ISSUE 13 | DECEMBER 2013 | ISSN 2219-746X

THE ADVANCED SCIENCE

OPEN ACCESS JOURNAL

Peer-review:

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THE ADVANCED SCIENCE JOURNAL

ISSN 2219-746X (Print); 2219-7478 (Online)
VOLUME 2013 ISSUE 13

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905 – BANGKING, FINANCIAL SUPPORT SERVICES
RECEIVED 12.08.2013 ACCEPTED 20.11.2013 PUBLISHED 10.12.2013

COST-EFFECTIVENESS ANALYSIS OF UKRAINIAN BANKS USING THE DEA METHOD

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Abstract. The purpose of this study is to determine the scale, technical and overall efficiency of the banking system of Ukraine using the DEA method in dynamics in the post-crisis period. The DEA method belongs to the group of non-parametric methods based on front's technology analysis and allows considering the totality of impacts both the input parameters (resources) and output (products / services). The structure of banks included 24 banks of Ukraine with total assets amounted to 806.7 billion UAH (72 % of banking system assets). Banks were classified into state-owned banks and banks in which the state has a controlling interest, banks with domestic capital, banks with Russian capital and banks with foreign capital (excluding Russia). Empirical data analysis demonstrated that over the period of analysis the effectiveness of large-scale banks increased, while pure technical remained at a moderate level. Most of the banks included in the sample operate with average effective or ineffective.

Introduction

At this stage of the functioning of the Ukrainian banking system banks are concentrated not on the expansion of the operation but on the effective management of available financial, material and human resources that requires the implementation of evidence-based methods of economic efficiency analysis. For these purposes nonparametric methods of the analysis of the bank economic efficiency should be used.

Significant research results for the use of nonparametric methods of the analysis of bank economic efficiency have been received by foreign scientists.

Sufian (2007, p.57) investigated the performance of Malaysian Islamic banking sector during the period of 2001-2005. Several efficiency estimates of individual banks are evaluated using non-parametric Data Envelopment Analysis (DEA). Two different approaches have been employed to differentiate how efficiency scores vary with changes in inputs and outputs. To examine the impact of risk factor on Islamic bank efficiency, he has incorporated problem loans as a nondiscretionary input variable in our analysis. The findings suggest that during the period of study, scale inefficiency dominates pure technical inefficiency in the Malaysian Islamic banking sector. He found that foreign banks have exhibited higher technical efficiency compared to their domestic peers. The inclusion of risk factors has mixed impact on Malaysian Islamic banks' efficiency.

Muhammad (2008, p.132) are used the non-parametric approach popularly known as Data Envelopment Analysis (DEA) and productivity growth using Malmquist Productivity index (MPI), in a sample of Nigerian commercial banks over the period of 5 years. Net fixed assets and total deposits were used as the input variables while total loans and advances, other earning assets and net operating income were used as the output variables. Under the Constant Return to Scale assumption, the average efficiency of all the banks over the 5-year period showed a constant improvement.

Wozniewska (2008, p. 84) presented the results of efficiency analysis, computed by means of classical index of balance sheet characteristics and the non-parametric DEA method. The analysis was carried out in the biggest banks operating in Poland in 000–2007. The empirical results show that the efficiency measures give a similar although not identical picture of Polish commercial banks' performance. These results (yielded by both methods) are complementary to each other and suggest that the non-parametric DEA method is really valuable and worth applying in bank practice.

Saad and El-Moussawi (2009, p. 7) uses two approaches to assess the cost efficiency of Lebanese commercial banks: a nonparametric method, Data Envelopment Analysis, and a parametric method, Stochastic Frontier Analysis. They considered 43 commercial banks over a period from 1992 to 2005. The

findings show that the average cost efficiency is quite high in both methods, and it is increasing over time. A test of convergence of the efficiency scores was done and indicates that there is convergence of efficiency levels of Lebanese banks between 1992 and 2005.

Nazin (2010, p.35) conducted evaluation of the financial crisis impact in 2008 on the economic efficiency of the Russian banking sector using Data Envelopment Analysis. The author defined that banks with foreign capital are more effective than national, moreover, this difference is exacerbated in a time of crisis and the difference between the Moscow and regional banks is insignificant.

