BANK BRANCH EFFICIENCY: AN APPLICATION OF DEA ANALYSIS

Athanasios G. Noulas
Professor

University of Macedonia
Greece

Niki Glaveli
PhD Candidate

University of Macedonia
Greece

Absract

In the 1990s the Greek banking system went under drastic changes due to the implementation of EU legislation leading to a more free and integrated market. These changes stimulated a positive orientation towards controlling costs and increasing profits. Since, it has been suggested that cost management is more efficient at the branch level, understanding efficiency at this level may help resolve a number of conceptual, measurement and policy questions at the bank level.

This paper investigates and discusses on the operating and profitability efficiency of 28 branches of a major commercial Greek for the years 1999 and 2000. The results indicated that the efficiency levels among the various branches vary and there is space for improvement. Profitability efficiency appears to be somehow higher than operational efficiency.

Keywords
Banks Efficiency; Branches; DEA

1. Introduction

Until the mid–1980s the Greek banking industry was heavily regulated in all areas of activity. Price regulation and the various credit controls forced by the government created a system where the concept of competition was almost unknown. Gradually, the deregulation of interest rates, the abolition of various credit controls, the further development of the capital market, the competition from non-bank institutions, the free movement of capital flows, and the fear of entrance of other European banking institutions into the Greek market led to significant changes. Waves of mergers and acquisitions that started in the late 1990s and continue until today have left the market with fewer and larger banking organizations. In the more competitive and integrated financial system the banks must thrive to achieve the maximum efficiency they can in order to stay alive and compete successfully. Berger (2001) reviews and examines the efficiency effects of the integration of the financial services industry.

One way through which the banks compete and try to maintain or increase the market share is through the branch network. Obviously, in a world of bank mergers and acquisitions some of the branches might be closed while new ones will be opened in an effort to have a better geographic allocation of branches. If a reconstruction of the branch network is about to take place, it is imperative for a bank to know the efficiency of its branches. Once the efficiency of each branch is known, the management of the bank is in a position first, to rank the branches, second to see where the inefficiency is coming from and third to suggest ways of improving the performance.

The purpose of this study is to measure the operating and profitability efficiency of 28 branches of a major Greek commercial bank in a given big city. The study utilizes the Data Envelopment Analysis (DEA) method to measure efficiency and adopts the intermediation approach in measuring inputs and outputs.

2. Review of the Literature

2a. Measuring efficiency

In the banking literature, the measurement of efficiency has been approached from a variety of dimensions. The traditional approach has used a variant of ratio analysis using a number of financial ratios (e.g., ROA, ROI). Financial ratios can measure the overall financial soundness of a bank or branch and the operational efficiency of its management (Chen and Yen, 1997). Ratio analysis was used for both normative and positive reasons (Whittington, 1980). The normative approach compares a company's ratio to a benchmark to judge its performance while the positive approach uses ratios to predict future performance and bankruptcy and assess the riskiness of the company (Al-Shammari and Salimi, 1998). Both approaches had some success. However, there have been many methodological problems (Barnes, 1987; Smith, 1990; Fernadez - Castro and Smith, 1994) that have pointed out the numerous weaknesses of the ratio analysis. Its main weakness is that the choice of a few or a single ratio does not provide enough information about the various dimensions of performance. As a result a bank that is poorly managed on certain dimensions may appear to be performing well as long as it compensates in other dimensions (Sherman and Gold, 1985). Furthermore, it is a short run analysis that may be inappropriate for describing the actual efficiency of the bank in the long-run (Oral and Yolalan, 1990) since it fails to consider the value of management actions and investment decisions that will affect future performance. Another problem that may arise is the choice of a benchmark against which to compare a univariate or multivariate score from ratio analysis (Al-Shammari and Salimi, 1998). Commonly used performance ratios fail to consider multiple outputs (services and/or transactions) provided with multiple inputs.

