

ANALYSIS OF FEATURES AND POSSIBILITIES OF BANK FUNCTIONING EFFICIENCY BASED ON THE METHOD OF STOCHASTIC FRONTIERS

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Abstract: *Given paper shows the importance of analyzing the banks performance in the process of their operation and development. The place and the role of researching of stochastic frontiers method for the banks performance assessment have been defined. The features and the possibility of assessing efficiency of banks activity with the usage of the of the stochastic frontiers method have been studied. The examples of performance assessment of banks activity in the aspect of the credit extension have been given. The expediency of the consideration of the multiple stochastic frontiers in the assessment of the effectiveness of the banks activities has been proved.*

Keywords: *efficiency, stochastic frontier analysis, financial flows, loss function, technical efficiency, allocative efficiency.*

ACM Classification Keywords: *G.3 Probability and statistics – Correlation and regression analysis, Multivariate statistics; J.1 Administrative data processing – Financial, J.4 Social and behavioral sciences – Economics.*

Introduction

Regularity of financial flows movement in the system of market interaction of inter-action between the different economic entities (including such specific as the state) to a large extent supported by the banking sector of the economy. This is due to the fact that the banking sector of economy contributes to the uncommitted resources transfer, not only from one economic entity to another, but also from the people to the various sectors of the economy by means of the savings transformation in investment re-source. Therefore, the investigation of the efficiency of banks activity on the basis of the analysis of their financial flows movement is under direct interest of researchers. The importance of the carrying out a relevant analysis is attributed not only to the possibility of studying of the bank financial flows impact on the development of economic stability overall, but also on the Bank and the banking sector development [Kuzemin, Lyashenko, 2009]. Thus, the performance analysis of banks can be considered as one of the priorities in researches concerning the economic dynamics and economic growth.

Performance analysis of banks and method of stochastic frontiers:

When considering the effectiveness of the bank activities primarily are focused on the analysis of various indicators of the operation results and the banks development in terms of the various financial flows movement.

For example, in the work [Collier, McGowan, Muhamad, 2006] and in the work [Aarma, Vainu, Vensel, 2004] the performance analysis of banks is made based on decomposition of return on assets and return on equity of banks under study.

However, in the work [Williams, 2005] the performance analysis of banks is based on econometric methods. The essence of this analysis consists of the consideration of the mutual influence of the various financial flows movement on the assessment of the Bank activities. Given assessment reflects the various performance and development indicators as unique bank, and whole sector.

Stochastic frontier analysis (SFA) is one of the most prospective analyses based on econometric methods among the approaches of the assessment of efficiency of banks activity. The essence of the SFA is described in works [Farrell, 1957], [Aigner, Lovell, Schmidt, 1997], [Battese, Coelli, 1992] and based on:

An efficiency frontier construction with the methods of statistical analysis,

Positioning of studied economic process or object relative to the resulting efficiency frontier,

Effectiveness determining of the studied economic process or object to a function that describe the attainability of constructed efficiency frontier.

The following model is used for of the efficiency frontier formalization [Aigner, Lovell, Schmidt, 1997]:

$$y = f(x, \beta) + \varepsilon, \quad (1)$$

$$g = v - u, \quad (2)$$

where y – vector of outcomes of the of the studied object or process (in this case the results of banks activities),

x – a vector of the resources used to produce certain banks results;

f – a function of the banks efficiency frontier;

β – a vector of function parameters of;

ε – a composite random element of the model;

v – a vector of random vibration of a model;

u – a vector describing the technical inefficiency of banks.

Then the effectiveness of a particular bank ($i, i = \overline{1, l}, l$ – a total number of studied banks), or rather its technical efficiency (TE_i), can be calculated as follows [Johdrow, Lovell, Materov, Schmidt, 1982]:

$$TE_i = e^{-M(u_i | \overline{\varepsilon_i})}, \quad (3)$$

where $M(u_i | \overline{\varepsilon_i})$ – a conditional mathematical expectation of u_i at an estimated value of $\overline{\varepsilon_i}$. In total $M(u | \varepsilon) = r(\varepsilon)$ is a regression vector of u by ε .

Thus the construction of a function that describes the efficiency frontier of banks and the calculation of this efficiency greatly depends on the following items:

Select of the model function form that describes the frontier of the bank effectiveness, there are various options for preferences that take into account both economic substance and significance of the models,

Select of u – the distribution component of the bank technical inefficiency, ε – a compound random element of the model, where, as a rule is considered a half-normal, truncated and exponential distribution [Murillo-Zamorano, 2004]. Although in general, the distribution component can be of any kind, but must be taken into account non-negative.