Andries and Cocris (2010, p. 68) analyses the efficiency of the main banks in Romania the Czech Republic and Hungary for the period 2000-2006, by using the frontier analysis. For the estimation of efficiency of banking they used a nonparametric method – the DEA Method (Data Envelopment Analysis) and a parametric method - the SFA Method (Stochastic Frontier Analysis). The results of the analyses show that the banks in the three East-European countries reach low levels of technical efficiency and cost efficiency, especially the ones in Romania, and that the main factors influencing the level of banks efficiency in these countries are: quality of assets; bank size, annual inflation rate; banking reform and interest rate liberalisation level and form of ownership.

Stavarec and Repkova (2012, p. 361) estimated the efficiency of the Czech commercial banks in the period 2001–2010 using the non-parametric Data Envelopment Analysis. They simultaneously are used two alternative specifications – CCR model and BCR model – that differ in returns to scale assumption. Differences in estimated efficiency scores of individual banks are quite large up to 70 percentage points. Largest banks perform significantly worse than mid-size and small banks. This efficiency gap decreases if variable returns to scale are considered in the estimation. The average efficiency in the banking sector remained nearly unchanged during the analysed period. Although each year is estimated separately one can observe a deterioration of average efficiency during the recent crisis period.

Muvingi (2012, p.159) analyses bank efficiency scores of Zimbabwean banks for the two currency periods understudy, that is the Zimbabwe dollar era and multicurrency era. The study utilised the financial intermediation approach based on data envelopment analysis. The methodology had two inputs and two outputs; total deposits, interest expenses, total loans and advances and interest income. Adoption of multi-currency in 2009 was associated with a drop in bank efficiency. All private owned banks, both foreign and locally owned banks, recorded higher efficiency scores as compared to the publicly owned banks, both foreign and locally owned banks .Bank efficiency of seven of the banks understudy improved under the multi-currency regime, whilst six banks recorded a decline of bank efficiency in multi-currency. Migration of an entity from one banking type to another, resulted a drop on bank efficiency .Size of a bank in terms of deposits does not translate to high bank efficiency. The low efficiency of foreign owned banks during the Zimbabwean dollar era was attributed to restrictive credit creation policies. The bank inefficiency in 2009 was mainly caused by high interest expenses emanating from liquidity challenges associated with the use of foreign currencies in place of the domestic currency. Banks with the least requirement adjustment for interest expense during year 2010 were expected to increase their loans and advances in order to achieve efficiency, in an environment characterised by liquidity improvements.

Shahwan and Hassan (2013, p.5) evaluated the profitability, marketability, and social disclosure efficiency of UAE banks using a nonparametric frontier method – data envelopment analysis (DEA). Based on nonparametric Wilcoxon signed rank test, paired-difference t test and sign test, this study reports significant evidence that the UAE banks are performing much better in profitability and social disclosure activities than marketability activities. The results also provide additional evidence regarding the positive relation observed between the performance of social disclosure and profitability performance.

Some principles, conclusions and recommendations of the above mentioned and other foreign scholars can be used in the implementation of cost-effectiveness analysis for the banks of Ukraine. But it is impractical to use overseas scholars' achievements to analyse the economic efficiency of Ukrainian banks because of the significant differences in the economic development of countries and specific features of their banking systems.

Issues of economic efficiency analysis of Ukrainian banks using nonparametric methods is not enough documented. In the paper of Khailuk (2010, p. 100) the use of nonparametric methods for assessing the economic efficiency of Ukrainian banks is investigated. Also in the paper of Khailuk (2012, p.261) the effectiveness, efficiency and productivity of banks in Ukraine for the two-step model of the DEA method was

evaluated and in order to conduct more detailed analysis of the results the using of «performance – effectiveness" matrix was proposed.

None of the studies provide results of analysis of the economic efficiency of banks in Ukraine using the DEA method in the post-crisis period. Despite the above mentioned, the purpose of this study is to determine the scale, technical and overall efficiency of the banking system of Ukraine with the use of the DEA method in dynamics in the post-crisis period.

Method

In this study the DEA method is proposed to use in order to analyse the economic efficiency of banks in Ukraine. It belongs to the group of non-parametric methods based on fronts' technology analysis and allows considering a set of influence factors both the input parameters (resources) and output (products / services).

Fronts' analysis technology was offered by Farrell (1957, p.275) based on the work of Debreu (1951, p.285) and Koopmans (1951, p.97). He developed his own theory of cost-effectiveness and its decomposition into locative (distribution) and technical. Using data on the total set of input and output or services provided, Farrell (1957, p. 283) proposed to build multiply firms in dimensional coordinate space, and on boundary points of the given set - the production front, which should cover all other points (firms). Measure of the effectiveness of the object is determined by its distance from the formed front.

