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COST EFFICIENCY OF UKRAINIAN BANKS. DOES IT MAKE DIFFERENCE?

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The paper presents a preliminary research on a possible application of stochastic frontier analysis to estimation of cost efficiency of Ukrainian banks. Unfortunately, due to lack of data on the personnel costs, we had to set limits to the year of 2008 only. According to the results of efficiency measurement, we found out that the efficiency of Ukrainian banks varies between 0.5224 and 0.9869 with an average value of 0.8734. Having checked a range of hypotheses, we discovered insignificant distinctions among banks by their size, type of owner and location.

Keywords: Ukrainian banks, cost efficiency, stochastic frontier analysis

1. Introduction

The present state of economy of Ukraine requires constant attention at the banking system and conduct of a policy aimed at creation of favorable conditions for stable and efficient functioning.

The economic crisis calls for banking activity assessment and discovering the causes of worsening financial position of commercial banks in order to preserve their financial stability. This is an important precondition for the country to come out of the crisis, to secure its economic growth and investment attractiveness. The problem is that none of the existing coefficients on banking activity (either absolute, or relative) gives exhaustive information on bank efficiency. Therefore, in modern practice of efficiency measurement along with classical analysis of financial coefficients, more sophisticated methods of frontier analysis are used. One of the main advantages of these methods is a possible integral estimation of efficiency of banking activity. With such an approach, the results of activity of a certain bank can be integrally compared with the results of selected banks to point out the ones with the best practice (i.e. making the most of the existing technology), those on the so called frontier. The methods of frontier analysis can be parametric or non-parametric, depending on the assumption used when modeling the frontier.

In our previous papers (see Pilyavskyy and Matsiv, 2009; Pilyavskyy et al., 2010) we used a non-parametric method of frontier analysis, namely Data Envelopment Analysis (DEA), while in this very paper we use one of the parametric approaches, i.e. stochastic frontier analysis (SFA). SFA is widely used for bank efficiency estimation in Central and Eastern Europe, in particular in Russia (Byelousova, 2009; Styrin, 2005; Peresetsky, 2010), Hungary (Hasan and Marton, 2003), Slovenia (Stavárek and Šulganová, 2009), Czech Republic (Weill et al., 2006). As to Ukraine, we are acquainted only with one paper devoted to efficiency measurement of Ukrainian banks using SFA (see Mertens and Urga, 2001). That is why we consider research in this direction quite vital. In this paper we propose to check whether:

- cost-inefficiency is present in the Ukrainian banking system;
- foreign banks are more efficient than the Ukrainian ones;
- efficiency of Ukrainian banks depends on their size;
- efficiency of Ukrainian banks somehow differs depending on their location.

The structure of our paper is as follows. In Section 2 the method and the model of banking activity as well as data used for estimation of efficiency of Ukrainian banks are discussed. In Section 3 we provide the main results of efficiency measurement and test some hypotheses. Finally, in Section 4 we summarize.

2. Method, model, data

The foundations for the methodology of frontier analysis and modern efficiency estimation are provided in the paper by Farrell (1957), who, in turn, on the basis of the preceding works by Debreu (1951) and Koopmans (1951), offered a simple measure of economic efficiency of a firm and its decomposition into allocative and technical aspects. Depending upon the way a production frontier is constructed, the methods of frontier analysis fall under: non-parametric, in which linear programming technique is used, and parametric, where econometric analysis is applied. SFA is the most widely used of the parametric methods.

SFA was introduced independently by Aigner et al. (1977) and Meeusen and van den Broeck (1977). In the approach to measurement of technical efficiency, econometric analysis is used to model production function, which contains two random components. One of them estimates random errors, while the other one deals with inefficiency measurement. Then, efficiency of a firm depends on the functional form used for approximation of a production frontier and the distribution form of random components. Cobb-Douglas and translog are the two functional forms most often used for efficiency estimation, taking into consideration the multiplicative nature of efficiency and the fact that Cobb-Douglas and translog can be linearized.

With a somewhat modified model used for technical efficiency measurement, SFA also allows for cost efficiency estimation. Cost function can be expressed as:

$$\ln C = f(y, w, z) + u + v, \tag{1}$$

where: C – costs, y – outputs (volume of output), w – prices of inputs (resources), z – so called netputs (fixed parameters), u – random inefficiency term, v – random error term. Distribution of the random error term can be considered normal, while random inefficiency term – half-normal, truncated normal, exponential, gamma etc. There are no clear criteria for choosing a distribution of random inefficiency term. That is why more often either half-normal or truncated normal distributions of random inefficiency term are chosen.

