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Abstract

This study illustrates how the recent developments in efficiency analysis and statistical inference can be applied when evaluating banks' performance issues from a potential merger. By using a sample of 29 Greek commercial banks the paper provides a six step procedure in order to evaluate whether a potential bank merger can exhibit economies of scale and characterized as favorable.

Keywords: Data Envelopment Analysis; Bootstrap techniques; Virtual Mergers; Bank efficiency.

I. Introduction

There is number of papers in the literature that use non-parametric methods analysing banks' efficiency (among others Pasiouras, 2008a, 2008b; Halkos and Salamouris, 2004; Berg et al., 1991; Berg et al., 1993; Ferrier and Lovell, 1990; Fucuyama, 1993). Most of the data envelopment analysis (DEA) studies have examined bank branch performance (Giokas, 2008; Athanassopoulos, 1997; Berger et al., 1997; Schaffnit et al., 1997). Furthermore other studies have used Farrell's (1957) approach for analyzing efficiency (Berg et al., 1991; Drake and Weyman Jones, 1992; Greenberg and Nunamaker, 1987; Nunamaker, 1985). Finally, Berger and Humphrey (1997) provide a comprehensive review of efficiency studies of financial institutions in 21 countries.

Chiou and Chen (2009) using a sample of 29 banks in Taiwan for the time period 2002-2004 used a stochastic frontier regression model and DEA method to capture the external environment risk effects on banks efficiency. Pasiouras et al. (2006) using country level data and bank level data for 71 countries and 857 banks explore the effect of bank regulations, market structure as well as bank characteristics on individual bank ratings. Their results show that larger and more profitable banks seem to have higher ratings while less cost efficient banks with higher than average levels of provisions compared to their income and lower liquidity seem to have lower ratings.

However the studies mentioned above demonstrate the efficiency levels of the banks under examination but they fail to establish bank's future strategic behaviour. At a first stage this paper by using a sample of 29 Greek banks measures their efficiency levels by applying the DEA technique. Due to the fact that efficiency scores are subject to biased by construction (Simar and Wilson, 1998, 2000) we perform the bootstrap procedure for the DEA estimators in order to obtain bias corrected results (Simar and Wilson, 1998, 2000). Some of its main applications are the correction for the bias and construction of confidence intervals of the efficiency estimators (Simar and Wilson, 1998; 2000), applications to Malmquist indices (Simar and Wilson, 1999), statistical procedures for comparing the efficiency means of several groups (Simar and Wilson 2008), test procedures to assess returns to scale (Simar and Wilson, 2002) and criterion for bandwidth selection (Simar and Wilson, 2002; 2008).

At a second stage we apply a procedure based on the work by Cooper et al. (2007) in order to check the effect of a virtual merger on banks' efficiency levels. Firstly we simulate a virtual merger between the two banks with the highest efficiency levels. Next we simulate a virtual merger between the two banks with the lowest efficiency levels and finally, we simulate the results between a virtual merger with the two largest banks. Then the biased corrected efficiency levels are extracted and the efficiency levels between the banks before and after the merger are analysed.

In addition, by applying the inferential approach introduced by Simar and Wilson (1998, 2000) and bootstrapped procedures introduced by Simar and Wilson (2002, 2008) we demonstrate how DEA techniques can been applied to simulate potential mergers and their effect (in short run) on their main competitors.

II. Methodology

II.1 Performance measurements

The first DEA estimator was introduced by Farrell (1957) to measure technical efficiency. However DEA became more popular when introduced by Charnes et al (1978) in order to estimate Ψ and allowing constant returns to scale (CCR model). The production set Ψ constraints the production process and is the set of physically attainable points (x, y) :

$$\Psi = \left\{ (x, y) \in \Re_{+}^{N+M} \middle| x \quad can \quad produce \quad y \right\} \tag{1}$$

where $x \in \Re_{+}^{N}$ is the input vector and $y \in \Re_{+}^{M}$ is the output vector. Later, Banker et al. (1984) introduced a DEA estimator allowing for variable returns to scale (BCC model). The CCR model uses the convex cone of $\hat{\psi}_{FDH}$ (Derpins et al., 1984) to estimate Ψ , where as the BCC model uses the convex hull of $\hat{\psi}_{FDH}$ to estimate Ψ .

