Performance Evaluation of Commercial Bank Branches Using Data Envelopment Analysis

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Considerable research has been devoted to using multiple criteria to measure the performance of business units such as bank branches. However, bank managers continue to use traditional methods to evaluate their branch offices. In general, subjective weights for various criteria are used to arrive at a weighted average score to measure the performance of a bank branch. Potential deficiencies in an existing set of weights include bias and inconsistency with organizational objectives. This paper employs Data Envelopment Analysis (DEA) to evaluate the operational performance of a bank branch relative to the performance of its peer branches. Utilizing data from 31 branches of a major bank located in Southern California, the use of DEA yields the following: 1) rankings of bank branches using efficiency scores, 2) identification of areas of deficiency and 3) establishment of the reference group against which a branch is evaluated. Twenty-two of the 31 branches were found to be in need of improvements in various areas. In addition to identifying best-practice branches and those that are out-of-line with the best practice branches, DEA also points to the specific changes that must be made in the less productive branches in order for them to catch up with their best-practice peer group. The findings of this study should help management in identifying the strengths and weaknesses of their bank branches.

This study introduces and applies a framework for evaluating the operational performance of a bank branch network to assist bank managers in appraising bank branches. This framework is a linear-programming-based method called Data Envelopment Analysis (DEA) (Charnes, Cooper, Huang, & Sun, 1990). DEA is a non-parametric method that can serve as a decision support tool for guiding bank managers as well as validating and interpreting their appraisal results.

In this study, DEA is used to evaluate a bank branch's production operation relative to its peer group in a multiple-output, multiple-input setting. Inputs are cost related, while outputs are revenue or service related. From observed values of the inputs and outputs for all branches, DEA develops an "efficiency frontier" with which each individual branch is compared. In other words, each branch is evaluated relative to its peer group among the best-practice branches. This paper addresses the question: Which branch(es) are more efficient in converting inputs into outputs?

When compared with many other evaluation methods, DEA is advantageous to use because it does not require pre-assigned weights for inputs and outputs and thus, overcomes the deficiency introduced by using arbitrary weights. The results of this study are predicted to help bank managers understand the relative strengths and weaknesses of their respective bank branches. The model proposed here underscores the importance of achieving efficiency to remain viable in an increasingly competitive financial services industry and of discriminating between strong and weak performers within the banking industry. The bank branch evaluation undertaken in this paper extends a previous analysis reported both in terms of inclusion of more bank branches (data) as well as by expanding the list of inputs and outputs (Fisher & Yavas, 2002). The first section of the paper briefly examines the evolution of commercial banking as part of a larger financial services industry. The second section discusses issues related to assessing the operational efficiency of bank branches and provides the rationale for using the DEA model to evaluate the performance of bank branches. The third section presents the data and criteria used in evaluating bank branches and follows with an empirical study of performance evaluations of these branches using the DEA model. Section four concludes the paper with summary remarks.

Evolution of the Commercial Banking Industry

The pressures of globalization, changing and unstable market dynamics, and the increased competition from non-banking financial institutions combine to greatly transform the once-stable banking industry. One of the main factors responsible for the industry's dramatic change is the burgeoning Information Technology (IT) business sector. Banks have heavily invested in information-based industry, and this relatively recent focus has facilitated innovations in delivery systems as well as in financial products.

Parallel to developments in technology, government regulations have also undergone dramatic changes, driven partly by information technology innovations. In 1982, deposit interest rate ceilings were removed, followed by a lifting of state restrictions on intrastate and interstate branching. In the early 1990s, nationwide branching was allowed. Later, banks began to engage in new areas such as insurance and securities. With the Gramm-Leach-Bliley Act of 2000, the full affiliation of commercial banks and other financial services became a reality. The result of these changes has been a shift from traditional banking to the provision of an array of financial services such as insurance, brokerage, and other non-traditional services.

At the same time, advances in both information technology and deregulation have given rise to greater competition that has led to the acceleration of broad restructuring in banking. For example, in the 1960s and the 1970s, finance companies were predominantly small firms specializing in small consumer loans. Today, finance company business lending is more than half that of U.S. depository institutions (Marquis, 2001). In this new era of competition, inefficient firms formerly protected by government regulation had to change, be acquired, or fail. Not surprisingly, a tremendous increase in merger activity followed deregulation, resulting in more than a 40 percent decline in the number of U.S. banks (Furlong, 2001). Banks also began to introduce new, less labor intensive systems for providing services. The proliferation of automated teller machines (ATMs) as well as the increasing use of point-of-sales transactions may also be offered as supporting evidence for the increase in banking restructuring.

