5. A COMPARATIVE ANALYSIS OF THE EFFICIENCY OF ROMANIAN BANKS[1]

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Abstract

In this paper, we analyze 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 we 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.

Keywords: efficiency, banking, DEA method, SFA method

JEL Classification: G21, C33

1. Introduction

The efficiency and profitability of banks constitute a very important element in the analysis of financial systems of the developing countries, for which the banking system represents the main component and which has experienced major mutations in the past years in what regards the level of structure of shareholding, as a result of

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privatization, the entering of foreign banks and the increase in competition caused by the liberalization of the market and the legislative changes.

The creation of a two-level banking system based on the free market principles, the implementation of new methods and instruments for bank regulation and supervision, financial or bank crises, the large volume of subprime loans, the entering of foreign banks through the privatization process or the creation of branches or subsidiaries, the creation of new banks, the acquisitions and mergers in the banking sector, the expansion of modern bank products and technologies – all these factors had significant effects on the efficiency and profitability of the banking sector in the countries in Central and Eastern Europe (Poloucek, 2004, p. 75).

The analysis of the bank efficiency is important both from a microeconomic and a macroeconomic perspective (Berger and Mester, 1997). From a microeconomic perspective, the efficiency of banks is important because of the increase in competition due to the entering of foreign banks and the improvement of the institutional framework, of regulation and supervision (Koutsomanoli-Filippaki s.a., 2009). From a macroeconomic perspective, the efficiency of the banking system influences the cost of financial intermediation and the stability of the entire financial system (Rossi *et al*., 2005). Moreover, an improvement of the performance of banks indicates a better allocation of financial resources and, thus, an increase in the investments favoring economic growth.

The increase in the number of studies regarding the analysis of profitability, performance and efficiency of banks is a result of the mutations in the structure of the financial services industry, and of the progress registered in the financial and non-financial technologies (Berger and Mester, 2003). The evaluation of the banking sector productivity presents a major interest for the public authorities, because an increase in the productivity of banks can lead to better bank performances, to the decrease in costs and the improvement of the quality of services, as well as an improvement in the allocation of resources and the increase in productivity in the entire economy. The increase in productivity contributes, also, to the increase in the soundness and stability of the banking system, provided that the achieved profits are channeled towards the increase in equity and in provisions that allow a better absorption of shocks (Casu *et al*., 2004). Furthermore, an analysis of the differences in productivity levels of several states can lead to the identification of the potential success or failure of some legislative initiatives.

Researches concerning the performance of financial institutions focused on frontier efficiency or X-efficiency, a concept that measures the performance deviations of some companies from the efficiency frontier, which is built on the basis of best practices. The frontier efficiency measures how efficient the financial institution is as compared to the most efficient institution on the market. The frontier efficiency or the X-efficiency quantifies the cost efficiency of financial institutions with a greater precision than the financial rates (DeYoung, 1997).

In the literature in the field, we find a considerable number of studies concerning bank efficiency; most of them are referring to the banking systems in the developed states, especially in the USA and the European Union. There is a low number of studies regarding the efficiency of banks in less developed states, and even less on the banks in Central and Eastern Europe. Most studies focused on the banking sector in Central and Eastern Europe were performed for only one state and did not offer comparative information regarding the efficiency of banks in these states. In the past years, studies concerning the comparative efficiency in the emerging states have intensified, focusing on the analysis of the impact of ownership form on the efficiency of banks, this because of the increasing presence of foreign investors in the financial systems in the transition countries.

Kraft and Tirtiroglu (1998) analyzed the scale efficiency and X-efficiency of banks in Croatia for the period 1994-1995 and showed that the newly established banks were less efficient, but more profitable than the older privatized banks and than the state ones. Fries and Taci (2001) analyzed the cost efficiency of the banking sector in the Czech Republic by considering the size and structure of shareholding. Jemric and Vujcic (2002) used data regarding the banks in Croatia for the period 1995-2000 and showed that foreign and newly established banks were more efficient. Drakos (2002) analyzed the effect of structural reforms on the bank efficiency in six states in Central and Eastern Europe in the period 1993-1999.

