Efficiency Measures of the Greek Banking Sector: A Non-Parametric Approach for the Period 1997-1999

Halkos, George and Salamouris, Dimitrios

University of Thessaly, Department of Economics

6 May 2001

University of Thessaly
Department of Economics
Discussion paper series 01/04

Efficiency measures of the Greek Banking Sector: A non-parametric approach for the period 1997-1999

By

George E. Halkos & Dimitrios S. Salamouris†

Department of Economics, University of Thessaly
Korai 43,38333, Volos, Greece

ABSTRACT

This study explores the efficiency of the Greek Banking sector with the use of a number of suggested financial efficiency ratios for the time period 1997-99. A non-parametric analytic technique (Data Envelopment Analysis) is employed for measuring efficiency. The suggested model in our analysis offers an empirical reference set for comparing the inefficient banks with the efficient ones. For each year we estimate the relative efficiency and determine the feasible targets for improvement of each bank. The analysis shows that, the total improvement in efficiency in the Banking sector is mainly attributed to the increase in the efficiency ratio resulting from the significant increase in revenues mainly from their activation in the Greek Stock Exchange Market. We find that the higher the size of total assets the higher the efficiency is. We also show that the increase in efficiency is accompanied with a reduction in the number of small banks due to mergers and acquisitions.

Keywords: Banking, Financial ratios, Data Envelopment Analysis

Introduction

In the Greek financial system, the commercial banks play an important role and contribute substantially to the finance of the national economy. The Greek banking industry has presented a substantial development over the last years. Since the end of 1980's it has entered a new stage with several changes which started with the Report of the Karatza's Committee (1987). These changes go on until today and it is expected to continue in the future as well.

The main changes in the banking system after 1992 include among others the liberalization of interest rate determination[1], the abolition of various credit rules, the free movement of capital and the increased competition from banks of the European Union (Noulas, 1999). As a result, banks are free to determine their interest policy for deposits and loans since 1993. In the same year, banks were allowed to follow their investment policy without the restriction of investing a certain percentage in government bonds. These two measures towards further liberalization have driven to increased competition to both price and quality levels of the offered services by the banking sector. The competition among banks has increased mainly due to this market liberalization, technological improvements and the entrance of non-banking institutions for the provision of banking services in the form of non-intermediation (Staikouras and Steliarou, 1999). The competition has strengthened with the emergence of banking institutes from the EU but also from the competition from other credit institutes such as insurance companies and cooperative banks.

Although till recently the main choice of banks to achieve their targets for development was by growing the components of their assets, today this choice is moved to the increase of profitability. All of the above require the determination of factors which play an important role in the profitability of banks in the new environment.

The task of this study is to examine the efficiency of the commercial banking system during the period 1997-1999 and the relative efficiency of each bank. For this reason we employ a non-parametric analytic technique (Data Envelopment Analysis, DEA) for the measurement of efficiency with the use of financial ratios which are

[1] For the consequences in banks' efficiency from the reduction in interest rates in the zone of EURO see Thanos (2001)

frequently applied in the banking sector[2]. It is also generally accepted among analysts of the banking sector, that the efficiency of a bank is multidimensional from its nature.

Specifically the efficiency of a bank is measured by using the ratios of return on equity, return on total assets, the difference of interest bearing elements Assets and Liabilities, the profit/loss per employee, the efficiency ratio and the net interest margin ratio. Our analysis includes 17 banks for the year 1999, 19 banks for the year 1998 and 21 banks for the year 1997. Our data were extracted and analyzed from the Balance Sheets and Profit and Loss Accounts of the Banks under consideration.

Before we proceed in the presentation of the method used, we have to emphasize that the derivation of reasonable conclusions related to the comparative performance of a subset of banks pre-supposes that this comparison is carried out among banks operating in homogeneous markets. That is, we compare banks with the maximum feasible homogeneity in their offered services. The structure of this study is as follows. In the next section the suggested non-parametric technique is described. Then the methodology and the financial ratios employed are analyzed and the banks included in our sample are also presented. Finally, we end to conclusions, comments and policy implications from the results obtained.

The Technique

In our study a non-parametric analytic technique for the evaluation of corporate performance is applied. Specifically, we employ a Data Envelopment Analysis (hereafter D.E.A.) technique which is a non-statistical method relying on linear programming. It provides a measure of relative technical efficiency of different decision-making units (hereafter DMUs) operating and performing in the same or similar tasks. The technique's main advantage is that it can deal with the case of multiple inputs and outputs as well as factors, which are not controlled by individual management.

The main advantage of this non-parametric technique, and in general of all the non-parametric techniques, is that we skip most of the usual difficulties, which arise by the use of parametric methods in the analysis of financial ratios. That is, we skip problems like the necessity to determine the functional form[3] or to determine the

[2] See Vasiliou D. (1993), Mathioudaki S. (1995), Siafakas N. (1980)
[3] It is usually assumed that the relationship between the variables is linear.

statistical distribution of the ratios. Additionally, when we refer to the analysis of financial ratios problems arise if the numerator or the denominator take negative values, while the manipulation of outliers is not clear. On the contrary, using the proposed technique we cope with these difficulties and we mainly seek for the most efficient banks relying on the empirical data in use. Then we may compare the less efficient banks with the most efficient ones in our sample.

In the literature the measurement of comparative efficiency of banks has shown a growing interest. A set of papers uses non-parametric methods for determining the efficient banks (Berg A., Forsund F. & Jansen E., 1991, Berg A., Forsund F., Hjalmarsson L. & Suminen M., 1993, Ferrier G & Lovell C., 1990, Fucuyama H., 1993). Another set of papers has studied the comparative efficiency of branches of a certain bank (Oral M. & Yolalan R., 1990, Sherman D. & Gold F., 1990, Haag E. and Jaska V., 1995). Concerning the Greek commercial banks we have a number of studies. Giokas D. (1991) and Vassiloglou M. & Giokas D. (1996) evaluated the relative effectivenes of the branches of some commercial banks while Noulas A. (1994) presents a comparison of efficiency for the Greek Banking Institutions.

