorporated nonlinearities in two ways. In the strategic-level analysis, we used the rank correlation to compute the correlation matrix that was input in the structural equation model. However, for this bank, explicit inclusion of asymmetries and nonlinearities, although statistically feasible, is not recommended for the strategic analysis. The reason is that the nonlinearities and asymmetries are likely to vary from branch-to-branch and any overall average in this regard can be misleading. It is for this specific reason that we do not advocate

using the strategic model to conduct “what if” analyses. Because of their localized nature, such complexities are best accommodated and understood at the branch level in the operational model. In our application, we do this by accommodating variable returns to scale in the DEA analysis.

Even so, specific nonlinearities had to be highlighted to management. Consider, for instance, the relationship between overall behavioral intention and behavioral outcomes among customers. The key outcomes for each level of stated behavioral intention are shown in Figure 5. For instance, while the relationship between overall behavioral intention and customer’s share of deposit at the bank is linear,

the other relationships are not. The number of transactions at a bank increases sharply when a customer moves from a rating of 1 to 2 but remains virtually unchanged from a movement in rating from 2 to 3. They increase sharply for a rating change between 3 and 4. Thus, for this metric of retention there seems to be a "zone of indifference" where customer behavior does not change much in response to a change in overall evaluation. For customer's tenure with the bank (Panel C) a different pattern of non-linearity ensues with this behavioral metric only changing for the rating change from 3 to 4. In summary, issues related to incorporating nonlinearities and asymmetries in the SPC need further research.

Measurement Issues. The measures used are specific to the bank providing us with the data. First, the attributes on which consumer perceptions are measured (human versus technology factors) are the ones that this bank's management decided to evaluate as part of its strategic initiative. Other firms may choose different attributes. Second, the overall measure of customer perceptions, "intention to recommend," is one that this bank's management has been using. Other firms may utilize different measures. Third, and similarly, the behavioral measures of retention are firm specific. Perhaps in the future, when enough studies are available, a meta-analysis can resolve measurement issues and help sort out which measures provide the best construct specification for the SPC framework. Finally, if available, it would be useful to explore the SPC in context of both short-term and long-term profitability data.

Multiperiod Analysis. Recognizing that SPC links entail lag effects and persistence, it would be desirable to test the SPC using multiperiod data at the branch level. Such a modeling approach is also needed to make stronger causal inferences about the links entailed in the SPC. Addressing these methodological concerns is a natural and immediate research avenue, and firms should capture longitudinal

data to address this concern. Moreover, a multi-period analysis can also alleviate concerns about capital budgeting issues. The long-term effects of SPC-related decisions and changes in key dependent measures can be investigated to separate the impact of recurring from that of one-time "investments" in service quality. Naturally, this sort of analysis is contingent on the firm's ability to capture and retain data to construct a data panel.

Depending on the type of data available, a firm can add refinements to the SPC framework. First, factors that systematically moderate the links in the SPC could be incorporated in the strategic model, although only those that are relevant to a majority of the subunits are appropriate. For instance, factors such as level of competition and branch size may moderate the extent to which a branch can translate operational investments into service quality perceptions and profitability. Second, this bank only considered the cost of operational investments as affecting firm profitability. Recently, firms have been also advised to consider customer acquisition costs as antecedents to profitability (Rust et al. 2000). If there is a way to allocate them, SPC tests should incorporate customer acquisition costs such as advertising and promotion in the model. Related to this, research is needed to develop analytical models for optimizing customer acquisition and operational costs. For instance, in industries where there is little differentiation among brands, acquisition costs are likely to be high. In industries with a high level of automation, the service costs may be low. The analytical model of the "cost of quality" could be used in reverse for setting customer acquisition and service budgets. Thus, developing allocative resource models is an additional area of research.

Firms should also capture detailed data on the characteristics of the subunits to run explanatory models explaining their relative efficiency for each step of the SPC. For instance, for each branch, the bank could have collected data on the degree of competition faced, the characteristics of customers it serves, and so forth. This could then be used to better understand the efficiency score attained by each branch.

