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Efficiency evaluation of Greek commercial banks using DEA

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Abstract. The purpose of this work is to evaluate the efficiency of the biggest commercial banks that operated in Greece at the financial year 2009. The method used is Data Envelopment Analysis. Each bank is modelled as a linear system with multiple inputs and outputs. The innovation of the paper refers to the choice of data and the use of a combination of the intermediation approach and the Sealey and Lindley (1977) approach. The data used was derived from the Hellenic Bank Association and from the balance sheets of its members. These data include the interest expenses, fixed assets, deposits etc. To estimate the relative efficiency of the chosen DMU's the MS Excel add-in program xIDEA 2.1 is employed. The results indicate several inefficiencies that may not have direct relation to the profitability of such institutions. But, these inefficiencies indicate the vulnerability of the Greek banking system and its potential to ask for help from the FSF (Financial Stability Fund).

Keywords: DEA; data envelopment analysis; banking performance evaluation; Greek commercial banks; efficiency

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Introduction

The European financial system is bank-based and so is the Greek financial system. The banking system in Greece is the most common instrument in exercising economic and monetary policy in accordance with the regulations made by the Bank of Greece, the European Central Bank, the European Investment Bank and other European organizations. Banks can change the demand and supply of money, the rate that money circulates and finally can influence the economic and productive forces in a country. As a result banks play an important role in the Greek economy.

Due to the globalization of the banking industry, the free movement of people, enterprises and capital in EU the capabilities that new information technology can offer Greek customers can nowadays seek and choose financial services from a wide range of commercial banks throughout the world. In addition, the Greek banking sector has faced radical changes in the field of communications, informatics, bank branch management. Furthermore changes have been made due to the expansion of ATM's and e-banking (Pasiouras, 2006) as well as the increasing integration of European money and capital markets, which was significantly promoted by the introduction of the euro, (Athanasoglou *et al*, 2009). As a result, competition was enhanced and operation and structure of the financial sector changed radically. From recent reports of the Bank of Greece, the Greek banking sector during the last years focuses in upgrading the methods of estimating and managing the credit risk, considering banks as production systems, introducing efficiency evaluating systems and using stochastic models for the credit risk management.

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Moreover commercial banks have expanded their products and services including activities such as brokerage, insurance and asset management. The general trend of expanding the operations and the services offered focuses in the area of Balkans and more specifically in countries such as Albania, Romania, Bulgaria, Serbia and FYROM. According to the Hellenic Bank Association, in year 2009 the challenge for the Greek banking system is threefold: i) to continue being stable having satisfactory ratios of capital adequacy, ii) to help businesses and households confront the difficulties caused by the financial crisis and iii) to manage the existing deposits more efficiently. For the reasons above managers need to consider banks as production systems and develop measures for estimating of efficiency.

Previous research in Greek banking provides valuable information on several aspects. A study by Karafolas and Mantakas (1996) who used a quadratic transcendental logarithmic cost function and a sample of 11 Greek banks over the period 1980-1989, did not find any significant total cost scale economies, although operating cost economies of scale were estimated to be statistically significant. Even when they divided the data into subgroups depending on the size of the commercial banks or on the specific periods of time (1980-1984, 1985-1989), the results did not change. They concluded that technical change did not affect the reduction of the average cost, (http://www.bankofgreece.gr/BogEkdoseis/Paper200409.pdf, accessed 9 January 2004).

Eichengreen and Gibson (2001) investigated the profitability of 25 Greek banks over the period 1993-98. They concluded that there is evidence of a bell-shaped relationship between profitability and bank size. More specifically they argued that profitability initially increases and then declines as bank size increases. Their results indicate that when profitability is measured by the rate of return on assets, ROA, scale economies are exhausted at around the average size of banks in their sample, which is very low by European standards. On the other hand, when profitability is measured by the rate of return on equity, ROE, they suggest that banks of all sizes may reap scale economies, (http://www.bankofgreece.gr/BogEkdoseis/Paper200525.pdf, accessed 25 June 2005).