The problems in financial ratio analysis have prompted researchers to new ways of measuring efficiency in the banking sector. They first turned to the parametric programming approach, concerned with the production or cost function base. It has been used for estimating the characteristics of the function and measuring economies of scale assuming all banks are operating efficiently (Banker and Maindiratla, 1988).

Finally, researchers have shifted to X-efficiency that refers to the ability of the bank to control costs and generate revenue. There are four different benchmarking techniques of measuring X-efficiency, which have been applied to the banking sector. The Econometric Frontier Approach (EFA) allows the error term to be composed of two terms. One term captures measurement errors and factors beyond the firm's control, and the other term measures inefficiency. The Thick Frontier approach (TFA) breaks the sample into quartiles based on the average cost. It assumes that the deviations in predicted costs between the highest and the lowest quartiles represent inefficiencies. The Distribution Free Approach (DFA) is applied when time-series data are used. It assumes that efficiency differences are stable over time, while random error averages out over time. That is, the efficiency of a unit is taken to be mean of its measured efficiency across all years. Charnes, Cooper and Rhoades (1978) developed the Data Envelopment (DEA) approach. DEA is based on linear programming. All deviations from the estimated frontier represent inefficiency. DEA has been quite popular and has been applied to several studies that measure the operating efficiency of bank branches.

2b. Review of the literature addressing the efficiency at the branch level

Since branches remain the major delivery vehicles of banking services in Greece, the efficiency of each branch is expected to have a significant impact on the bank as a whole. The existence of an efficient branch network will lead to improved financial services and products, a higher volume of funds intermediated, a generally more responsive financial system and improved risk-taking capabilities if efficiency profit gains are channeled into improved capital-adequacy position.

Berger *et al.* (1997) by analyzing the relative efficiency of 760 branches of a large US commercial bank, discussed extensively on the benefits delivered from branch efficiency analysis. In their analysis they addressed two sets of academic and policy issues that may help improve our understanding of the underpinnings of efficiency at the bank level and help resolve a number of conceptual, measurement and policy questions in the standard bank level analysis. First, cost efficiency at the bank level may be mismeasured when efficiency at the branch level is not taken into consideration. They found for example that a bank may operate twice as many branches as would minimize costs, but this may be optimal from a profitability standpoint because "overbranching" raises revenues from providing extra customer convenience. Second, they found that X-inefficiencies were quite large, over 20% of operating costs. According to the authors these findings may help explain some efficiency results commonly found in bank level analysis and have important implications regarding mergers and acquisitions and the formation of interstate branching networks. As their findings suggested cost management is more efficient at the branch level. Consequently, branch inefficiencies may be improved through consolidations where the deposits of an inefficient branch are transferred to a near by more efficient branch.

A number of studies have applied DEA to the question of efficiency in bank branches (see Table 1). Sherman and Gold (1985), applied DEA to 14 branches of a US saving bank. In their model they identified as output the number of four transaction types processed by the branch and as input they identified labor, office space and supply costs. DEA identified 6 of the 14 branches to be relatively efficient. Analysis of the results with management led to some useful observations and conclusions relative to the explanation of the inefficiency sources. Weak management, size, liquidity and diseconomies of scale with respect to personnel were identified as the main sources of inefficiency.

Parkan (1987), examined the efficiency of service operations of 35 branches of a major commercial bank in Canada. The inputs used in the study were: total authorized FTE, annual rent, quality of customer service space ranking, telephone/stationary expenses, number of on-line terminals, marketing activity ranking. The outputs were: number of transactions, commercial account openings, number of loan applications, customer service survey ratings and number of corrections. Only 11 of the 35 branches were found to be relatively efficient. The author suggested that operating techniques were the main sources of branch inefficiency.