Links to Other Conceptual Models. The model used in this application was based on the service-profit chain and ROQ approaches. However, several other models of customer profitability, most notably the customer equity (Blattberg and Deighton 1996), customer asset management (Bolton et al. 2001, Rust et al. 2000), and customer lifetime value approach (Berger and Nasr 1998, Keane and Wang 1995) have gained popularity amongst academics and practitioners. It is important to understand that these emergent approaches are complementary, rather than competing approaches to linking customers, customer satisfaction, service quality, and profitability. Research should bridge the conceptual gaps in the customer-based approaches (customer equity, customer lifetime value, and customer asset management) and the operational quality and service satisfaction-based approach used here. Although the end goal is the same—linking marketing actions to profitability—there are important differences. First, the customer-based approaches emphasize customer identification, that is, the acquisition and retention of the “right” customers for the firms. Second, the emphasis is on allocating financial resources among a heterogeneous base of customers with the most resources being devoted to the most profitable customers. Third, depending on industry and customer characteristics, the time horizon for such allocations may be rather long. In summary, the spotlight in our approach is on the firm’s operations and satisfaction/service-quality drivers, whereas the spotlight in the customer-based approaches is on identification of the “right” customers. It will be important to meld these two foci to develop comprehensive models that enable managers not only to identify the right customers but also to configure the service-profit chain to serve them. Thus, it can be envisioned that different service-profit chains exist and can be optimized (the SPC approach) for different customer groups identified via the customer equity and customer asset management approaches. The challenge for researchers is to develop such models, and for firms it is to lay the groundwork—strategic and tactical—for implementing such models.

In summary, we have highlighted a comprehensive approach to examining the SPC at a firm. Our hope is that this documentation will encourage more firms to assess their SPC comprehensively and share the results with others. Such sharing, eventually, is likely to lead to demonstrable improvement in simultaneously enhancing service quality and profitability at firms.

Appendix 1 Constructs and Measures

PERPRC_i is a latent variable measuring customer *i*’s perception of the bank’s personnel at her branch.

Indicator Variables

MANAGER_i = average perceptual ratings of managers given by customer *i*.

CLERK_i = average perceptual ratings of clerks given by customer *i*.

TELLER_i = average perceptual ratings of tellers given by customer *i*.

PERSON_i = number of problems (out of five possibilities) with personnel indicated by customer *i* (with inverted sign). Higher scores indicate higher customer perceptions.

EQUIPRC_i is a latent variable measuring customer *i*’s perception of the bank’s equipment at her branch.

Indicator Variables

EQUIP_i = number of problems (out of 28) with equipment indicated by customer *i* (with inverted sign). Higher scores indicate higher customer perceptions.

FACIL_i = number of problems (out of six) with facilities indicated by customer *i* (with inverted sign). Higher scores indicate higher customer perceptions.

PEREFF_i is a latent variable measuring allocation of personnel at customer *i*’s branch.

Indicator Variables

CUSTEL_i = number of customers per teller (with inverted sign to reflect effort) in the branch patronized by customer *i*. Higher scores indicate more tellers per customer.

CUSTMGR_i = number of customers per manager (with inverted sign). Higher scores indicate more managers per customer.

CUSTEMP_i = number of customers per employee (with inverted sign). Higher scores indicate more employees per customer.

CUSTBEH_i is a latent variable measuring customer *i*’s level of retention with the bank.

Indicator Variables

TRANSACT_i = number of transactions per month by customer *i* in the past year.

$BKNSHARE_i$ = percentage of total deposits that customer i has with this bank.

$YEARS_i$ = number of years customer i has been with this bank.

$PROFIT_i$ = direct measure of the monthly average profits generated by customer i during the past year. Computed as the marginal contribution of all accounts held by the customer, minus the fixed costs incurred at the customer's main branch, prorated at the customer level based on the total number of customers served by the branch.

$INTENT_i$ = likelihood to recommend (four-point scale indicating how likely the customer would be to recommend the bank to a friend).

$EQUEFF_i$ = the allocation of equipment to a customer by the bank. Measured as number of customers per internal ATM (with inverted sign). Higher scores indicate more operational inputs as higher number of ATMs.

Notes. With respect to the latent constructs $PERPRC$, $EQUIPRC$, and $CUSTBEH$, we conducted tests of discriminant validity and established unidimensionality, using methods suggested by Anderson and Gerbing (1988). In a confirmatory factor analysis, each indicator loaded significantly on its respective construct but non-significantly on the others, and the three-factor model fit the data significantly better than the naive one-factor model ($p < 0.01$). Moreover, the correlation between each of these constructs was nonsignificant, establishing discriminant validity. Furthermore, the reliability alphas are as follows: $PERPRC$ (0.91), $EQUIPRC$ (0.67), and $CUSTBEH$ (0.51). The reliability for $CUSTBEH$ (alpha = 0.51) would be deemed too low for self-reported measures (due to spurious correlations induced by halo effects and common-method biases) but is reasonable considering that it is based on a combination of self-reported ($BKNSHARE$) and objective ($TRANSACT$ and $YEARS$) measures.