Christopoulos and Tsionas (2001) use homoscedastic and heteroscedastic frontiers in order to estimate the efficiency of the Greek banking industry over the period 1993-1998. The results, implicate an average technical efficiency about 80% for the heteroscedastic model and 83% for the homoscedastic one. While banks get larger, both technical and allocative inefficiencies decrease over time. The regression of inefficiency measures against some trend indicates that the improvement in technical and allocative inefficiencies for small banks equals 19.7% and 39.1% respectively. The corresponding results for large banks are 10.4% and 21.1%.

Apergis and Rezitis (2004) specify a translog cost function to examine the cost structure, technical change and the rate of growth in total factor productivity in the Greek banking industry for the period 1982-1997. They use both the intermediation and the production approach and a sample of six banks, state and private. Both approaches indicate significant economies of scale and negative annual rates of growth in technical change and in total factor productivity. However, the study does not measure the degree of efficiency of the Greek banking sector.

Halkos and Salamouris (2004) apply DEA by using financial ratios as output measures with no use of input measures at all. Their sample varies between 15 and 18 banks depending on the year under consideration. The results depict a wide variation in average efficiency through 1997-1999, as well as a positive relationship between size and efficiency. Finally, they argue that there is a non-systematic relationship between transfer of ownership through privatization of public banks and last's period performance.

Rezitis (2006) uses a sample of six banks and more specifically the National Bank of Greece, the Commercial Bank of Greece, the Ionian Bank, and the Bank of Macedonia and Thrace which are state banks as well as the Alpha Credit Bank and the Ergo Bank which are the private ones. The study specifies two output and three input variables (Noulas 1997). It employs the Malmquist productivity index (Lovell, 2003) and DEA to measure and decompose productivity growth and technical efficiency in the Greek banking industry for the period 1982-1997. Furthermore, it compares the 1982-1992 and 1993-1997 sub-periods, because after 1992 the Greek banking industry faced substantial changes. Tobit regression model is used in order to explain the differences in efficiency among banks. The results indicate that the average level of the overall technical efficiency is 91.3%, while productivity growth increased on average by 2.4% over the entire period. The productivity growth is higher after 1992 and is being attributed to technical progress. On the other hand, until 1992 growth is mainly attributed to improvements in efficiency. In addition, during the second sub-period pure efficiency is higher and scale efficiency is lower which indicates that although banks achieved higher pure technical efficiency, they moved away from optimal scale. Finally, the regression results show that size and specialization have positive effects on both pure and scale efficiency.

Furthermore, some notable studies with application of DEA in financial institutions have been presented by Athanassopoulos (1997) and Thanassoulis (1995) which address issues of service quality, although most DEA models developed to assess bank branch performance do not include service quality as an output. A number of other studies have used DEA to evaluate the performance of bank branch networks. These kind of studies are discussed in Berger and Humphrey (1997).

Pastor *et al* (1997) argue that considering the "internal efficiency" of each country, obtained by means of a DEA model which evaluates only the banks of that country and comparing the results of the complete and basic models, they conclude that the environmental variables are too influential and, in some sense, distort the efficiency results. Their results show that when the common frontier is defined without environmental variables, the average efficiency scores of the banks of each European country are lower than when these variables are considered. Finally, they suggested that a possible way out would be to create a general model that encompasses various modeling philosophies as particular cases. But care has to be exercised since the more inputs and outputs a model contains, the more units become efficient through specialization.

Oral and Yolalan (1990) found that a DEA model aimed at estimating service efficiency in bank branches in Turkey produced indistinguishable results from an alternative DEA model focused on profitability.

Serrano-Cinca and Mar Molinero (2004) and Serrano Cinca *et al* (2005) apply a recent methodological approach based on the combination of DEA and multivariate statistical analysis. This approach has the advantage of visualizing the way in which a particular DEA score has been achieved by a financial institution, and how this score is related to the model selected. The relationship between efficiency and the number of inputs and outputs has been studied by Pedraja Chaparro *et al* (1999).

Sirvent *et al* (2005) have performed a comparison of specification searches. They argued that it is difficult to assess what are the consequences for individual units of adding or removing an input/output without engaging in considerable extra work.

