“ATM and banking efficiency: the case of Greece”

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ATM and banking efficiency: the case of Greece

Abstract

This paper shows how useful the number of ATMs is for modelling and estimating banking efficiency. We examine banking efficiency for Greece using data from top 10 commercial banks. To estimate banking efficiency we employ DEA and FDH using three inputs (number of employees, number of branches and number of ATMs) and one output (loans). We find that large banks are more efficient than medium and small sized banks. Furthermore, we report that banks with a large number of ATMs are more efficient than those with a less number of ATMs. Finally, we conclude that the provision of e-banking services by banks does not influence their efficiency scores.

Keywords: banking efficiency, e-banking, ATM, Greece.
JEL Classification: E58, G21.

Introduction

The performance of the banking sector has become a very popular topic, especially after the provision of electronic banking services by banks, such as ATMs, Internet banking, Telephone banking etc. The usage of these technologies has increased significantly during the past 15 years mainly due to the fact that they are offering various advantages to banking customers.

The use of ATMs is also very widespread as in the last years they have been used for other purposes apart from cash withdrawals. In the recent years, ATMs are able to offer their customers a wide range of services. ATMs accept deposits of money and checks, print mini statements, check customers' balances, proceed payments of utility bills and transfer funds to other bank accounts. In addition, customers can purchase credit for their 'pay and go' mobile phones, as well as they can purchase other goods and services, for example train and concert tickets.

Banks gain more revenues (and increase their efficiency) by offering e-banking services such as ATMs, in addition to the reduction of their costs, as fewer physical branches are needed and consequently fewer employees. A large number of studies examine banking efficiency.

Duncan and Elliott (2004) explain that the concept of efficiency can be regarded as the relationship between outputs of a system and the corresponding inputs used in their production. Efficiency is treated as being a relative measure that reflects the deviations from maximum attainable output for a given level of input (English et al., 1993). Farrell (1957) draws upon the studies of Debreu (1951) and Koopmans (1951) in order to define a simple efficiency measure which would be able to account for multiple inputs. He argues that the efficiency of a firm consists of technical and allocative efficiency. Technical efficiency is the ability of a firm to obtain maximum output from a given set of inputs, and allocative efficiency is the ability of a firm to use the inputs in optimal proportions given their respective prices. When these two measures are combined they provide a measure of total economic efficiency.

In this paper, we examine banking efficiency for Greece using three inputs (number of employees, number of branches and number of ATMs) and one output (loans). A limited number of papers include the number of ATMs as an input to estimate banking efficiency. This paper shows how useful ATM is for modelling and estimating banking efficiency using data from 10 commercial banks from Greece.

1. Methodology

There are a number of different approaches that can be followed in order to examine the efficiency of banks. These include the Stochastic Frontier Analysis (SFA), Thick Frontier Approach (TFA), Distribution Free Approach (DFA), Free Disposal Hull (FDH) and the Data Envelopment Analysis (DEA).

This paper uses both the DEA and FDH to estimate the efficiency of Greek banks. We describe the DEA input and output orientated models by using Constant, Variable, Increasing and Decreasing Returns to scale approaches.

1.1. Input-orientated model. Farrell (1957) uses a simple example which involves the use of two inputs (x_1 and x_2) to produce a single output (y) under the constant returns to scale assumption. It should be noted that this assumption allows the presentment of the technology by using a unit isoquant.

Figure 1 shows the unit isoquant if a fully efficient firm which is shown as SS' in Figure 1 and measures the technical efficiency. In point P a firm can use quantities of inputs to produce a unit of output, and the technical inefficiency is represented by the distance QP which is the amount by which inputs could be proportionally reduced without reducing the amount of output. This is also expressed in percentage by the ratio QP/OP which represents the percentage by which all inputs could be reduced. The technical efficiency (*TE*) of a firm is measured by the ratio $TE = \frac{OQ}{OP}$ which is equal to 1- $\frac{QP}{OP}$. Technical efficiency takes the value between one and zero and therefore indicates the degree of a firm's inefficiency. The value one indicates that the firm is fully technically efficient. Point Q is considered technically efficient due to the fact that it lies on the efficient isoquant.

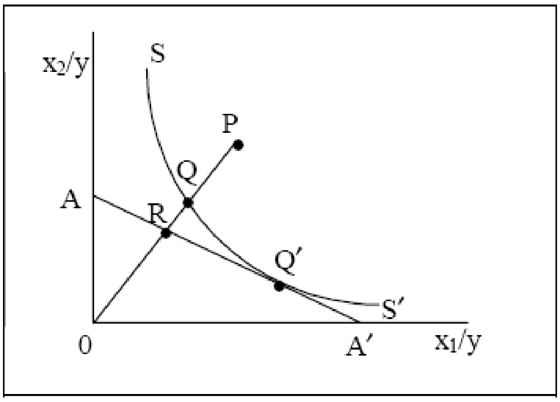


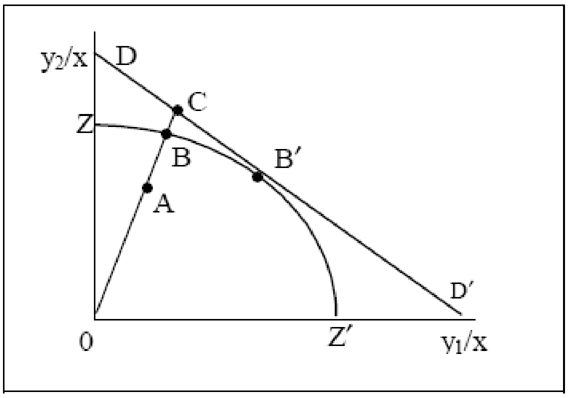
Fig. 1. Input-orientated model

AA' line represents the input price rate, also known as allocative efficiency. The allocative efficiency (*AE*) of a firm can be calculated by the ratio $AE = \frac{OR}{OQ}$. *RQ* represents the reduction in production costs that would occur if production were to occur at the allocative (and technically) efficient point *Q*' instead of occurring at the technically efficient but allocative inefficient point *Q*.