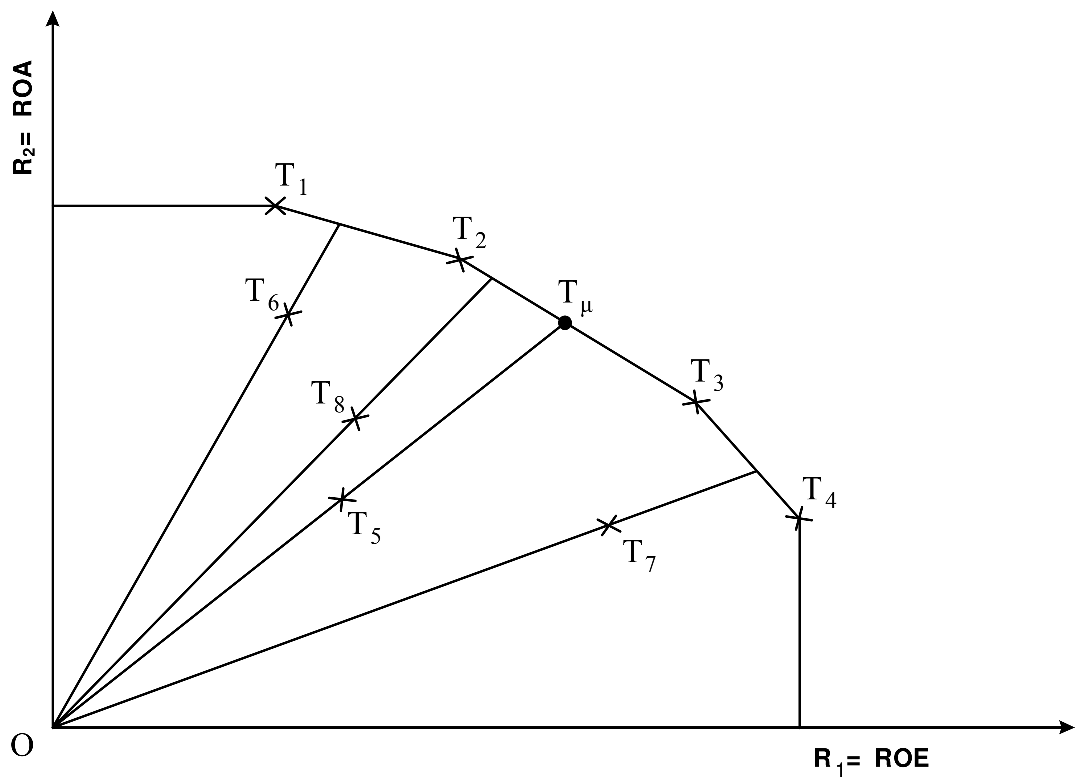
The application of this technique facilitates the comparison of efficiency for a large sample of banks with the simultaneous use of multiple criteria, which determine efficiency for each bank. The comparative advantage of this model in comparison to the broadly employed simple ratio analysis, is that it forms a rounded judgement on firms efficiency, taking into consideration a variety of ratios simultaneously and combining them into a single measure of efficiency. Thus, the comparison of relative efficiency of the sample banks is carried out, relying on the derived efficiency ratio for every bank, as the solution of the mathematical model. The higher a bank's efficiency ratio in relation to the corresponding ratio of another bank the higher is the efficiency of this bank.

We may think of DEA as measuring the technical efficiency of a given bank by calculating an efficiency ratio equal to a weighted sum of outputs over a weighted sum of inputs. For each DMU these weights are derived by solving an optimization problem which involves the maximization of the efficiency ratio for that DMU subject to the constraint that the equivalent ratios for every DMU in the set is less than or equal to 1.

That is, DEA seeks to determine which of the N DMUs determine an envelopment surface or efficient frontier. DMUs lying on the surface are deemed efficient, while DMUs that do not lie on the frontier are termed inefficient, and the analysis provides a measure of their relative efficiency. As mentioned, the solution of the model dictates the solution of (N) linear programming problems, one for each DMU. It provides us with an efficiency measure for each DMU and shows by how much each of a DMU's ratios should be improved if it were to perform at the same level as the best performing banks in the sample. In this way we extract an efficiency ratio for each bank which shows us by how much the ratios of each bank could be improved so as to reach the same level of efficiency with that of the most efficient banks in the sample.

The fundamental feature of DEA is that technical efficiency score of each DMU depends on the performance of the sample of which it forms a part. This means that DEA produces relative, rather than absolute, measures of technical efficiency for each DMU under consideration. DEA evaluates a DMU as technically efficient if it has the best ratio of any output to any input and this shows the significance of the outputs/inputs taken under consideration.

Let us now consider the problem diagrammatically. Assume that we examine the efficiency of eight commercial banks (T_1, T_2, … , T_8). To simplify things, we use two efficiency ratios: (a) the return on equity (ROE) and (b) the return on total assets (ROA). Suppose that banks that achieve the optimal efficiency are T_1, T_2, T_3 and T_4. The efficient frontier is determined from the segments that pass through points T_1, T_2, T_3 and T_4. Bank T_5 is not lying on the frontier and it is considered either as less efficient or not efficient. Point T_μ on the surface which determines the optimal level of efficiency, represents the combination of the two ratios R_1 and R_2 in the same proportion as bank T_5 and thus it is considered as the reference point which is used for the measurement of relative efficiency of bank T_5. T_μ is a linear combination of T_2 and T_3. That is the reference subset for bank T_5 is banks T_2 and T_3. The portion by which T_μ prevails T_5 shows us the size of inefficiency. The degree of efficiency for bank T_5 is found by the ratio of the distances OT_5/OT_μ.



Let us now consider the problem from the mathematical point of view. On contrast with the original model suggested by Charnes *et al.* (1978) in our suggested model we do not take inputs under consideration. The main hypothesis behind this is that, inputs are considered similar and equal for all banks as they operate in the same markets for money and services. Thus we give attention to output in the form of financial efficiency ratios. The N under consideration banks produce a vector of outputs R_i in the form of the mentioned financial ratios. The matrix of outputs R_i (with i=1,2,3,…,m) is known for each bank n (with n=1,2,….,N). The n+1 variables to be determined are a set of weights[4] (λ), $(\lambda=\lambda_1, \lambda_2, \ldots, \lambda_\kappa)^{\ell}$ placed on each of the banks in forming the efficiency frontier for firm (ℓ) and an efficiency measure Θ^{ℓ}.