In this paper we use input oriented models since the decision maker through different bank policies may have greater control over the inputs compared to the output used (Halkos and Tzeremes, 2010).

Following the notation by Simar and Wilson (2008), the CCR model developed by Charnes *et al* (1978) can be calculated as:

$$\hat{\Psi}_{CRS} = \left\{ \begin{array}{l} (x, y) \in \Re^{N+M} \middle| y \leq \sum_{i=1}^{n} \gamma_i y_i ; x \geq \sum_{i=1}^{n} \gamma_i x_i \quad for \quad (\gamma_1, \ldots \gamma_n) \\ such \quad that \quad \gamma_i \geq 0, i = 1, \ldots n \end{array} \right\} \tag{2}$$

The BBC model developed by Banker *et al* (1984) allowing for variable returns to scale can then be calculated as:

$$\hat{\Psi}_{VRS} = \left\{ \begin{array}{l} (x,y) \in \Re^{N+M} \left| y \leq \sum_{i=1}^{n} \gamma_i y_i ; x \geq \sum_{i=1}^{n} \gamma_i x_i \quad for \ (\gamma_1, ... \gamma_n) \right. \\ such \ \ that \ \ \sum_{i=1}^{n} \gamma_i = 1; \ \gamma_i \geq 0, i = 1, ... n \end{array} \right\} \quad (3)$$

Then the input oriented efficiency score based on the Farrell (1957) measure for a unit operating at the level (x, y) can be obtained by plugging in $\hat{\Psi}_{DEA}$ in equation:

$$\theta(x,y) = \inf \left\{ \theta \middle| (\theta x, y) \in \Psi \right\} \quad (4)$$

II.2 Bias correction using the bootstrap technique

According to Dyson and Shale (2010) bootstrap procedures produce confidence limits on the efficiencies of the units in order to capture the true efficient frontier within the specified interval. As a result the main drawbacks concerning their inability to conduct statistical inference will disappear (Halkos and Tzeremes, 2010). In addition Simar and Wilson (1998, 2000, 2008) suggest that DEA estimators were shown to be biased by construction. They introduced an approach based on bootstrap techniques (Efron, 1979) to correct and estimate the bias of the DEA efficiency indicators.

Then the bootstrap bias estimate for the original DEA estimator $\hat{\theta}_{DEA}(x, y)$ can be calculated as:

$$\hat{BIAS}_B \left(\hat{\theta}_{DEA}(x,y) \right) = B^{-1} \sum_{b=1}^{B} \hat{\theta}^*_{DEA,b}(x,y) - \hat{\theta}_{DEA}(x,y) \quad (5)$$

Furthermore, $\hat{\theta}^*_{DEA,b}(x, y)$ are the bootstrap values and B is the number of bootstrap reputations. In this way a biased corrected estimator of $\theta(x, y)$ can be calculated as:

$$\begin{aligned} \hat{\hat{\theta}}_{DEA}(x,y) &= \hat{\theta}_{DEA}(x,y) - \hat{BIAS}_B \left(\hat{\theta}_{DEA}(x,y) \right) \\ &= 2\hat{\theta}_{DEA}(x,y) - B^{-1} \sum_{b=1}^{B} \hat{\theta}^*_{DEA,b}(x,y) \end{aligned} \quad (6)$$

But according to Simar and Wilson (2008) this bias correction may create an additional noise and the sample variance of the bootstrap values $\hat{\theta}^*_{DEA,b}(x, y)$ need to be calculated. The calculation of the variance of the bootstrap values is illustrated below as:

$$\hat{\sigma}^2 = B^{-1}\sum_{b=1}^{B}\left[\hat{\theta}^*_{DEA,b}(x, y) - B^{-1}\sum_{b=1}^{B}\hat{\theta}^*_{DEA,b}(x, y)\right]^2 \tag{7}$$

