# An internal customer service quality data envelopment analysis model for bank branches

**Andreas C. Soteriou**
University of Cyprus, Nicosia, Cyprus
**Yiannos Stavrinides**
University of Cyprus, Nicosia, Cyprus

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**Abstract**
Over the last few years data envelopment analysis (DEA) has been gaining increasing popularity as a performance assessment methodology. DEA has been successfully applied to bank branch performance evaluation. However, most DEA models which have been developed for bank branch performance assessment do not include service quality as an output. Service quality has been considered by many as the key to gaining competitive advantage and customer loyalty. Develops a DEA model that can be used to provide direction for improvement to branches which do not use their resources in the most efficient way to produce service quality. Focuses on internal customer service quality which is sometimes easier to measure. Presents results from an empirical study undertaken at a bank to demonstrate the applicability of the model.

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## Introduction

Much has been said about the importance of achieving high levels of service quality (SQ) (Zeithaml *et al.,* 1990). SQ is considered by many as the key to gaining competitive advantage and its importance has been documented in a number of studies (Cronin and Taylor, 1992; Parasuraman *et al.,* 1985; Bolton and Drew, 1991). Today, the field of service quality management is experiencing a number of advances and, in the banking industry alone, it is difficult to identify a single bank which has not initiated some kind of service quality improvement programme. Nevertheless, no universally accepted methodology exists on how to improve service quality.

Data envelopment analysis (DEA) is a benchmarking technique which has been gaining increasing popularity during the last few years. Developed by Charnes, Cooper and Rhodes in 1978 (Charnes *et al.,* 1978), DEA has successfully been used to provide bank branch benchmarks, when multiple outputs are produced with multiple inputs (Berger *et al.,* 1994; Berger and Humphrey, 1997; Al-Faraj *et al.,* 1992; Zenios *et al.,* 1995). However, even though some DEA models were presented in the literature which address issues of service quality (Thanassoulis, 1995; Athanassopoulos, 1997), most DEA models developed to assess bank branch performance do not include service quality as an output.

In this paper, we present results from an ongoing study on the efficiency of bank branches. The broader study examines issues of operating efficiency and profitability, and the results have been reported elsewhere (see Zenios *et al.,* 1995; Soteriou and Zenios, 1996; Zenios and Soteriou, 1997). In this project we add the quality dimension in order to complete the capabilities-service quality-performance triad, as described by Roth and Jackson (1995). More specifically, we focus on the problem of improving service quality at the branch level. To this end, we develop a DEA model that can be used to provide direction for improvement to branches which do not use their resources in the most efficient way to produce service quality. The paper does not aim to develop service quality measures but rather to show how such measures can be incorporated into a model which can provide useful suggestions towards service quality improvement.

Schneider and Bowen (1985) report strong correlation between internal and external customer perceptions of service in bank branches. The model focuses on internal customer perceptions of service quality which are sometimes easier to measure.

The rest of the paper is structured as follows. First, we present a brief description of the DEA methodology. A DEA model to provide internal customer service quality benchmarks of bank branches is then developed. We next demonstrate the applicability of the DEA model in a banking environment. Model results and limitations are then discussed, followed by concluding remarks.

## Background on data envelopment analysis

Data envelopment analysis is a mathematical programming technique developed by Charnes *et al.* (1978) to evaluate the relative efficiency of public-sector not-for-profit organizational units where accounting and financial ratios are of little value, multiple outputs are produced with multiple inputs, and the input-output transformation relationships are not known. DEA compares the observed outputs and inputs for all units of an organization, identifies the relatively best practice or yardstick units to define an efficient frontier, and then measures the degree of inefficiency of the other units relative to this frontier.

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Consider, for example, Figure 1, which illustrates seven decision-making units (DMUs). Each DMU consumes a single input ($x$) to produce a single output ($y$). DEA establishes an envelopment surface which defines the frontier of efficient units, against which inefficient units are identified. Referring to Figure 1, one such possible envelopment surface can be constructed by DMUs 1, 3, 4, 6 and 7. Clearly, DMUs 2 and 5 in this example are inefficient. They could improve their operations either by reducing their input or by augmenting their output.

