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BANK'S BRANCHES EFFICIENCY AND PRODUCTIVITY CHARACTERISTICS: EVIDENCE FROM A GREEK BANK

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ABSTRACT

The paper investigates the major factors that affect efficiency and productivity of Banks on a branch level. DEA analysis is used to estimate the efficiency level of a bank's branch network. Technical and scale efficiency (SE) scores are calculated obtained through an input-oriented DEA model. For the research study, a sample of 49 branches of a Greek bank is used, operating in 4 regions of Greece over the period 2009-2011. First a classification technique is used to classify firms with common characteristics and the score of the most important variables used become subsequently inputs to DEA model to explore the efficiency and productivity of the branches. Secondly an econometric model is used to determine the impact of internal and external factors on the efficiency and productivity scores. The main contribution of this work is a better understanding of various factors that may affect a bank's branch efficiency and insolvency. This provides important implications for managers and policy makers for the better understanding of profitability and productivity issues in the Greek banking system, especially those contributing to branches viability.

Keywords: Banks' Efficiency, DEA, Econometric Analysis

1. Introduction

During financial crisis, that suppresses the banks' profitability, it is a common practice for management to aim to minimize inefficiencies in bank operations. This paper reports on an assessment of the efficiency in operations of homogenous branches of a Greek bank, over the period 2009-2011, in two different areas: their efficiency in managing the economic record of the branches and their efficiency in generating profits.

A non-parametric method of input-oriented data envelopment analysis (DEA) is used under variable returns to scale, for the different efficiency assessments. The bank of this study is a representative unit to observe with branch homogeneity which is a basic requirement of DEA in order to minimize estimation bias ([7], [8]), by selecting retail branches of the specific bank with common characteristics such as the age of branch establishment, the branch location, the number of employed personnel and similar services provided towards individuals and small enterprises. Furthermore, the data set used is unique, based on inside information derived from yearly financial statements gathering from the Management Information System of the bank of the study.

The results indicated that the average pure technical efficiency both in the two dimensions reduced during the crisis period. The differences are statistically significant in DEA VRS Model. Also, there is the scope for substantial efficiency improvements in the branch network through cost controls and credit risk management, in order to offset the negative impact on earnings caused by the crisis.

In the first part of this paper (sections 2 to 4) we describe core characteristics and calculate Technical Efficiency (TE) scores through an input-oriented DEA model for a sample of 47 branches of a Greek Bank, operating in 4 regions in Greece, over the period 2009-2011 (141 observations).

In the second part (section 5), DEA scores calculated earlier become an input to eight regression models, with Return on Assets (ROA) as dependent variable and core bank's financial characteristics as independent variables. Results and further research also described in the conclusion section.

2. Characteristics of the Research -Basics structure in DEA

In this research input-oriented Technical Efficiency (TE) is used. As Coelli et al. (1999) point out the input-oriented TE measures address the question how much can input quantities be proportionally reduced without changing the output quantities produced. –Also, Constant returns to scale (CRS) and Variable Returns to Scale (VRS) assumptions are employed in the study. More specifically:

- CRS assumption is appropriate when all firms are operating at an optimal scale. The causes in which firms are not at the optimal scale are imperfect competition, constraints on finance, etc.
- VRS specification is appropriate when not all firms are operating at the optimal scale.

In this paper the input-oriented DEA model with Variable Returns to Scale (VRS) developed by [3] is used which allows the possibility that the production technology of DMUs may exhibit increasing, constant and decreasing returns to scale. The VRS specification adds a convexity constraint to the original [6] Constant Returns to Scale (CRS) model and should be calculated as:

$$\begin{aligned} &\min_{\theta,\lambda} \theta \\ &st \quad -y_i + Y\lambda \geq 0, \\ &\qquad \theta x_i - X\lambda \geq 0, \\ &\qquad N1'\lambda = 1 \\ &\qquad \lambda \geq 0, \end{aligned} \tag{1}$$