Vassiloglou and Giokas (1990), assessed the relative efficiency of 20 branches for the Commercial Bank of Greece employing the DEA approach. Labor, monetary value of supplies, office space and computer terminals at each branch were used as inputs. Branch output was measured in terms of the number of transactions. Of the twenty branches in the sample, nine were found to be efficient. The authors suggested that for a useful interpretation of DEA results is necessary to discuss the results with management in the light of their knowledge of the special characteristics of the branch network.

Giokas (1991) repeated the application of DEA analysis for 17 branches of a regional division of the Commercial bank of Greece. The inputs employed for the analyses included: labor (person hours), operating expenses and utilized space branch. The outputs included the complete number of the total (72) number of transactions grouped according to the section of the branch, which performed them. From the sample of 17 branches (consisted of satellite rather than center branches) only 5 were found to be efficient. The study concluded that small branches show increasing returns to scale while large branches operate under constant returns to scale. As sources of inefficiency were identified the branch size and the scale economies related to personnel and supply usage. His conclusions further refer to the advantages of DEA method in analyzing the branch efficiency.

Oral and Yolalan (1990), measured the operating efficiencies of a set of 20 bank branches of a major Turkish commercial bank offering relatively homogeneous products in a multi-market business environment. In an effort to assess not only efficiency but also profitability and the connection between the two, the study employed two DEA models. For both models different input-output combinations were considered in order to find the most meaningful one. They concluded that the use of the number of: personnel, terminals, credit applications and commercial and saving accounts as inputs and the use of the time on: general services, credits, saving accounts and foreign exchange as outputs, had the capacity to better discriminate the branches according to the service efficiency assessment. The efficiency level for the most meaningful input-output combination was 20% (4/20 branches). A comparison of the characteristics of the group of the most efficient branches with those of most inefficient ones revealed that: the younger the age of the branches, the smaller the number of personnel, the higher the number of "active" accounts, the bigger the size of administrative expenses, and the proximity of branches to newly urbanized sections of the cities, the most efficient the branch.

Drake and Howcroft (1994), investigated the relative efficiency of 190 branches of a UK clearing bank. They used as inputs the number of interview rooms and of ATM's, the floor area in square meters, management and clerical grades and stationary costs and as outputs the size of till transactions, lending products, deposit products, automated transfers, clearing items, ancillary business and insurance business. Out of the sample of 190 branches some 83 (43.68%) were found to be efficient. The results of their analysis showed that the size of the branches in terms of number of staff (7-9 members of staff – allowing for individualities- had the higher efficiency score and the higher scale efficiency), location, age, competitive environment and the existence of economies of scale, determined the level of the branches efficiency.

Al-Faraj, Alidi, Bu-Bshait (1993) assessed the performance of 15 bank branches in Saudi Arabia employing a production technology with eight inputs and eight outputs. All but three branches were found to be efficient. They concluded that profitability should not be the sole criteria to determine whether to close the branch or not.

Athanassopoulos (1998) proposed a framework where market and cost efficiency are recognized as two complementary components of bank branch efficiency. Nonparametric deterministic frontier models were suggested for assessing site-specific and aggregate market and cost efficiency of 580 branches of a commercial bank in the UK. He applied this framework by grouping the bank branches into clusters of homogeneous operating profiles. The results obtained showed a site specific and aggregate average market efficiency of 90 percent and 85 percent respectively, which shows scope for improving the sales performance of throughout the bank branch network. Considerable inefficiencies were also found on the site-specific (88 percent) and aggregate (82 percent) cost behavior of branches. He suggested that besides size, level of competition, location and account size; product mix, economies of scope and quality may be the determinants of bank efficiency.

Two sets of general conclusions emerge from this literature. The first set refers to the sources of bank branch inefficiency. Weak management, size (in terms of number of staff and number of accounts), age, location, proximity to center, to newly urbanized sections of the cities or other branches, personnel inefficiencies, existence of economies of scale, administrative costs and liquidity are the most commonly identified ones. On the other hand, there is conflicting evidence as far as the connection of profitability and operating efficiency is concerned. The second set refers to the limitations and the powerful characteristics of DEA when used for measuring the relative efficiency of bank branches. DEA has been proven to be useful when used in combination with management insights and information on the particular characteristics of each branch, since DEA can only indicate the relative inefficiency of the individual branches. The last point may also be considered as an advantage since it facilitates comparisons between branches that can be compared directly.