Measuring efficiency

In general, there are two basic types of methods that estimate efficiency, the parametric and the non-parametric ones. Parametric methods require explicit assumptions about the function that converts inputs into outputs and about the distribution of the error terms. Aigner and Chu (1968) were the first to estimate a deterministic frontier production function using a Cobb-Douglas production function. They argued that in a given industry, firms may differ in efficiency from each other because of certain parameters in the industry, differences in scales of operation or because of alternative organizational structures. Given this assumption, they considered a Cobb-Douglas production function with an empirical production frontier such that, $y_i \le f(x_i)$. This is a brief relationship between inputs x_i, the observed output y_i and the maximum output $f(x_i)$. This technique is called Stochastic Frontier Analysis (SFA) and it is applied mostly in production theory econometrics. The parametric technique of the efficiency estimation is described briefly as $y_i = f(x_i, \beta)TE_i$, (Debreu, 1951), where i indicates the observation of DMU_i, y_i is the observable amount of production, $f(x_i, \beta)$ is the production function (i.e. the parametric production frontier) that expresses the production technology, β is the matrix of the unknown parameters that need to be estimated and TE_i is the technical efficiency, $0 < TE(y_i, x_i) \le 1$. From the function above occurs the logarithmic production function which is helpful to estimate economies of scale as well as the substitution elasticities of inputs, $\ln y_i = \ln f(x_i, \beta) + \ln TE_i = \ln f(x_i, \beta) - u_i$, where u constitutes the measure of inefficiency estimation since, $u_i = -\ln TE_i \approx 1 - TE_i$.

If we set $e_i = -u_i$, then we assume that e_i is randomly distributed across firms. An important assumption that can be easily dropped is that the distribution of e_i is independent of all variables in the model. Then we make some hypothesis for the distribution of the random variable e_i, for example that it follows the standard normal distribution, the Gamma distribution, the exponential distribution etc.

On the other hand the non parametric methods (including Data Envelopment Analysis) do not require any functional form hypothesis. DEA requires only the necessary data, inputs and outputs. Due to the advantages of non parametric methods, in recent years DEA has gained researchers' and managers' interest. The method is used to estimate the relative efficiency of homogenous decision making units such as hospitals, public institutions, banks, financial institutions, schools, farms etc. DEA is a mathematical programming approach calculating the

technical efficiency expressed by the ratio of the weighted sum of outputs to the weighted sum of inputs. The purpose of this case study is to estimate the relative efficiency of the 19 biggest banks that operate in Greece.

The basic DEA model was proposed by Charnes *et al* (1978) and is called the CCR model. It is important to mention that the CCR model is used only in problems with constant returns to scale (CRS). By employing the property of duality that characterizes linear programming, the CCR model can take the following form,

$\min_{\theta,\lambda} \theta$

Subject to:

$$-y_i + \mathrm{Y}\lambda \geq 0$$
$$\theta x_i - \mathrm{X}\lambda \geq 0$$
$$\lambda \geq 0$$

where θ is a parameter that expresses technical efficiency and λ is a vector that corresponds to peer weights (lambdas vector). In addition, the dual model contains fewer constraints so it is easier to solve. Banker *et al* (1984) expanded the CRS model in order to solve problems with variable returns to scale (VRS) adding one constraint:

$\min_{\theta,\lambda} \theta$

Subject to:

$$-y_i + \mathrm{Y}\lambda \geq 0$$
$$\theta x_i - \mathrm{X}\lambda \geq 0$$
$$\mathrm{N1}'\lambda = 1$$
$$\lambda \geq 0$$

Furthermore we need to mention that there are two options for the objective function. The first is to maximize outputs given inputs (output oriented) and the second is to minimize inputs given the outputs (input oriented). The input oriented model is formed like the basic CCR model.

The Greek financial system

Year 2009 was chosen as the financial year for the evaluation is because that year was very crucial for the Greek economy and for the Greek financial system as well. It was the first year after the global financial crisis that began during 2008 and the Greek economy had to face a radical recession. Year 2009 was the first year that the financial crisis affected the real economy and the fiscal aggregates internationally.