The combination of technical and allocative efficiency provides the total economic efficiency. Total economic efficiency is defined by the ratio $EE = \frac{OR}{OP}$. *RP* is the distance where there is a reduction in the cost. $TE * AE = \frac{OQ}{OP} * \frac{OR}{OQ} = \frac{OR}{OP} = EE$. All the three measures take values between one and zero.

1.2. Output-orientated model. Furthermore, Figure 2 presents the output orientated model. *AB* is the distance which represents technical inefficiency; the amount by which outputs could be increased without the need of extra inputs. The technical efficiency of the output orientated model is given by the ratio $TE = \frac{OA}{OB}$.

We also define the allocative efficiency if we draw the isorevenue line *DD*' in the case that we have available the price information $AE = \frac{OB}{OC}$.



Source: Coelli (1996).

Fig. 2. Output-orientated model

We also define the overall economic efficiency as the product of technical and allocative efficiency: $EE = \frac{OA}{OC} = \frac{OA}{OB} \text{ x } \frac{OB}{OC} = TE \times AE$.

1.3. Data envelopment analysis (DEA). DEA is a non-parametric method which was first introduced by Charnes et al. (1978) and has been used ever since to measure the empirically derived relative efficiency (Molyneux et al., 1996). It computes a comparative ratio of outputs to inputs for each decision making unit (DMU), which is reported as being the relative efficiency score (Avrikan, 2005). This efficiency score is usually expressed as a number between zero and one or zero and 100 per cent. A decision making unit with a score less than one is considered to be an inefficient unit relatively with other DMUs with score equal to one which are considered to be efficient. Traditionally, DEA measures the technical efficiency of DMUs opposed to their allocative efficiency[1]. According to Pasiouras (2006), the best practice production frontier for a sample of DMUs is constructed through a linear combination of input-output sets that envelops the input-output correspondence of all DMUs in our sample.

Charnes et al. (1978) propose a model which was input orientated and assumed constant returns to scale, while Pasiouras (2006) reports that the use of constant returns to scale is appropriate when all firms are operating at an optimal scale. In the case where firms are not operating at an optimal scale due to various constraints in finance or imperfect competition then the use of variable returns to scale was suggested by Banker et al. (1984) so as to calculate technical efficiency without containing any scale efficiency effects. Damar (2005) argues that

[1] Technical efficiency examines how well the production process converts inputs into outputs whereas allocative efficiency is the effective choice of inputs vis a vis prices with the objective of minimising the costs of production.

inefficiency is measured as the distance between the firms' observed input-output combination and the frontier.

Halkos and Salamouris (2004) argue that the main advantage of the DEA technique is that it can deal with the case of multiple inputs and outputs, as well as factors, which are not controlled by individual management. Another advantage is that the method skips some usual problems which arise from the use of parametric methods in the analysis of financial ratios. The usual problems are considered as being the need to determine the functional form or to determine the statistical distribution of the ratios. In addition, problems arise when the numerator or the denominator of the financial ratios take negative values. According to Gutierrez-Nieto et al. (2007), DEA can be used when the conventional cost and profit functions can not be justified. Damar (2005) explains that the DEA method allows for zero output values and handles zero input values. According to Sufian (2006), DEA is less data demanding as it handles small sample sizes. Additionally, DEA does not require a preconceived structure or a specific functional form to be imposed on the data in the process of identifying and determining the efficient frontier. Wu et al. (2005) argue that the DEA technique allows efficiency to change over time and it does not require prior specification of the best production frontier.

However, Farc et al. (2000) identify that one of the most important objections to the DEA model is its non stochastic nature. When the DEA model is used any deviations from the frontier are attributed to inefficiency. They report that DEA does not adequately address the underlying economics (i.e., DEA accommodates economic behavior only by using cost and revenue specifications). Wu et al. (2005) also explain that DEA is sensitive to outliers and statistical noise, so the outcome of the analysis can be warped in the case that the data are contaminated by statistical noise.

According to Pasiouras (2006), the DEA method assumes the data to be free of measurement errors and is very sensitive to outliers. Also, Gutierrez-Nieto (2007) argues that there is no statistical framework on which significance tests can be based regarding the selection of inputs and outputs in a DEA model[1]. There is also a possibility that inputs and outputs might be highly correlated.

1.4. Constant returns to scale model. Here we define the constant returns to scale (CRS) model which was proposed by Charnes et al. (1978). We assume that we have K inputs and M outputs on each of the N firms or Decision making units (DMU). For the i-th DMU these are represented by the vectors x_i and y_j respectively. The best method to introduce the DEA CRS model is via the ratio form. For each DMU we obtain a measure of the ratio of all outputs over all inputs, such as $u'y_i \,/\, v' x_i$, where u is an M x 1 vector of output weights and v is a K x 1 vector of inputs weights. In order to select the optimal weights we define the following mathematical programming problem:

$$\max_{u,v} (u'y_i / v' x_i),$$
$$\text{St } u'y_j / v' x_j \le 1, j= 1, 2\ldots, N \qquad (1)$$
$$u, v \ge 0.$$