In their seminal paper, Charnes *et al.* (1978) present the following fractional programming model which forms the basis of data envelopment analysis:

$$\text{Maximize } Ek = \left\{\sum_{r=1}^{R} u_{rk}y_{rk}\right\} \Bigg/ \left\{\sum_{i=1}^{I} v_{ik}x_{ik}\right\} \quad (1)$$

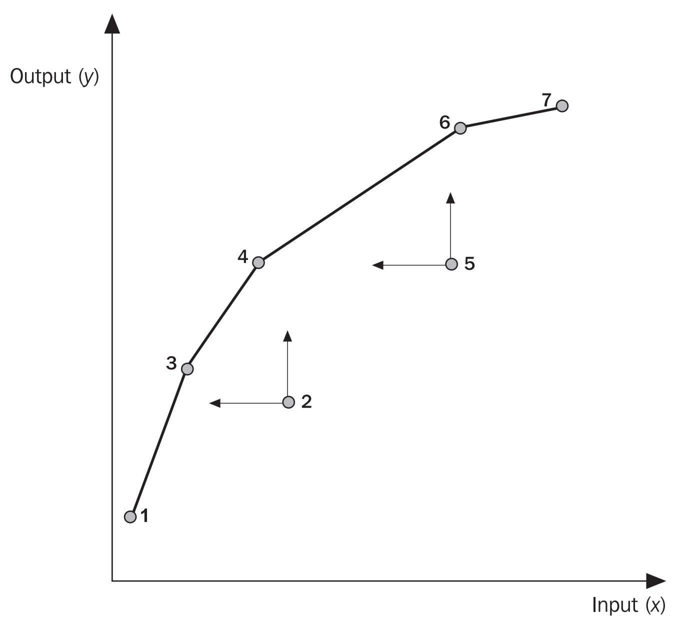
$$s.t.\left\{\sum_{r=1}^{R} u_{rk}y_{rj}\right\} / \left\{\sum_{i=1}^{I} v_{ik}x_{ij}\right\} \leq 1 \text{ for all } j \quad (2)$$

$$urk,\ v_{ik} \geq 0 \text{ for all } r, i, \quad (3)$$

where

- $y_{rj}$: observed quantity of output $r$ produced by unit $j$ = 1, 2, ... $n$,
- $x_{ij}$: observed quantity of input $i$ used by unit $j$ = 1, 2, ..., $n$,
- $u_{rk}$: the weight (to be determined) given to output $r$ by the base unit $k$,
- $v_{ik}$: the weight (to be determined) given to input $i$ by the base unit $k$.

**Figure 1**
Envelopment surface of the example DMUs




This fractional programming model can be easily transformed into an ordinary linear programming model (Charnes *et al.,* 1978; Schneider and Bowen, 1984). During the last few years, a number of enhancements to the basic DEA models have been presented in the literature (see Charnes *et al.,* 1994 for a more detailed discussion on recent DEA enhancements.)

Within the context of commercial banking, the DEA model has the following interpretation. We include $n$ bank branches in the observation set, each producing $R$ different outputs using $I$ different inputs. We define the efficiency of a branch $k$ as the sum of its weighted outputs to the sum of its weighted inputs. The relative efficiency $E_k$ of base branch $k$ – with respect to all other branches in the set – needs to be determined. To this end, DEA yields the highest possible value of $E_k$ by assigning weights to the outputs and inputs of branch $k$ in such a way that none of the other branches has an efficiency index greater than 1. The solution of $n$ such programmes as formulated in equations (1)-(3) above is required, which yields $n$ different weight sets. The efficiency of each bank $k$ under evaluation will lie between $0 < E_k \leq 1$, indicating whether the branch is inefficient compared to the best practice units in the observation set ($E_k < 1$), or efficient ($E_k = 1$).