Furthermore, the banking industry had to confront the high cost of deposits that occurred because the Greek banks offered high interest rates in order to enhance their liquidity. In addition, for one more year the industry had to face a sudden contribution to the Greek public debt. After all these facts it is important to mention some features of the Greek economy during 2009 that are analyzed in detail at the annual report the Greek banking system published by the Hellenic Bank Association (http://www.hba.gr/main/Ereunes-meletes/EllinikoTrapeziko2010-FullForWeb.pdf, accessed June 2010) and the International Monetary Fund (IMF).

The annual real GDP has been decreased by 2%. The deficit of the general government has reached the 13.6% of the annual real GDP in contrast with 2008 when it was at 7.7%. Regarding the Greek public debt (along with the general government's deficit), it was formed at 115.1% of the annual real GDP while in 2008 it was at 99.2%. Furthermore, the Greek public debt is expected to be increased in 2010 at 122.9% according to Hellenic Statistical Authority (EL.STAT.). The Balance on Current Account in 2009 is decreased by 11.2% of the annual real GDP compared with 2008 when it was at 14.6% of the GDP. The prediction of the International Monetary Fund is to be more decreased during 2010 at 9.7%. That is expected to take place due to commercial deficit as a result of the reduction in imports caused by the international financial crisis. Additionally, the HCPI (Harmonized Consumer Price Index) has reached 1.3% in 2009 while in 2008 it was at 4.2% and in 2010 it is predicted to reach 1.9% according to IMF. Finally, regarding the employment, the rate of unemployment was decreased during 2008 at 7.8%, while in 2007 was at 8.4% and during 2009 it was increased at 9.6% with a prediction made for 2010 at 12.0%, according to IMF.

According to IMF's Country Report No. 10/110 for Greece on May 2010, it is stated that during 2009 the financial system has been adversely affected. Fiscal results were deteriorated, government bonds had been downgraded by

rating agencies, and investors started backing out of Greek bonds, driving up their yields. The deep macroeconomic and structural problems combined with unavoidable strong fiscal adjustment over the medium term are likely to weigh on activity for some time. This combination of factors affects negatively the banking system. Impaired loans are rising while borrowing costs in the interchange and wholesale markets have increased, putting pressure on bank profitability.

IMF states that the Bank of Greece should implement intensified supervision and increase the resources dedicated to banking monitoring. This would include an increase in the frequency and speed of data reporting, and the further development of a comprehensive framework for regularly stress-testing financial institutions and efficiency measurement. Staffing would be increased both for on-site inspections and off-site review, also taking into account the new responsibilities of the Bank of Greece with respect to insurance supervision. Additional flexibility will be introduced in the management of human resources, and all Bank of Greece staff would be granted strong legal protection for actions performed in good faith, (http://www.imf.org/external/pubs/ft/scr/2010/cr10110.pdf, accessed May 2010).

Additionally, it is mentioned by the IMF that while Greek banks have weathered the global crisis well and are comfortably capitalized, the decline in economic activity that lies ahead could expose vulnerabilities. The establishment of a FSF (Financial Stability Fund) that stands ready to inject funds in the case that a bank's capital gets impaired is a very important precautionary measure. The management of this fund must consist of independent experts, to ensure that affected banks quickly return to viability.

Finally, regarding this study, it seems to be of a great importance to estimate which banks are vulnerable or relatively more vulnerable to need FSF for their existence and for the stability of the Greek banking system and the Greek economy itself. As a result, it is important to monitor the Greek commercial banks for the financial year of 2009 and estimate which of them are less efficient.

Model inputs and outputs

In general, there are two basic approaches that a DMU in a DEA model can be considered, (Berger *et al*, 1987). The first is called intermediation approach. According to this approach a commercial bank is a financial vehicle that borrows funds from depositors and lends them for profit. The intermediation approach has a lot of variants depending on the application. For example, Berger and Humphrey (1991, 1992) classify the activities that offer banks high value-added as outputs. Such activities are loans, demand deposits and savings deposits. On the other hand, they consider labor, capital and purchased funds as important outputs. In this case the banks' outputs are loans and the inputs are different costs of these funds such as interest expenses, labor, capital and operating costs, (Wheelock and Wilson, 1999). Generally, according to intermediation approach inputs are defined as labor, machines, deposits, materials and other costs. An accurate description of the intermediation approach can be found in Barnett (1987).