Along with these developments in the industry, banks have become customer-centric. The issue of "adding value to service" has assumed greater importance among bank managers who are striving for excellence. As the competition in the financial services industry has intensified, banks have increasingly engaged in pro-active efforts to differentiate themselves from their competitors. Often, such differentiation is accomplished through a customer-based strategy (Cook & Hababou, 2001). Some examples of such a strategy include development of interpersonal relationships to improve customer loyalty and creation of innovative products to better serve customer needs.

Literature Review

While many have questioned the future of bank branches in an Internet era that features widespread on-line banking, the full-service bank branch has survived even though substantial changes have occurred in banking's image and the structure needed to meet the requirements of the new banking environment (Camanho & Dyson, 2005). The structural changes summarized above (competition, deregulation, and advances in IT technology) have changed banks' demands for inputs, particularly for labor. Banks must now hire more skilled staff than ever before because of the changing mix of banking services and of the knowledge set required for selling these new services. With an increasingly more productive and higher-paid work force, banks have improved the organization of their production processes and provided higher levels of service. In an effort to establish the connection between banking services provided and profits, some recent studies have focused on the strategies employed by service organizations and have investigated the links between service quality and performance (Berger & Humphrey, 1997). Soteriou and Zenios (1999) argue that without thorough consideration of the design of the operating system, attempts to establish such a linkage would fail.

Another focus of research parallel to the efforts to identify performance drivers has taken place in benchmarking the efficiency of commercial banks (Berger & Humphrey, 1997). Benchmarking and best practice approaches have already been used by managers to evaluate multi-unit organizations having the main goal of improving operational efficiency. Examples may be found in a variety of industries, both in manufacturing and services (e.g. Ford Motor Company, Emerson Electric, General Electric, GMAC, and Merrill Lynch). Studies of operational efficiency within banking typically utilize the resources of a bank (e.g., human, technology, space, etc.) as inputs, and services provided (such as number of loans or other transactions serviced) as outputs (Soteriou & Zenios, 1999).

However, even though it is fairly easy and straightforward to carry out analyses, closer examination indicates that the identification of best practices and other critical measures may not be satisfactory. This is especially the case for service organizations whose operations may be too complex to allow correct identification of benchmarks and best practices since many service organizations typically have hundreds or thousands of sites where services are delivered (Metters et al., 1999). Both the volume and dispersion of sites create managerial difficulties in measuring performance.

In addition, many common performance measures used by manufacturing firms may have drawbacks when used in service organizations. Consider the case of a multi-branch bank that provides financial services. Unlike a manufacturing operation, a bank clearly has many subjective factors that affect its long-term success. These include, but are not limited to, customer needs, skills and judgments of service providers, and the mix of services provided.

If we consider the question of what measures banks use to track such factors, we often note a disconnect between the goals and the measures used to track whether or not the goals are being achieved. For example, banks typically use such measures as ratios, transaction per teller, cost per transaction, and loans generated per employee to measure their outputs. However, since branch location may be the most important factor driving these ratios, it is conceivable that small branches located near major business centers could generate high profits, and that large branches located in residential areas could generate smaller profits because they handle more of the less profitable transactions such as numerous small deposits.

Conversely, higher profitability in smaller but well located branches may mask operational inefficiencies there. Therefore, considerable debate exists among retail bank managers regarding the usefulness of bank branch profitability statements in evaluating bank branch performance (Metters et al., 1999). Even if profits could be accurately measured, branches may have different missions that would alone make comparisons based on the bottom line inadequate (Sherman & Ladino, 1995).

Method

Data

Given the above changes in the banking business, the purpose of this paper is to develop a framework for performance appraisal (DEA) and apply it to a multi-branch bank. Data utilized in this study came from 31 branches of a large national bank. These branches are located in the Los Angeles metropolitan and Orange County areas of Southern California. With the main objective of adapting to the changing environment in the financial services marketplace, the bank has undergone a recent merger, which resulted in a major restructuring of its business, including the mix of services provided. Following the merger, the bank began making the transition from a product orientation to a customer orientation. The managers of the bank were interested in streamlining operations without losing profitable customers and in finding an objective way to compare branch performance for the purpose of improving banking efficiency.