Then, having K banks, efficiency of a bank k ($k = 1,\ldots,K$), Eff_k, can be calculated as follows:

$$Eff_k = e^{-\hat{u}_k}, \quad (2)$$

where $\hat{u}_k$ is an estimate of parameter u_k.

Unfortunately, there exists no simple way of calculating $\hat{u}_k$ of u_k. It depends upon both distribution of u_k, and the chosen method of estimation. For details see, e.g., Kumbhakar and Lovell (2000).

Efficiency of the banking system on the whole (Eff) is the arithmetic mean of measures of efficiency of individual banks:

$$Eff = \frac{\sum_{k=1}^{K} Eff_k}{K}. \quad (3)$$

One of the biggest problems in efficiency assessment of bank branches using frontier analysis methodology consists in the choice of inputs and outputs. The question has not yet been fully solved. This is associated with specification of bank activity, since bank resources can be services at the same time and the products are not homogeneous. Although several methodological approaches to estimation of inputs and outputs of bank branches were forwarded in the literature, the choice among them still fully depends upon the aims of study and availability of necessary data.

Most frequently used are production and intermediation approaches. In the production approach banks are considered as "producers" of services for debtors and investors. This approach was first suggested in Benston (1965). A set of inputs in this approach consists only of physical variables (or the associated costs), such as labour, production area, materials, information systems. The aggregate inputs do not contain interest costs. Outputs are represented by the services the clients are offered. These services are determined through the type and quantity of transactions. In case of lack of such detailed data, quantitative data on time deposits, current deposits and loan accounts are used. According to the intermediation approach (see Sealey and Lindley, 1977) banks are considered as financial intermediaries between depositors and borrowers. Banks 'produce' intermediary services attracting deposits and other funds and allocate them in the earning assets (loans, securities, etc.). In practice, production approach is more often used for efficiency assessment of bank branches, while intermediation approach is commonly used for efficiency assessment of banks of a certain country. This is connected with availability of respective data.

In our study, for efficiency measurement of Ukrainian banks we use data on the activity of Ukrainian banks in 2008[1] from the NBU website[2]. In the study we applied the intermediary approach to modeling of banking activity. Loans and secu-

[1] We use data of 2008, since the National Bank of Ukraine (NBU) ceased publishing data on personnel costs after 2008 and it is the key parameter for efficiency estimation.
[2] www.bank.gov.ua

rities and other earning assets are outputs in our model. Prices of labour, borrowed funds and physical capital make the price of inputs. We use the amount of banking capital as a netput (fixed input) (for the detailed list of variables see Table 1). However, independent variables that form a regression equation may significantly correlate with each other, which is undesirable, because of sensitivity of regressors even to inconsiderable data changes, so we calculated variance inflation factors (VIF) (see Gujarati, 2004) to discover multicollinearity. For all independent variables VIF values appear to be less than 10, so it can be considered that there is no multicollinearity.

Table 1. Variables and their definitions

Variable	Name	Definition
TC	Total costs	operative costs, interests and charges
TL	Total loans	personal or commercial loans but for the reserves under them
SOEA	Securities and other earning assets	securities (including state securities) and assets in other banks but for the reserves under them
PBF	Price of borrowed funds	interest and charge costs divided by all the types of borrowed funds
PL	Price of labour	personnel costs divided by assets[3]
PPC	Price of physical capital	total administrative costs divided by tangible and intangible assets
BC	Capital of bank	banking capital

Sources: own elaboration

Consequently, we have data on activity of 151 Ukrainian banks in 2008. The following step was to choose the functional form and the distribution of random inefficiency term. In order to choose between functional forms of either Cobb-Douglas or Trans-Log models, we used the Log-Likeliood Ratio Test (LR Test) (see Coelli et al., 2005). The LR statistic is calculated as:

$$LR = -2\left\{\ln\left[L(H_0)\right] - \ln\left[L(H_1)\right]\right\}, \tag{4}$$

where $L(H_0)$ and $L(H_1)$ are the values of the log likelihood function under the null and alternative hypotheses, respectively. In our case the null hypothesis H_0: *Cobb-Douglas* is tested versus alternative hypothesis H_1: *translog* through the whole significance of the parameters of the translog that do not appear in the Cobb-Douglas, with a critical region defined as $LR_{\exp} > \chi^2_{10,\alpha}$.

According to the results of the test, at the level of significance $\alpha = 0.05$, the translog functional form is preferred.