Grigorian and Manole (2002) performed an analysis of the banking sector in 17 states from Central and Eastern Europe in the period 1995-1998 and showed that banking sectors with less banks but better capitalized were more efficient and that the privatization of banks was not always associated with the increase in efficiency. Weill (2003) analyzed the influence of the nature of ownership form on the efficiency of 47 banks in the Czech Republic and Poland in 2007; the study showed that foreign banks had a higher level of efficiency than the local banks. Hasan and Marton (2003) analyzed the banking sector in Hungary in the transition period and showed that the efficiency level improved over the analyzed period and that foreign banks were more efficient than the local ones. Matousek and Taci (2004) analyzed the banking sector in the Czech Republic in the '90s and showed that the efficiency of Czech banks improved over the analyzed period.

Using data over the period 1996-2000 regarding 225 banks in 11 states in transition, Bonin, Hasan and Wachtel (2005) analyzed the effect of the ownership form and showed that the privatization of banks was not enough to increase the efficiency of banks and that banks with state capital were not significantly more inefficient than the private banks. Fries and Taci (2005) studied the banking systems in 15 states in Eastern Europe and showed that banking systems in which the larger share of assets was owned by foreign banks presented lower cost inefficiency and that banks privatized with local investors were the most efficient ones. Rossi *et al*. (2005) analyzed the efficiency level and the behavior of bank management in 9 countries in Central and Eastern Europe in the period 1995-2002. The study showed that the banks in these states had a low level of efficiency and that there were significant differences among countries.

By analyzing the efficiency of the banking industry in Poland between 1997 and 2001, Havrylchyk (2006) showed that the efficiency level did not increase over the analyzed period and that foreign banks newly entered on the market presented a higher level of efficiency than the local banks or than the foreign banks that acquired local banks. Yildirim and Philippatos (2007) studied the efficiency of banking sectors in 12 countries in transition in Central and Eastern Europe during the period 1993-2000. The authors showed that the efficiency level of banks was directly proportional to the level of assets and the profitability rate and that the efficiency level of foreign banks in comparison to local banks was higher from the perspective of costs, but lower from the perspective of profits. The authors also showed that one third of the banks in this area were inefficient. Koutsomanoli-Filippaki *et al*. (2009) studied the efficiency of banks in Central and Eastern Europe in the period 1998–2003 and showed that bank efficiency was influenced by the level of concentration and competition in the national banking system and that the foreign banks registered a higher level of efficiency than the local private banks and state banks.

In the literature in the field, there is a low number of researches regarding the efficiency of banks in Romania made with the help of frontier methods. Asaftei and Kumbhakar (2008), based on a panel-type set of data on the period 1996-2002, estimate the cost efficiency of banks in Romania by using a model that combines the stochastic frontier analysis and the cost function. The results of the research indicate that the cost efficiency of all banks in Romania increases with the improvement of the regulation framework and with the adjustment of the monetary policy to the market conditions. Dardac and Boitan (2008) use the DEA method to measure the relative efficiency of a homogeneous group of credit institutions and to identify the factors generating inefficiency, highlighting the impact of the performance of management on bank efficiency.

2. Research methodology

In the analysis of the efficiency of the main banks in Romania in comparison with the main banks in Hungary and the Czech Republic we will use two methods: a parametric method – the SFA Method (Stochastic Frontier Analysis) and a nonparametric method – the DEA Method (Data Envelopment Analysis). The use of two different methods is justified by the following reasons: a) although in many researches regarding efficiency and productivity a hierarchy of methods was tried, until now there was no consensus reached regarding which method should be used (Bauer *et al*., 1998); b) the use of different methods for the analysis of an economic phenomenon is a cross-verification method for the robustness of the obtained results (Learmer and Leonard, 1983); c) considering that the real level of efficiency of a financial institution is not known and that the opportunity for using a certain method is given by the distribution of the set of data, the use of both methods will reduce the potential error caused by the data set distribution hypothesis (Berger and Humphrey, 1997).