Data Envelopment Analysis (DEA)

Data Envelopment Analysis (DEA) is a non-parametric, linear programming-based method of analysis developed by Charnes, et al. (1979) to evaluate the performance of multi-input and multi-output production operations. DEA requires neither an explicit formulation of the underlying functional relationship nor pre-assigned weights for outputs and inputs in evaluating a branch's production operation relative to its peer group. The main advantage of using DEA is its ability to explicitly take into account the use of multiple inputs (resources) to indicate multiple outputs (services). DEA also helps to minimize the complexity of analysis by simultaneously evaluating the attributes of interest and presenting a single, composite score, referred to as "efficiency."

An increasingly popular management tool, DEA has been successfully applied as a decision support tool to improve bank branch productivity (Al-Faraj et al., 1993; Sherman & Ladino, 1995; Thanassoulis, 1999; Soteriou & Zenios, 1999); health maintenance organization services (Al-Shammari, 1999; Maniadakis & Thanassoulis, 2000); assessment of MBA programs (McMullen, 1997); selection of mutual funds (McMullen & Strong, 1998); efficient large market cap securities (Powers & McMullen, 2000); evaluation of software (Fisher & Sun, 1995-1996; Fisher et al., 1996); software projects (Banker et al., 1991; Mahmood et al., 2000); and operational performance of airlines (Schefczyk, 1993).

Numerous studies have compared DEA with other methods of performance assessments. For example, Joro et al., (1998) demonstrated the structural similarity between DEA and Multiple Objective Linear Programming (MLOP) and argued that the two methods were complements rather than substitutes. A similar conclusion was reached by Athanassopoulos and Curram (1996) when comparing DEA with Neural Networks, another non-parametric methodology. Pendharkar et al. (2000) compared DEA and Learning Bayesian Networks (LBN) against a popular statistical linear discriminant analysis technique and found that DEA and LBN outperformed statistical linear discriminant analysis.

Using the simple DEA model, each production operation is evaluated with weights that are the most favorable for its own aggregate performance. Later versions of the model have restricted weight flexibility (Charnes et al., 1991; Dyson & Thanassoulis, 1988; Wong & Beasely, 1990). A theoretical discussion of various models of DEA is beyond the scope of this paper. Suffice it to say, the version presented by Charnes et al. (1991) provides a more general approach than do the others. In the current study, the approach proposed by Charnes et al. to restrict weight flexibility was adopted and the BCC (Banker, Charnes, & Cooper) model with constant return to scale (Banker et al., 1984; Charnes et al., 1990; Kornbluth, 1991; Sun & Gong, 1993) was chosen.

In DEA convention, a production operation using m inputs to produce s outputs is called a Decision Making Unit (DMU). A DMU has discretion in using an input mix to produce an output mix. In this study, we use the following linear programming formulation of the DEA model (Charnes et al., 1990; Sun et al., 1993):

$$\begin{aligned} &\text{Maximize} \quad V_P = \boldsymbol{\mu}^T \boldsymbol{y}_o \\ &\text{Subject to} \quad \boldsymbol{\mu}^T \boldsymbol{y}_j - \boldsymbol{\omega}^T \boldsymbol{x}_j < 0, \; j = 1, \ldots n \\ &\qquad\qquad\quad \boldsymbol{\omega}^T \boldsymbol{x}_o = 1 \end{aligned} \tag{1}$$

μ^T, $\omega^T > 0$, where n is the number of DMUs; x_j is the input vector; y_j is the output vector; DMU_o is the DMU currently being evaluated; μ and ω correspond to x_o and y_o respectively and are the implied weights. The DEA model evaluates all n DMUs consecutively. The dual of (1) takes the following form:

$$\text{Minimize} \quad V_D = \theta - \varepsilon \left(\sum_{i=1}^{m} S_i^- + \sum_{i=1}^{s} S_i^+ \right)$$

$$\text{Subject to} \quad \sum_{j=1}^{n} y_{ij} \lambda_j - S_i^+ = y_{jo}, \ i = 1, \dots s$$

$$\sum_{j=1}^{n} x_{ij} \lambda_j - S_i^- = \theta x_{io}, \ i = 1, \dots m \qquad (2)$$

$$\sum_{j=1}^{n} \lambda_j = 1, \lambda_j \geq 0$$

$$S^+, S^- \geq 0,$$

where **m** is the number of inputs; **s** is number of outputs; S^+ is the output slacks; S^- is the input slacks; λ is a coefficient vector for DMUs, and ε is a sufficiently small number. It can be proved that optimal solutions exist for (1) and (2), and $V_D < V_p < 1$.