We also used the LR Test to choose a distribution of random efficiency term between half-normal and truncated normal. A half–normal distribution is preferred according to the results of the test on the significance level of 0.05.

[3] Let us note that the best approximation of labour costs is the ratio of personnel costs to the number of employees. Unfortunately, NBU does not publish data on the number of personnel.

Consequently, the specification of our model is as follows:

$$\ln\left(\frac{TC}{PPC \cdot BC}\right) = \beta_0 + \beta_1 \ln\frac{TL}{BC} + \beta_2 \ln\frac{SOEA}{BC} + \beta_3 \ln\frac{PBF}{PPC} + \beta_4 \ln\frac{PL}{PPC} + \beta_5 \ln^2\frac{TL}{BC} +$$

$$+\beta_6 \ln^2\frac{SOEA}{BC} + \beta_7 \ln^2\frac{PBF}{PPC} + \beta_8 \ln^2\frac{PL}{PPC} + \beta_9 \ln\frac{TL}{BC}\ln\frac{SOEA}{BC} + \beta_{10} \ln\frac{TL}{BC}\ln\frac{PBF}{PPC} + \quad (5)$$

$$+\beta_{11} \ln\frac{TL}{BC}\ln\frac{PL}{PPC} + \beta_{12} \ln\frac{SOEA}{BC}\ln\frac{PBF}{PPC} + \beta_{13} \ln\frac{SOEA}{BC}\ln\frac{PL}{PPC} +$$

$$+\beta_{14} \ln\frac{PBF}{PPC}\ln\frac{PL}{PPC} + u + v$$

Random components are distributed in the following manner:

$$v \sim N(0, \sigma_v^2), \qquad u \sim N_+(0, \sigma_u^2) \quad (6)$$

It is known that the cost function has to be homogeneous. To satisfy this condition, we used one of the prices (PPC), namely the numeraire, and divided total costs by it. In order to eliminate the heteroscedasticity effect, total costs and all outputs were divided by the banking capital.

3. Results

To estimate the efficiency of Ukrainian banks, we applied an R program, namely the Benchmarking package (see Bogetoft and Otto, 2011). The estimates of cost function parameters (4) are given in Table 2.

Having used the Wald test (see Coelli et al (2005)), on the significance level of 0.05, we can affirm that inefficiency is present in the Ukrainian banking system. Moreover, taking into consideration the results of estimation, 95% of total variation can be explained by the inefficiency and only 5% - by random errors. The Cost-efficiency distribution of Ukrainian banks is given in Fig.1.

The average cost-efficiency of Ukrainian banks is rather high; it is 0.8734, while individual measures of cost-efficiency vary within 0.5224 to 0.9869. Within the framework of our research we also discuss cost-efficiency of Ukrainian banks by their size[4], type of owners (banks with foreign capital and Ukrainian ones) and their location (Kyiv or regional).

[4] In the paper we use the NBU's methodology of differentiation of banks into groups. The methodology anticipates referring a certain bank to one of four groups by amount of their assets and regulatory capital.

Table 2. Summary of estimation (calculations done with R program, Benchmarking package)

Parameter name	Estimator of parameter	Std.err	t-value	Pr(>|t|)
β_0	-1.50712	0.08606	-17.5126	0.000
β_1	0.65071	0.05497	11.8368	0.000
β_2	0.50007	0.06704	7.4589	0.000
β_3	0.39522	0.05632	7.0176	0.000
β_4	0.61489	0.07581	8.1113	0.000
β_5	0.11808	0.01891	6.2449	0.000
β_6	0.07776	0.01102	7.0588	0.000
β_7	0.11479	0.01545	7.4289	0.000
β_8	0.11395	0.01562	7.2942	0.000
β_9	-0.20917	0.02032	-10.2942	0.000
β_{10}	0.00609	0.02680	0.2272	0.820
β_{11}	0.04712	0.02704	1.7424	0.083
β_{12}	0.06520	0.02262	2.8819	0.004
β_{13}	-0.05360	0.02698	-1.9868	0.048
β_{14}	-0.21266	0.02898	-7.3376	0.000
Λ	4.60382	1.30053	3.5400	0.000

σ^2=0.035358, σ^2_v=0.001593, σ^2_u =0.033765; log likelihood=120.2094, $\lambda = \sqrt{\frac{\sigma_u^2}{\sigma_v^2}}$