The key point in Farrell model (1957, p.285) is building production capacity limits of the company (bank) according to which its cost effectiveness will be analysed. The starting point for solving this problem is the description of the operating technology of the bank by displaying costs and revenues through a set of input and output parameters (resources). Depending on how the data display options cost-effectiveness analysis will be conducted regarding limiting or boundary in the space of initial parameters for the production vector or relative maximum limit in the space of input parameters for a given cost vector.

Koompans (1951, p.97) defined the main characteristics of technical efficiency: increasing the value of any output leads to a decrease of at least one exit or increase the value of at least one entry, reducing the value of any input leads to an increase in the value of at least one input or decrease the value at least one exit.

Fedotov (2012, p.56) defined that analysing economic efficiency by the DEA method we can get an estimate of the object being analysed and simultaneously define reference objects that form the boundary of production possibilities.

To illustrate the nature of fronts' technology analysis consider a bank that uses two inputs (x1 and x2) to produce one product (y1) (Fig. 1):

Items Q and Q' in Figure 1 form a front of efficiency. Points A and A' are izokost, provided that the price of inputs is known. The object P is inefficient, and therefore can be projected to the point Q. Then we can use the definition of technical, alocative and economic efficiency.

Technical efficiency (TE) – the ability of the bank to achieve maximum output of products using the given values of resources. Figure 1 TE = 0Q/0P.

Alocative efficiency (AE) – the ability of the bank to use the resources in optimal proportions for a certain price level. Figure 1 AE = 0R/0Q.

Economic efficiency (EE) – the product of technical and alocative efficiency. EE = (0Q/0P) / (0R/0Q) = 0R/0P.

Mathematical record of DEA method according to Lasitta (2012) is as follows:

$$\sum_{m=1}^{n} y_{im} \times \lambda_m \geq y_{j0} \quad (1),$$

$$\sum_{m=1}^{n} x_{im} \times \lambda_m \geq x_{i0} \times \theta_0 \quad (2),$$

$$\lambda_m, x_i \geq 0 \quad (3)$$

where y_{jm} – value of j-th output parameter m-th bank;
x_{im} – the value of the ith input parameter m-th bank;
y_{j0} – the value of the j-th output parameter of the bank;
h_{j0} – the value of the ith input parameter of the bank;
λ_m – variable weighting factor;
θ – meaning the efficiency of the bank.

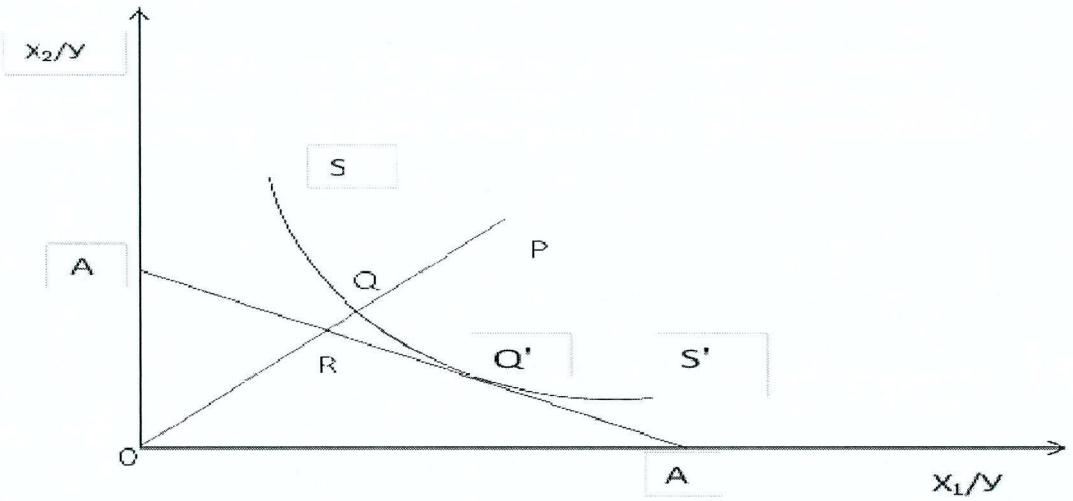

Fig. 1 Schematic representation of the front efficiency according to M.J.Farrell

This model is called the CRS-model. It is the assumption of constant returns to scale. This means that the proportional increase in inputs several times gives a proportional increase in the output of products or services.