2. Data and Methodology

Measuring efficiency in this paper

In this paper, efficiency is measured through the DEA method. The DEA approach provides a measure for relative efficiency. A branch can be said to be efficient relative to another branch if (a) it produces the same level of output with fewer inputs, or (b) it produces more output with the same level of inputs. DEA uses observed inputs and outputs and seeks to find which of the branches in the sample determine an envelopment surface. Branches that lie on the surface are deemed efficient and receive a score of one. Branches that do not lie on the surface are deemed inefficient and receive a score of less than one.

The DEA Model

The DEA approach measures efficiency by the ratio of weighted outputs (virtual output) to weighted inputs (virtual input), which can take the values between zero and one. An efficient branch does not necessarily produce the maximum level of output given the set of inputs. Rather, efficiency means that the branch is a "best practice" firm in the sample.

Consider a number (N) of decision making units (DMU), each one producing m different products by using n different inputs. Then efficiency of the DMU is measured as:

$$h_s = \sum_{i=1}^{m} u_{is}\, y_{is} \,/\, \sum_{j=1}^{n} v_{js}\, x_{js} \qquad (1)$$

where: y_{is} (> 0) is the amount of output i produced by the sth DMU, x_{js} (> 0) is the amount of input j used by the s^{th} DMUs, u_{is} is the output weight, v_{js} is the input weight, i runs from 1 to m, and j runs from 1 to n. The efficiency ratio (1) is then maximized subject to

$$\sum_{i=1}^{m} u_{is}\, y_{ir} \,/\, \sum_{j=1}^{n} v_{js}\, x_{jr} \leq 1 \qquad \text{for } r = 1,\dots, N, \ (2)$$

$$\text{and } u_{is}, v_{js} \geq 0. \qquad (3)$$

The first inequality guarantees that the efficiency ratios of other DMUs cannot exceed one, while the second one requires the weights to be positive. The weights for each output and input are determined by DEA so that each DMU maximizes its own efficiency ratio. Any other set of weights results in a lower efficiency score. In other words, DEA gives the benefit of the doubt to each DMU in calculating the efficiency ratio. The above nonlinear problem can be transformed into a linear one and be solved. For a linear pro-

gramming problem, there exists a pair of expressions, which are dual to its other. The problem we solve is:
min

$$\theta_s - (\sum_{i=1}^{m} s_{r_s}^{+} + \sum_{j=1}^{n} s_{js}^{-}) \quad (4)$$

s.t.

$$\sum_r^N \lambda_{sr} \; y_{ir} - y_{is} - s_{rs}^{+} = 0 \; ; i = 1, \ldots, m \quad (5)$$

$$\theta_s \; x_{js} - \sum_r^N \lambda_{sr} \; x_{jr} - s_{js}^{-} = 0; j = 1, \ldots, n \quad (6)$$

$$\lambda_{sr}, \; s_{rs}^{+} \geq 0, \; s_{js}^{-} \geq 0, \textit{ and } \theta_s \text{ free.} \quad (7)$$

By linear programming duality theory, the optimal value of θ_s equals the optimal value of h_s and must lie between zero and one.[1] The represents the surplus in output, while the represents the slack in input j. Efficiency is achieved only when $\theta_s = 1$ and = 0, = 0. If the DMU_s is inefficient, it can become efficient by adjusting output and inputs as follows:

$$y_{rs}^{*} = y_{rs} + s_{rs}^{+} \textit{ and} \quad (8)$$

$$x_{js}^{*} = \theta_s x_{js} - s_{js}^{-}. \quad (9)$$

The advantages of the DEA model that make it powerful are: (a) it can handle multiple input and multiple output models, (b) it does not require an assumption of a functional form relating inputs and outputs, (c) Decision-Making Units are directly compared against a peer or a set of peers, (d) inputs and outputs can have very different units (it handles both quantitative and qualitative variables). The DEA method however is not free of shortcomings since it is an extreme point technique, and noise such as measurement error can cause significant problems.