The two methods used present both comparative advantages and disadvantages. The DEA method is a deterministic method based on linear programming, which does not take into account the random errors and, thus, does not require predefinition of the distribution of the error term, while the SFA Method is a stochastic method, which integrates random errors, but also requires predefinition of the functional form. In the case of the SFA method, the output of a company is a function of inputs, inefficient and random errors, and requires predefinition of the error term distribution. The DEA method does not take into account the statistic noise; so that the estimations regarding efficiency can be biased if the production process of the company is characterized by stochastic elements.

Because of its deterministic character, the DEA method assumes that all efficiency deviations are caused by the company. Nevertheless, there are some elements, such as the legislative framework, level of competition, etc., which cannot be controlled by the company and which affect the performance of the company. On the contrary, the SFA method allows for the modeling of these factors by introducing the random error in the specification of the determining model for the frontier efficiency (Murillo-Zamorano, 2004).

2.1. The DEA Method (Data Envelopment Analysis)

The DEA method is a nonparametric method for linear programming used to create efficiency frontier and to evaluate the efficiency of the decisional unit. The DEA method provides the efficiency frontier for the ensemble of the analyzed units, and then each decision unit from the data set used is evaluated in relation to this frontier, and a relative efficiency is associated to the units with the best performances. These units with the best performances that are in the efficiency frontier are considered to be efficient, while the other ones are considered inefficient and an inefficiency score is associated to them.

The decisional units found as being inefficient are inefficient in that at least one other decisional unit can produce the same quantity of outputs with a smaller quantity of inputs or a larger quantity of outputs with the same quantity of inputs. The level of efficiency of each decisional unit should not exceed 1. The DEA method is designed to maximize the relative efficiency of each decisional unit, provided that the averages thus obtained for each decisional unit are also feasible for all other decisional units in the data set. In this way, both the reference points (the relatively efficient functional units) that define the efficiency frontier and the interior points (the relatively inefficient units) that are below the efficiency frontier are identified. If a functional unit is inefficient, the DEA method suggests the necessary strategies to increase the efficiency of this unit, by referring to the selected units as being the best practices. Depending on these data, the manager can evaluate to what extent a less efficient unit underuses or overuses certain inputs and what is required to improve the situation.

From among the versions developed in the literature, in the present paper we will apply the model proposed by Charnes, Cooper and Rhodes (1978), an input-oriented model which is based on the hypothesis of the constant efficiency rates to scale. This model is also called the Constant Rate to Scale Model.

The DEA models can be input-oriented models or output-oriented models. In the case of input-oriented models, the DEA Method defines the efficiency frontier, seeking for each analyzed decisional unit the maximum reduction in the use of inputs in order to maintain the level of outputs constant. In the case of output-oriented models, the levels of the inputs are maintained constant and the possible maximum for outputs is searched. In case the productive process is characterized by a direct proportionality connection between the size of inputs and the size of outputs, the two measurements of efficiency produce the same efficiency scores. Otherwise, the two approaches lead to different efficiency scores.

Charnes, Cooper and Rhodes (1978) proposed a model based on the allocation of different averages to the inputs and the outputs of each decisional unit, in which the efficiency of each decisional unit can be obtained as a solution of the following problem:

$$\max \quad w_0 = \frac{\sum_r u_r y_{rj_0}}{\sum v_r x_{ij_0}} \qquad \text{subject to} \quad :$$

$$\frac{\sum u_r y_{ri}}{\sum v_r x_{ij}} \leq 1, \text{for each} \quad j = 1,2,..., n; \tag{1}$$

$$u_r, v_i \geq 0, r = 1,..., k; i = 1,..., m$$

where: w_0 – relative efficiency; u_r, v_i – weights of output r and inputs i; x and y – the input and output vectors; n, m and k – number of DMUs, inputs and outputs, respectively.

The objective function consists in maximizing ratio (1). The restrictions of the problem impose that no decisional unit has that ratio improper. The model described above is partially linear, in which the numerator must be maximized and the denominator minimized simultaneously, and present an infinite number of solutions. This problem was solved by introducing a new restriction:

$$\sum_{i=1}^{m} v_i x_{i_0} = 1 \tag{2}$$

By introducing this restriction, the problem becomes:

$$\max \quad w_0 = \sum_r u_r y_{rj0}, \text{ subject to}$$

$$\sum_r v_i x_{ij0} = 1 \tag{3}$$

$$\sum_r u_r y_{rj} - \sum_r v_i x_{ij} \leq 0 \text{ for } j = 1,.. n$$

$$u_r \geq 0 \text{ for } r = 1,..., k$$

$$v_i \geq 0 \text{ for } i = 1,..., m$$

By introducing the additional restrictions (2), which means that the sum of all inputs is established to be equal to 1, it was actually imposed to seek the solution that ensures the maximum value for outputs maintaining the constant inputs.