Definition of Efficiency: Let (μ^*, ω^*) denote an optimal solution to (1). DMU_o is said to be efficient if $\mu^T y_o = 1$ where $\mu^* > 0$ and $\omega^* > 0$. Alternatively, the efficiency of DMU_o can be measured in terms of the dual problem (2). DMU_o is efficient if $\theta^* = 1$, $S^{+*} = 0$, $S^{-*} = 0$ where $(\lambda^*, \theta^*, S^{+*}, S^{-*})$ is an optimal solution to problem (2). For an efficient performance, DMU_o's optimal inputs and outputs should be (x_o^*, y_o^*) where $x_o^* = \theta^* x_o - S^{-*}$ and $y_o^* = y_o + S^{+*}$. Therefore, the input wastes are S^{-*} and corresponding output shortfalls are S^{+*}.

From the **Definition of Efficiency**, when $\theta^* = 1$, $S^{+*} = S^{-*} = 0$, then $x_o^* = x_o$, and $y_o^* = y_o$, i.e., optimal values equal observed values. Otherwise, $\mu^T y_o < 1$ and DMU_o is said to be inefficient and has an efficient score of less than one. Furthermore, it is inefficient relative to its peer group, which consists of efficient DMUs.

The peer group, or reference set, consists of the left-hand side of the equation, $\sum_{j=1}^{n} y_j \lambda_j$ and $\sum_{j=1}^{n} x_j \lambda_j$, of (2). An inefficient DMU can, thus, improve its productivity by eliminating input wastes, S^-, and/or decreasing output deficiencies, S^+, relative to its reference set. The resulting reference set may be interpreted as "data envelopment" since the value on the right hand side of an equation cannot exceed the value on the left hand side (Charnes et al., 1991).

Empirical Study

Data used in this study was drawn from a survey conducted internally to evaluate the performance of 31 selected branches of a large national bank located in the Los Angeles metropolitan and Orange County areas of Southern California. To maintain anonymity, each branch has been assigned a letter, A through AE.

Various environmental factors affect the operational efficiency of a given bank branch. For example, of the 31 branches, three are in-store branches located in supermarkets. Traffic near some of the branches is extremely heavy and makes access to the branches difficult. Branch A is located closest to downtown Los Angeles and is open on Saturdays. However, it has rather limited parking during peak hours.

Branches E and F also suffer from limited parking, and extensive construction near branch F affects access to the branch. Branch G lacks visibility outside of the immediate communities in which it is located. The location of Branch J offers high visibility of the branch and access to it. Branch L has recently moved to a new location. Branch M is in the heart of a major developing area, soon expected to be a hot spot, while Branch N is already well-established with a strong connection to the Laguna Beach community.

Branches Q, R, and S are all located in a commercial district surrounded by well-established suburban Orange County. Branch T is the result of consolidating five branches into one; Branch V was currently relocated; Branch X is in the heart of a very busy street; the locations of Y and Z offer good visibility, but higher local competition. Branch AB is a recently opened branch, while Branch AC has a parking problem, but it occupies a central location. Finally, Branch AD serves primarily seniors and is located in one of the largest senior living complexes in the area. Additional information on the branches can be gleaned from Table 1.

Output and Input Variables

Based on the survey data from these branches as well as on managerial input, attributes are divided into *output variables* and *input variables*. One can think basically of banking services as a result of combining different inputs (buildings, employees, etc.) to produce outputs (income, loans). The *output variables* measure the service and revenue of each branch, while the *input variables* reflect the costs of operating each branch. The selection of inputs and outputs is guided by the answers to the question: "What determines when a branch is 'out of line' relative to its peer group?"

The managerial input that determines the selection of both inputs and outputs was also taken into account. In the end, the designated output variables analyzed include (1) retail deposits and (2) small business deposits. Unfortunately, data on loans from all of the branches in the sample was not available. Thus, for consistency's sake, neither retail nor business loans are taken into consideration. The input variables that relate to costs include (a) Number of employees: full-time equivalent (FTE); (b) lobby hours (i.e. number of hours of bank operations per week); (c) number of ATMs; (d) safety deposit boxes and (e) average wait (the average waiting time in line for service).