We need to avoid the bias correction illustrated in (6) unless:

$$\frac{\left|\hat{BIAS}_B(\hat{\theta}_{DEA}(x, y))\right|}{\hat{\sigma}} > \frac{1}{\sqrt{3}} \tag{8}$$

Finally, the $(1-\alpha)$ x 100 - percent bootstrap confidence intervals can be obtained for $\theta(x, y)$ as:

$$\frac{1}{\hat{\delta}_{DEA}(x, y) - nc^*_{1-a/2}} \leq \theta(x, y) \leq \frac{1}{\hat{\delta}_{DEA}(x, y) - nc^*_{a/2}} \tag{9}$$

II.3 Checking for economies of scale and virtual mergers

According to Baumol et al. (1982) economies of scope can be identified if the cost reduction of producing both products by one firm is less than the cost of producing them separately in specialised firms such that:

$$C(y_1, y_2) < C_1(y_1, 0) + C_2(0, y_2) \tag{10}$$

where $C(y_1, y_2)$ is the cost of joint production by the diversified firm and $C_1(y_1, 0)$ and $C_2(0, y_2)$ are the respective costs of production of y_1 and y_2 by two specialized firms. Then the degree of economies of scope (DES) for firm j can be defined as:

$$DES_j = \frac{C_1(y_1, 0) + C_2(0, y_2) - C(y_1, y_2)}{C(y_1, y_2)} \tag{11}$$

If $DES_j > 0$ then j exhibits economies of scope, if $DES_j < 0$ implies diseconomies of scope and if $DES_j = 0$ means that costs are additive in nature. Following Cooper et al. (2007) first an input oriented BCC model needs to be applied in order to define the efficient banks.

However, Cooper et al. (2007) calculate the virtual merger between different groups and not at the same group. When considering whether to merge a Product 1-

Firm 1 (υ_{1k}, z_{1k}) with a Product 2-Firm 2 (υ_{2h}, z_{2h}) first Cooper et al. (2007, p. 386-387) remove the cost-inefficiency by applying the input –oriented BCC model. Then they form a virtual firm by combining the input(s) and output(s) of the virtual production possibility set. Cooper et al. (2007) suggest that the virtual possibility set can be formed from the combination of only the BCC-efficient DMUs of the different groups. Then they check for economies of scope by running a super-efficient input oriented BCC model (Andersen and Petersen, 1993). If:

$$\begin{aligned} &C(z_1, z_2) > C_1(z_1, 0) + C_2(0, z_2) && \text{Merger is unfavourable} \\ &C(z_1, z_2) = C_1(z_1, 0) + C_2(0, z_2) && \text{Merger is indifferent} \\ &C(z_1, z_2) < C_1(z_1, 0) + C_2(0, z_2) && \text{Merger is favourable.} \end{aligned} \tag{12}$$

In our case we use a different procedure in order to define whether a merger between the banks in the same sample is favorable or not following the steps illustrated below:

1) As in Cooper et al. (2007) we use the input oriented BCC model in order to identify the efficient banks.
2) Then following the procedure introduced by Simar and Wilson (1998, 2000) we create the bias corrected results for the 29 banks sampled.
3) Next we form the virtual mergers by using all the combinations of the cost efficient banks reported in stage 1. The virtual mergers are formed by combining the inputs and output(s) of the virtually merged firms.
4) We rerun the input oriented BCC model of the 29 banks plus all the combinations of virtual mergers (in our case a total of 57 DMUs).
5) We produce the bias corrected efficiency scores following the bootstrap procedure illustrated previously.
6) We identify the existence of DES using the following formula:

$$DES_{VM(B1,B2)} = 1 - \frac{\hat{\hat{\theta}}_{DEA-B1}(x,y) + \hat{\hat{\theta}}_{DEA-B2}(x,y) - \hat{\hat{\theta}}_{DEA-VM(B1,B2)}(x,y)}{\hat{\hat{\theta}}_{DEA-VM(B1,B2)}(x,y)} \tag{13}$$

Where $\hat{\hat{\theta}}_{DEA-B1}(x,y)$ indicates the biased corrected efficiency scores of bank 1 obtained from steps 1 and 2, $\hat{\hat{\theta}}_{DEA-B2}(x,y)$ is the biased corrected efficiency scores of bank 2 obtained from steps 1 and 2 and $\hat{\hat{\theta}}_{DEA-VM(B1,B2)}(x,y)$ is the biased corrected efficiency scores of the merger of banks 1 and 2 obtained from steps 4 and 5.