In the above model we find values for u and v, such that the efficiency measure of the i-th DMU is maximized, subject to the constraint that all the efficiency measures have to be less than or equal to one. Because this ratio formulation has an infinite number of solutions, we impose the constraint $v' x_i =$ 1, which provides:

$$\max_{\mu,v} (\mu' y_i),$$
$$\text{st } v'x_i =1, \qquad (2)$$
$$\mu' y_j - v'x_j \le 0, j = 1, 2,\ldots, N$$
$$\mu ,v \ge 0.$$

The notation has changed from u and v to μ and v as to reflect the transformation. This is known as the multiplier form of a linear programming model. By using duality in linear programming we can derive an equivalent envelopment form of this problem:

$$\min_{\theta,\lambda} \theta,$$
$$\text{st } - y_i + Y\lambda \ge 0, \qquad (3)$$
$$\theta x_i - X\lambda \ge 0,$$
$$\lambda \ge 0.$$

Where θ is a scalar and λ is an N x 1 vector of constants. Notice that the envelopment form involves fewer constraints than the multiplier form and therefore it is more preferable to solve. The value of θ which we obtained is the efficiency score for the i-th DMU. It will satisfy the $\theta \le 1$, with the value 1 indicating a point on the frontier and consequently a technically efficient DMU according to the definition by Farrell (1957). The above linear programming model can be solved N times, once for every DMU and obtain a value of θ for each DMU.

1.5. Variable returns to scale model. The variable returns to scale (VRS) model was suggested by Banker, Charnes and Cooper (1984) as an extension to the constant returns to scale model because the

[1] When employing the DEA method we don't apply any statistical tests and in the case that we need to solve large problems there might not be feasible results.

latter model is only appropriate in the case where all the DMUs are operating at an optimal scale. The use of the CRS model when not all DMUs are operating at an optimal scale will result in measures of Technical Efficiency which are confounded by scale efficiencies. With the use of the VRS model we can calculate technical efficiency without taking into consideration the scale efficiency effects.

We modify the CRS linear programming problem to account for VRS by adding the convexity constraint: $N\,1'\lambda = 1$ to equation (3) in order to provide:

$$
\begin{aligned}
&\min_{\theta,\lambda} \theta \\
&\text{st} - y_i + Y\lambda \geq 0, \\
&\theta x_i - X\lambda \geq 0, \qquad (4) \\
&N\,1'\lambda = 1, \\
&\lambda \geq 0,
\end{aligned}
$$

where $N1$ is an N x 1 vector of ones. By following this approach we form a convex hull of intersecting planes which envelope the data points more tightly than the CRS conical hull and thus provide technical efficiency scores which are greater than or equal to the ones that we obtained when using the CRS model.

1.6. Super efficiency. Andersen and Petersen (1993) suggest a criterion that permits the ranking of firms which are all found to be 100 % efficient by the DEA method. We consider a single input, single output case and suppose that a firm with input-output (x_o, y_o) has been found to be technically efficient in an output-orientated problem. It is clear that if the firm's output has been any larger than y_o then it would have remained efficient. Furthermore, a small deterioration in the firm's performance may be allowed without becoming inefficient. In other words, the firm's observed output exceeds what is necessary for the firm to be considered efficient relative to other firms in the sample and this firm is considered to be super efficient. The Super efficiency model can be formulated after the reformulation of equation (4) and is given by:

$$
\begin{aligned}
&\min_{\theta,\lambda} \theta \\
&\text{st} - y_i + Y\lambda \geq 0, \qquad (5) \\
&\theta x_i - X\lambda \geq 0, \\
&\lambda = 0, \\
&N\,1'\lambda = 1.
\end{aligned}
$$

1.7. Free disposal hull. The free disposal hull model (FDH) was first introduced by Deprins et al. (1984) as an alternative method to the data envelopment analysis model, where only the strong (free) disposability of inputs and outputs is assumed. This model was initially presented as a VRS DEA model excluding the linear combination of observed production plans. There are two methods to solve FDH problems. The first method was introduced by Tulkens (1993) and later by Cherchye et al. (2001) and is based on enumeration algorithms, and the second method is the use of mathematical programming. The computation of the technical efficiency measures using the FDH method requires solving non-linear mixed integer programs.

For a set of observed production plans (x^k , y^k), $k \in K$, where K is an index set, producing R outputs with I inputs. Then (x_k, y_k) $\in \mathrm{R}^{R+I}$, $\forall\, k \in K$. Let a technology T be defined by

$T = \{(x, y)\}$: y can be produced by x.

Following Leleu (2006), the technical inefficiency of an observed production plan (x^o, y^o) is defined by: $E\,(x^o, y^o) = \min\,(\theta^o : (\theta^o x^o, y^o) \in T$. The FDH technology exhibits a strong free disposability assumption on T but does not impose any convexity assumption. The traditional FDH technology is under variable returns to scale and is labelled $T_{FDH\,-\,VRS}$. This FDH technology is represented by its production possibility set: $T_{FDH\,-\,VRS}$ = { (x,y): $\sum_{k=1}^{K} z_k y_k \geq y, \sum_{k=1}^{K} z_k y_k \leq x, \sum_{k=1}^{K} z_k = 1$, $z_k \in \{0,1\}$, $k \in K\}$. For more information about the FDH approach, see Leleu (2006).

1.8. Selection of inputs-outputs. In recent years research efforts have been devoted to measuring the efficiency of the banking industry. More specifically the attention has been focused on estimating an efficient frontier and measuring the average difference between banks. In order to estimate the efficiency of the banking industry the inputs and outputs that will be used have to be defined. According to Boulding (1961), the concept of economic activity as an input-output process is perhaps the most basic concept of economics. Nevertheless it is vague, and curious difficulties emerge when an effort is made to specify the inputs and outputs involved and to define the nature of transformation implied.