On the other hand, there is the production approach where a bank is a DMU that uses capital and labor to produce a variety of loans and deposit account services. The banks' inputs are labor, capital and operating costs in order to produce accounts and transactions as outputs. See, for example, Vassiloglou and Giokas (1990), Schaffnit *et al* (1997), Soteriou and Zenios (1999).

Additionally, there is the user cost approach which is applied by Aly *et al* (1990) and Hancock (1991) where a bank's asset is considered as an output only if the financial return on the asset exceeds the opportunity cost of the investment. On the other hand, a liability is classified as an input only if the financial cost of the liability is less than its opportunity cost.

Sealey and Lindley (1977) used an accounting balance-sheet approach to distinguish which accounts should be considered as inputs and outputs respectively. They argued that all liabilities (core deposits and purchased funds) and financial equity capital provide funds and should be treated as outputs. It needs to be mentioned that it is different from the intermediation approach which is used mostly from the perspective of cost/revenues management and is consistent with the value-added definition of output production by financial firms, (Feng and Serletis, 2009). Additionally, it is obvious that differs from the user cost approach.

This case study uses the DEA method according to the approach proposed by Sealey and Lindley in order to evaluate the 19 biggest banks that participate in the Greek banking system estimating the relative efficiency of each one. The commercial banks being evaluated are Attica Bank, Emporiki Bank, ATE Bank, CitiBank Europe,

EFG Eurobank Ergasias, Panellinia Bank, National Bank of Greece (NBG), FBBank, Geniki Bank, Millenium Bank, Hellenic Bank, Piraeus Bank, PRO Bank, Proton Bank, T Bank, Hellenic Postbank, Alpha Bank, Marfin Egnatia Bank and HSBC. Bank of Cyprus operates also in Greece but the data required were not available. The data (inputs and outputs) are given below:

Table 1. Inputs and Outputs.

Inputs	*Outputs*
Interest expenses/deposits	Loans
Other overhead expenses/fixed assets	Other earning assets
Personnel expenses/total assets	Deposits

The three outputs taken into consideration according to Sealey and Lindley (1977) approach are,

1. loans,
2. deposits and
3. other earning assets which include stocks, bonds, income from rental property, certificates of deposit and other interest, dividend earning accounts or instruments, (Maudos *et al*, 2002).

On the other hand, the inputs used according to the intermediation approach are the prices of the production factors (expenses),

- interest expenses/deposits referring to the cost of deposits,
- other overhead expenses/fixed assets corresponding to the ratio of non-personnel expenses divided by the fixed assets (physical capital) and
- personnel expenses/total assets which indicate the price of labor, (Liadaki and Gaganis, 2010).

All the data employed are expressed in Euros (€). The DEA model used is input oriented with VRS (variable returns to scale). To get the results for each DMU an MS Excel add-in program called xIDEA 2.1 is used which is developed by a Greek software house called Productivity Tools.

Computational results and conclusions

In Figure 1 the y-axis indicates the estimate of the relative efficiency of each DMU (Unit). The commercial banks evaluated are indicated in the x-axis. Unit 1 denotes Attica Bank, unit 2 denotes Emporiki Bank etc. As it can be observed, commercial banks that are efficient according to Farrell (1957) (non zero slacks) are: ATE Bank (Unit-3), EFG Eurobank Ergasias (Unit-5), National Bank of Greece (Unit-7), Piraeus Bank (Unit-12) and HSBC (Unit-19). Emporiki Bank (Unit-2) appears to be the less efficient and MARFIN Egnatia Bank (Unit-18) is close to become relatively efficient.

Table-2 and Table-3 show the potential improvement for each DMU. At Table-2 the first column below each input indicates the target value for this input and the second column indicates the necessary decrease to reach the target. Respectively, Table-3 shows the target value for each output as well as the increase to be made.