Then the linear program for each bank can be written as:

[4] If a bank wishes to improve its score it would be best to concentrate on those outputs with the highest weight, as the efficiency score is most sensitive to those outputs.

$$
\begin{aligned}
\text{max} \quad & \vartheta_{\ell} \\
\text{subject to} \quad & \sum_{n=1}^{N} \lambda_n R_{in} \geq \vartheta_{\ell} R_{i\,\ell} \quad (\mathrm{i} = 1, 2, \ldots\ldots, \mathrm{m}) \\
& \sum_{n=1}^{N} \lambda_n = 1 \\
& \vartheta_{\ell} \geq 0 \\
& \lambda_n \geq 0 \quad (\mathrm{n} = 1, 2, \ldots\ldots, \mathrm{N})
\end{aligned}
$$

The efficiency score for each bank is given by $\Theta_{\ell}{}^{*} = \dfrac{1}{\vartheta_{\ell}}$, and it is positive and less than or equal to one. DMUs with Θ^* value of unity are deemed efficient while DMUs with a Θ^* score of less than one are considered as inefficient. The optimal weights $(\lambda_1^*, \ldots, \lambda_n^*)^{\ell}$ of the reference group in the solution set a feasible target for improvement in each ratio (R_i) for bank ℓ .

$$
\hat{\mathrm{Y}}_{i\,\ell} = \sum_{n=1}^{N} \lambda_n^{*} R_i \quad \text{or} \quad \hat{\mathrm{Y}}_{i\,\ell} = R_{i\,\ell} \Theta_{\ell}^{*} + s_{i\,\ell}
$$

where ($s_{i\,\ell}$) is the slack on ratio (i) and reflects the non-proportional residual output slack, while (Θ_{ℓ}^{*}) reflects the proportional output augmentation. In the number of cases where a DMU exhibited a negative ratio, the constraint associated with the negative ratio was amended to the following:

$$
\sum_{n=1}^{N} \lambda_n R_{in} \geq R_{i\,\ell}
$$

ensuring that the reference group exhibits performance not worse than a reference bank on the ratio on which this firm has negative performance along the lines suggested by Banker and Morey (1986) and Smith (1990).

The analysis of weights is particularly instructive when we consider banks which seems to be efficient (Θ^*=1). The weights indicate whether this efficiency is a result of exceptional performance in just one or two dimensions. A bank may choose to concentrate on just one output producing an exceptional performance along that dimension. Then whatever the performance along other outputs this bank will be deemed efficient. There is simply no other bank with which to compare it. This is a drawback of DEA and shows the difficulty of interpreting apparent efficiency in banks adopting unusual patterns of ouputs (or inputs). The weights derived in this way show the importance given on the output by the bank under consideration. DEA makes no judgments about the validity of such values and limits the search for optimal performance amongst comparison groups adopting similar values.

Methodological approach

In our analysis we take under consideration all the Greek commercial banks members of the Union of Greek Banks[5]. We exclude banks with particular characteristics like ETBA and ETEBA as they are considered as investment rather than commercial banks. This is done for insuring the maximum feasible comparability among banks. Thus knowing that all banks considered in our sample offer approximately same services we secure that whatever observed difference in efficiency can be explained in differences in technical efficiency and not in lack of comparability.

Multiple criteria are used in our effort to explore the efficiency of banks. A variety of financial ratios are applied for this evaluation with each ratio to provide indications for a bank's technical efficiency. However it is worth mentioning, that no one of these ratios on its own provides an adequate indication of a bank's efficiency. Thus in our study we select six financial ratios which reflect the most important dimensions of their performance. The financial ratios used as outputs of a commercial bank's activities are the following[6].

1. Return Difference of Interest Bearing Assets (R.D.I.B.A):

This ratio is calculated as the return difference of the interest bearing Assets and the interest rate cost of the Liabilities. Specifically,

---

[5] Banks which are included in our sample for the years 1997, 1998, 1999 are (by alphabetical order) the following: Agricultural Bank of Greece, Bank of Athens, ALPHA Bank, Aspis Bank, Bank of Attica, General Bank, Egnatia Bank, National Bank of Greece, National Housing Bank of Greece (where in its balance sheets and profit and loss accounts the economic-financial data of the National Mortgage Bank S.A. are included which has been acquitted by the Law No 2515/97), Commercial Bank of Greece, Ergasias Bank, EFG Eurobank (EFG Eurobank Ergasias), Ionian and Popular Bank of Greece, Bank of Central Greece, Bank of Crete, Popular Bank Hellas (former European and Popular Bank), Macedonia-Thrace Bank, Telesis Investment bank (former Doriki), Xiosbank.

[6] The choice of ratios used in our study of efficiency, rely on what is most commonly used by bankers and financial analysts. It must be clarified that the ratios chosen could have been more or different depending on the subject of research

$$\textbf{R.D.I. B.A=} \quad \frac{IRSI_t}{(IBA_t + IBA_{t-1})/2} - \frac{IRSC_t}{(IBL_t + IBL_{t-1})/2}$$

where:

IRSI: Interest receivable and similar income
IRSC: Interest receivable and similar charges
IBA: Interest bearing Assets[7]
IBL: Interest bearing Liabilities[8]
t: Time

This ratio is derived as the difference between the interest income divided by the assets that yield interest and the interest cost divided by the liabilities that yield this cost. The larger this difference is, the more efficient is the management of the bank's capital.

2. Return on Equity (**R.O.E., average)**

$$\textbf{R.O.E.=} \quad \frac{PBT_t}{(E_t + E_{t-1})/2}$$

where:

PBT: Profit (Loss) Before Tax
E: Equity[9]
t: Time

This ratio shows the profitable capability of the bank and estimates the efficiency with which the bank exploits its equity.

3. Return on Assets **(R.O.A., average)**

$$\textbf{R.O.A.=} \quad \frac{PBT_t}{(TA_t + TA_{t-1})/2}$$

where:

PBT: Profit (Loss) Before Tax
TA: Total Assets
t: Time

This ratio calculates the yield of the total assets of a bank and therefore it can consist a criterium for evaluating the management goals achieved; i.e. with this index we estimate the efficiency of the invested capital (equity and foreign capital) of a credit institution.

---

[7] Interest Bearing Assets = Cash in hand + Balances with Central Banks + Loans and advances to credit institutions + Loans and advances to customers .

[8] Interest Bearing Liabilities = Amount owned to Credit Institutions + amounts owned to customers + subordinated liabilities

[9] Equity = Shareholders capital + reserves + fixed assets (revaluation) reserve + fixed asset investment subsidy + retained earnings.

4. Profit/Loss per employee **(P/L)**

$$\textbf{P/L} = \frac{PBT_t}{(L_t + L_{t-1})/2}$$

where:

PBT: Profit (Loss) Before Tax
L: Number of employees
t: Time

This ratio shows us the productivity of the bank's labor. A rise in the index number shows a rise in productivity and vice versa.

5. Efficiency ratio **(EFF)**

$$\textbf{EFF} = \frac{OE_t}{GOP_t}$$

where:

OE: Operational expenses[10]
GOP: Gross Operating Profit (Loss)
t: Time

The ratio expresses the percentage of gross income absorbed by the operational costs (management, appropriation, depreciation etc.). The smaller the index is, the more efficient the bank is, because the percentage of the bank's profits and losses is sufficient to cover its financial and other expenses.

We should mention here, that, since the specific ratio is derived as the ratio of the operational expenses to the gross operating profit and loss, the smaller this ratio is, the more efficient this bank is. For reasons of convenience with the other indices, the efficiency variable (EFF) was used in our application as 1/EFF.