The *input-output* combinations used in this study are consistent with those found in previous studies. For example, Thanassoulis (1999) reported inputs and outputs utilized by British and Finnish banks surveyed. Among the *inputs* mentioned are number of tellers, number of computer terminals and number of ATMs. Among the *output* variables mentioned are number of mortgage applications, number of transactions processed and deposits generated. Soteriou and Zenios (1999), in their study of Cypriot bank branches, used managerial and clerical personnel, computer terminals and space as *inputs*; and total time involved in processing the tasks, various measures of quality, and profit as *outputs*. Camanho and Dyson (2005) in the production approach used number of employees and operational costs as inputs; and total value of deposits, loans and off balance sheet business, as well as number of transactions as outputs. Therefore, the set of attributes used in the current study is consistent with attributes in the existing literature.

Results

Performance Evaluations

The DEA model presented in equation (1) above is used to evaluate the 31 branches consecutively. Each branch is compared with the remainder of the branches and an efficiency score ($\boldsymbol{\mu}^T \boldsymbol{y}_0$) for this branch is generated in reference to a set of best-practice branches. An efficient or best-practice branch has an efficiency score of 1. A branch with an efficiency score of less than 1 is less productive relative to a reference set of best-practice branches. Table 1 presents the efficiency scores of the 31 branches and their corresponding reference sets.

The results of the DEA analysis indicate that of the 31 bank branches included in this study, 22 can make substantial improvements in terms of increasing productivity. On the other hand, branches B, C, D, I, J, K, O, X and AA are efficient. In other words, these best-practice branches generate volume and provide a mix of services requiring fewer resources than do their peers. Closer examination of these efficient branches reveals that the results are not unexpected. For example, branch B has only two ATMs, but a high ATM transactions volume; Branch C has the second largest number of deposits, and branch K has the largest. Branch D not only has a large number of deposits, but its average wait time is also considerably less than the average in the sample.

DEA results also show that branches I and J do a good job of converting *inputs* into *outputs*. We should note that they both are centrally located in the middle of a vibrant west Los Angeles business area. Branch I has one of the lowest average wait times (2.5 minutes), while branch J generates sizable deposits using a work force of less than average size. Branch K also benefits from a good location and has the largest amount of deposits in the sample. Branch O has a relatively short average waiting time, and Branch X has a large amount of deposits relative to inputs, such as waiting time and lobby hours. Finally, Branch AA, located in Newport Beach, has the third largest deposits, but relatively few lobby hours and a relatively low number of full time equivalent (FTE) employees. Table 1 details efficiency scores as well as the peer group against which each individual branch has been evaluated.

At the other end of the spectrum, branch L is the least efficient (efficiency score of .0369) followed by branches G, E, S and AB, respectively. Closer examination of the bank branch data reveals that branch L has the least amount of total deposits, and it compares unfavorably with its peer branches B and AA, both of which were found to be efficient. Furthermore, L is a new branch, located in a building that has been vacant for seven years. Note that Table 1 includes peer groups (or reference sets) in addition to the efficiency scores obtained from the DEA analysis.