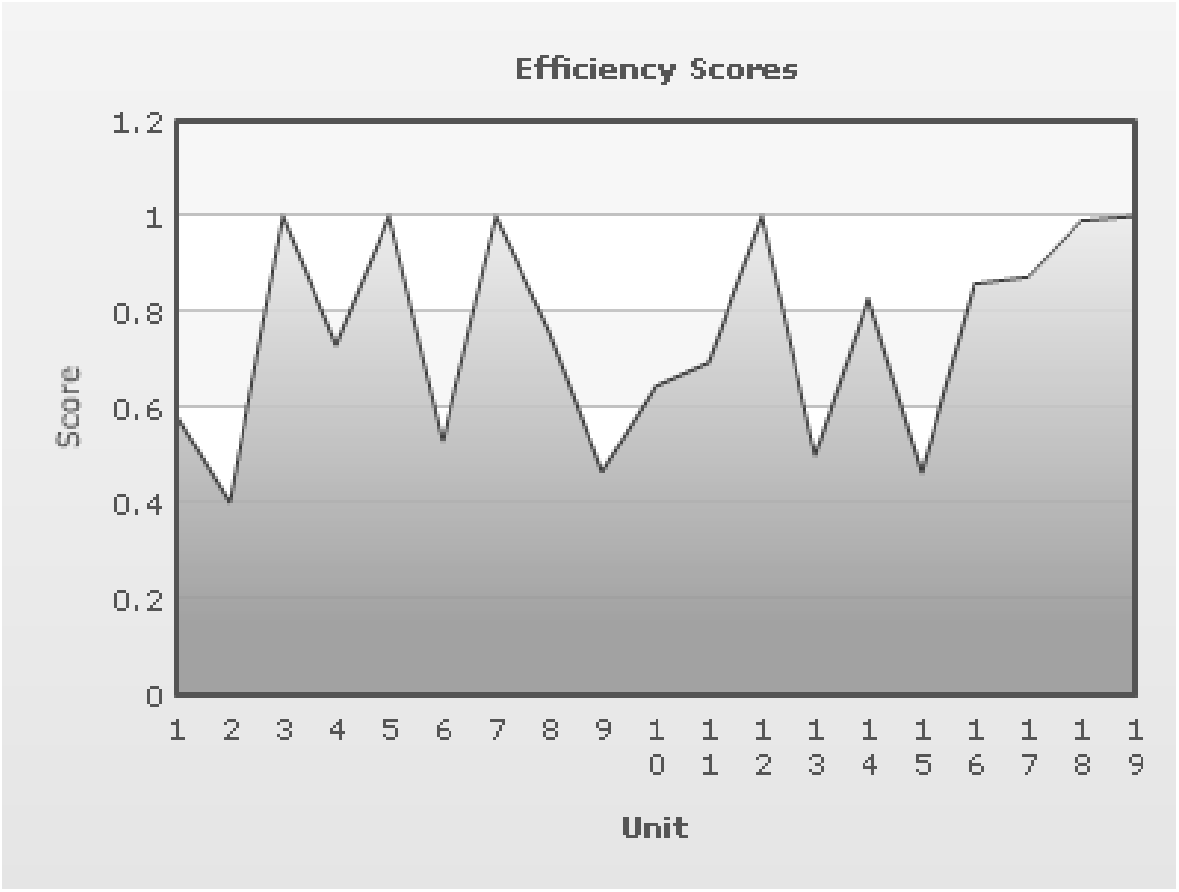

Fig. 1. Relative efficiency of each unit/commercial bank.

Efficient peers and weights	Unit-3	Unit-5	Unit-7	Unit-12	Unit-19
Unit-1			0,2178	0,1398	0,6424
Unit-2				0,0120	0,9880
Unit-3	1,0000				
Unit-4					1,0000
Unit-5		1,0000			
Unit-6				0,2799	0,7201
Unit-7			1,0000		
Unit-8				0,3370	0,6630
Unit-9	0,3571				0,6429
Unit-10				0,3216	0,6784
Unit-11	0,0633		0,5263		0,4105
Unit-12				1,0000	
Unit-13				0,0025	0,9975
Unit-14			0,1850	0,4710	0,3439
Unit-15			0,3412	0,1163	0,5426
Unit-16				0,2761	0,7239
Unit-17				0,9072	0,0928
Unit-18				0,6882	0,3118
Unit-19					1,0000

Fig. 2. Peers and relevant weights.

Table 2. Virtual inputs.