The $DES_{VM(B1,B2)}$ in our case indicates the degree of economies of scales (since we have the same output) for the merger of Bank-1 (B_1) and Bank-2 (B_2). If $DES_{VM(B1,B2)} > 0$ implies that the virtual merger exhibits economies of scale and thus the merger is favorable. When $DES_{VM(B1,B2)} < 0$, implies diseconomies of scale indicating that the merger is unfavorable. Finally, when $DES_{VM(B1,B2)} = 0$ the costs are additive in nature and the merger is indifferent.

III. Data and Empirical Results

This study uses a sample of 29 Greek commercial banks (members of the Union of Greek banks) for the year 2007. For our DEA setting we use two inputs (number of employees and total assets in thousand €) and one output (loans in thousand €) (Benston, 1965; Bell and Murphy, 1968) from the statistical database of the Hellenic Bank Association (2007).

Table 1 illustrates the efficiency scores under the variable returns to scale assumption. The results indicate that eight banks are reported to be cost efficient (i.e. efficient scores = 1). These are the National Bank of Greece, EFG Eurobank-Ergasias, ATE Bank, TT Hellenic Postbank, Evros Bank, Pieria Bank, Drama Bank and Kozani Bank. Following the bootstrap procedure the bias corrected efficiency scores are presented and reported in the second column alongside with the estimated bias, the bias' standard deviation and the 95% confidence intervals of the bias corrected efficiency scores.

Following the proposed procedure illustrated previously we create from the efficient banks 28 possible virtual mergers (VM) by combining the inputs and the outputs of the banks (Cooper et al., 2007). As such we create 28 additional DMUs from all possible merger combinations derived from the eight cost efficient banks. In addition to the 29 banks (original sample) we created now a sample of 57 DMUs (banks and VMs). Then as illustrated previously we run again the input oriented BCC model of the 57 DMUs in order to capture the effect of cost efficiency among the original banks and all the proposed virtual mergers. Table 2 presents the results obtained when we apply steps 4 and 5 from the proposed procedure in order to obtain bias corrected efficiency scores of the virtual mergers.

Table 1: Efficiency scores of the 29 banks initially sampled.

Bank Names	VRS	Bias-Corrected	BIAS	STD	LB	UB
National Bank Of Greece	1.000	0.889	-0.125	0.011	0.727	0.995
Alpha Bank	0.656	0.617	-0.095	0.004	0.564	0.653
Emporiki Bank	0.751	0.702	-0.093	0.005	0.625	0.748
EFG Eurobank-Ergasias	1.000	0.890	-0.123	0.009	0.745	0.995
Piraeus Bank	0.667	0.624	-0.103	0.005	0.566	0.664
Geniki Bank	0.719	0.699	-0.041	0.001	0.665	0.718
ATE Bank	1.000	0.913	-0.096	0.004	0.812	0.996
Attica Bank	0.845	0.816	-0.043	0.001	0.773	0.843
Proton Bank	0.753	0.704	-0.093	0.006	0.613	0.751
Probank	0.996	0.969	-0.027	0.000	0.926	0.994
Panellinia Bank S.A.	0.604	0.590	-0.041	0.001	0.569	0.603
First Business Bank	0.882	0.846	-0.049	0.001	0.791	0.878
Aspis Bank	0.894	0.871	-0.030	0.000	0.833	0.893
TT Hellenic Postbank	1.000	0.889	-0.125	0.010	0.736	0.996
Evros Bank	1.000	0.960	-0.042	0.000	0.920	0.995
Achaiki Bank	0.882	0.866	-0.021	0.000	0.842	0.880
Chania Bank	0.823	0.808	-0.023	0.000	0.783	0.821
Pancreta Bank	0.927	0.898	-0.035	0.000	0.859	0.924
Ioannina Bank	0.955	0.930	-0.029	0.000	0.900	0.952
Lamia Bank	0.893	0.871	-0.029	0.000	0.840	0.891
Trikala Bank	0.913	0.889	-0.030	0.000	0.864	0.909
Karditsa Bank	0.869	0.813	-0.079	0.003	0.743	0.865
Korintia Bank	0.866	0.827	-0.054	0.001	0.772	0.863
Evoia Bank	0.949	0.929	-0.023	0.000	0.902	0.946
Pieria Bank	1.000	0.939	-0.065	0.001	0.875	0.996
Drama Bank	1.000	0.916	-0.091	0.003	0.832	0.993
Lesvou Bank	0.880	0.856	-0.032	0.000	0.825	0.877
Serres Bank	0.917	0.874	-0.053	0.001	0.826	0.913
Kozani Bank	1.000	0.884	-0.131	0.011	0.725	0.995