6. Net Interest Margin **(N.I.M.)**

$$\textbf{N.I.M.} = \frac{NI_t}{(TA_t + TA_{t-1})/2}$$

where:

NI: Net Income

[10] Operating expenses = Commissions payable + staff costs and other administrative expenses + fixed assets depreciation + other operating charges + extraordinary charges.

TA: Total Assets
t: Time

This ratio shows the Total Assets' efficiency. Thus, taking as granted the fact that all the other factors, which influence a bank's yield, are fixed, we calculate a bank's efficiency with the use of the above-mentioned indices, which reflect different efficiency aspects.

EMPIRICAL RESULTS

According to the derived results from the solution of the model, it emerges that the annual efficiency ratios of the commercial banks under consideration range from 0,29 to 1. Six banks are considered to be efficient for the year 1999, four for the year 1998 and four for the year 1997. Specifically, as it can be seen in Table 1, efficient banks are considered to be those with efficiency ratio equal to one ($\Theta^*=1$). The banks that appear to have a rather good performance in the year 1999 are banks 7, 8, 9, 10, 14 and 16, which form the reference set or the comparison group for the inefficient banks. Similar conclusions may be derived from Tables 2 and 3. The efficient banks for the year 1998 are 4, 7, 9 and 16 whereas for the year 1997 are banks 4, 5, 7 and 9.

The first columns in Tables 1-3 represent the banks, the second columns the efficiency ratios, the third columns the reference set for the inefficient banks compared to the efficient ones, whereas the last columns show the rank of banks according to their efficiency. The same column shows us how many times the efficient banks constitute a reference and comparison criterium for the inefficient banks (the numbers in parentheses). That is, how many times the specific bank appears to be a member of the reference set.

Table 1: Efficiency ratios, reference set and rank for 1999

1999	$\Theta_\ell^* = \frac{1}{\vartheta_\ell}$	Reference Set	Rank
7	1.0000	$T_7 = 1$	1 (3)
8	1.0000	$T_8 = 1$	1 (8)
9	1.0000	$T_9 = 1$	1 (12)
10	1.0000	$T_{10} = 1$	1 (1)
14	1.0000	$T_{14} = 1$	1 (3)
16	1.0000	$T_{16}=1$	1 (3)
4	0.9317	$T_9 = 1$	7
17	0.9085	$T_8 = 0{,}3981$ $T_9 = 0{,}6019$	8
2	0.8474	$T_9 = 0{,}7185$ $T_{16} = 0{,}2815$	9
15	0.8253	$T_9 = 0{,}1619$ $T_{14} = 0{,}5878$ $T_{16} = 0{,}2504$	10
5	0.8007	$T_8 = 0{,}0266$ $T_9 = 0{,}9734$	11
11	0.7264	$T_8 = 0{,}6632$ $T_9 = 0{,}3368$	12
6	0.6784	$T_8 = 0{,}2482$ $T_9 = 0{,}7517$	13
13	0.6454	$T_7 = 0{,}1453$ $T_8 = 0{,}4697$ $T_9 = 0{,}385$	14
12	0.5311	$T_7 = 0{,}099$ $T_9 = 0{,}901$	15
3	0.4879	$T_8 = 0{,}0872$ $T_9 = 0{,}9128$	16
1	0.3844	$T_8 = 0{,}7758$ $T_9 = 0{,}0589$ $T_{14} = 0{,}1654$	17

Table 2: Efficiency ratios, reference set and rank for 1998

1998	$\Theta_\ell^* = \frac{1}{\vartheta_\ell}$	Reference Set	Rank
4	1.0000	$T_4 = 1$	1 (12)
7	1.0000	$T_7 = 1$	1 (10)
9	1.0000	$T_9 = 1$	1 (8)
16	1.0000	$T_{16} = 1$	1 (13)
14	0.8906	$T_7 = 0{,}2037$ $T_{16} = 0{,}7963$	5
5	0.8444	$T_4 = 0{,}7211$ $T_7 = 0{,}2789$	6
17	0.8076	$T_4 = 0{,}0811$ $T_7 = 0{,}1412$ $T_9 = 0{,}7777$	7
8	0.8067	$T_4 = 0{,}3592$ $T_7 = 0{,}5517$ $T_{16} = 0{,}0891$	8
2	0.7765	$T_9 = 0{,}5865$ $T_{16} = 0{,}4135$	9
6	0.7762	$T_4 = 0{,}8797$ $T_7 = 0{,}1058$ $T_{16} = 0{,}0146$	10
3	0.7640	$T_4 = 0{,}8973$ $T_7=0{,}0758$ $T_{16} = 0{,}0269$	11
15	0.6993	$T_9 = 0{,}0986$ $T_{16} = 0{,}9014$	12
13	0.6316	$T_4= 0{,}3027$ $T_7 = 0{,}364$ $T_{16} = 0{,}3332$	13
10	0.5394	$T_7= 0{,}4166$ $T_{16} = 0{,}5833$	14
12	0.5079	$T_4 = 0{,}0046$ $T_9 = 0{,}2579$ $T_{16} = 0{,}7375$	15
18	0.4880	$T_4=0{,}6745$ $T_7=0{,}2309$ $T_{16}=0{,}0945$	16
19	0.4488	$T_4=0{,}3737$ $T_9=0{,}5342$ $T_{16}=0{,}0922$	17
11	0.4350	$T_4=0{,}1864$ $T_9=0{,}7835$ $T_{16}=0{,}0302$	18
1	0.2874	$T_4=0{,}0377$ $T_9=0{,}9623$	19

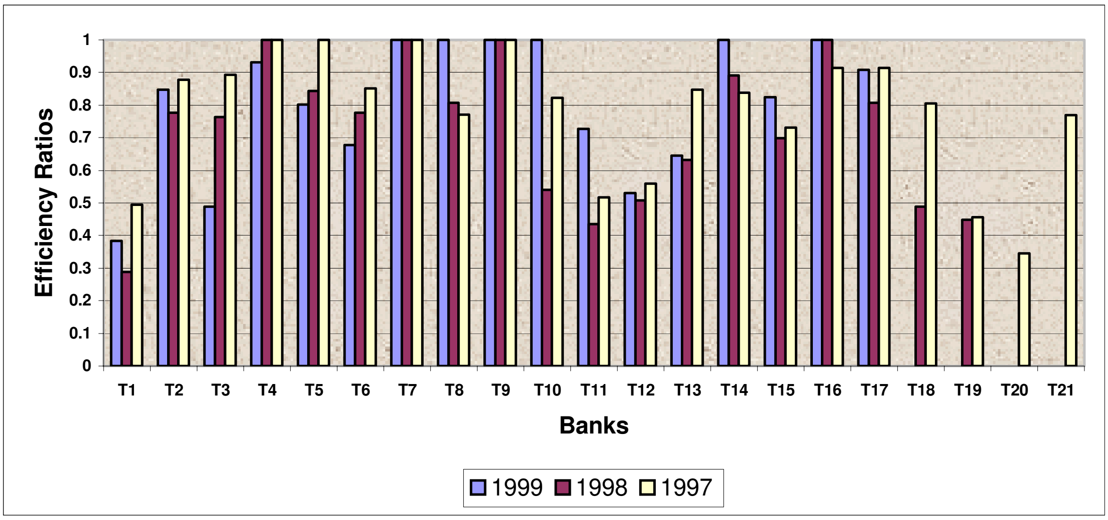
Table 3: Efficiency ratios, reference set and rank for 1997