where θ is a scalar; λ is an $N \times 1$ vector of constants; and $N1'\lambda = 1$ is the convexity constraint, where N1 is an $N \times 1$ vector of ones. The linear programming model must be solved N times, one for each DMU in the sample. The obtained value of θ is the efficiency score for the i-th firm and it satisfies $\theta \leq 1$, with a value of 1 indicating a point on the frontier, i.e. a technically efficient bank. Scale efficiencies are measured by running the same dataset through both the CRS and VRS models. They are calculated by dividing the CRS efficiency score by the corresponding score of the VRS model and retain values between zero and one. Slack variables are also analyzed. These indicate excess input combinations in non-best practice banks relative to the benchmark efficient banks. In this paper both VRS and CRS models are used.

3. Literature Review

An abundant international literature on cost efficiency in banking and, to a lesser extent, productivity exists (see the extensive bank efficiency surveys by [4] and [13]; and the works on productivity growth by [14] and [5]). The vast majority of efficiency studies over the last decade or so have adopted frontier analysis to estimate alternative efficiency measures (e.g. X- and scale efficiencies).

More specifically, [19] integrated DEA and neural networks (NN), to examine the profit efficiency of 142 branches of a Canadian bank. By comparing the efficiency scores with DEA normal results, they found that the combined system identifies more efficient branches.

In [17] researchers assessed the transaction, production and profit efficiency of 57 branches of a Portuguese bank and identified benchmark bank branches and also problematic branches. They found positive links between production and profit efficiency and also between transaction and production efficiency.

As far as Greece is concerned, several studies explored efficiency of retail branch networks by employing DEA under different approaches.

[1], using 68 branches of a commercial bank, investigated the relationship between production efficiency and profit efficiency using a multivariate modeling technique. He found that branch location, network size, product range, personnel abilities and reliability of services have significant effect on Greek branches efficiency. [12], also, assessed the production, transaction and profit efficiency in operations of a branch network consisting of 44 branches for the financial year 2002.

The empirical results indicate that there branches with previous good profit and production efficiency seem that acted decisively after the burst of the financial crisis and gave a priority to credit risk management to offset the consequences of the crisis. Loans write – offs is an enormous burden not only for banks profitability and viability. It also increases the overall credit risk of the Bank's loans portfolio.

4. DEA-models Characteristics

In order to calculate efficiency of Bank's branches and compare branches on each dimension, an input-oriented analysis is used, following most of the recent studies ([10], [16], [12], [11], [19], [15]), to identify sources of inefficiency at the input level, which is under direct control of bank management. As [18] state, during periods of crises it is a common practice for management to aim to enhance the cost efficiency (reducing expenses without lowering the volume of output), so this gives rise to input-oriented models.

The two following DEA Models, of the Greek banking institution are used:

1. Model DEA1 based on yearly based data

Inputs

- Cost of Employees (EMPLOYEE)
- Operational Expenses (except outsourcing activities) (EXPENSES)
- Branch's Interest commission (INTEREST)

Output

Fee Income (INCOME)

2. And the Model 2, based also on yearly based data

Inputs

- Cost of Employees (EMPLOYEE)
- Operational Expenses(except outsourcing activities) (EXPENSES)
- ranch's Loans Loss Provisions (PROVISIONS)

Output

Fee Income (INCOME)

As mentioned before, Bank's Branches Technical Efficiency (TE) is estimated using both CRS and VRS DEA Model. Statistical software EMS 1.3 used to conduct DEA analysis for calculating TE.