Table 1: DEA Efficiency Scores and Rankings

Bank Branches	Efficiency Score	DEA Rankings	Reference Set	Special Notes
A	0.9744	10	J, AA	Closest branch to downtown Los Angeles; Congested parking during peak hours
B	1.0000	1	B, C, O, AA	Heavy traffic; Easy visibility/Access; Ample parking
C	1.0000	1	B, C, O, AA	Extremely busy due to closures of nearby branches
D	1.0000	1	D, J	Located in Century City
E	0.1500	28	C, J, X	Very busy; Bad parking history
F	0.2457	27	B, AA	Extensive construction in the neighborhood; Minimal signage and parking
G	0.1196	30	D, J, X	Poor location: Low visibility outside immediate communities
H	0.3694	24	B, X	Inside a supermarket; 72 safe deposit boxes but no viewing area
I	1.0000	1	I, K	In the heart of Brentwood
J	1.0000	1	J, AA	On a major commuting corridor; Heavy traffic provides visibility but makes ingress and egress difficult
K	1.0000	1	I, K	In downtown Pasadena District; A destination center with a Starbucks and a mortgage partner at the front entrance
L	0.0369	31	B, AA	Just opened; Building was vacant for 7 years
M	0.5219	21	K, AA	In the heart of a major developing area; Soon to be a hot spot
N	0.7032	16	J	Located in Laguna Beach; Strong connection to community
O	1.0000	1	B, C, O, AA	Center location on Harbor Blvd
P	0.8868	12	C, J, O, AA	Located in Huntington Beach; 70% of customers are from Westminster, Cypress, Stanton
Q	0.5982	19	I, AA	Surrounded by well established suburban businesses; Adequate parking, although left turns out are difficult
R	0.6078	17	I, AA	Location offers a high consumer opportunity
S	0.3601	25	B, AA	Local businesses are car dealers, service stations, fast food restaurants, and repair shops
T	0.8994	11	B, AA	The store consolidated with 5 other stores; Located in the NW corner of South and Carmenita
U	0.7991	14	B, O, AA	Busy intersection, good visibility, and ample parking
V	0.4556	22	B, AA	Relocated recently, has grown at about 4.25% this year
W	0.5320	20	C, K, AA	Good signage, competition nearby, parking a problem
X	1.0000	1	C, J, X	On a very busy street
Y	0.3851	23	B, O, AA	Eight financial institutions within 1 mile. Good location and cost of doing business is lower
Z	0.2541	26	B, O, AA	A busy in-store branch Good visibility
AA	1.0000	1	J, AA	Newport Beach
AB	0.1426	29	B, J	Recently opened in a master planned community
AC	0.7918	15	K, AA	Parking a problem during peak hours, centrally located
AD	0.8112	13	K, AA	In Seal Beach, serving 55 and over
AE	0.6073	18	D, J, X	On Tustin Street that has the biggest concentration of businesses in Orange

Consideration of other branches reveals that Branch G suffers from having a higher than average number of employees generating the second lowest number of deposits--both retail and small business. Poor location and a resulting lack of visibility is another problem for Branch G. Here we note that the reference group for G includes D, J and X, all having efficiency scores of 1. Branch E, with an efficiency score of 0.1500, compares unfavorably with its peers, branches C, J, and X. Another inefficient branch, S, has a relatively low number of deposits, and its average wait time is among the longest of those banks in this study. In sum, it could be argued that the DEA results ranking the branches in terms of their operational efficiency did not contain any surprises. The results were mostly predictable based on a careful examination of the data at the branch level.

As shown earlier, in addition to efficiency scores, the model generates slacks, S^+ and S^-, in the dual problem (See equation 2). The slack for an attribute is the difference between the value measured and the value that is considered efficient. Slacks not only identify the areas that are deficient, but also provide estimated amounts of improvement in individual areas for a branch to attain efficiency. Therefore, bank management could identify and target specific areas for attention and concentrate efforts to improve those areas that help the branch rise to the level of best practice peer group.

For example, Branch B has an efficiency score of 1.000, and the values of slack variables are all zero. This finding indicates that there are no areas of deficiency. However, if we consider Branch L, which has the lowest efficiency score (0.0369), we can see how DEA identifies areas of deficiency as well as estimates what it takes to make those areas efficient. As shown in Table 2, Branch L can improve its performance by drastically increasing its small business deposits (from $0 to $112,900) and by reducing lobby hours.

Table 2: Branch L (0.0369)

	Value Measured	Value If Efficient
Deposit		
Retail	$1,706,0000	$1,706,000
Small Business	$0	$112,900
Average Wait	3	3
FTEs	12.8	0
Lobby Hours	50	48.9
Boxes	239	239
No. of ATMS	2	2

As another example, let us consider Branch A, which has an efficiency score of 0.9744. Compared to its peers, Branches J and AA, Branch A needs to concentrate its efforts on reducing average waiting time and its number of FTE employees. This branch appears to be overstaffed. The DEA recommendation would be to reduce the number of employees from 11 to 7.7. Staff reduction may be accomplished by laying off some of the personnel or transferring them to new branches being established in other locations. In addition, branches that are situated in close proximity to one another could share branch managers and/or loan officers. A further recommendation includes reducing the number of lobby hours that the bank is open (see Table 3).

Table 3: Branch A (0.9744)

	Value Measured	Value If Efficient
Deposit		
Retail	$80,737,401	$80,737,401
Small Business	6,641,393	6,641,393
Average Wait	7.5	2.3
FTEs	11	7.5
Lobby Hours	50	22.5
Boxes	2227	1350
No. of ATMS	1	1

Conclusion

The information resulting from DEA analysis is valuable to management in that a given bank should be able to make productivity improvements and/or cost reductions in the branches that are identified as less than efficient. However, it is clear that not all the recommendations may be immediately feasible for bank managers to undertake. Consider, for example, the following question: How do we reduce lobby hours in the short run? It should be clear that while DEA does a good job of pointing out opportunities to improve operations, some of its recommendations may not be feasibly accomplished. Nevertheless, it may also be argued that the main usefulness of the DEA lies in its power to identify areas of deficiency regardless of whether corrective action can be readily taken.