Virtual inputs/ outputs	interest expenses/deposits		other overhead expenses/fixed assets		personnel expenses/total assets	
Unit-1	0,02	*41,45%*	0,15	*41,45%*	0,01	*41,45%*
Unit-2	0,01	*59,81%*	0,20	*90,87%*	0,01	*59,81%*
Unit-3	0,02	*0,00%*	0,09	*0,00%*	0,01	*0,00%*
Unit-4	0,01	*26,86%*	0,20	*74,45%*	0,01	*51,26%*
Unit-5	0,09	*0,00%*	0,07	*0,00%*	0,01	*0,00%*
Unit-6	0,02	*47,00%*	0,17	*90,65%*	0,01	*47,00%*
Unit-7	0,02	*0,00%*	0,04	*0,00%*	0,01	*0,00%*
Unit-8	0,03	*24,14%*	0,16	*71,14%*	0,01	*24,14%*
Unit-9	0,02	*53,50%*	0,16	*53,50%*	0,01	*53,86%*
Unit-10	0,03	*35,55%*	0,16	*83,83%*	0,01	*35,55%*
Unit-11	0,02	*30,41%*	0,11	*30,41%*	0,01	*30,41%*
Unit-12	0,05	*0,00%*	0,09	*0,00%*	0,01	*0,00%*
Unit-13	0,01	*49,97%*	0,20	*67,04%*	0,01	*49,97%*
Unit-14	0,03	*17,20%*	0,12	*17,20%*	0,01	*17,20%*
Unit-15	0,02	*53,66%*	0,13	*53,66%*	0,01	*53,66%*
Unit-16	0,02	*14,13%*	0,17	*41,32%*	0,01	*14,13%*
Unit-17	0,05	*12,62%*	0,10	*34,89%*	0,01	*12,62%*
Unit-18	0,04	*1,01%*	0,12	*36,45%*	0,01	*1,01%*
Unit-19	0,01	*0,00%*	0,20	*0,00%*	0,01	*0,00%*

Table 3. Virtual outputs.

Virtual inputs/ outputs	loans		other earning assets		deposits	
Unit-1	213.018.281.966,50	*5330,75%*	6.209.098.382,69	*4047,99%*	253.793.425.283,26	*7291,41%*
Unit-2	301.797.806.247,69	*1329,56%*	8.804.245.638,19	*2899,09%*	365.643.865.540,73	*2327,73%*
Unit-3	22.133.348.352,05	*0,00%*	704.705.984,00	*0,00%*	22.682.800.128,05	*0,00%*
Unit-4	305.074.962.431,91	*10198,38%*	8.900.366.336,00	*4036,84%*	369.761.189.887,89	*5260,11%*
Unit-5	42.014.998.527,95	*0,00%*	871.000.000,00	*0,00%*	45.807.001.599,95	*0,00%*
Unit-6	228.443.533.644,85	*33918,06%*	6.652.726.615,88	*25154,25%*	273.483.676.773,90	*53499,66%*
Unit-7	58.129.698.816,16	*0,00%*	1.697.746.048,00	*0,00%*	58.081.165.312,16	*0,00%*
Unit-8	212.782.920.630,17	*13567,37%*	6.193.392.679,26	*32076,81%*	253.808.135.044,38	*18321,50%*
Unit-9	204.038.181.309,61	*4993,10%*	5.973.744.376,09	*9309,25%*	245.821.544.556,89	*9120,02%*
Unit-10	217.024.127.294,01	*4150,10%*	6.317.789.479,76	*2982,65%*	259.136.664.561,03	*7342,21%*
Unit-11	157.212.507.033,28	*3421,32%*	4.591.278.017,60	*7133,89%*	183.772.445.403,58	*2695,39%*
Unit-12	31.245.445.120,01	*0,00%*	868.803.968,00	*0,00%*	25.729.695.744,01	*0,00%*
Unit-13	304.396.825.688,99	*11303,10%*	8.880.476.232,12	*17211,98%*	368.909.198.476,62	*12175,09%*
Unit-14	130.399.791.518,83	*10620,26%*	3.784.529.541,00	*7377,24%*	150.040.683.060,95	*10231,99%*
Unit-15	188.991.686.184,35	*9975,64%*	5.509.370.483,29	*4885,90%*	223.431.324.030,82	*12090,48%*
Unit-16	229.474.408.434,87	*2747,95%*	6.682.962.710,40	*1364,53%*	274.778.838.076,35	*2070,84%*
Unit-17	56.644.491.579,77	*35,48%*	1.613.771.229,86	*226,33%*	57.640.323.893,83	*63,48%*
Unit-18	116.615.404.775,18	*803,49%*	3.372.749.349,98	*516,30%*	132.986.046.569,48	*1167,74%*
Unit-19	305.074.962.431,86	*0,00%*	8.900.366.336,00	*0,00%*	369.761.189.887,83	*0,00%*