It should be added that the loss function ε selection in considering the model function form that describes the efficiency frontier of the bank activity has a definite impact on the estimated value, and therefore on the value of the individual components of the vector u .

Assessment of the bank's performance with different loss function selection in the description of the functions model form that describes its frontiers:

Let make a performance analysis of Ukrainian banks in the area of the extension of credit recourses, as a specific example that shows the effect of the loss function selection in considering model function forms that describes the frontier of the bank activity. This is due to the fact that the credit activity is one of the main components of the

banks functioning. The selection of the Ukrainian banks as objects for case study is associated with the following facts:

On the one hand, the performance rating of Ukrainian banks on the basis of analysis of stochastic frontiers is not considered in related studies,

On the other hand, crediting problems of real sector of economy are one of the vital issues of development of the banking sector of the Ukrainian economy at the present stage of progress.

For further analysis let consider the production Cobb-Douglas function as a model function form that describes the frontiers of performance of banks in terms of extension of credit recourses. The basic parameters of this function are:

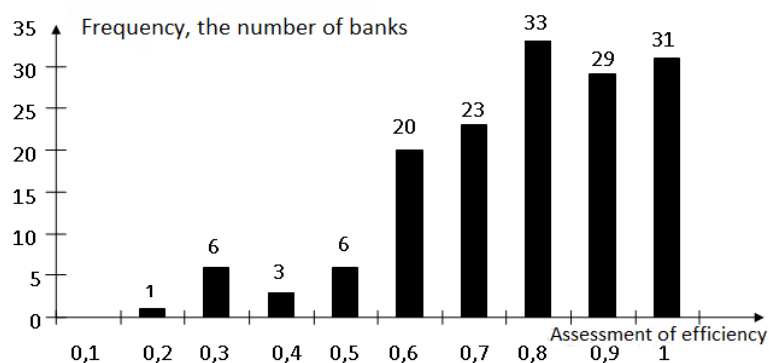
the value of total volume of credits to various business entities and the people (KR) is taken as a vector of evaluation banks performance, the value of the volume of resources attracted from other banks (DB), the value of the volume of deposits attracted from economic entities and people (DO), the value of the volume of administrative and other operating expenses of banks (AZ) are taken as separate components of the vector of resources used to produce certain results of the bank. (DO) represents the ability of banks to use financial resources to extend credits, (AZ) displays the fact of labor resources usage for the banking activities

Then the form of the corresponding function model that describes the frontiers of the effectiveness of the banks activities takes the following form in the aspect of the extension of credit resources:

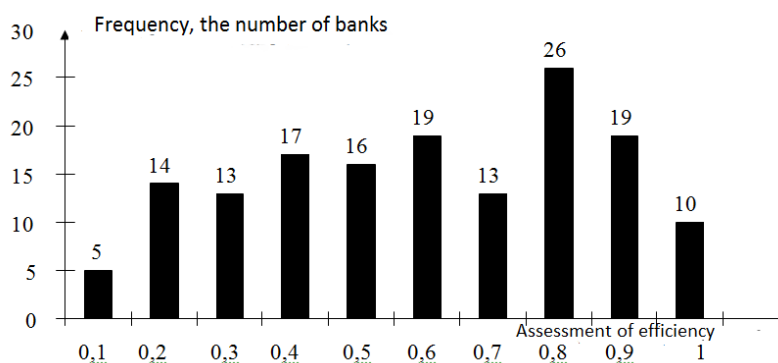
$$\ln(KR) = \beta_0 + \beta_1 \cdot \ln(DB) + \beta_2 \cdot \ln(DO) + \beta_3 \cdot \ln(AZ) + \varepsilon. \quad (4)$$

Appropriate values of the Ukrainian banks activities as of the date 01.04.2010 (the data for analysis were taken from the site www.bank.gov.ua) have been examined with the purpose of researching the influence of the loss function selection in considering forms of the model function that describes the frontiers of the bank effectiveness. Two methods of the loss function calculation have been studied in given paper, they are ordinary least squares and maximum likelihood method. In both cases, statistically significant models describing the frontiers of the effectiveness of the banks activities in the aspect of the credit resources extension requested in accordance with the Cobb-Douglas function have been obtained. Nevertheless, the results evaluating the performance of the studied banks in terms of the credit extension are not identical.

The histogram of the assessment of the effectiveness of the credit assignment for the form of model function is presented on the following picture. This histogram describes the limits of the efficiency of banks' activity, where the function of loss is calculated by the ordinary least squares method.



Next picture shows a histogram of evaluating the effectiveness of credit extension for the form of the model function that describes the frontiers of the effectiveness of the banks activities, where the loss function is calculated by the maximum likelihood method.