Frisch (1965) identifies the production process as a transformation method which is controlled by human beings and it is desirable by a number of individuals. With the term transformation it is implied that goods or services (inputs) enter a process where they lose their original form while at the same time other goods or services are generated and these are the outputs. The concept of inputs and outputs is used widely in a number of sectors such as the manufacturing and the agricultural sector. In the banking industry the production process includes the use of deposits and other assets, and the output of banks is measured in terms of quantity.

Fixler and Zieschang (1992) and Beger and Humphrey (1992) argue that there is a confusion in the definition of output measurement, because of the integrated nature of the production process in the banking industry (see also Mlima and Hjalmarsson, 2002). This confusion exists mainly due to the theoretical gap in the banking literature on multi-input multi-output production structure as well as due to the non-tangible nature of the outputs. For this reason there have been made attempts by researchers to overcome this problem by introducing two different approaches which can be used in measuring the banking efficiency; the production approach or the intermediation approach. It is stated though by Wykoff (1992) that problems exist even after the adoption of one of the approaches due to the non-availability of data on certain physical quantities such as the number of checks cashed or the number of loans issued, etc.

1.9. The production or service provision approach. The production approach is also known as service provision approach or value-added approach and it is used for analyzing the technological efficiency of the banking systems. According to this approach, banks provide their services to customers by keeping customers deposits, issuing loans, cashing checks and by administering various financial transactions that are made by customers (Berg et al., 1991, 1993). The analysis of productivity and efficiency is made by comparing the quantity of services given with the quantity of the resources used. The five activities that are performed by banks are identified by Berg at al. (1991) and these are the following: 1) supplying demand, facilitating deposit services, 2) short and long term loan services, 3) brokerage and other services, 4) property management, and 5) provision of safe deposit boxes. Apart from these five activities Berg et al. (1991) also add that a bank can incur positive cost in terms of labor, machines, buildings and materials.

1.10. The asset or intermediation approach. According to the asset or intermediation approach, banks accept deposits from customers and then transform them into loans to their clients. Mester (1997) argues that the usual inputs which are included in this approach are labor, material and deposits and the outputs used are loans and other income generating activities. This approach is mainly used by researchers in estimating the economic efficiency of the banking sectors. It must be added that the asset approach is sub divided into two groups: 1) the profit approach, and 2) the risk-management approach. The profit approach or the cost approach can be used to estimate the economic efficiency, and according to this approach, the goal of the bank's manager is to maximize the profit function of the bank. In the process of production bank managers must take into account all the types of costs that incur as well as the income that is being generated. The profit approach can measure simultaneously the inefficiency occurred in the inputs and the outputs side. On the other hand, the risk-management approach is used to evaluate risks that may be attached to various forms of assets in a bank, where banks take risks in order to produce acceptable returns. In the risk management approach the management decision making process is used as inputs and the shareholders' value and bank profits are used as outputs.

2. Data description

The data for this study were obtained from the *Bankscope database* and the official webpage of the Hellenic Bank Association (www.hba.gr). The sample considers only the years 2004 and 2005 due to lack of data (mainly number of ATMs), for the ten largest commercial Greek banks ranked according to their total assets. These banks are the following: the National Bank of Greece, Eurobank, Piraeus bank, Alpha Bank, the Agricultural bank of Greece, Emporiki Bank, Greek Postal Savings Bank, Geniki bank, Egnatia Bank and Attica Bank. We calculate the efficiency scores using three inputs (number of employees, number of branches and number of ATMs) and one output (loans)[1]. The research objective of this paper is the use of the number of ATMs as an input in the modelling of banking efficiency. Table 1 shows the descriptive statistics for all variables.

Table 1. Descriptive statistics

Year	2004			
Name	**Minimum**	**Maximum**	**Mean**	**Std. dev.**
Number of branches	59	455	234.4	131.8485
ATMs	52	1315	491.2	386.0152
Number of employees	1118	12702	4888.5	3497.1503
Loans	1726.8	26052.7	11509.41	8863.8953
Year	**2005**			
Name	**Minimum**	**Maximum**	**Mean**	**Std. dev.**
Number of branches	59	567	275.1	164.7674
ATMs	61	1352	525.7	389.2768
Number of employees	1118	13175	4848.3	3662.4819
Loans	1787.6	29528.2	13691.56	10582.8563

Source: Bankscope and Hellenic Bank Association.

[1] Loans are money lent by banks to borrowers, and borrowers agree to return the borrowed amount of money along with an interest rate.

3. Empirical results

The results show that there is an obvious decrease in the efficiency scores in 2005 compared to 2004. More specifically, the greatest decrease is observed for the super efficiency method for both the input and the output orientation. The highest scores are observed for the all the methods employing the VRS.

In particular, National Bank of Greece has higher efficiency scores for the year 2004 and for the super efficiency input and output models. We report a significant decrease in the efficiency in 2005 for all the methods that are employed. Eurobank follows the pattern that National Bank of Greece follows. There is a significant decrease in the super efficiency both for the input and output orientation but there is no change observed for the other methods. Alpha bank, on the other hand, exhibits an increase in the super efficiency scores for both input and output orientation for 2005 in addition to an increase in the FDH efficiency scores. Piraeus bank shows a decrease in 2005 in all methods but it should be mentioned that the FDH method generates the higher efficiency scores in comparison to the other methods. Emporiki Bank exhibits a small decrease in 2005 in all the methods except for the FDH method where a small increase since the year 2004 is observed. Agricultural bank of Greece exhibits a small decrease in all the efficiency scores obtained from all the types of method for 2005.

Greek Postal Savings Bank's efficiency scores are decreased in 2005 with the major decrease being observed for super efficiency input and output oriented methods.