The inputs used, consist of the most basic expenses a commercial bank can make in order to operate and also are used by the majority of researchers that apply DEA in banking industry. On the other hand the outputs chosen: loans, deposits and other earning assets help us understand which accounts provide each commercial bank with funds. Furthermore Table-2 and Table-3 show that for the inefficient DMU's a large amount of increase at their

outputs is demanded in order to become relatively efficient. Moreover, the percentage increase needed for outputs is quite larger than the possible percentage decrease for inputs so that
$\frac{virtual\,outputs_i}{virtual\,inputs_i} = 1,\ \forall i = 1,...,19$.

For every inefficient DMU that means that a very small amount of virtual output per virtual input is produced.

up to 0.10	0
0.10+ to 0.20	0
0.20+ to 0.30	0
0.30+ to 0.40	0
0.40+ to 0.50	3
0.50+ to 0.60	3
0.60+ to 0.70	2
0.70+ to 0.80	2
0.80+ to 0.90	3
0.90+ to 1.00	6

Fig. 3. Score frequencies.

From Figure 3, it is indicated that apart from the five commercial banks which are characterized as relatively efficient commercial banks and are located on the efficient frontier, we could consider MARFIN Egnatia Bank to operate relatively efficiently as well, because it is located in $[0.90, 1.00]$. As a result, it is implied that the 31.58% of the Greek banking industry operates efficiently. On the other hand, if we would consider that the rest of the commercial banks are relatively inefficient, we could conclude that the 68.42% of the Greek banking sector operates inefficiently. These DMU's are located in the $[0.00, 0.90)$ space. If we would take into consideration the less efficient banks of the inefficient ones in the sample, these would be in the $[0.40, 0.50]$ space and they would form the 15.79% of the commercial banks. Another interpretation of the results could be that the majority of the examined DMU's, over the 50.0%, operate inefficiently. Furthermore, it is important to interpret the results taking into consideration the proposals of the IMF's report regarding the Greek economy and the Greek financial system. The International Monetary Fund suggests that the Bank of Greece should implement intensified supervision and increase the resources dedicated to banking supervision in order to set a comprehensive framework of data selection, stress testing and efficiency evaluation. Although in in the sample under examination there exist not many banks that are inefficient in a way that they are located far away from the efficient frontier (in the $[0.00, 0.40]$ we do not have any inefficient DMU's, it is important to recognize the fact that the inefficient ones are more vulnerable to need help from the Financial Stability Fund. This conclusion occurs, taking for granted that IMF states that the Greek banking system is steady and vulnerable at the same time. In addition, precautionary measures need to be taken and that is why FSF has been created and stands ready to inject funds for the stability of problematic banks.

It is obvious that the 68.42% of Greek banking is inefficient. Inputs are not converted into outputs efficiently in the case of inefficient banks. Although DEA method does not use the production function it is important to investigate how inputs are allocated to the operations of each inefficient bank estimating the production function of the Greek banking sector and apply the SFA method. Moreover, the expenses that are taken into account as inputs can have an effect on other data even on other inputs of the balance sheets such as earning per share or interest income. It would be important to investigate such relations before choosing the accounts that provide us with data. Finally, under these suggestions of the IMF, it would be an alternative to run again a DEA model considering each DMU according to the approach proposed by Sealey and Lindley using as output the financial debt and other liabilities of each commercial bank and not only equity. This is something that corporate finance theory suggests for the seniority of debt $Debt \succ Equity$, (Hart and Moore, 1995). That would make DEA as present vulnerable banks as efficient.

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