The best practice units define the efficiency reference set, which is graphically represented as the efficient frontier illustrated in Figure 1. The base branch $k$ is then compared against the efficient frontier to define the sources of its inefficiency. To make a relatively inefficient branch efficient, the proper input and output weights can be chosen in such a way that the distance between each unit and the efficient frontier is minimized. For a more detailed discussion on the basic concepts of DEA and its use in banking, see Boussofiane *et al.* (1995).

## A service quality DEA model

One of the challenges that service managers face today is how to deliver services of high quality (Zeithaml *et al.,* 1990; Parasuraman *et al.,* 1994). SQ is an important factor that must be considered when assessing bank branch performance. Most DEA models developed for bank branches consider issues of operating efficiency and/or profitability (see Berger and Humphrey (1997) for an international survey of recent studies). A bank branch, however, needs to ensure not just high volume of output, but also volume of high quality. A branch may report high

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volume of products and services offered, as well as profits, but lose this advantage in the long run because of eroding SQ. The following DEA model is developed which helps point towards resources not utilized properly. Figure 2 provides a graphical illustration of the model.

Each branch utilizes some consumable resources, such as personnel, space, computers, etc., given a certain account structure of their clientele to provide some level of service quality. The DEA model compares branches on how well they transform these resources (inputs) to achieve their level of service quality (output), given their client base.

We hereby define the term "SQ efficiency" to indicate how well this transformation takes place when compared with the transformation observed at the remaining branches under consideration. The DEA model will identify the under-performers and suggest ways for their improvement.

The inputs of the model consist of two sets: the consumable resources used by the branches such as personnel, computer time, etc., and the number of accounts in different account categories. The utilization of most consumable resources is typically reported by branches to produce performance measures, such as accounts per FTE, etc. Furthermore, other SQ determinants such as personnel training, education, etc., can also be incorporated in the input set. Often this information is available.

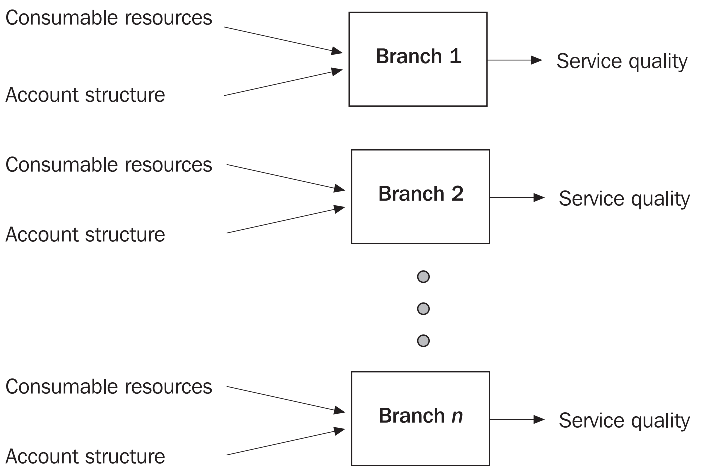
While the number of accounts has been typically viewed as an output of a branch, it is considered here as an input, because it reflects the microenvironment of a branch (Zenios *et al.,* 1995; Oral and Yolalan, 1990). The clientele infrastructure reflects the steady-state market conditions of a branch which are tightly linked with each branch and may change very slowly over time.

The output of the model is the level of SQ achieved, as perceived by the personnel of the branch. SQ perceptions from external customers may not always be available, and collection of such information is usually expensive. The human resource management literature provides evidence on the strong relationship between internal and external customer service perceptions (Schneider and Bowen, 1985). Different instruments which can be used to measure SQ perceptions can also be found in the marketing literature (Cronin and Taylor, 1992; Parasuraman *et al.,* 1988).