Egnatia Bank is also showing a small decrease in the efficiency for 2005 with the larger difference for super efficiency scores both for input and output orientated methods. On the other hand, Geniki bank is showing a significant increase in its efficiency in 2005 for all the methods employed but the larger increase is observed for super efficiency input and output oriented methods. Lastly, Attica bank is also showing a decrease in the efficiency in 2005 for all methods with the larger increase being observed for the super efficiency input and output models. Table 2 shows a summary of the results by year (Part A shows the results for 2004, while part B shows the results for year 2005) and methods. In addition, Table 3 presents the results for each bank by year and methods.

Table 2. Summary of empirical results (efficiency scores)

	PART A. Year 2004			
All banks	Basic input crs	Basic input vrs	Basic input irs	Basic input drs
	83.06%	89.10%	89.02%	83.13%
	Basic output crs	Basic output vrs	Basic output irs	Basic output drs
	83.06%	86.62%	86.55%	83.13%
	Super eff. input crs	Super eff. input irs		
	93.18%	93.18%		
	Super eff output crs	Super eff output drs		
	93.18%	93.63%		
	Fdh crs	Fdh vrs	Fdh irs	Fdh drs
	84.29%	100.00%	92.29%	84.35%

	PART B. Year 2005			
All banks	Basic input crs	Basic input vrs	Basic input irs	Basic input drs
	74.71%	91.47%	87.96%	78.21%
	Basic output crs	Basic output vrs	Basic output irs	Basic output drs
	74.71%	89.38%	85.87%	78.21%
	Super eff. input crs	Super eff. input irs		
	75.77%	75.77%		
	Super eff output crs	Super eff output drs		
	75.77%	80.07%		
	Fdh crs	Fdh vrs	Fdh irs	Fdh drs
	74.71%	98.50%	93.02%	78.21%

Table 3. Empirical results: bank vs. method (efficiency scores)

Nbg	2004	2005
Input oriented	100.00%	82.47%
Output oriented	100.00%	82.47%
Super effic input orient	163.25%	64.94%
Super effic. output orient	163.25%	86.44%
Fdh	100.00%	82.47%
Efg	**2004**	**2005**
Input oriented	100.00%	100.00%
Output oriented	100.00%	100.00%
Super effic input orient	108.36%	106.41%
Super effic output orient	108.36%	106.41%
Fdh	100.00%	100.00%

agric	2004	2005
Input oriented	66.65%	58.11%
Output oriented	64.81%	56.18%
Super effic input orient	64.34%	55.70%
Super effic output orient	64.34%	55.70%
Fdh	75.99%	70.35%
gpsb	**2004**	**2005**
Input oriented	100.00%	82.19%
Output oriented	100.00%	82.19%
Super effic input orient	129.57%	64.37%
Super effic output orient	129.57%	64.37%
Fdh	100.00%	82.19%

Table 3 (cont.). Empirical results: bank vs. method (efficiency scores)

Alpha	2004	2005
Input oriented	99.62%	100.00%
Output oriented	99.62%	100.00%
Super effic input orient	99.23%	104.26%
Super effic output orient	101.51%	104.26%
Fdh	99.72%	100.00%
Pir	**2004**	**2005**
Input oriented	95.48%	93.43%
Output oriented	95.39%	93.16%
Super effic input orient	92.00%	90.85%
Super effic output orient	92.00%	90.85%
Fdh	96.00%	95.43%
Empo	**2004**	**2005**
Input oriented	66.20%	64.24%
Output oriented	64.53%	62.59%
Super effic input orient	64.48%	62.36%
Super effic output orient	64.48%	62.36%
Fdh	75.72%	76.25%

egna	2004	2005
Input oriented	87.37%	85.18%
Output oriented	86.49%	81.96%
Super effic input orient	82.09%	75.20%
Super effic output orient	82.09%	75.20%
Fdh	93.50%	87.60%
geb	**2004**	**2005**
Input oriented	51.96%	75.21%
Output oriented	44.07%	71.81%
Super effic input orient	41.41%	53.51%
Super effic output orient	41.41%	53.51%
Fdh	64.76%	76.76%
attica	**2004**	**2005**
Input oriented	93.51%	90.07%
Output oriented	93.51%	90.07%
Super effic input orient	87.02%	80.13%
Super effic output orient	87.02%	80.13%
Fdh	96.67%	90.07%

Notes: nbg – National Bank of Greece, efg – Eurobank, Pir – Piraeus bank, Alpha – Alpha Bank, agric – Agricultural Bank of Greece, Empo – Emporiki Bank, gpsb – Greek Postal Savings Bank, geb – Geniki bank, egna – Egnatia Bank, and attica – Attica Bank.

Summary and conclusion

This paper examines the banking efficiency of top 10 largest commercial Greek banks. We employ data from 2004 and 2005, while we use both the DEA and FDH models with Constant, Variable, Increasing and Decreasing Returns to scale. The objective of this paper is twofold: (i) to describe and apply the most recent methods of efficiency in Greek banking, and (ii) to calculate the efficiency scores using three inputs (number of employees, number of branches and number of ATMs) and one output (loans). To the best of our knowledge, only a limited number of studies include the number of ATMs as an input when calculating the efficiency scores.

The overall efficiency scores range between 71% (for 2004) and 73.6% (for 2005). The empirical results show that the average level of overall technical efficiency is 72%, suggesting that Greek banks could have increased their outputs by 28% with the existing level of inputs. The variation of efficiency scores is plotted in Figure 1 (Appendix). The high overall technical efficiency scores are in line with studies by Pasiouras (2006), Tsionas (2001) and Spathis (2001). Similarly the low overall efficiency scores are in line with Halkos and Salamouris (2004); they report that the average efficiency score of the Greek banking system is around 60%. As far as the various methods employed are concerned, only the FDH with VRS for case 1 and the year 2004 shows an efficiency score equal to unity. Casu and Molyneux (2003), note that when an efficiency score of unity is achieved then this combination of inputs/outputs is the 'best practice' units and therefore the efficient frontier is generated.