In addition to highlighting the areas of deficiency for a branch, the findings also identify the reference sets relative to which the branch is compared. The comparison allows a bank manager to identify specific operating characteristics that separate efficient branches from inefficient ones. For example, a manager could pinpoint what makes a less efficient branch more costly to operate. Reference back to the example of Branch A reveals that the branch employs too many staff (or FTEs). This specific branch should be able to provide the same level of services using fewer employees. The same bank could also reduce its lobby hours.

Making decisions is where the role of the bank manager becomes critical. Managers in various bank branches handle labor issues differently; some rely more on full-time employees, while others make heavy use of part-time employees. Before jumping to conclusions or making quick decisions, bank managers might want to compare both efficient and inefficient branches such as those in this study to see if there are differences among branches in terms of making changes regarding such things as staffing policies or hours of operation. Such comparisons might reveal that some of the DEA recommendations might actually be very difficult to accomplish.

This paper also identifies another issue of concern: using what is referred to as "technical efficiency" in the sense that prices of inputs were not taken into consideration. In our analysis, a bank branch would be considered efficient if it delivered its outputs at the lowest level of inputs, not at the minimum cost. If it is important to assess not only the extent to which a bank branch can lower its input levels, but also the extent to which it can lower aggregate cost of inputs, relative prices of inputs must be specified, not just their quantities.

Discussion

Banks operate in a volatile environment that constantly requires them to alter their products and services. As indicated earlier, the trend is more revenues coming from such non-traditional offerings as insurance and financial services, while traditional banking revenues have declined. In fact, since World War II, the share of depository institutions in total assets held by the industry has declined from 55.9 percent to 35.6 percent between 1948 and 2000 (Saunders & Cornett, 2003). On the other hand, investment companies that give savers cheaper access to securities markets have seen their share of that business increase reflecting savers' shifting preferences toward securities markets over those products offered by commercial banks. In addition, information technology and a changing regulatory environment have resulted in consolidations in the commercial banking industry (Saunders & Cornett, 2003). In such an environment, banks compete with one another by developing new financial products and devising new ways of delivering these products to customers. Online banking and smart debit cards are two examples of new products in the banking industry. Equity and bond mutual funds are among the more recent offerings. Earlier examples of innovation included Automated Teller Machines (ATMs) and credit and debit cards.

Along with seriously considering and analyzing domestic trends, commercial banks must now also compete with foreign banks and other financial intermediaries. Against this background, it is clear that the future performance of commercial banks will be based largely on the extent to which they adopt the newest technologies and offer new, competitively priced products, such as mutual funds and insurance. In such a highly competitive environment, performance evaluation of bank branches assumes greater importance. The challenges brought about by this environment may require new operating principles that in turn make changes necessary at the bank branch level as the mix of product offerings changes. Regardless of the sources of these changes, bank managers must know whether their banking policies have improved productivity and whether the changes and the new initiatives affect some branches differently than others.

Instead of using traditional techniques such as ratio analysis and observation, the management of the bank studied here decided to use DEA to identify areas where improvement could be made in the performance of the branches while maintaining service quality and also pinpointing opportunities where savings could be achieved.

The identification of bank branches that are functioning efficiently in contrast to inefficient branches is one of the most important outcomes of a DEA assessment. This is so because both efficient and inefficient bank branches typically use a similar set of resources (inputs) in producing a similar mix of services (outputs) in a similar environment. Therefore, inefficient branches can learn from and emulate their efficient peers regarding what needs to be done to improve. Furthermore, operational practices identified as contributing to efficiency may be studied, and information gathered may be disseminated throughout the entire organization that seeks to investigate, improve and grow.

Suggestions for further use of DEA include development of a DEA-based index (Fare et al., 1994) that measures productivity change and can be used to investigate the changes in productivity resulting from changes in product offerings and/or operating principles. In addition to measuring the impact of new offerings, such analyses could help address the questions of how to allocate operating budgets to units, how to minimize financial risks at branch levels, and how to use inter-branch data to monitor a bank's performance vis-à-vis other branches as well as other banks in the industry.

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