The choice of the set of branches, i.e. $j = 1, 2, \ldots n$, has important implications for the results of the analysis. There are many factors that contribute to the SQ efficiency of a branch, and it is important to isolate these, and analyse them separately if we are to arrive at meaningful managerial recommendations. For example, if two branches use different technology (one is fully automated while the other mostly relies on human-based activities) the difference in their SQ efficiencies will result from both technological and managerial differences. In the next section, we discuss how the effect of these factors can be analysed.

It is important to note that the aim of the model developed in this section is not to provide some parsimonious branch performance assessment tool, but rather to point out resources which can be better utilized to produce higher SQ levels. In the next section, we also show how this model can be used with other operating efficiency models to provide more meaningful suggestions to the branch manager.

**Figure 2**
Graphical illustration of the DEA SQ model




## An application to a banking environment

### Data collection

Data from a major bank of a Mediterranean country were collected over the period July-December 1994 to demonstrate the applicability of the proposed model. The bank has already classified the various branches according to their size and location, taking into account the type and operations performed at each branch. To maintain homogeneity, only medium branches (five to ten employees) located in urban areas were considered. The branches of this group provide similar services and use similar resources. Maintaining homogeneity is important since this is one of the major requirements of the DEA methodology. For instance, it is meaningless to compare an urban with a rural branch since they provide different services. The model's input is as follows:

- clerical personnel (person hours);
- managerial personnel (person hours);
- computer terminals (terminal hours);
- working space ($m^2$);
- number of personal accounts;
- number of savings accounts;
- number of business accounts;
- number of credit application accounts.

Two types of personnel were used as input: managerial and clerical, as distinguished by rank and function. A percentage of computer unavailability was subtracted from the total computer time of each branch to establish the terminal hours used by each branch. Personal and joined accounts were aggregated into one category of accounts since they employ, to a large extent, similar transactions. A similar aggregation took place for all business accounts. This information was all readily available by the bank.

The model's output consists of the employee SQ perceptions of the bank branches. The bank has put in place an interdisciplinary committee to initiate a process of measuring SQ from both internal and external customers. After discussions with members of the committee of the bank, an SQ measurement instrument was developed, based on SERVQUAL (Parasuraman, 1988). The instrument was used to measure the employee SQ perceptions of the bank's branches. A pilot study was undertaken three months prior to data collection, during which the questionnaire was administered to the personnel of ten branches, with a response rate of 24 per cent. Based on the results of the pilot study, two items which were identified as inappropriate for internal customers were removed, and an overall measure of branch SQ was also included. To increase the response rate, a cover letter from the retail department of the bank, explaining the relevance and importance of the study, was attached to the questionnaire. The instrument was finally administered to the personnel of the 28 medium urban branches by the management of the bank, and 194 completed questionnaires were returned from 26 branches. The overall response rate increased to 82 per cent.

## Results and discussion

Since the aim of this study is not to develop a definitive measure of SQ as perceived by the internal customers, it was decided, for the purpose of this study, to use the overall SQ measure included in the instrument as a proxy for the SQ internal customer perceptions for each branch. An average measure was calculated for each branch from the responses of its personnel, and used as a single output indicator of the SQ level of the internal customer perceptions for the branches included in the study.

Both input minimization and output maximization DEA models were run for each branch in the group, in order to identify the relative best practice or yardstick branches and the inefficient branches in the group. The input minimization model provides information on how much could the consumable resources be reduced while delivering the same level of SQ, given how the other branches of the group perform. The output maximization model provides information on how much SQ can be improved using the same consumable resources. For the input minimization model, branch efficiencies varied from 39 per cent to 100 per cent, with an average efficiency of 78.6 per cent. Table I presents sample results and suggested managerial guidelines for one of the inefficient branches that will bring it in line with the yardstick within its peer group.