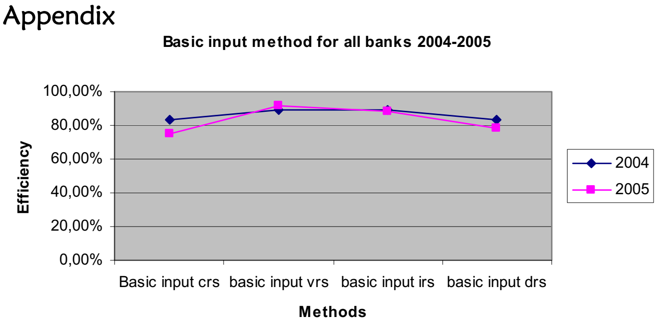
The results for the average efficiency scores show that National Bank of Greece, Eurobank, Alpha and the Greek Postal Savings Bank exhibit the higher efficiency score with a percentage almost 100 % for every case, and this indicates that these banks' relative efficiencies are located on the efficient frontier. Those banks which have efficiency values from 0.6 to 0.9, representing fairly performance, include Piraeus Bank, Agricultural Bank and Attica Bank. Other banks (Geniki Bank) are ranking below 0.6, representing relatively poor efficiency. The competitiveness of Geniki Bank is clearly lagging behind the other 9 Greek banks. Figure 2 (Appendix) shows the range of efficiency scores per method employed for all banks in 2004 and 2005.

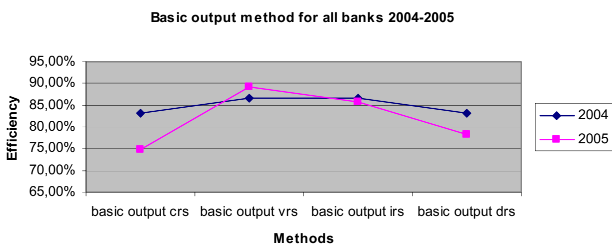
From the DEA analysis, we find that large banks (NBG, Eurobank, Alpha Bank) are more efficient than medium and small sized ones. However, it appears that small banks without offering e-banking services exhibit very high efficiency scores (Greek Postal Savings Bank), while the results of Geniki Bank show that Geniki Bank is less efficient in terms of technical efficiency. We also find that banks with a large number of ATMs (National Bank of Greece) are more efficient than those with less ATM, and this is in line with the study of Pasiouras et al. (2007). They suggest that the banks with broader ATM networks are more technical and cost efficient. However, they notice that the influence of ATMs on the efficiency of banks disappears when a control on market conditions was imposed. Further, we conclude that the provision of e-banking services by banks does not influence their efficiency scores. Future research should examine the e-banking efficiency of Greek and other European banks using recent data and methods.

References

1. Avrikan, N. (2005). Developing foreign bank efficiency models for DEA grounded in finance theory. Socio-Economic planning sciences 40 (2006), pp. 75-296.
2. Berg,S., Forsund, F. and Jansen, E. (1991). Bank output measurement and the construction of best practice frontiers. Journal of productivity analysis, 2, pp. 127-142.
3. Berger, A. and Humphrey, D. (1993). Measurement and efficiency issues in commercial banking. University if Chicago Press, pp. 245-279.
4. Boulding, K. (1961). Some difficulties in the concept of economic input. National Bureau of Economic Research, 25, pp. 331-334.
5. Casu, B. & Molyneux, P. (2003). A comparative study of efficiency in European Banking. Applied Economics, 35 (17), pp. 1865-1876.
6. Charnes, A., Cooper, W. and Rhodes, E. (1978). Measuring the efficiency of decision making units.European Journal of Operations Research, 2, pp. 429-444.
7. Coelli T.J. (1996). A Guide to DEAP version 2.1: A Data envelopment analysis (Computer) Program. Cepa Working Papers, 8 (96), pp. 1-50.
8. Damar, H. (2006). The effects of shared ATM networks on the efficiency of Turkish banks. Applied Economics, 38, pp. 683-697.
9. Farc, R., Grosskopf, S., Kirkley, J. and Squires, D. (2000). Data envelopment analysis (DEA): A framework for assesing capacity in fisheries when data are limited. International Institute of Fisheries Economics and Trade.
10. Farrell, M. (1957). The measurement of productive efficiency. Journal of Royal statistical society, 3, pp. 253-290.
11. Frisch, R. (1965). Theory of production. Dordrecht: D. Reidel.
12. Gutierrez-Nieto B., Serrano-Cinca C. And Molinero (2007). Microfinance institutions and efficiency. The international journal of management science, 35, pp. 131-142.
13. Halkos, G. & Salamouris D. (2004). Efficiency measurement of the Greek commercial banks with the use of financial ratios: a data envelopment analysis approach. Management Accounting Research, 15, pp. 201-224.
14. Mester, L. (1996). A study of bank efficiency taking into account risk preferences. Journal of banking and finance, 20, pp. 1025-1045.
15. Mlima, A. and Hjalmarsson, L. (2002). Measurement of Inputs and Outputs in the Banking industry. Tanzaret Journal, 3 (1), pp. 12-22.
16. Molyneux, P., Altunbas, Y.& Gardener, E. (1996). Efficiency In European Banking. Chichester: Wiley.
17. Pasiouras, F. (2006). Estimating the technical and scale efficiency of Greek commercial banks: the impact of credit risk, off-balance sheet activities, and international operations. University of Bath. School of Management. 2007, 16.
18. Spathis, Ch., Kosmidou, K. and Doumpos, M. (2002). Assessing profitability factors in the Greek banking system: A multicriteria methodology. International Transactions in operational research, 9, pp. 517-530.
19. Sufian, F. (2006). Trends in the efficiency of Singapore's commercial banking groups: A non stochastic frontier DEA window analysis approach. International Journal of Productivity and Performance Management, 56, (2), pp. 99-136.
20. Tsionas, E., Lolos, S.& Christopoulos D. (2001). The performance of the Greek banking system in view of the EMU: results from a non-parametric approach. Economic Modelling, 20, pp. 571-592.
21. Wu, D., Yang Z. and Liang L. (2006). Using DEA-neural network approach to evaluate branch effieciency of a large Canadian bank.Expert Systems with applications, 31, pp. 108-115.
22. Wykoff, F. (1992). Comments on measurements and efficiency in banking. University of Chicago Press, pp. 279-287.