1997	$\Theta_\ell{}^* = \frac{1}{\vartheta_\ell}$	Reference Set	Rank
4	1.0000	$T_4 = 1$	1 (5)
5	1.0000	$T_5 = 1$	1 (9)
7	1.0000	$T_7 = 1$	1 (4)
9	1.0000	$T_9 = 1$	1 (17)
17	0.9139	$T_5 = 0{,}224$ $T_9 = 0{,}776$	5
16	0.9134	$T_5 = 0{,}1445$ $T_9 = 0{,}8555$	6
3	0.8930	$T_4 = 0{,}1521$ $T_9 = 0{,}8479$	7
2	0.8771	$T_9 = 1$	8
6	0.8518	$T_4 = 0{,}1304$ $T_9 = 0{,}8696$	9
13	0.8478	$T_5 = 0{,}3958$ $T_9 = 0{,}6042$	10
14	0.8387	$T_5 = 0{,}3846$ $T_9 = 0{,}6154$	11
10	0.8217	$T_5 = 0{,}2995$ $T_9 = 0{,}7005$	12
18	0.8061	$T_5 = 0{,}2387$ $T_9 = 0{,}7613$	13
8	0.7703	$T_5 = 0{,}5508$ $T_7 = 0{,}2374$ $T_9 = 0{,}2118$	14
21	0.7688	$T_9 = 1$	15
15	0.7309	T9 = 1	16
12	0.5600	$T_7 = 0.1533$ $T_9 = 0{,}8467$	17
11	0.5178	$T_5 = 0{,}2807$ $T_7 = 0{,}2236$ $T_9 = 0{,}4957$	18
1	0.4944	$T_4 = 0{,}5358$ $T_9 = 0{,}4642$	19
19	0.4568	$T_4 = 0{,}1605$ $T_9 = 0{,}8395$	20
20	0.3462	$T_9 = 1$	21

The following figure 1 and table 4 give us a clear and complete picture of relative efficiency for our sample's banks during the time period 1997-99. As it can be seen, banks T_{20} and T_{21} in 1998 and banks T_{18} and T_{19} in 1999 were absorbed or acquired by other sample banks. If we compare the efficiency of these banks with the average as well as the median efficiency for our sample banks, we realize that it is much lower. Thus the conclusion that can be extracted is that less efficiency makes banks vulnerable and it may lead to mergers and acquisitions[11].

[11] The reasons that lead to a merger or acquisition are more than one and do not relate to the specific study; the economic state, however, plays an important role.

Diagram 1: Relative efficiencies of Commercial Banks during 1997 -1999



The efficiency of the banking sector in total shows an improvement during the period 1997-1999. As it can be seen in table 4 the average banks' efficiency increased from 78.14% in 1997 to 80.98% in 1999 with a remarkable decrease in 1998 to 72.12%. During the time period 1997-1999 eight banks appear to be efficient. Among them, banks T_7 and T_9 appear to be efficient in all three years of our study, banks T_4 and T_{16} in two years, while banks T_{14}, $T_{5,}$ T_8 and T_{10} in just one year. In table 4, a banks' efficiency, for the examined time period, is presented in the 5th column while the corresponding rank of banks is shown in the last column.

Table 4: Average efficiency ratio and total rank for the years 1997-99

Bank	1999	1998	1997	Average	Rank
T_9	1	1	1	1	1
T_7	1	1	1	1	2
T_4	0.9317	1	1	0.9772	3
T_{16}	1	1	0.9134	0.9711	4
T_{14}	1	0.8906	0.8387	0.9098	5
T_5	0.8007	0.8444	1	0.8817	6
T_{17}	0.9085	0.8076	0.9139	0.8767	7
T_8	1	0.8067	0.7703	0.8590	8
T_2	0.8474	0.7765	0.8771	0.8337	9
T_{10}	1	0.5394	0.8217	0.7870	10
T_6	0.6784	0.7762	0.8518	0.7688	11
T_{21}			0.7688	0.7688	12
T_{15}	0.8253	0.6993	0.7309	0.7518	13
T_3	0.4879	0.764	0.893	0.7150	14
T_{13}	0.6454	0.6316	0.8478	0.7083	15
T_{18}		0.488	0.8061	0.6471	16
T_{11}	0.7264	0.435	0.5178	0.5597	17
T_{12}	0.5311	0.5079	0.56	0.5330	18
T_{19}		0.4488	0.4568	0.4528	19
T_1	0.3844	0.2874	0.4944	0.3887	20
T_{20}			0.3462	0.3462	21
Mean	0.8098	0.7212	0.7814	0.7815	
Median	0.8474	0.7762	0.8387	0.8388	
Maximum	1	1	1	1	
Minimum	0.3844	0.2874	0.3462	0.3462	

At this point it is worth mentioning that a bank which appears to be in the efficient frontier for the less efficient banks, the most times, is considered to be the Global leader. By counting how many times each bank appears to be in the reference set (Tables 1-3), we notice that bank T_9 is the most efficient. This bank appears 37 times (more than all the other efficient banks) to be part of the reference set during the time period considered. This means that its performance is greater on average in all dimensions of efficiencies as they are described in our model compared to the other efficient sample banks.

Whenever possible, it is recommended to study banks' efficiency for a period of more than one year, especially when a non parametric technique such as the Data Envelopment Analysis is used. Such an analysis is sensitive to outliers or to error measurement of the variables included. For example, as it can be seen in Table 4, bank $T_{10,}$ and to a less extent, bank $T_{8,}$ have an average efficiency during all three years of

78,70% and 85,90%, respectively, and thus they are ranked as 8^{th} and 10^{th}. In the case we explore an one-year efficiency we should, potentially, exclude these banks from our sample or we should redefine the evaluation criteria (variables).

As it can be seen from the mathematical formulation, the feasible target for the improvement of every ratio is achieved by summing up the products of the weights (λ_i) and the respective ratios (R_i). The financial ratios that are used for each bank's efficiency as well as the feasible target for improving any ratio are shown in Tables 5-7. We notice that for the banks that consist the efficient frontier, there is no difference between the real ratios and the feasible targets. On the other hand, there is a possibility of improvement for all banks whose efficiency, according to Tables 1-3, is less than 1.