Table 1: Descriptive efficiency results comparisons – Technical Efficiency (TA)

	2009	2010	2011
DEA1-CRS			
Average efficiency (%)	52,14%	53,31%	50,58%
% of efficient branches	42.55%	44.68%	38.29%
DEA1-VRS			
Average efficiency (%)	75,94%	76,19%	69,44%
% of efficient branches	55.32%	55.32%	48.93%
DEA2-CRS			
Average efficiency (%)	54.56%	49.63%	48.75%
% of efficient branches	39.58%	37.50%	36.17%
DEA2-VRS			
Average efficiency (%)	73.92%	71.71%	57.78%
% of efficient branches	53.19%	44.68%	38.29%

Also, an Independent Samples T-test is conducted (Table 2). Results for t-test between the two panels, DEA1 panel (with interest commissions as input) and DEA2 panel (with Loans Loss Provisions as input) indicate that the average Technical Efficiency (TE) between the two panels is statistically significant at 5% only in VRS mode.

Table 2: Independent Samples T-test

DEA	t- test for equality of means	
	F	Sig.
CRS	267.78	0.68
VRS	279.65	0.017 (significance at 5%)

We see that the Mean Value DEA1-VRS equals to 0.73, when at the same time the Mean Value DEA2-VRS equals to 0.67. It clearly shows that TE is greater in DEA1 than in DEA2 panel.

No other significance in bank's branches Technical A found between the sampling years (2009-2011), which represent the start and the running of the Greek financial crisis period.

5. Determinants of Bank Efficiency

In the second stage of this research a fixed effects regression model is set to investigate whether and to what extent among others outsourcing and interest rate spread are related to efficiency. The model can be written as follows:

$$Y = b_0 DEA_{ik} + b_2\,(\text{Total Income/ Total Expenses}) + b_3\,(\text{Total cost of outsourcing}) + b_4\,(\text{Loans write – offs}) + b_5\,(\text{Estimated Cost of Capital}) + b_6\,[\text{Interest spread - yearly based (Average Loans Interest- Average Deposits Interest)}] + \varepsilon$$

Where

Y is the Dependent Variable: ROA (RETURN ON ASSETS)

and

1. DEA_{ik} is the score of DEA of the i panel (i=1 for DEA1 and i=2 for DEA2), for k returns to scale (1=for CRS an 2=for VRS)
2. Ratio Total Income/ Total Expenses per Branch per year
3. Total cost of outsourcing per Branch per year
4. Loans write – offs per Branch per year
5. Estimated Cost of Capital per Branch per year, and
6. Interest spread - yearly based (Average Loans Interest- Average Deposits Interest)] per Branch per year
7. ε is the error term

All regressions are estimated through fixed effects regression. Based on the Breusch-Pagan test ([2]), the Lagrange Multiplier (LM) statistic is calculated. Comparing the relevant statistic of each model with $X^2_{0,001,n}$ where n refers to the number of variables, the null hypothesis that the errors are homoscedastic cannot be re-

jected. Therefore, the fixed effects method used in this analysis is appropriate for all 4 regressions, i.e. with DEA1 and DEA2 models for CRS and VRS options respectively.

Also, White's transformation is used to control the cross-section heteroscedasticity of the variables. Results are shown in Tables 3 and 4.

Table 3: DEA1 Models & Results

	DEA1-crs	DEA1-vrs
C	0.247886 (0.0182)	0.161480 (0.0550)
DEA	0.063821 (0.0140)**	0.178610 (0.0003)*
EXP_INC	-0.001175 (0.4694)	-0.001147 (0.3511)
OUTSOURSING	-0.000912 (0.0000)*	-0.000785 (0.0000)*
WRITE_OFFS	-5.69E-05 (0.0022)*	-4.34E-05 (0.0008)*
COST_OF_CAP	0.000678 (0.2636)	0.000785 (0.1683)
SPREAD	-0.027699 (0.0041)*	-0.033888 (0.0000)*
R-squared	**0.881723**	**0.884539**
Durbin-Watson stat	2,0421	2,0072
Breusch-Pagan test (LM)	15,49 ($X^2_{0,001,6}$=22,46)	16,89 ($X^2_{0,001,6}$=22,46)
degrees of freedom (df)	6	6
F-statistic	12,6157	12,9647
Prob(F-statistic)	0,0000	0,0000

p is in parenthesis, (*) statistical significance at 1% and (**) statistical significance at 5%

Results show that DEA scores are statistical significant factors to ROA in all panels (DEA1 & DEA2 models) and any return to scale (CRS and VRS) and statistically significant at 1% or 5%, with positive (+) relation to ROA. Also, Total Income / Total Expenses ratio is found statistically significant at 1%, only in DEA-Panel B (with loan loss provisions),with negative relation (-) to ROA.