Table 2: Efficiency scores of the 29 banks and the 28 virtual mergers (VM).

Bank Names	VRS	Bias-Corrected	BIAS	STD	LB	UB
National Bank Of Greece	0.897	0.878	-0.023	0.000	0.843	0.896
Alpha Bank	0.621	0.606	-0.041	0.000	0.589	0.620
Emporiki Bank	0.751	0.739	-0.021	0.000	0.715	0.750
EFG Eurobank-Ergasias	1.000	0.973	-0.028	0.001	0.913	0.999
Piraeus Bank	0.652	0.638	-0.033	0.000	0.620	0.651
Geniki Bank	0.719	0.711	-0.016	0.000	0.696	0.719
ATE Bank	1.000	0.981	-0.020	0.000	0.944	0.999
Attica Bank	0.845	0.834	-0.016	0.000	0.816	0.845
Proton Bank	0.753	0.734	-0.035	0.001	0.701	0.751
Probank	0.996	0.985	-0.011	0.000	0.964	0.995
Panellinia Bank S.A.	0.604	0.597	-0.019	0.000	0.587	0.603
First Business Bank	0.882	0.869	-0.017	0.000	0.849	0.881
Aspis Bank	0.894	0.884	-0.013	0.000	0.866	0.894
TT Hellenic Postbank	1.000	0.972	-0.029	0.000	0.923	0.997
Evros Bank	1.000	0.968	-0.033	0.000	0.936	0.996
Achaiki Bank	0.882	0.874	-0.011	0.000	0.862	0.881
Chania Bank	0.823	0.815	-0.011	0.000	0.803	0.822
Pancreta Bank	0.927	0.915	-0.015	0.000	0.895	0.926
Ioannina Bank	0.955	0.939	-0.018	0.000	0.919	0.953
Lamia Bank	0.893	0.878	-0.020	0.000	0.857	0.892
Trikala Bank	0.913	0.901	-0.015	0.000	0.886	0.911
Karditsa Bank	0.869	0.825	-0.060	0.002	0.769	0.866
Korintia Bank	0.866	0.835	-0.042	0.001	0.792	0.863
Evoia Bank	0.949	0.938	-0.013	0.000	0.920	0.948
Pieria Bank	1.000	0.952	-0.050	0.001	0.900	0.997
Drama Bank	1.000	0.931	-0.074	0.002	0.857	0.997
Lesvou Bank	0.880	0.863	-0.023	0.000	0.842	0.878
Serres Bank	0.917	0.885	-0.039	0.001	0.846	0.914
Kozani Bank	1.000	0.907	-0.102	0.009	0.728	0.997

Then following step 6 we determine the existence of economies of scale and thus the desirability of the virtual merger. Table 3 presents the results from step 6. As can be realized 15 mergers are reported to be favorable whereas 13 are reported to be unfavorable. As can be realized in most of the cases the merger between the cooperative banks (Evros Bank, Pieria Bank, Drama Bank and Kozani Bank) are reported to be unfavorable. It seems that due to the fact these banks are relative small banks when they are merging they cannot exploit size effects and thus economies of scale. However when the merger is between small and big banks then in most of the cases the merger is characterized as favorable.