It is worth mentioning that Table 5 must be read along with Table 1, as both Tables refer to the year 1999. For instance, let us examine bank 2 (T_2). By looking first at Table 1, we notice that the reference set of T_2 is T_9 and T_{16}. This means that T_9 defines by 0,7185 and T_{16} by 0,2815 the feasible improvement targets of all T_2's ratios. So, as is shown in Table 5, the feasible target for the respective T_2's ratios will be given as the sum of the products of the respective weights for the reference set (T_9 και T_{16}) of T_2 multiplied by the matrix-columns that include the ratios of the reference set banks. Specifically, for the case under consideration:

$$\hat{\Upsilon}_{i2} = \sum_{n=1}^{N} \lambda_n^* R_i$$

so, the feasible target for T_2 will be calculated as:

$$\hat{\Upsilon}_{i\,2} = 0{,}7185 * \begin{bmatrix} 0{,}044 \\ 0{,}492 \\ 0{,}047 \\ 34{,}240 \\ 0.312 \\ 0{,}044 \end{bmatrix} + 0.2815 * \begin{bmatrix} 0{,}050 \\ 0{,}088 \\ 0{,}031 \\ 45{,}636 \\ 0{,}331 \\ 0{,}034 \end{bmatrix} = \begin{bmatrix} 0{,}046 \\ 0{,}379 \\ 0{,}043 \\ 37{,}448 \\ 0{,}317 \\ 0{,}041 \end{bmatrix}$$

In a similar way, for each bank the rest of the feasible efficient target ratios can be calculated for every year.

The current trend towards mergers and acquisitions in combination with privatization policies for the publicly owned-controlled banking institutes establish new conditions in the banking sector. The main task is the increase in efficiency and competitiveness of the banking system through the increase of the average size of Greek banks and the exploitation of economies of scale.

Table 5: Financial ratios per bank and feasible targets (1999)
The feasible targets for each ratio appears in parentheses

Banks	RDIBA	ROE	ROA	P/L	EFF	NIM
1	0,007 (0,073)	0,328 (0,676)	0,024 (0,071)	20,936 (43,137)	1,076 (0,555)	0,012 (0,032)
2	0,024 (0,046)	0,310 (0,379)	0,028 (0,043)	31,505 (37,448)	0,376 (0,317)	0,020 (0,041)
3	0,023 (0,047)	0,024 (0,518)	0,006 (0,050)	4,548 (34,848)	0,817 (0,338)	0,012 (0,043)
4	0,036 (0,044)	0,212 (0,492)	0,027 (0,047)	8,872 (34,240)	0,595 (0,312)	0,041 (0,044)
5	0,036 (0,045)	0,260 (0,500)	0,018 (0,048)	5,725 (34,425)	0,706 (0,320)	0,035 (0,043)
6	0,033 (0,053)	0,122 (0,566)	0,015 (0,055)	7,355 (35,966)	0,726 (0,387)	0,028 (0,041)
7	0,094 (0,094)	0,384 (0,384)	0,018 (0,018)	14,440 (14,440)	0,510 (0,510)	0,022 (0,022)
8	0,080 (0,080)	0,790 (0,790)	0,078 (0,078)	41,208 (41,208)	0,616 (0,616)	0,033 (0,033)
9	0,044 (0,044)	0,492 (0,492)	0,047 (0,047)	34,240 (34,240)	0,312 (0,312)	0,044 (0,044)
10	0,087 (0,087)	0,141 (0,141)	0,019 (0,019)	12,737 (12,737)	0,842 (0,842)	0,030 (0,030)
11	0,024 (0,068)	0,501 (0,689)	0,020 (0,068)	9,808 (38,861)	0,638 (0,513)	0,023 (0,037)
12	0,026 (0,049)	0,120 (0,482)	0,009 (0,044)	8,587 (32,280)	0,610 (0,331)	0,021 (0,042)
13	0,044 (0,068)	0,091 (0,616)	0,014 (0,058)	6,986 (34,636)	0,679 (0,483)	0,023 (0,036)
14	0,052 (0,052)	0,205 (0,205)	0,046 (0,046)	55,328 (55,328)	0,356 (0,356)	0,019 (0,019)
15	0,038 (0,050)	0,180 (0,223)	0,035 (0,042)	40,840 (49,493)	0,414 (0,343)	0,020 (0,027)
16	0,050 (0,050)	0,088 (0,088)	0,031 (0,031)	45,636 (45,636)	0,331 (0,331)	0,034 (0,034)
17	0,053 (0,059)	0,316 (0,611)	0,029 (0,060)	23,149 (37,014)	0,523 (0,433)	0,036 (0,040)

Table 6: Financial ratios per bank and feasible targets (1998)

The feasible targets for each ratio appears in parentheses

Banks	RDIBA	ROE	ROA	P/L	EFF	NIM
1	0,006 (0,048)	0 (0,495)	0 (0,038)	0 (23,778)	1,232 (0,367)	0,013 (0,045)
2	0,030 (0,054)	0,308 (0,397)	0,023 (0,038)	20,434 (26,313)	0,485 (0,362)	0,025 (0,043)
3	0,040 (0,053)	0,037 (0,183)	0,004 (0,018)	1,772 (4,903)	0,922 (0,714)	0,037 (0,049)
4	0,047 (0,047)	0,171 (0,171)	0,018 (0,018)	3,880 (3,880)	0,732 (0,732)	0,051 (0,051)
5	0,055 (0,065)	0,156 (0,209)	0,009 (0,016)	2,277 (5,178)	0,825 (0,700)	0,036 (0,043)
6	0,042 (0,054)	0,016 (0,186)	0,001 (0,018)	0,664 (4,737)	0,912 (0,715)	0,037 (0,048)
7	0,112 (0,112)	0,310 (0,310)	0,012 (0,012)	8,535 (8,535)	0,616 (0,616)	0,021 (0,021)
8	0,068 (0,084)	0,155 (0,254)	0,009 (0,016)	3,951 (8,669)	0,764 (0,636)	0,027 (0,034)
9	0,048 (0,048)	0,507 (0,507)	0,039 (0,039)	24,557 (24,557)	0,352 (0,352)	0,045 (0,045)
10	0,045 (0,083)	0,045 (0,269)	0,005 (0,025)	3,644 (20,356)	0,834 (0,476)	0,014 (0,032)
11	0,021 (0,048)	-0,298 (0,437)	-0,011 (0,035)	-5,302 (20,834)	0,887 (0,424)	0,020 (0,046)
12	0,030 (0,059)	0,131 (0,308)	0,006 (0,036)	5,245 (27,593)	0,727 (0,372)	0,021 (0,042)
13	0,048 (0,076)	0 (0,244)	0 (0,021)	0 (13,878)	0,839 (0,571)	0,023 (0,037)
14	0,065 (0,073)	0,219 (0,254)	0,027 (0,030)	19,522 (24,674)	0,491 (0,426)	0,024 (0,036)
15	0,022 (0,062)	0,186 (0,266)	0,018 (0,035)	19,823 (28,384)	0,862 (0,374)	0,019 (0,041)
16	0,063 (0,063)	0,240 (0,240)	0,035 (0,035)	28,802 (28,802)	0,377 (0,377)	0,040 (0,040)
17	0,046 (0,057)	0,365 (0,452)	0,019 (0,034)	11,823 (20,618)	0,639 (0,420)	0,034 (0,042)
18	0,031 (0,064)	-0,174 (0,209)	-0,016 (0,018)	-4,884 (7,310)	1,324 (0,672)	0,021 (0,043)
19	0,022 (0,049)	-0,077 (0,357)	-0,008 (0,031)	-2,166 (17,224)	0,971 (0,496)	0,021 (0,047)