As can be seen from the data presented on both histograms, evaluations of the performance of the banks under consideration in terms of the credit extension are different. This is determined by the loss function used in determining the parameters of the model function that describes the scope of performance of banks.

Thus objective question about the features of the method of analysis of the effectiveness of the banks, based on method of investigation of stochastic frontiers there is raised. The answer to this question lies in the fact that method for evaluation of the performance of banks for the application of stochastic frontier analysis may be useful, first of all, to distinguish nature of determination of the appropriate ratings.

So when evaluating the performance of banks will be cover only a specific time slot and a specific form of the model function that describes the frontiers of the effectiveness of the banks, the selection of the loss function should be based on the most important statistical estimates in the model function that describes the boundaries of performance of banks.

If the evaluation of the effectiveness of the bank will be conducted in a comparative aspect, it is natural to use the same models, which determine the form of the function describing the frontiers of performance of banks for different data. In such case, it is important to show the obtained statistical evaluation forms of the model function that de-scribes the frontiers of the effectiveness of the banks when selecting a particular loss function. In other words, the manifestation of the features of the method of analysis of stochastic frontiers to calculate estimates of the effectiveness of the banks is primarily observed in a comparative analysis of the functioning of banks for different data sets. But exactly a comparative analysis is the basis for making the right decisions on the functioning and development of banks. Thus, for a comparative analysis for evaluating the performance of banks is important to show the most significant forms of estimates of the model function that describes the effectiveness of the frontiers of banks activities. At the same time, in order to obtain more reliable estimates of such a frontier a collection of primary data used for analysis can be modified. Objective factors of such variation may be the selection of particular set of banks used for further study.

In this case, the important fact is that some of the banks in different intervals can be either under the interim administration, or deprived of licenses for certain activities, which imposes restrictions on the formation of a sample of banks used for further studies. However, taking into account these factors can significantly affect the degree of reliability and relevance of estimations in selecting the form of the model function that describes the frontier of performance of banks.

The use of the stochastic frontiers set as an opportunity to expand the analysis of the effectiveness of the banks:

It is also important to consider opportunities offered by the analysis of the effectiveness of the banks based on the use of the stochastic frontiers set, along with its certain features.

To our opinion, one of the key features of the use of the stochastic frontiers research, for analyses of the banks' work, is to consider these assessments for a variety of functions describing the efficiency frontiers of banks work with the accounting of the economic substance diversity.

In particular, from the point of view of providing of credit resources, such diversity involves not only the consideration of the banks' work effectiveness, but also the consideration of the amount of credits given to business entities and people.

Then, along with equation (4) it is also appropriate to consider the following equations, which define the models describing effectiveness frontiers of banks' work:

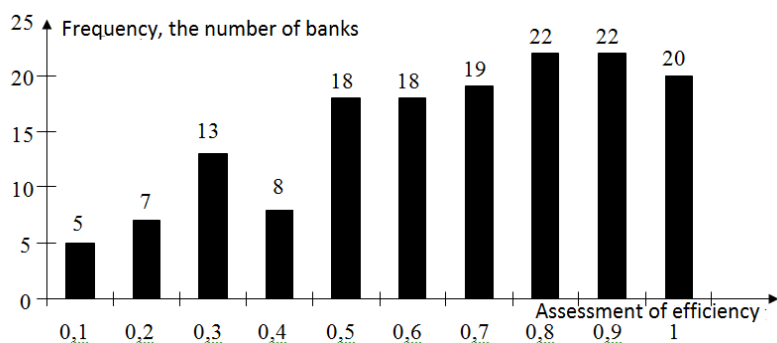
$$\ln(KRS) = \beta_{01} + \beta_{11} \cdot \ln(DB) + \beta_{21} \cdot \ln(DO) + \beta_{31} \cdot \ln(AZ) + \varepsilon_1 \quad (5)$$

$$\ln(KRN) = \beta_{02} + \beta_{12} \cdot \ln(DB) + \beta_{22} \cdot \ln(DO) + \beta_{32} \cdot \ln(AZ) + \varepsilon_2 \quad (6)$$

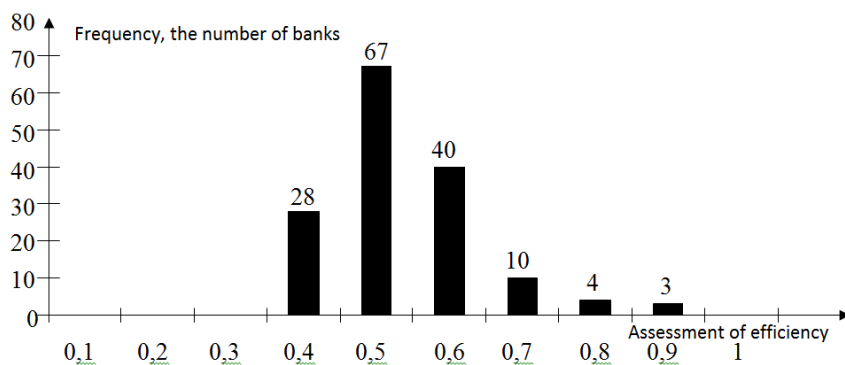
where KRS – the amount of credits given to various business entities, KRN – the amount of credits given to people.