Introducing additional constraints (equation 4) to CRS-model we obtain VRS-model that takes into account the variable returns to scale.

$$\sum \lambda_m = 1, \tag{4}$$

where λ_m – variable weighting factor of specific object of protection function.

Efficiency designed by VRS-model is called pure technical efficiency (PTE), for CRS-model - technical efficiency (TE).

Thus, we can determine the scale effect (SE) (Lasitta, 2012)

$$TE = PTE \times SE, \tag{5}$$

Except evaluation of the economic efficiency of the bank, the DEA method allows to determine: production front that conventionally chosen as the standard, homogeneous group of banks for a bank that is subject to analysis; the projection of the bank on the front surface of the production front (if it is inefficient); impact type from the scale.

In the course of solving linear programming problem which is represented by the formulas (1) - (3) the production front and the economic efficiency of the analysing bank is determined. The closer the bank to the front of the production line the higher its cost effectiveness. During the analysis they determine the resulting level of efficiency has been achieved, factors that affected it and how to improve it.

Results

To determine the input and output data in the analysis of economic efficiency of Ukrainian banks mediation approach to the essence of banking have been used.

Staff costs, individuals' funds, funds of legal entities and equity of the bank were selected as inputs. Net loans and securities held for sale were selected as initial resources.

The annual financial bank statements and data of the National Bank of Ukraine acted as informational base.

Approbation of the DEA method was performed on data from 24 banks of the first and second groups according to the classification of the National Bank of Ukraine (hereinafter – the NBU). Their total assets of 806.7 billion UAH (72 % of banking system assets).

Banks selected for analysis are classified as follows: public banks and banks in which the state has a controlling interest, banks with domestic capital, banks with Russian capital and banks with foreign capital (excluding Russia).

Summarized results of the economic efficiency of banks using the DEA method is shown in Fig. 2.

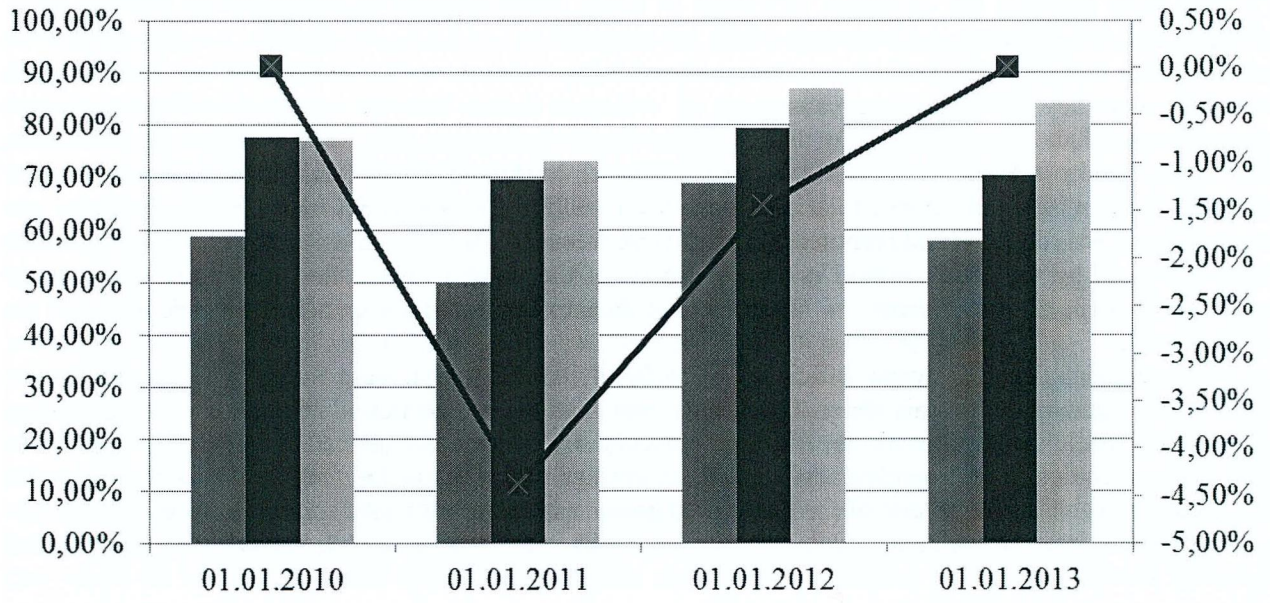

Fig. 2 Results of assessing the economic efficiency of the existing banks samples using the DEA method from 01.01.2010 to 01.01.2013

During the analysis of the economic efficiency of the existing bank samples the following results were obtained.