Source: own calculations

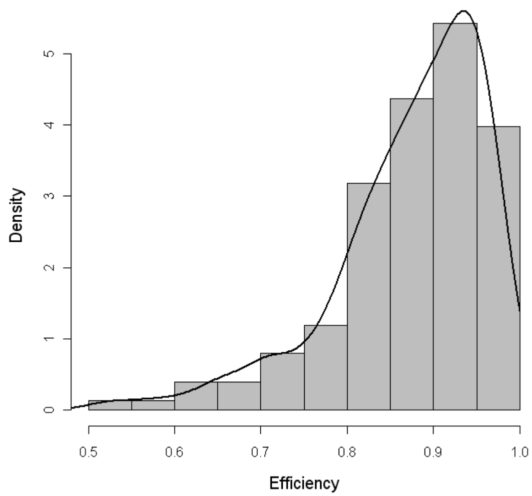

Figure 1. Efficiency distribution of Ukrainian banks
Source: own calculations

Table 3. Results of efficiency estimation

	N	mean	min	max	sd
All banks	151	0.8734	0.5224	0.9869	0.0885
Banks by size:					
I (The Largest)	17	0.9153	0.8340	0.9869	0.0470
II (Large)	19	0.8785	0.7019	0.9612	0.0739
III (Medium)	21	0.8768	0.7044	0.9652	0.0730
IV (Small)	94	0.8640	0.5224	0.9797	0.0974
Banks by owner:					
With foreign capital	44	0.8708	0.5224	0.9797	0.0877
Ukrainian	107	0.8744	0.5697	0.9869	0.0888
Banks by location:					
In Kyiv	96	0.8765	0.5697	0.9869	0.0944
In regions	55	0.8678	0.5224	0.9709	0.0769

Source: own calculations

We can see from Table 3 that the larger the banks, the higher their efficiency. Thus, the efficiency of the largest banks is 0.9153, while that of the small ones is 0.8640. In the largest-bank-group the smallest efficiency variation is observed, while in the group of small banks it is the highest. However, having used ANOVA to check the hypothesis on the differences in efficiency among the bank groups by their size at the significance level of 0.05, we can affirm that there exist no differences in efficiency of banks by the groups.

As to the efficiency of banks by the type of owner, the average value of banks with foreign capital (0.8708) hardly differs from that of Ukrainian banks (0.8744). The thing is quite the same with the banks located in Kyiv or in the regions (the average values being, respectively, at 0.8765 and 0.8678). At the significance level of 0.05 the t-tests also suggest that efficiencies of foreign banks vs. domestic ones, as well Kyiv banks vs. regional ones do not differ.

4. Summary

This paper presents the results of the stochastic frontier analysis (SFA) of cost efficiency of Ukrainian banks. In view of lack of data on the personnel costs, we had to limit the analysis to the year of 2008 only. In this paper we apply the intermediary approach to modeling banking activity as being among the ones most commonly used in literature. The intermediary approach treats banks as classical intermediaries between borrowers and lenders that transform deposits and other funds into loans and other earning assets. Considering the results of statistical tests, we chose translog functional form of cost function and half–normal distribution of random efficiency term.

As a result of the study, we found out that efficiency of Ukrainian banks varies between 0.5224 and 0.9869 with the average of 0.8734. Having checked a range of hypotheses, we discovered insignificant distinctions among banks by their size, type of owner and location. It should be noted that this paper presents only the results from the preliminary research on a possible application of SFA to the estimation of cost efficiency of Ukrainian banks. We consider, however, that investigations in this direction are quite promising, as we can find only one paper devoted to this specific problem (see Mertens and Urga, 2001).

It should be emphasised that bank efficiency assessment is a very complicated issue, with different method of analysis being required for solving it. In our previous studies (Pilyavskyy and Matsiv, 2009; Pilyavskyy et al., 2010) we used DEA for this purpose. But the results of our DEA-based investigations can hardly be compared with those of the present study, because we used DEA for the measurement of technical efficiency of Ukrainian banks, while our SFA analysis is used to assess cost efficiency of Ukrainian banks. So, further work in this area is necessary.

Appendix A

Table A.1. Descriptive statistics of data used for estimation*

Variable	mean	min	max	StD
TC	544 081	7 396	10 000 821	1 194 851
TL	4 431 940	25 548	64 420 601	10 067 381
OEA	800 842	1 343	18 916 820	1 949 545
PBF	0.086	0.011	0.262	0.033
PL	0.027	0.003	0.143	0.017
PPC	0.332	0.027	0.978	0.221
BC	747 273	28 057	15 471 943	1 721 791

* Values of variables TC, TL, OEA and BC are given in thousands of UAH
Source: own calculations

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