Appendix





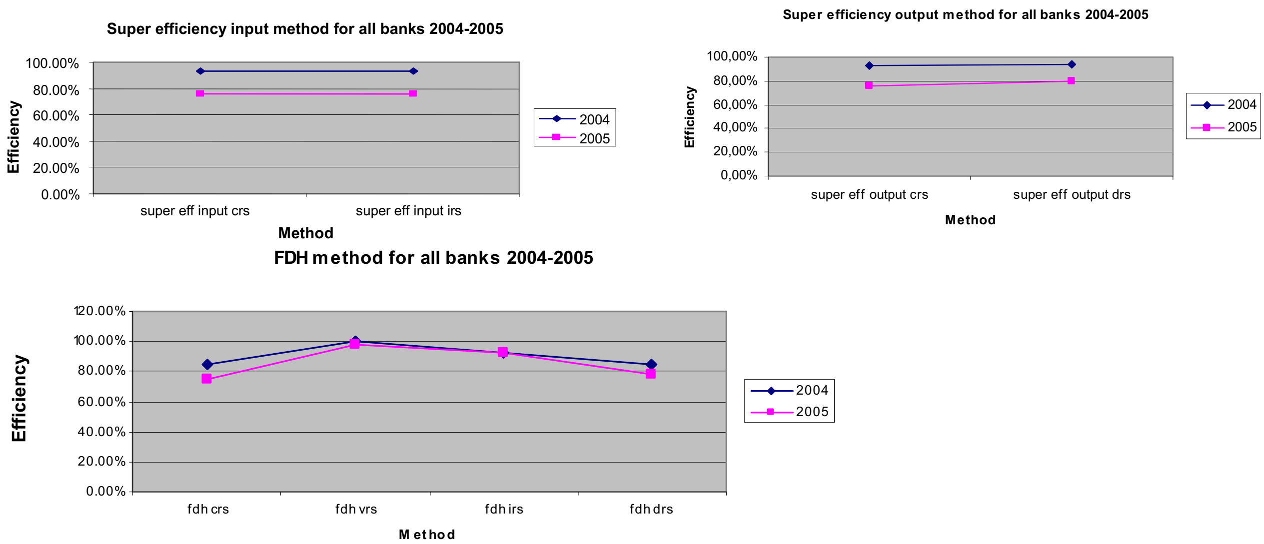
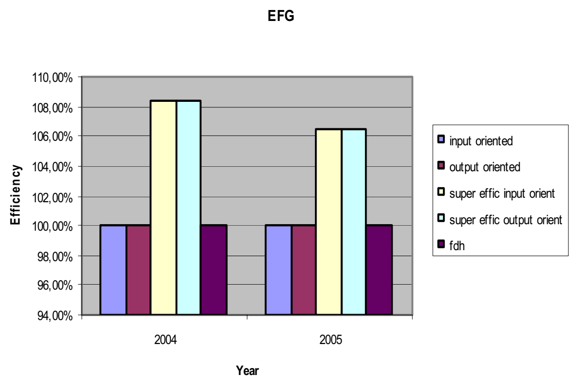
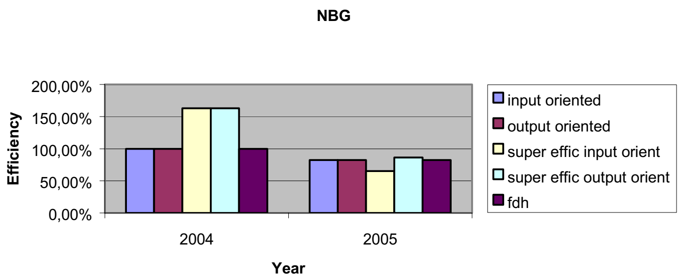
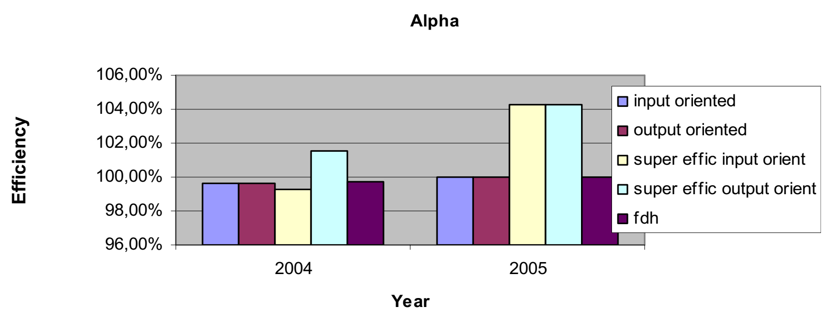
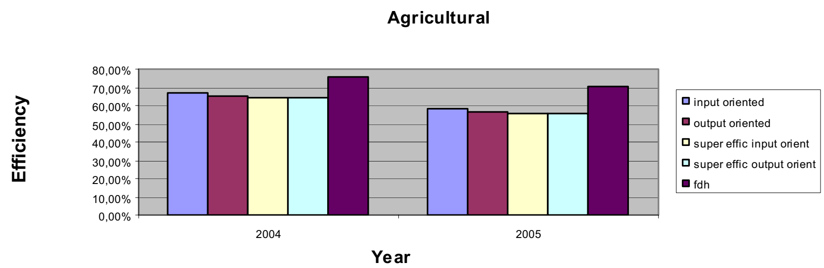