Scale efficiency of banks selected for analysis increased by 10 %, due to the policy of major banks regarding cost optimization such as the creation by a number of banks ATM network «Atmosphere» which allowed to reduce the cost of maintaining their own networks . Also, a number of banks reduced their regional limits (PAT «Ukrsibbank», PAT «Raiffeisen Bank Aval»).

Pure technical efficiency of the existing sample of banks was almost unchanged (up 2 %) and is average.

In our opinion, this is due to the fact that labor costs for the banks at the moment are very high and the economic activity of legal entities and individuals is low. In addition, deductions from reserves remain considerable and it results to the increase of costs and diversion of funds.

Technical efficiency of banks selected for analysis for the research period increased by 10 %, but still remains low (on 01/01/2013 – 70 %). Decomposition of this indicator shows that the increase of technical efficiency is due the massive increase in efficiency.

The following conclusions can be drawn from the present study. We have analysed the economic efficiency of the existing banks' sample and it was found that over the period of analysis scale efficiency increased while the pure technical efficiency remained at a moderate level. Also we have identified patterns in terms of efficiency between banks that were assigned to one subgroup.

The results of the analysis of banks' economic efficiency make it possible to conclude that the majority of banks operate with an average efficiency or ineffective.

Depending on the formed groups for analysis we identified the following features:

- high level of scale efficiency and low level of pure technical efficiency is inherent for banks with Russian owners;

- the average level of scale and pure technical efficiency is inherent for state-owned banks and banks in which the state has a controlling interest;
- banks with foreign capital have low level of pure technical efficiency and medium level of scale efficiency (with a tendency to increase);
- banks with domestic capital have high level of pure technical efficiency and close to low level of scale efficiency.

Discussion

This study analyses the economic efficiency of banks in Ukraine for the period from 2010 to 2012. During this period the post-crisis recovery of the banking system in Ukraine took place. For the analysis we used the DEA method, which belongs to the group of non-parametric methods, is based on front analysis technology and allows to take into account a set of influence factors both the input parameters (resources) and output (products / services). To determine the input and output data in the analysis of economic efficiency of banks in Ukraine we used mediation approach to the essence of banking. Staff costs, funds of individuals and entities and equity of the bank have been selected for inputs. Net loans and securities for sale have been selected for the initial resources. Studies have found the problem of informed choice of input and output resources by the DEA method under conditions of the limited information provision. Using in the analysis only popular performance of banks' public financial reporting may affect the adequacy of the analysis results.

The scale, technical and overall efficiency of banks in Ukraine in dynamics for the period from 2010 to 2012 has been determined in this study. The results show that during the period of analysis scale efficiency has increased, while the pure technical efficiency of banks in Ukraine has remained at a moderate level. Most of the banks included in the sample operated with an average efficiency or ineffective. It was identified that the bank's capital belonging to one of the designated groups (state-owned banks and banks in which the state has a controlling interest; banks with domestic capital, banks with Russian capital; banks with foreign capital (excluding Russia)) affects the indicators of economic efficiency. Empirical data suggests that for banks with Russian owners is inherent large-scale high efficiency and low level - pure technical efficiency; for public banks and banks in which the state has a controlling interest is inherent the average pure technical and scale efficiency; the banks with foreign capital have low level of pure technical efficiency and medium - scale efficiency (with a tendency to increase); the banks with national capital have high level of pure technical efficiency and close to low level – scale efficiency.

These results are generally consistent with previous studies which determined that the largest banks are less efficient and banks with foreign capital are more efficient than banks with domestic capital. Thus, small and medium -sized banks can improve economic efficiency through the use of scale effects. For large and major banks it is necessary to develop measures for optimization its performance and reduce overhead costs.

The results of this investigation show that the DEA method can be used at the macro level by the National Bank of Ukraine in the macro-prudential analysis and supervision; at the level of individual bank - in the management system at all levels of government. At the strategic level of bank management the results should be used to specificate the sample of banks with similar economic indicators in order to determine the bank effectiveness in the market. At the tactical level the proposed method can be used to analyse the cost-effectiveness of the structural units of the bank. At the operational level the method can be used as a tool for analysing the economic efficiency of banking products.

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