Appendix 2 Structural Model Specification

The standardized regression coefficients for each of the paths are as follows:

$$\begin{aligned} CUSTEL &= 0.72(PEREFF) \\ CUSMGR &= 0.56(PEREFF) \\ CUSEMP &= 0.27(PEREFF) \end{aligned}$$

$$\begin{aligned} CLERK &= 0.93(PERPRC) \\ TELLER &= 0.87(PERPRC) \\ MANAGER &= 0.85(PERPRC) \\ PERSON &= 0.73(PERPRC) \end{aligned}$$

$$\begin{aligned} EQUIP &= 0.54(EQUIPRC) \\ FACIL &= 0.93(EQUIPRC) \end{aligned}$$

$$\begin{aligned} BANKSHR &= 0.53(CUSTBEH) \\ TRANSCT &= 0.59(CUSTBEH) \end{aligned}$$

$$YEARS = 0.41(CUSTBEH)$$

$$\begin{aligned} PROFIT &= 0.13(CUSTBEH) \\ PROFIT &= -0.12(PEREFF) \\ PROFIT &= -0.04(EQUEFF) \end{aligned}$$

$$\begin{aligned} PERPRC &= 0.22(PEREFF) \\ EQUIPRC &= 0.08(EQUEFF) \\ INTENT &= 0.62(PERPRC) \\ INTENT &= 0.19(EQUIPRC) \\ CUSTBEH &= 0.27(INTENT) \end{aligned}$$

The structural error specification and estimates are as follows: The mean for each theta is set as 0, and the path from each theta to the construct is set as 1. The variances for each theta are as follows:

Variance

$$\begin{aligned} \text{Theta1} &= 0.18 \\ \text{Theta2} &= 27,430.05 \\ \text{Theta3} &= 5.73 \\ \text{Theta4} &= 479.69 \\ \text{Theta5} &= 0.62 \end{aligned}$$

Each indicator for the latent construct has its associated error with mean set at 0 and the path to the observed indicator as 1. These errors and their variances are as follows:

Variance

$$\begin{aligned} \text{Alpha1 (CUSTEL)} &11,166.19 \\ \text{Alpha2 (CUSMGR)} &0.0003 \\ \text{Alpha3 (CUSTEMP)} &34,899.18 \\ \text{Beta1 (CLERK)} &0.03 \\ \text{Beta2 (TELLER)} &0.06 \\ \text{Beta3 (MANAGER)} &0.08 \\ \text{Beta4 (PERSON)} &0.68 \\ \text{Sigma1 (BANKSHARE)} &1,323.16 \\ \text{Sigma2 (TRANSACT)} &951.42 \\ \text{Sigma3 (BANKSHARE)} &69.34 \\ \text{Phi1 (FACIL)} &0.38 \\ \text{Phi2 (EQUIP)} &14.08 \end{aligned}$$

References

- Anderson, James, David Gerbing. 1988. Structural equation modeling in practice: A review and recommended two step approach. *Psych. Bull.* **103** (May) 411-423.
- Anderson, Eugene W., Vikas Mittal. 2000. Strengthening the satisfaction profit chain. *J. Service Res.* **3** (2) 107-120.
- Athanassopoulos, Andreas D., Nikos Lambroukos, Lawrence Seiford. 1999. Data envelopment scenario analysis for setting targets to electricity generating plants. *Eur. J. Oper. Res.* **115** (3) 413-428.
- Berger, Allen N., John H. Leusner, J. J. Mingo. 1997. The efficiency of bank branches. *J. Monetary Econom.* **40** (1) 141-162.