Table 2 (continued) Efficiency scores of the 29 banks and the 28 virtual mergers (VM)

Bank Names	VRS	Bias-Corrected	BIAS	STD	LB	UB
VM-ATE Bank-Drama Bank	1.000	0.981	-0.020	0.000	0.944	0.999
VM-ATE Bank-Evros Bank	1.000	0.981	-0.020	0.000	0.944	0.999
VM-ATE Bank-Kozani Bank	1.000	0.980	-0.020	0.000	0.944	0.999
VM-ATE Bank-Pieria Bank	1.000	0.980	-0.020	0.000	0.944	0.999
VM-ATE Bank-TT Hellinic Postbank	1.000	0.936	-0.069	0.002	0.885	0.997
VM-Drama Bank-Kozani Bank	0.877	0.858	-0.025	0.000	0.833	0.874
VM-National Bank of Greece-ATE Bank	1.000	0.929	-0.077	0.003	0.838	0.998
VM-National Bank of Greece-Drama Bank	0.896	0.878	-0.023	0.000	0.843	0.896
VM-National Bank of Greece-EFG Eurobank	1.000	0.911	-0.098	0.008	0.734	0.997
VM-National Bank of Greece-Evros Bank	0.896	0.878	-0.023	0.000	0.843	0.896
VM-National Bank of Greece-Kozani Bank	0.897	0.879	-0.023	0.000	0.843	0.896
VM-National Bank of Greece-Pieria Bank	0.897	0.879	-0.023	0.000	0.843	0.896
VM-National Bank of Greece-TT Hellenic Postbank	1.000	0.961	-0.041	0.001	0.902	0.997
VM-EFG Eurobank-ATE Bank	0.795	0.767	-0.046	0.000	0.744	0.793
VM-EFG Eurobank-Drama Bank	0.999	0.972	-0.028	0.001	0.913	0.999
VM-EFG Eurobank-Evros Bank	0.751	0.739	-0.021	0.000	0.716	0.750
VM-EFG Eurobank-Kozani Bank	1.000	0.973	-0.028	0.001	0.913	0.999
VM-EFG Eurobank-Pieria Bank	1.000	0.972	-0.028	0.001	0.913	0.999
VM-EFG Eurobank-TT Hellenic Postbank	0.832	0.811	-0.031	0.000	0.778	0.830
VM-Evros Bank-Drama Bank	0.932	0.920	-0.014	0.000	0.902	0.931
VM-Evros Bank-Kozani Bank	0.918	0.905	-0.016	0.000	0.887	0.916
VM-Evros Bank-Pieria Bank	0.954	0.941	-0.014	0.000	0.925	0.952
VM-Pieria Bank-Drama Bank	0.919	0.905	-0.018	0.000	0.885	0.917
VM-Pieria Bank-Kozani Bank	0.918	0.896	-0.028	0.000	0.869	0.916
VM-TT Hellinic Postbank-Drama Bank	0.999	0.976	-0.024	0.000	0.927	0.998
VM-TT Hellinic Postbank-Ebros Bank	1.000	0.977	-0.023	0.000	0.928	0.999
VM-TT Hellinic Postbank-Kozani Bank	1.000	0.974	-0.027	0.000	0.924	0.998
VM-TT Hellinic Postbank-Pieria Bank	1.000	0.975	-0.025	0.000	0.926	0.998

Table 3: Degree of Economies of Scale (DES) and merger desirability.