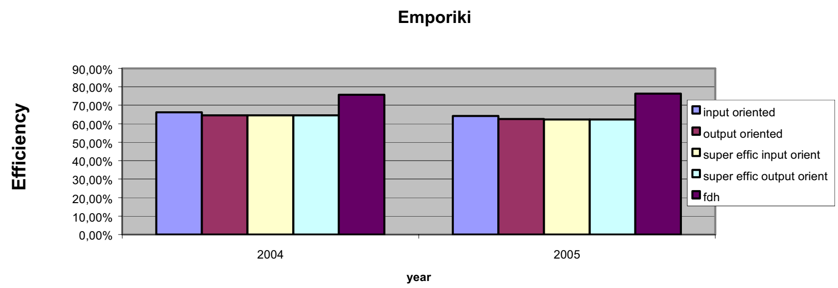
Fig. 1. Variation of efficiency scores (method vs. year)











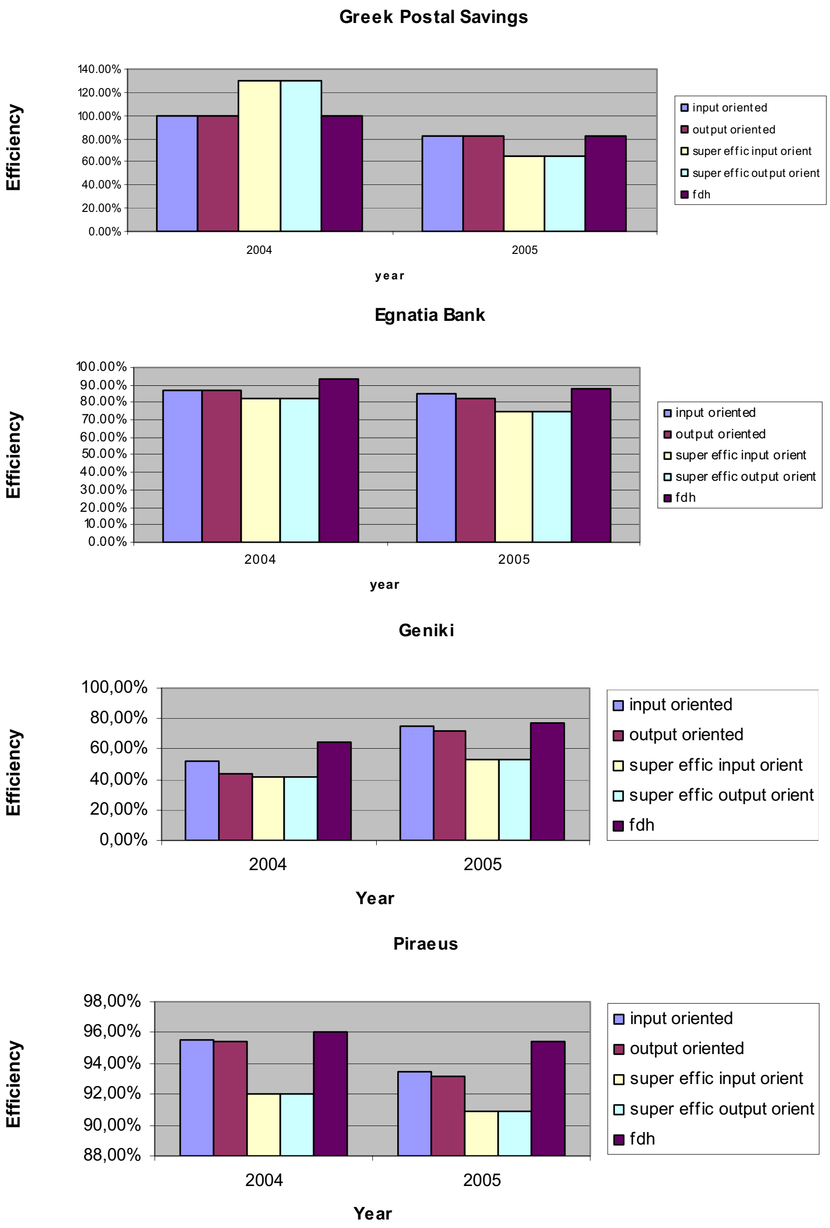


Fig. 2. Range of efficiency scores (method vs. bank/year)

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Technical efficiency of the Malaysian commercial banks: a stochastic frontier approach

Abstract

The purpose of this study is to examine the technical efficiency of the Malaysian commercial banks over the period of 2000-2006, using the stochastic frontier approach (SFA). The findings show that Malaysian commercial banks have exhibited an average overall efficiency of 81 percent implying an input waste of 19 percent. The results also found that the level of efficiency has increased during the period of study. Finally, domestic banks are found to be more efficient relative to foreign banks.

Keywords: technical efficiency, commercial banks, SFA, domestic banks, foreign banks.
JEL Classification: C21, H21, E59.

Introduction

The structure of the Malaysian financial institutions has changed dramatically for the last twenty years. In