- Berger, Paul D., Nada I. Nasr. 1998. Customer lifetime value: Marketing models and applications. *J. Interactive Marketing* 12 (1) 17–30.
- Blattberg, Robert C., John Deighton. 1996. Managing marketing by the customer equity test. *Harvard Bus. Rev.* 74 (July–Aug) 136–144.
- Bolton, Ruth N. 1998. A dynamic model of the duration of the customer's relationship with a continuous service provider: The role of satisfaction. *Marketing Sci.* 17 (1) 45–65.
- , James H. Drew. 1994. Linking customer satisfaction to service operations and outcomes. Roland T. Rust, Richard L. Oliver eds., *Service Quality: New Directions in Theory and Practice*. Sage Publications, Thousand Oaks, CA, 173–200.
- , Katherine N. Lemon, Peter Verhoef. 2001. CUSAMS: A decision support model for customer asset management in service industries. *Marketing Sci. Inst. Working Paper Ser.* Forthcoming.
- Carr, Nicholas G. 1999. Marketing: The economics of customer satisfaction. *Harvard Bus. Rev.* (March–Apr). 15–18.
- Charnes, A., W. W. Cooper, A. Y. Lewin, L. M. Seiford. 1994. *Data Envelopment Analysis: Theory, Methodology and Applications*. Kluwer Academic Publishers, Norwell, MA.
- Frei, Frances X., Patrick T. Harker. 1999. Measuring the efficiency of service delivery process: An application to retail banking. *J. Service Res.* 1 (4) 300–312.
- Grosskopf, Shawna, Kathy J. Hayes, Lori L. Taylor, William L. Weber. 1999. Anticipating the consequences of school reform: A new use of DEA. *Management Sci.* 45 (4) 608–620.
- Hauser, John R., Duncan I. Simester, Birger Wernerfelt. 1994. Customer satisfaction incentives. *Marketing Sci.* 13 (Fall) 327–350.
- Heskett, James L., Thomas O. Jones, Gary W. Loveman, W. Earl Sasser, Jr., Leonard Schlesinger. 1994. Putting the service-profit chain to work. *Harvard Bus. Rev.* 72 (2) 164–174.
- Ittner, Christopher, David F. Larcker. 1998. Are nonfinancial measures leading indicators of financial performance? An analysis of customer satisfaction. *J. Accounting Res.* 36 (Suppl.) 1–35.
- Keane, Timothy J., Paul Wang. 1995. Applications for the lifetime value model in modern newspaper publishing. *J. Direct Marketing* 9 (2) 59–66.
- Kimes, Sheryl E. 1999. The relationship between product quality and revenue per available room at Holiday Inn. *J. Service Res.* 2 (2) 138–144.
- Loveman, Gary W. 1998. Employee satisfaction, customer loyalty, and financial performance: An empirical examination of the service profit chain in retail banking. *J. Service Res.* 1 (1) 18–31.
- Mittal, Vikas, Wagner A. Kamakura. 2001. Satisfaction and repurchase behavior: The moderating influence of customer and market characteristics. *J. Marketing Res.* 38 (1) 131–142.
- Morwitz, Vicki G., David Schmittlein. 1992. Using segmentation to improve sales forecasts based on purchase intent: Which "Intenders" actually buy? *J. Marketing Res.* 9 (Nov) 391–405.
- Parasuraman, A., Valarie Zeithaml, Leonard L. Berry. 1988. SERVQUAL: A multiple-item scale for measuring consumer perceptions of service quality. *J. Retailing* 64 (Spring) 12–40.
- Post, Thierry, Jaap Spronk. 1999. Performance benchmarking using interactive data envelopment analysis. *Eur. J. Oper. Res.* 115 (3) 472–487.
- Roth, Aleda V., William E. Jackson III. 1995. Strategic determinants of service quality and performance: Evidence from the banking industry. *Management Sci.* 41 (11) 1720–1733.
- Rucci, Anthony J., Steven P. Kim, Richard T. Quinn. 1998. The employee-customer-profit chain at Sears. *Harvard Bus. Rev.* (Jan–Feb) 83–97.
- Rust, Roland T., Anthony J. Zahorik, Timothy L. Keiningham. 1995. Return on quality (ROQ): Making service quality financially accountable. *J. Marketing* 59 (Apr) 58–70.
- Rust, Roland T., Valerie Zeithaml, Katherine Lemon. 2000. *Driving Customer Equity: How Customer Lifetime Value Is Reshaping Corporate Strategy*. Free Press, New York.
- Schaffnit, Claire, Dan Rosen, Joseph C. Paradi. 1997. Best practice analysis of bank branches: An application of DEA in a large Canadian bank. *Eur. J. Oper. Res.* 98 (2) 269–289.
- Sherman, H. David, Franklin Gold. 1985. Bank branch operating efficiency. *J. Banking Finance* 9 (2) 297–315.
- Simester, Duncan I., John R. Hauser, Birger Wernerfelt, Roland T. Rust. 2000. Implementing quality improvement programs designed to enhance customer satisfaction: Quasi-experiments in the United States and Spain. *J. Marketing Res.* 37 (Feb) 102–112.
- Soteriou, Andreas C., Stavros A. Zenios. 1999. Operations, quality, and profitability in the provision of banking services. *Management Sci.* 45 (9) 1221–1238.
- , Yiannos Stavrinos. 1997. An internal customer service quality data envelopment analysis model for bank branches. *Internat. J. Oper. Productions Management* 17 (8) 780–789.
- Thanassoulis, Emmanuel. 1999. Data envelopment analysis and its use in banking. *Interfaces* 29 (3) 1–13.
- Zeithaml, Valarie A. 2000. Service quality, profitability and the economic worth of customers: What we know and what we need to learn. *J. Acad. Marketing Sci.* 28 (1) 67–85.
- Zenios, Christiana V., Stavros A. Zenios, Kostas Agathocleous, Andreas C. Soteriou. 1999. Benchmarks of the efficiency of bank branches. *Interfaces* 29 (3) 37–51.

This paper was received February 16, 2001, and was with the authors 6 months for 2 revisions