Bank Names	DES	Merger
VM-ATE Bank-Drama Bank	0.135	Favourable
VM-ATE Bank-Evros Bank	0.090	Favourable
VM-ATE Bank-Kozani Bank	0.167	Favourable
VM-ATE Bank-Pieria Bank	0.111	Favourable
VM-ATE Bank-TT Hellinic Postbank	0.074	Favourable
VM-Drama Bank-Kozani Bank	-0.100	Unfavourable
VM-National Bank of Greece-ATE Bank	0.060	Favourable
VM-National Bank of Greece-Drama Bank	-0.055	Unfavourable
VM-National Bank of Greece-EFG Eurobank	0.046	Favourable
VM-National Bank of Greece-Evros Bank	-0.105	Unfavourable
VM-National Bank of Greece-Kozani Bank	-0.018	Unfavourable
VM-National Bank of Greece-Pieria Bank	-0.080	Unfavourable
VM-National Bank of Greece-TT Hellenic Postbank	0.149	Favourable
VM-EFG Eurobank-ATE Bank	-0.351	Unfavourable
VM-EFG Eurobank-Drama Bank	0.118	Favourable
VM-EFG Eurobank-Evros Bank	-0.503	Unfavourable
VM-EFG Eurobank-Kozani Bank	0.175	Favourable
VM-EFG Eurobank-Pieria Bank	0.119	Favourable
VM-EFG Eurobank-TT Hellenic Postbank	-0.193	Unfavourable
VM-Evros Bank-Drama Bank	-0.004	Unfavourable
VM-Evros Bank-Kozani Bank	-0.039	Unfavourable
VM-Evros Bank-Pieria Bank	-0.017	Unfavourable
VM-Pieria Bank-Drama Bank	-0.051	Unfavourable
VM-Pieria Bank-Kozani Bank	-0.036	Unfavourable
VM-TT Hellinic Postbank-Drama Bank	0.151	Favourable
VM-TT Hellinic Postbank-Ebros Bank	0.108	Favourable
VM-TT Hellinic Postbank-Kozani Bank	0.179	Favourable
VM-TT Hellinic Postbank-Pieria Bank	0.126	Favourable

VI. Conclusions

This paper provides a procedure of how the bootstrap techniques may be used in order to calculate the effects of potential mergers on banks efficiency levels. By applying a 6 step procedure merger desirability between firms in the same sector can be estimated and assessed. According to our empirical findings it seems that relative small banks cannot exploit size effects and thus economies of scale when they are merged while when the merger is between small and big banks in most of the cases the merger may be considered as favorable.

References

Andersen, P., Petersen. NC (1993) A procedure for ranking efficient units in data envelopment analysis. Management Science 39 1261-1264.

Athanassopoulos, A.D., 1997. Service quality and operating efficiency synergies for management control in the provision of financial services: evidence from Greek bank branches. European Journal of Operational Research 98, 301–314.

Banker RD, Charnes A, Cooper WW (1984) Some models for estimating technical and scale inefficiencies in data envelopment analysis. Management Science 30(9):1078–1092.

Baumol, W.J., Panzar, J.C. and Willig R.D., (1982). Contestable Markets and the Theory of Industry Structure. San Diego: Harcourt Brace Jovanovich.

Bell, F. and Murphy, N. (1968) Economies of scale and division of labor in commercial banking. National Banking Review, 5, 131-139.

Benston, G. (1965) Branch banking and economies of scale. Journal of Finance, 20, 312-331.

Berg, A., Forsund, F., Jansen, E., (1991). Technical efficiency in Norwegian banks: a non parametric approach to efficiency measurement. Journal of Productivity Analysis 2, 127–142.

Berg, S.A., Forsund, F.R., Hjalmarsson, L., Souminen, M., (1993). Banking efficiency in the Nordic countries. Journal of Banking and Finance 17 (2/3), 371–388.

Berger, N.A. and Lorreta, J.M., (1997). Inside the black box: What explains differences in the efficiencies of financial institutions? Journal of Banking & Finance 21 895-947.

Charnes A, Cooper WW, Rhodes E (1978) Measuring efficiency of decision making units. European Journal of Operational Research 3:429–444.

Chiou, Y.H. and Chen, Y.C., (2009). The analysis of Taiwanese bank efficiency: Incorporating both external environment risk and internal risk, Economic Modelling 26, 456–463.