Table 7: Financial ratios per bank and feasible targets (1997)

The feasible targets for each ratio appears in parentheses

Banks	RDIBA	ROE	ROA	P/L	EFF	NIM
1	0,020 (0,049)	0 (0,319)	0 (0,025)	0 (11,593)	1,041 (0,637)	0,024 (0,049)
2	0,030 (0,051)	0,308 (0,595)	0,023 (0,044)	20,434 (23,413)	0,485 (0,346)	0,025 (0,048)
3	0,045 (0,050)	0,038 (0,517)	0,005 (0,038)	1,992 (20,058)	0,905 (0,429)	0,043 (0,048)
4	0,047 (0,047)	0,080 (0,080)	0,008 (0,008)	1,353 (1,353)	0,889 (0,889)	0,049 (0,049)
5	0,092 (0,092)	0,093 (0,093)	0,004 (0,004)	0,732 (0,732)	0,879 (0,879)	0,034 (0,034)
6	0,043 (0,050)	0,176 (0,528)	0,011 (0,039)	2,729 (20,537)	4,555 (0,417)	0,041 (0,048)
7	0,091 (0,091)	0,124 (0,124)	0,004 (0,004)	2,433 (2,433)	0,653 (0,653)	0,015 (0,015)
8	0,064 (0,083)	0,104 (0,207)	0,007 (0,012)	2,535 (5,940)	0,811 (0,712)	0,025 (0,033)
9	0,051 (0,051)	0,595 (0,595)	0,044 (0,044)	23,413 (23,413)	0,346 (0,346)	0,048 (0,048)
10	0,052 (0,063)	0,285 (0,445)	0,019 (0,032)	9,533 (16,620)	0,781 (0,506)	0,036 (0,044)
11	0,037 (0,071)	0,009 (0,349)	0 (0,024)	0,180 (12,355)	0,923 (0,564)	0,019 (0,037)
12	0,032 (0,057)	0,130 (0,523)	0,007 (0,038)	5,909 (20,197)	0,666 (0,393)	0,018 (0,043)
13	0,057 (0,067)	0,161 (0,396)	0,008 (0,028)	2,771 (14,436)	0,867 (0,557)	0,036 (0,043)
14	0,056 (0,066)	0,200 (0,402)	0,024 (0,028)	10,252 (14,690)	0,604 (0,551)	0,034 (0,043)
15	0,019 (0,051)	0,292 (0,595)	0,014 (0,044)	17,115 (23,413)	0,976 (0,346)	0,025 (0,048)
16	0,052 (0,057)	0,214 (0,523)	0,024 (0,038)	15,848 (20,136)	0,526 (0,423)	0,42 (0,046)
17	0,055 (0,060)	0,388 (0,483)	0,016 (0,035)	7,975 (18,333)	0,688 (0,466)	0,041 (0,045)
18	0,049 (0,060)	0,000 (0,475)	0 (0,034)	0,005 (17,999)	0,826 (0,473)	0,036 (0,045)
19	0,022 (0,050)	0,035 (0,512)	0,004 (0,038)	1,017 (19,873)	0,840 (0,433)	0,022 (0,048)
20	0,055 (0,051)	0,029 (0,596)	0,002 (0,044)	0,340 (23,413)	0,955 (0,346)	0,036 (0,048)
21	0,035 (0,051)	0,334 (0,595)	0,012 (0,044)	18,497 (23,413)	0,473 (0,346)	0,020 (0,048)

Table 8 ranks all the banks according to the size of their Total Assets in two categories, large and small for all the years of our study. We observe that the average size of assets shows a continuous increase where from 1.436.785 in 1997 reached 1.738.477 in 1998 and 2.375.170 in 1999. At the same time the larger banks appear to be more efficient than the smaller ones in almost all the period of our study. Analytically, the average efficiency of large banks in 1997 is greater than the corresponding for the small banks by 5.4%, while in 1999 the difference in efficiency between small and large banks takes the greatest value of 7.5%. In 1998 the efficiency of these two categories appears to be similar.

Table 8: Comparative bank efficiency according to the size of Total Assets (in million Greek drachmas)

Banks	1999	Θ*	Banks	1998	Θ*	Banks	1997	Θ*
7	12.978.476	1,000	7	12.092.565	1,000	7	9.802.976	1,000
2	5.904.191	0,847	1	4.399.758	0,287	1	4.152.730	0,494
1	4.846.440	0,384	2	4.274.130	0,777	2	3.447.019	0,877
8	4.543.799	1,000	8	3.396.175	0,807	8	3.087.548	0,770
10	2.575.014	1,000	11	1.879.707	0,435	21	2.515.763	0,769
9	2.186.263	1,000	9	1.729.332	1,000	11	2.209.380	0,518
11	1.990.697	0,726	10	1.290.418	0,539	9	1.403.402	1,000
14	1.525.060	1,000	14	670.421	0,891	10	685.257	0,822
13	830.278	0,645	13	642.747	0,632	13	489.949	0,848
17	676.432	0,909	5	523.025	0,844	5	394.880	1,000
5	654.991	0,801	17	508.595	0,808	19	394.234	0,457
6	525.035	0,678	6	418.184	0,776	17	332.617	0,914
4	341.798	0,932	19	401.396	0,449	14	319.294	0,839
12	294.911	0,531	12	206.710	0,508	12	181.698	0,560
3	226.255	0,488	4	197.498	1,000	18	165.889	0,806
16	186.863	1,000	18	178.131	0,488	4	140.262	1,000
15	91.384	0,825	3	88.735	0,764	6	128.726	0,852
			16	85.040	1,000	20	119.520	0,346
			15	48.497	0,699	15	75.679	0,731
						16	64.509	0,913
						3	61.147	0,893
Total Assets	40.377.887			33.031.064			30.172.479	
Mean Assets	2.375.170			1.738.477			1.436.785	
Median Assets	830.278			523.025			394.234	
Average efficiency		0,9177			0,806			0,7814
Average efficiency of Large banks		0,845			0,721			0,810
Average efficiency of Small banks		0,770			0,721			0,756