According to Table I, a virtual branch (a combination of real branches) exists for unit X, which uses less personnel, computer time, space and a somewhat different account structure to produce similar levels of service quality perceptions. The model can point towards the resources which are not properly utilized for the purpose of delivering high levels of SQ. Pointing out these resources can provide the branch manager with a starting point for improvement. The output maximization version of the model can also provide the internal customers' SQ level which could be achieved by the branch given its resources and its account structure.

We observe, however, that the virtual branch constructed by the model is much smaller than the inefficient branch. This can, on the one hand, explain why the virtual branch performs better since smaller branches are typically perceived as better SQ providers. On the other hand, this size difference deems the comparison with the virtual branch to be unfair. A more careful examination of the peer branches and the identification of "well behaved" branches similar to the branch under consideration can provide the means for a fair comparison and point towards better quality practices. For example, Table II presents actual data from one of the peer branches similar in size to branch X.

A closer look at Table II reveals that when comparing branch X with the similar-in-size branch in the peer set, we observe that the peer branch uses much less computer time to provide similar levels of SQ. Thus, further investigation into how the excess computer time can be used to increase SQ perceptions should be initiated. (See Banker and Thrall (1992) for a detailed discussion on economies of scale and their identification.)

Other interesting observations involve the effects of the client base on the SQ efficiency of each branch. This can suggest the types of accounts which are associated with employee perceptions of "better" quality, and the accounts which can "justify" additional personnel or other consumable resources to provide the observed service quality level. When, for example, we run the DEA model without including the current accounts as an input to the model, a number of branches were deemed inefficient. When we included the current accounts, some of these branches became efficient, suggesting that the high-quality service of such accounts may justify more resources.

Clearly, a model which incorporates only one output is myopic in nature. Bank branch performance is associated with more than one output. As a result, the recommendations of the model should be interpreted with caution, unless all the relevant branch outputs are incorporated, or used with other existing performance tools. For example, banks may already have other DEA models (such as operating and/or profitability models) in place. In a previous study, Zenios *et al.* (1995) present an operating efficiency DEA model for bank branches. The model uses consumable resources and accounts as inputs. The output of the model consists of the total work produced at the branch level. To demonstrate how the SQ DEA model can be used along with other DEA models which may exist, we apply the operating efficiency model presented by Zenios *et al.* (1995) to the same group of branches used in this study. Figure 3 presents graphically the relative position of the branches along the two dimensions of operating and SQ efficiency.

We observe that some branches find themselves on the upper right-hand corner of the graph. These branches are on the efficient frontier of both models, and can be considered as the best practice units. Such branches can serve as role models for others. Branches such as B2 are 100 per cent efficient when considering SQ only as output, but are not operating efficient. These branches need to improve their operating efficiency while keeping their SQ efficiency at the same levels. The operating efficiency DEA model can provide direction on how to do this. Branches such as B1 are operating efficient but not SQ efficient. These branches can benefit from the model presented here to improve their SQ. Finally, branches such as B3 need both SQ and operating efficiency improvement and can benefit from both models. All branches should try to move along the diagonal towards the upper right-hand corner of the graph.

For the purposes of this study we used only data from the medium urban group. However, this model can also be used to isolate the effects of other factors, such as the effect of the external environment or technology on service quality. Charnes *et al.* (1981) propose an approach which can isolate efficiency differences among two groups after managerial inefficiencies have been removed. This approach can be applied to groups operating in different environments – such as, for example, rural versus urban versus touristic – or utilizing different technologies, to establish the impact of the external environment or technology on their service quality efficiency.