Data

Data for our analysis come from 28 branches of a major commercial Greek for the years 1999 and 2000. We specify two models. The first model examines the operating efficiency of the branches and specifies outputs in terms of the value of total (a) loans, (b) financial products (i.e., repurchase agreements and mutual funds) and (c) deposits. In order for a branch to produce these products, it uses labor, and technology facilities. Accordingly, as inputs are taken to be (a) the labor expense and (b) other operating expenses. This model examines the ability of the branches to produce efficiently. Of course, the problem here is that the value of accounts depends on the number and the size of accounts. Two branches for example might have the same value of loans but might be very different in terms of number and size of accounts. Branch A may have a few large accounts and branch B may have a large number of small accounts. If their expenses are similar, the technique will show that the two branches have the same efficiency level, something that may not be true from a pure technical point of view. A remedy to this problem would be to use the production instead of the intermediation approach, that is, to take the number of accounts and the number of employees. Data limitation however leads us to use the intermediation approach and define the variables in terms of their monetary values, something that is being done in the banking literature. Given that our sample is coming from only one city and not from across the country, the problem of very different branches does not appear to be a major one. To further minimize the problem of having branches with different characteristics, we run the model twice: once with all the branches and another excluding the ones that appear to be different.

The second model examines the profitability or revenue efficiency and uses three inputs and two outputs. The inputs include (a) the interest expense, (a) the labor expense, and (b) other operating expenses. The two outputs include the interest revenue and non-interest revenue. These variables capture the sources of revenue for the Greek bank branches. Higher profitability efficiency does not necessarily imply and higher operating efficiency. Similarly, higher operating efficiency does not necessarily imply and higher profitability efficiency. A branch that presents a very good picture profit wise may be operating inefficiently and thus have a lot of potential. On the other hand, the operating efficiency of a branch may be high and its profitability poor. A branch in this category might be a candidate for closing since the resources are being used effectively but there is not much potential here. Branches with low profitability and operating efficiency might become good ones with the appropriate managerial help. In general, once the profitability and operating efficiencies have been found the branches can fall into various categories as Table 2 shows.

Results

Table 3 shows the efficiency levels for each branch as well as the minimum and the average value for the whole group. Several conclusions emerge with respect to operating efficiency. First, the average operating efficiency for 1999 is about 81% and for 2000 is about 76%. Thus, on the average branches would have to reduce cost by about 19% (24%) in 1999 (2000) in order to become efficient. Second, the minimum efficiency level is about 50% (46%) in 1999 (2000). Third, seven (five) branches appear to be efficient in 1999 (2000). Fourth, seventeen branches had lower efficiency in the year 2000 than in 1999.

The profitability efficiency presents, in general, the same picture with that of the operating efficiency. First, the profitability efficiency is higher in 1999 (86%) than in 2000 (82%). Second, the minimum efficiency level is about 56% (59%) in 1999 (2000). Third, eleven (five) branches appear to be efficient in 1999 (2000). Fourth, twelve branches had lower efficiency in the year 2000 than in 1999.

Four branches (1, 8, 25, 28) seem to dominate our sample. These four branches show operating ant profitability efficiency equal to one in both years and belong to category one according to Table 2. Three branches (7, 19, 20) in our sample appear to be efficient profit wise in both years, but their operating efficiency appears to be the smallest in the sample. Obviously, the management of the bank has to take a careful look as why there is such a big difference between profitability and operating efficiency for these branches. These branches belong to category two according to Table 2.