Cooper WW, Seiford LM, Tone K (2007) Data envelopment analysis: A comprehensive text with models, applications, references and DEA-Solver software. Springer, New York.

Cooper WW, Seiford LM, Tone K (2007) Data Envelopment Analysis: A comprehensive text with models, applications, references and DEA-solver software, Springer, New York.

Derpins D, Simar L, Tulkens H. (1984). Measuring labor efficiency in post offices. In: Marchand M, Pestieau P, Tulkens H (eds) The performance of public enterprises: concepts and measurement. North-Holland, Amstredam, pp 243–267.

Drake, L., Weyman Jones, T.G., (1992). Technical and scale efficiency in UK building societies. Applied Financial Economics 2, 1–9.

Dyson, R.G. and Shale, E.A. (2010). Data envelopment analysis, operational research and Uncertainty, Journal of the Operational Research Society, 61, pp. 25—34.

Efron, B. (1979). Bootstrap methods: another look at the jackknife, Annals of Statistics **7**:1-16.

Farrell, M.J. (1957). The measurement of productive efficiency', Journal of the Royal Statistical Society Series A, 120, pp. 253–281.

Ferrier, G., Lovell, C., (1990). Measuring cost efficiency in banking: econometric and linear programming evidence. Journal of Econometrics 46, 229–245.

Fucuyama, H., (1993). Technical and scale efficiency of Japanese commercial banks: a non parametric approach. Applied Economics 25, 1101–1112.

Giokas, D.I. (2008). Assessing the efficiency in operations of a large Greek bank branch network adopting different economic behaviors, Economic Modelling 25 559–574.

Greenberg, R., Nunamaker, T., (1987). A generalized multiple criteria model for control and evaluation of non-profit organizations. Financial Accounting Management 3 (4), 331–342.

Halkos, NG. and Tzeremes NG. (2010). The effect of foreign ownership on SMEs performance: An efficiency analysis perspective. Journal of Productivity Analysis. DOI 10.1007/s11123-010-0174-2.

Halkos, G. and 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, 201-224.

Hellenic Bank Association (2007) Greek Banking System Data. Available from: http://www.hba.gr/English/Index_en.asp?Menu=5

Nunamaker, T.R., (1985). Using data envelopment analysis to measure the efficiency of nonprofit organizations: a critical evaluation. Managerial and Decision Economics 6 (1), 50–58.

Pasiouras F., Gaganis C. and Zopounidis C (2006). The impact of bank regulations, supervision, market structure, and bank characteristics on individual bank ratings: A cross-country analysis. *Review of Quantitative Finance and Accounting* 27(4): 403-438.

Pasiouras F. (2008a). Estimating the technical and scale efficiency of Greek commercial banks: The impact of credit risk, off-balance sheet activities, and international operations. *Research in International Business and Finance* 22(3): 301-318

Pasiouras F. (2008b). International evidence on the impact of regulations and supervision on banks' technical efficiency: an application of two-stage data envelopment analysis *Review of Quantitative Finance and Accounting* 30(2): 187-223.

Schaffnit, C., Rosen, D., Paradi, J.C., (1997). Best practice analysis of bank branches: an application of DEA in a large Canadian bank. European Journal of Operational Research 2(16), 269-289.

Simar L, Wilson P (2008) Statistical interference in nonparametric frontier models: recent developments and perspectives. In: Fried H. Lovell CAK, Schmidt S (eds). The measurement of productive efficiency and productivity change, Oxford University Press, New York.

Simar L, Wilson PW. (1998). Sensitivity Analysis of Efficiency Scores: How to Bootstrap in Nonparametric Frontier Models. Management Science 44: 49–61.

Simar L, Wilson, P.W. (1999). Estimating and Bootstrapping Malmquist Indices. European Journal of Operational Research 115, pp.459– 471.

Simar L, Wilson PW (2000). A general methodology for bootstrapping in non-parametric frontier models. Journal of Applied Statistics 27(6): 779 -802.

Simar L, Wilson PW (2002). Nonparametric tests of returns to scale. European Journal of Operational Research, pp.115– 132.