CONCLUSIONS AND POLICY IMPLICATIONS

In this study the most obvious output is an efficient score for each bank under consideration as well as the generation of target output levels for inefficient banks derived from the performance of the selected comparison group. A continuous improvement of the total performance of the Greek banking system is observed. The reasons for this improvement in profitability for the time period 1997-99 are mainly the following[12]:

i. The significant gains from bonds and participating interest realization, which were 27% higher in 1998 in comparison with 1997 and 182% higher in 1999 in relation to 1998 due to the favorable conditions in the Stock market.
ii. The increase in interest income by 11% in 1998 in comparison with 1997 and 23% in 1999 in relation to 1998, which reflects the increase in loans and interest income from fixed income securities
iii. The increase in revenues from income from shares and other variable yield securities in 1999

The above mentioned reasons show that the profitability of banks is to a less extent due to the increase of traditional banking works and more to the activation of banking institutes in the Athens Stock Exchange Market. Moreover the good performance especially in 1999 is attributed to the improvement in the efficiency ratio. During the three years of our study a noticeable improvement in the efficiency ratio for all of our sample banks is observed. Specifically the average efficiency in 1999 was 91,77%, which was significantly higher in both 1998 and 1997 which were respectively 80,6% and 78,14%. This continuous improvement can be attributed to the significant increase in revenues and not to the reduction in the operating expenses which appear to be increased for all the years of our study. Thus in the following years the reduction in operating expenses is expected to be the means of improvement for banks' competition.

[12] See Union of Greek Banks (2000).

Apart from the increase in the efficiency ratio we observe an increase in size of total assets. The higher the size of total assets the higher the efficiency is. This is confirmed from the significant increase in the sum of the total assets employed in the market as well as the increase in the average level of Banks' Assets. Specifically from 1436785 in 1997 and 1738477 in 1998 it reached its maximum of 2375170 in 1999.

We also observe that the increase in efficiency is accompanied with a continuous reduction in the number of small banks due to mergers and acquisitions. At the same time the increase in competitiveness among banks as well as the privatization policies for the publicly owned-controlled banking institutes have resulted to a significant reduction in the number of banks. It is also worth mentioning that the difference in efficiency between large and small banks takes its maximum value in 1999.

REFERENCES

Ali Al. & Seiford m. (1993), «The Mathematical Programming Approach to Efficiency Analysis. In the Measurement of Productive Efficiency» (Edited by Fried O., Lovell C & Schmidt S.). Oxford University Press, Oxford.

Banker R.D. & Morey R.C. (1986), «Efficiency Analysis for Exogenously Fixed Inputs and Outputs», Operations Research, 34, pp. 513 - 521.

Berg A., Forsund F. & Jansen E. (1991), «Technical Efficiency in Norwegian Banks: A Non Parametric Approach to Efficiency Measurement», Journal of Productivity Analysis, 2, pp.127 – 142.

Berg A., Forsund F., Hjalmarsson L. & Suminen M. (1993), «Banking Efficiency in the Nordic Countries», Journal of Banking and Finance, 17, pp.371 - 388.

Charnes A., Coopers W., Rhodes E. (1978), «Measuring the Efficiency of Decision Making Units», *European Journal Operational Research*, 3, pp. 429 - 444.

Drake & Howcroft D. (1994), «Relative Efficiency in the Branch Network of a U.K. Bank: An Empirical Study», Omega International Journal of Management Science, 22 (1), pp.83 - 90

Fernandez Castro A. & Smith P. (1994), «Towards a General Non Parametric Model of Corporate Performance», Omega International Journal of Management Science, 22 (3), pp.237 – 249.

Ferrier G & Lovell C. (1990), «Measuring Cost Efficiency in Banking: Econometric and Linear programming evidence», Journal of Econometrics, 46, ½, pp.229 – 245.

Fucuyama H. (1993), «Technical and Scale Efficiency of Japanese Commercial Banks: A Non Parametric Approach», Applied Economics, 25, pp.1101 - 1112.

Giokas D. (1991), «Bank Branch Operating Efficiency: A Comparative Application of DEA and the log linear Model», Omega International Journal of Management Sciences, 19, 6, pp. 549 – 557

Haag E. and Jaska V. (1995), «Interpreting Inefficiency Ratings: An Application of Bank Branch Operating Efficiencies», Managerial and Decision Economics, 16 (1), pp.7 – 14

Mathioudaki S. (1995), The efficiency of the Greek Banks in the decade 1985-1994, Economic Review, Commercial Bank of Greece, Volume 3, pp.32 – 39

Noulas A. (1994), «Operating Efficiency in the Hellenic Bank Industry: A Data Envelopment Analysis Approach», 40th International Atlantic Economic Conference in Williamsburg.

Noulas A. (1999), Profitability and efficiency of the Greek Banks (1993 – 1998), Bulletin of the Union of Greek Banks, pp. 53 – 60.

Oral M. & Yolalan R. (1990), «An Empirical Study on Measuring Operating Efficiency and Profitability of Bank Branches», European Journal of Operational Research, 46, pp.282 – 294.

Sherman D. & Gold F. (1990), «Bank Branch Operating Efficiency: Evaluation with Data Envelopment Analysis Approach», Journal of Banking and Finance, 9, pp.297 - 315.

Siafakas N. (1980), Analyses of Balance Sheets based on economic and financial components, Issue of the General Bank

Smith P. (1990), «Data Envelopment Analysis applied to Financial Statements», Omega International Journal of Management Sciences, 18, pp.131 - 138.

Staikouras Ch. and Steliarou M. (1999), Determinants of profitability for the Greek Banking Institutes, Issue of the Union of Greek Banks, pp. 61 – 66

Thanos G. (2001), «How Dropping Interest Rates but Increasing Banking Products Sales Yield Higher Banking Profits», Archives of Economic History (forthcoming)

Union of Greek Banks (1999), 1998: The Banks in Greece, Athens

Union of Greek Banks (2000), 1999: The Banks in Greece, Athens

Vassiloglou M. & Giokas D. (1996), «A Study of the Relative Efficiency of Bank Branches: An Application of Data Envelopment Analysis», Journal of the Operational Research Society, 41 (7), pp. 591 - 597.

Vasiliou D. (1993), Exploring the profitability of the Greek Banking market, Bulletin of the Union of Greek Banks, Volume 37-38(A), pp. 95 – 98