There is only one branch (12) that appears to be operationally efficient and inefficient profit wise.

Conclusion

The efficiency of individual bank branches is an important issue in an environment where mergers and acquisitions are taking place. Knowing the branch efficiency the banks can better position themselves into the market. This study examined the efficiency of 28 branches of a major greek commercial bank in a given area, using the DEA method which allows the bank management to compare the various branches. The method is specific in identifying where the inefficiency is coming and how much the inputs must be reduced or the outputs to be increased in order for the branch to become efficient. The method constitutes an additional instrument that the bank can use to evaluate the branch along with other traditional measures of branch efficiency.

The results indicated that the efficiency levels among the various branches vary and there is space for improvement. Profitability efficiency appears to be somehow higher than operational efficiency.

Table 1. Studies on bank branch efficiency.

Authors	**Country**	**Inputs /Outputs**	**Results**
Sherman and Gold (1984)	U.S.	*Inputs*: Labor, office space supply costs *Output*: No of transactions processed	No of efficient branches: 6/14 (42,85%) *Sources of relative inefficiency*: Weak management, Size, Liquidity and Diseconomies of scale with respect to personnel, operating aspects
Parkan (1987)	Canada	*Inputs*: Total authorized FTE, annual rent, quality of customer service space, telephone/stationary expenses, number of on-line terminals, marketing activity ranking. *Outputs*: No of transactions, commercial account openings, number of loan applications, customer service survey ratings, No of corrections.	*No of efficient branches: 11/35* (31,4%) *Sources of relative inefficiency*: Operating techniques. Need to take into account price, wage and resource utilization rate

Table 1. (continue).

Authors	**Country**	**Inputs /Outputs**	**Results**
Oral and Yololan (1990)	Turkey	*Model A* *Inputs*: No of personnel, No of terminals, No of credit applications, No of commercial and savings accounts *Outputs*: time on general services, credits, saving accounts and foreign exchange *Model B* *Inputs*: Personnel, expenses, administrative expenses, depreciation, interests paid *Outputs*: interests earned, non-interest income.	*Model A* (service operating efficiency): *Average Efficiency level*: 85% *No of efficient branches*:4/20 (20%) *Model B* (Profitability assessment): *Average Efficiency level*: 51.25% *No of efficient branches*:3/20 (15%) *Sources of relative inefficiency*: No of personnel, Branch Age, No and "activity" of accounts, location, administrative expenses
Vasiloglou and Giokas (1990)	Greece	*Inputs*: Labor, supplies, floor-space, computer terminals *Outputs*: No of transactions	*Average Efficiency level*: 90.6% *No of efficient branches*:9/20 (45%) *Sources of relative inefficiency*: Location, Size, Proximity of branches

Table 1. (continue).

Authors	**Country**	**Inputs /Outputs**	**Results**
Giokas (1991)	Greece	*Inputs*: labor (person hours), operating expenses and utilized space branch. *Outputs*: Transactions	*Average Efficiency level*: 87.3% *No of efficient branches*: 12/17 (70.6%) *Sources of relative inefficiency* Branch size, economies of scale related to personnel and supply usage
Al-Faraj, Alidi and Bu-Bshait (1993)	Saudi Arabia	*Inputs*: No of employees, % of employees with college degrees, location index, highest authority rank index (%), index of expenditure on decoration (%), index of the average monthly salaries (%), index for other operational expenses (%) *Outputs*: Average monthly net profits, average balance of: current accounts, saving accounts, other accounts, average value of mortgages, index for loans, no. of current accounts	*Average Efficiency level*: 86% *No of efficient branches*: 12/15 (80%)
Drake and Howcroft (1994)	UK	*Inputs*: No of interview rooms, No of ATM's, floor area, management grades, clerical grades, stationery costs *Outputs:* till transactions, lending products, deposit products, automated transfers, clearing items, ancillary business, insurance business	*No of efficient branches*: 83/190 (43.68%) *Sources of relative inefficiency*: Size (number of staff), Branch Age, Location and Competitive environment, Returns to Scale

Table 1. (continue).