Moreover, the total cost of outsourcing is statistically significant at 1%, in all cases except in DEA2-VRS with negative relation (-) to ROA.

Table 4: DEA2 Models & Results

	DEA1-crs	DEA1-vrs
C	0.236079 (0.0728)	0.078213 (0.4762)
DEA	0.095538 (0.0001)*	0.326724 (0.0000)*
EXP_INC	-0.001120 (0.5044)	-0.002352 (0.0002)*
OUTSOURSING	-0.000850 (0.0000)*	-0.000274 (0.2387)
WRITE_OFFS	-5.46E-05 (0.0159)**	4.02E-06 (0.8942)
COST_OF_CAP	0.000701 (0.2439)	0.000997 (0.0925)
SPREAD	-0.029693 (0.0058)*	-0.036360 (0.0000)*
R-squared	**0.882662**	**0.897234**
Durbin-Watson stat	2,0625	2,1389
Breusch-Pagan test (LM)	16,10 ($X^2_{0,001,6}$=22,46)	20,23 ($X^2_{0,001,6}$=22,46)
degrees of freedom (df)	6	6
F-statistic	12,7302	14,775
Prob(F-statistic)	0,0000	0,0000

p is in parenthesis, (*) statistical significance at 1% and (**) statistical significance at 5%

As expected, loans write – offs are statistically significant at 1% in DEA-Panel A (with interest commission as an input), with negative relation (-) to ROA. Also, Interest spread - yearly based (Average Loans Interest- Average Deposits Interest) is statistically significant at 1%, in all cases with negative relation (-) to ROA.

5. Conclusion

Comparing the average technical efficiency of the sampling branch network with other studies for Greek retail branches, similarities with other researches, e.g. [16] and [10] are observed, where they found an average efficiency of 70% but before the year 2005. In particular, [16], calculated TE for the financial years 2000-2001, while [10], for the period 2002-2005.

DEA method should become an important factor for profitability issues in Bank's managerial policy. It gives good explanation of the results in both models (with or without the use of loans loss provisions).

Outsourcing has also negative influence to banks financial condition, due to significance in any case of our models. This means that a reengineering of the bank's operations need to be done in a sense of giving out less amount of external banking employments to third parties.

Furthermore the sample Bank's branches seem to have little effect in efficiency scores from the Greek economic crisis started out the year 2009. There is no evidence that the crisis influenced negativity the Bank's network efficiency scores in a substantial volume, which is a great managerial task on its own. In period of the financial crisis (2009 and after), branches with previous good profit and production efficiency seem that acted decisively after the burst of the financial crisis and gave a priority to credit risk management to offset the consequences of the crisis. Loans write – offs is an enormous burden not only for banks profitability and viability. It also increases the overall credit risk of the Bank's loans portfolio.

The core implication of our paper is that Bank's branches in order to avoid the realization of great loss efficiency during the crisis period ahead, should further focus on an effective proactive credit risk management in the credit sales boom period, in order to sustain their viability.

Further research can be done towards using multicriteria analysis models in conjunction with Data Envelopment Analysis to make a comparison of the results. Also, an option in using Stochastic Frontier Analysis as well as DEA to find out similarities in bank branches efficiency is critical for research. Furthermore, cluster analysis techniques can be examined in order to find specific types of branches with similar features in discrete efficiency clusters.

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