**Table I**
Actual and target values of inefficient branch X. Underutilized resources are identified

| Inputs/output | Branch X (actual) | Branch X (target) |
|---|---|---|
| Clerical personnel (hours) | 12,320.92 | 4,340.58 |
| Managerial personnel (hours) | 3,700.48 | 1,460.3 |
| Computer terminal (hours) | 8,767.7 | 3,127.96 |
| Working space ($m^2$) | 495 | 153.3 |
| Number of personal accounts | 1,211 | 312 |
| Number of savings accounts | 5,179 | 2,043.8 |
| Number of business accounts | 906 | 95.5 |
| Number of credit application accounts | 1,851 | 448 |
| Service quality | 5.6 | 5.6 |

**Table II**
Comparison of an inefficient branch with a peer branch similar in size

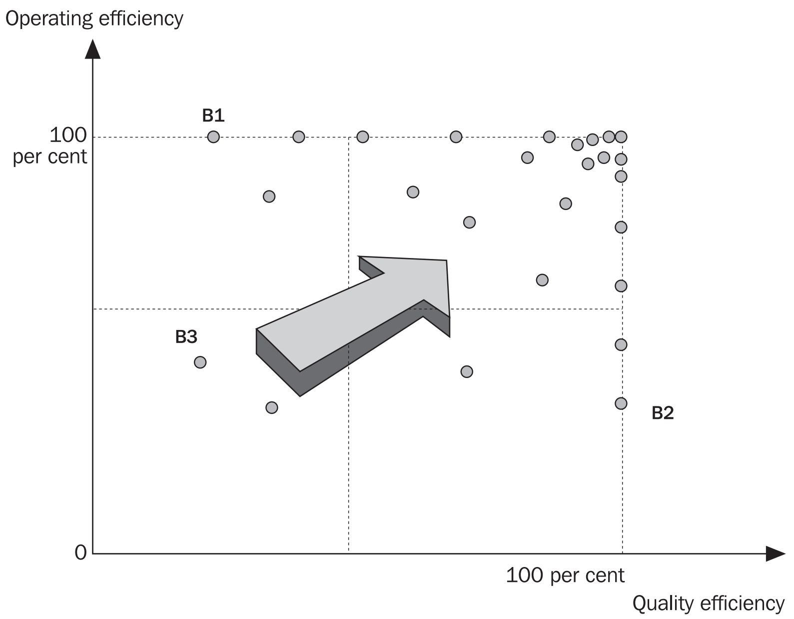
| Inputs | Branch X (actual) | Peer for X (actual) |
|---|---|---|
| Clerical personnel (hours) | 12,320.92 | 11,322.24 |
| Managerial personnel (hours) | 3,700.48 | 3,567.54 |
| Computer terminal (hours) | 8,767.7 | 3,227.36 |
| Working space ($m^2$) | 495 | 422 |
| Number of personal accounts | 1,211 | 1,098 |
| Number of savings accounts | 5,179 | 4,877 |
| Number of business accounts | 906 | 902 |
| Number of credit application accounts | 1,851 | 1,546 |

## Conclusion

In this paper we develop a DEA model which incorporates SQ output to provide bank branch benchmarks of internal customer service quality perceptions. Clearly, the model cannot be used alone to assess branch performance since it only considers a single SQ output which may ignore other important bank branch performance measures. Nevertheless, the model provides guidelines and direction towards service quality pitfalls.

The model can also provide the basis for the development of richer models which include multiple outputs to capture the multi-objective nature of bank branches. Such models can provide realistic branch performance benchmarks. Furthermore, the nature of the linkages between SQ, profitability, and operating efficiency provides food for future research. We are currently working towards this direction. DEA can provide an excellent research tool for such investigation.

**Figure 3**
Relative branch position along the dimensions of operating and SQ efficiency




## References

Al-Faraj, T.N., Alidi, A.S. and Bu-Bshait, K.A.(1992), "Evaluation of bank branches by means of data envelopment analysis", *International Journal of Operations & Production Management*, Vol. 13 No. 9, pp. 45-52.

Athanassopoulos, A.D. (1997), "Embodying service quality into operating efficiency for assessing the effort effectiveness in the provision of financial services", *European Journal of Operational Research*.

Banker, R.D. and Thrall, R. (1992), "Estimation of returns to scale using data envelopment analysis", *European Journal of Operational Research*, Vol. 17, pp. 74-84.