Authors	Country	Inputs /Outputs	Results
Athanassopoulos (1998)	UK	*Model A* *Inputs:* No of transactions, potential market, sales representatives, internal automatic facilities, Branch outlets in the surrounding area *Outputs*: Liability sales, loans and mortgages, insurances and securities, no of cards *Model B* *Inputs: Direct labor costs, total technology facilities* *Outputs: No of transactions* Liability sales, loans and mortgages, insurances and securities, no of cards	*Average efficiency level*: Model A (aggregate market efficiency): 85% Model B (aggregate cost efficiency): 82% *Sources of relative inefficiency*: size, level of competition, location, account size; product mix, economies of scope and quality

Table 2. Categories of Branches.

	High operating efficiency	Low operating efficiency
High Profitability	The best-practice branches (1)	Under-performing good branches (2)
Low Profitability	Effectively managed but low profitability. (3)	Under-performing branches (4)

Table 3. Efficiency results.

Branches	Profitability Efficiency (2000)	Profitability Efficiency (1999)	Operational Efficiency (2000)	Operational Efficiency (1999)
1	1.000000	1.000000	1.000000	1.000000
2	0.853370	0.815540	0.891020	0.945650
3	0,790940	0,780800	0,901060	0,940490
4	0,587330	0,686940	0,540640	0,644340
5	0,852440	0,705490	0,686840	0,626830
6	0,835480	1,000000	0,813520	1,000000
7	1,000000	1,000000	0,540360	0,757360
8	1,000000	1,000000	1,000000	1,000000
9	0,742110	1,000000	0,657240	0,714540
10	0,662560	0,829810	0,514970	0,500110
11	0,692640	0,820080	0,722160	0,747490
12	0,868470	0,800970	1,000000	1,000000
13	0,657560	0,688630	0,672640	0,697910
14	0,658320	0,983010	0,736210	0,731880
15	0,759350	1,000000	0,679160	0,810050
16	0,728570	0,671970	0,814020	0,789820
17	0,810610	1,000000	0,946220	0,931720
18	0,821310	0,901500	0,908910	1,000000
19	1,000000	1,000000	0,516800	0,890740
20	1,000000	1,000000	0,457300	0,625630
21	0,668680	0,561620	0,600180	0,642480
22	0,863550	0,761370	0,516900	0,632980
23	0,715350	0,853950	0,910750	0,955760
24	0,625990	0,683270	0,834270	0,854000
25	1,000000	1,000000	1,000000	1,000000
26	1,000000	0,841690	0,665130	0,656310
27	0,721400	0,669790	0,681120	0,698820
28	1,000000	1,000000	1,000000	1,000000
Average	0,81843	0,859158	0,757408	0,814104
Minimum	0,58733	0,561620	0,457300	0,500110

Endnotes

1.The model assumes constant return to scale (CRS). This allows the comparison between small and large branches. In a sample where a few large branches are present, the use of variable returns to scale (VRS) framework raises the possibility that these large branches will appear as being efficient for the simple reason that there are no truly efficient branches [see Berg at al. (1991) for more on this point]. Since our sample includes a few large branches, we adopt the CRS framework.