Own values of the effectiveness assessments are calculated, according to the models, that reflect certain assignment of frontiers of banks' work effectiveness.

Next picture shows a histogram of the assessment of the effectiveness of providing a credit to business entities for the given form of the model function. This form describes the frontiers of the efficiency of banks' work with the function of the loss calculated by the method of maximum likelihood.



Next picture shows a histogram of the assessment of the effectiveness of providing a credit to people, for the given form of the model function. This form describes the frontiers of the efficiency of banks' work with the function of the loss calculated by the method of maximum likelihood.



As can be seen from three previous pictures assessments of the effectiveness of the banks' work in terms of credit providing are different. Moreover, three previous pictures show that the effectiveness of the banks' work in terms of credit providing (for a certain period of time) is largely determined by the efficiency of credit resources

given different business entities and to they are in a positive correlation. In this case, for considered banks, the correlation between the efficiency of providing a credit in general and the effectiveness of providing a credit to people is negative. The above allows making a conclusion about the possibility of establishing the relationship between the models of functions, describing the effectiveness of the relevant frontiers of banks in terms of providing a credit. In addition, for comparison of such correlation it is important to consider the transformation between the technical and allocative efficiency, where the last reflects the efficiency of available resources [Cooper, Seiford, Tone, 2007], that is especially important in terms of providing a credit.

It is based on the fact that the use of resources for providing a credit may not be effective in the case of insufficient use of all available resources for crediting, and vice versa not appropriate resources can be used for lending operations (such as time limits for applying the deposits), that leads to unreasonable providing of non-existent resources.

In general, the effectiveness of the work of l researched banks in terms of credit providing in whole (TE^o) and the effectiveness of the work of l banks providing a credit to different business entities (TE^s) and to people (TE^n) can be presented in its simplest form, in the form of a regression relationship:

$$TE^o = \lambda_0 + \lambda_1 \cdot TE^s + \lambda_2 \cdot TE^n + \eta \quad (7)$$

where λ – parameters of the regression model;

η – random member of the model.

If we take into account the formulas (3-6), model (7) can also be written as follows:

$$e^{-M(u|\bar{\varepsilon})} = \lambda_0 + \lambda_1 \cdot e^{-M(u_1|\bar{\varepsilon}_1)} + \lambda_2 \cdot e^{-M(u_2|\bar{\varepsilon}_2)} + \eta \quad (8)$$

At the same time, the ratio between the individual assessments of the bank's work can be a reflection of the ratio of the results of the bank activity, that exist during consideration of such assessments. In particular, in this case above, the correlation between the estimates of the effectiveness of the bank in terms of lending to various business entities and the public in some way reflects the existing ratio in the volume of loans as a business entity, and the public. In particular, in the case above, the correlation between the assessments of the effectiveness of the banks' work, in terms of providing a credit to various business entities and to people, in some way reflects the existing ratio in the amount of credits given to business entities, and people. This statement follows from equation (3), considering that value ε can be represented as a function which depends on the amount of credits in accordance with equations (4) and (5).

Conclusion

Thus, some of the features and possibilities of the analysis of the effectiveness of the banks' work based on stochastic frontiers research were considered in this paper. These features and possibilities provide more objective results. The selected features of the application of the method of investigation of stochastic frontiers of the analyses of the efficiency of banks are considered by other authors. But it should be emphasized that, we have focused on the account of such features in terms of the comparative analysis of the evaluation of banks' work. Allocation of such direction in the analysis of the effectiveness of the banks' work is chosen due to the fact, that features of stochastic frontiers method appear precisely within the comparison. At the same time, mutual consideration of several stochastic frontiers for the comparative analysis of the banks can be considered as a new perspective of application and development of stochastic frontiers method in the practice of economic analysis. It is important to find the correlation between the technical and allocative efficiency. It allows us to

consider the overall economic efficiency of the researched events, processes and objects at a different level of understanding of individual kinds of efficiency. The questions of formalizing relations between the assessments of the efficiency of different banks from the point of their various activity directions aren't less important. This formalizing allows not only to extend the appropriate analysis, but also refines it. It helps to uncover and to take into consideration the correlation of stochastic frontiers.

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