Banker, R.D., Charnes, A. and Cooper, W.W. (1984), "Some models for estimating technical and scale inefficiencies in data envelopment analysis", *Management Science*, Vol. 30, pp. 1078-92.

Berger, A.N. and Humphrey, D.B. (1997), "Efficiency and financial institutions: international survey and directions for future research", *European Journal of Operational Research*.

Berger, A.N., Leusner, J. and Mingo, J. (1994), "The efficiency of bank branches", paper presented at the 3rd Productivity Workshop, Georgia.

Bolton, R.N. and Drew J.H. (1991), "A multistage model of customers' assessments of service quality and value", *Journal of Customer Research*, Vol. 17, pp. 375-84.

Boussofiane, A., Thanassoulis, E. and Dyson, R.G. (1995), "Applied data envelopment analysis", *European Journal of Operations Research*, Vol. 15 No. 5, pp. 1-15.

Charnes, A., Cooper, W.W. and Rhodes, E. (1978), "Measuring the efficiency of decision-making units", *European Journal of Operations Research*, Vol. 2, pp. 429-44.

Charnes, A., Cooper, W.W. and Rhodes, E. (1981), "Evaluating program and managerial efficiency: an application of data envelopment analysis to program follow-through", *Management Science*, Vol. 27, pp. 668-97.

Charnes, A., Cooper, W.W., Lewin, A. and Seiford, L. (Eds) (1994), *Data Envelopment Analysis: Theory, Methodology and Applications*, Kluwer Academic Publishers, Boston, MA.

Cronin, J.J. Jr and Taylor, T.S. (1992), "Measuring service quality: a re-examination and extension", *Journal of Marketing*, Vol. 56 No. 3, pp. 55-69.

Oral, M. and Yolalan, R. (1990), "An empirical study on measuring operating efficiency and profitability of bank branches", *European Journal of Operational Research*, Vol. 46, pp. 282-94.

Parasuraman, A., Zeithaml, A.V. and Berry L.L. (1985), "A conceptual model of service quality and its implications for future research", *Journal of Marketing*, Vol. 49, pp. 41-50.

Parasuraman, A., Zeithaml, A.V. and Berry, L.L. (1988), "SERVQUAL: a multiple-item scale for measuring perceptions of service quality", *Journal of Retailing*, Vol. 64 No. 1, pp. 12-40.

Parasuraman, A., Zeithaml, A.V. and Berry, L.L. (1994), "Reassessment of expectations as a comparison standard in measuring service quality: implications for further research", *Journal of Marketing*, Vol. 58 No. 1, pp. 111-24.

Roth, A.V. and Jackson, W.E. III (1995), "Strategic determinants of service quality and performance: evidence from the banking industry", *Management Science*, Vol. 41 No. 11, pp. 1720-31.

Schneider, B. and Bowen D.E. (1985), "Employee and customer perceptions of service in banks: replication and extension", *Journal of Applied Psychology*, Vol. 70 No. 3, pp. 423-33.
Soteriou, A.C. and Zenios, A.S. (1996), "Using DEA to cost bank products", working paper 96-04, Department of Public and Business Administration, University of Cyprus, Cyprus.
Thanassoulis, E. (1995), "Exploring output quality targets in the provision of perinatal care in England using data envelopment analysis", *European Journal of Operational Research*, Vol. 80, pp. 588-607.
Zeithaml, V.A., Parasuraman A. and Berry L.L. (1990), *Delivering Service Quality*, The Free Press, New York, NY.
Zenios, A.S. and Soteriou, A.C. (1997), "Efficiency, profitability and quality of banking services", paper presented at the Performance of Financial Institutions Conference, The Wharton School, Pennsylvania, May.
Zenios, C., Zenios, S., Agathocleous, K. and Soteriou, A. (1995), "Benchmarks of the efficiency of bank branches", working paper 95-15, Department of Public and Business Administration, University of Cyprus, Cyprus.