References

1. Al-Faraj, T., Alidi, A.S. and Bu-Bshait, K.A. (1993). Evaluation of Bank Branches by Means of Data Envelopment Analysis. *International Journal of Operations and Production Management*, No. 13, pp. 45-52.
2. Al-Shammari, M. and Salimi, A. (1998). Modeling the operating efficiency of banks: a nonparametric methodology. *Logistics Information Management*, Vol. 11, No.1, pp. 5-17.
3. Athanassopoulos, A.D. (1998). Nonparametric Frontier Models for Assessing the Market and Cost Efficiency of Large-Scale Bank Branch Networks. *Journal of Money, Credit and Banking*, Vol. 30, No. 2, pp. 172-192.
4. Banker, R.D. and Maindiratla, A. (1988). Nonparametric analysis of technical and allocative scale inefficiencies in data envelopment analysis. *Management Science*, Vol. 30, No. 9, pp. 1315 –32.
5. Barnes, P. (1987). The analysis and use of financial ratios: A review article. *Journal of Business, Finance and Accounting*, Vol. 14, pp. 449-61.
6. Barr, R.S. and Siems, T.F. (1994). Predicting Bank Failure Using DEA to Quantify Management Quality. Financial Industry Studies Working Paper, No. 1-94, *Federal Reserve Bank of Dallas.*
7. Berger, A.N. (2001). The integration of the financial services industry: Where are the efficiencies? *North American Actuarial Journal*, Vol. 4, No. 3, pp. 25-44.
8. Berger, A.N., Leusner, J.H. and Mingo, J.J. (1997). The Efficiency of bank branches. *Journal of Monetary Economics*, Vol. 40, pp.141-162.
9. Charnes, A. Cooper, W. and Rhoades, E. (1978). Measuring the efficiency of decision making units", *European Journal of Operation Research*, Vol. 2, pp. 429-44.
10. Chen, T. and Yen, T. (1997). A study of efficiency evaluation in Taiwan's bank's. *International Journal of Service Industry Management*, Vol. 9, No. 5, pp. 402-415.
11. Drake, L. and Howcroft, B. (1994). Relative efficiency in the branch network of a U.K. bank: An empirical study. *OMEGA*, Vol. 22, No.1, pp. 83-90.
12. Drake, L. and Wayman –Jones, T.G. (1992). *Productive and Allocative Inefficiency in UK Building Societies: A Comparison of Non-Parametric and Stochastic Frontier Techniques*, Loughborough University of Technology Economic Research Paper, No. 92/2.

13. Fernadez – Castro, A. and Smith, P. (1994). Towards a general non-parametric model of corporate performance, *OMEGA*, Vol. 22, No. 3, pp. 237-49.
14. Giokas, D. (1991). Bank branch operating efficiency: A comparative application of DEA and the loglinear model. *OMEGA International Journal of Management Science*, Vol. 19, pp. 549-557.
15. Miller, S. and Noulas, A. (1996). The technical efficiency of large bank production. *Journal of Banking and Finance*, 20, pp. 495-509.
16. Molyneux, P. Altunbas, Y, and Gardener, E. (1997). *Efficiency in European Banking*, Wiley & Sons Ltd, England.
17. Noulas, A. (1997). Productivity growth in the Hellenic banking industry: state versus private banks. *Applied Financial Economics*, No. 7, pp. 223-228.
18. Noulas, A. (2001). Deregulation and operating efficiency: The case of Greek banks. *Managerial Finance*, Vol.27, No. 8, pp. 35-47.
19. 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, No. 3, pp. 282-94.
20. Parkan, C. (1987). Measuring the efficiency of service operations: an application to bank branches. *Engineering Costs and Production Economics*, Vol. 12, No. 2, pp. 237-42.
21. Sherman, H.D. and Gold, F. (1985). Bank branch operating efficiency: evaluation with data envelopment analysis. *Journal of Banking and Finance*, Vol. 9, No. 2, pp. 297-315.
22. Smith, P. (1990). Data envelopment analysis applied to financial statements. *OMEGA*, Vol. 18, No. 2, pp. 131-8.
23. Vassiloglou, M. and Giokas, D. (1990). A study of the relative efficiency of bank branches: An application of data envelopment analysis. *Journal of the Operational Research Society*, Vol. 41, No. 7, pp. 591-7.
24. Whittington, G. (1980). Some basic priorities of accounting ratios. *Journal of Business, Finance and Accounting*, Vol. 72, No. 2, pp. 219-23.