In the case of linear programming problems, in general, the more restrictions we have the more difficult it is to solve the problem. For any linear program, by using the same data, the dual problem of the linear program can be built. The solutions of the primary (initial) program and of the dual program are identical. In the case of the DEA model, the solving of the dual program reduces the number of restrictions of the model. That is why in the empirical analyses the dual program of the DEA model is used more than the initial one. The dual program of the linear programming problem (3) can be written as:

$$\begin{aligned}&\min \quad \theta \text{ , subject to :}\\&\theta x_{ij_i} - s_{\bar{i}} - \sum_j x_{ij}\lambda_j = 0, \ for \quad i = 1,..., \ m\\&- s_{\hat{r}} + \sum_j y_{rj}\lambda_j = y_{rj_0}, \ for \quad r = 1,..., \ k\\&s_{\bar{i}}, s_{\hat{r}}, \lambda_j \geq 0, \ j = 1,..., \ n\end{aligned} \tag{4}$$

where: θ_j – efficiency of DMU j; y_{rj} – the amount of rth output produced by DMU j using x_{ij} amount of ith input; $s_{\bar{i}}, s_{\hat{r}}$ – input and output slack.

The result of problem (3) represents technical efficiency. The optimum solution θ_j represents the level of technical efficiency of the decisional unit j. The level of efficiency of all decisional units is obtained by repeating the solving of problem (4) for all n decisional units. The original CCR model assumed that all units under consideration were operating on an optimum scale. The banks face non-constant returns to scale due to imperfect competition, prudential requirements, etc. The BCC model formulation relaxed the assumption of optimum scale, this model accomodated the scale effect by relaxing the constant return to scale assumption by introducing another constraint into the original CCR model – $\sum \lambda = 1$.

The BCC model can be written formally as:

$$\begin{aligned}&\min \ z_0 = \theta - \varepsilon \sum_i s_{\bar{i}} - \varepsilon \sum_r s_{\hat{r}}, \text{ subject to}\\&\theta x_{ij_i} - s_{\bar{i}} - \sum_j x_{ij}\lambda_j = 0 \text{ for } i = 1,..., m\\&- s_{\hat{r}} + \sum_j y_{rj}\lambda_j = y_{rj_0} \text{ for } r = 1,..., k\\&\sum \lambda_j = 1, s_{\bar{i}}, s_{\hat{r}}, \lambda_j \geq 0\end{aligned}$$

The units with the level of efficiency $\theta_j < 1$ are relatively inefficient and the ones with $\theta_j = 1$ are relatively efficient units and are positioned on the efficiency frontier.

The estimation of the level of technical efficiency and of cost efficiency through the DEA method will be made by using the DEA Frontier software.

2.2. The SFA Method (Stochastic Frontier Analysis)

The SFA method is an econometric, deterministic method for the estimation of the efficiency frontier. Unlike the nonparametric methods based on the linear programming technique, the SFA method entails a certain functional form for the relation between inputs and outputs. The SFA method was first proposed by Aigner, Lovell and Schmidt (1977) and Meeusen and van den Broeck (1977).

The deterministic production frontier is given by the relation:

$$y_i = f(x_i;\beta) \times \exp\{-u_i\} \tag{5}$$

where: $TE_i = \exp\{-u_i\} \text{ si } u_i \geq 0$

Transposed in log-linear form, the determinist production frontier becomes:

$$\ln y_i = \ln f(x_i;\beta) - u_i \tag{6}$$

or

$$\ln y_i = \beta_0 + \sum_n \beta_n \ln x_{ni} - u_i \tag{7}$$

where: $u_i \geq 0 \Rightarrow y_i \leq f(x_i;\beta)$.

A major problem of the deterministic method is the fact that it does not allow the decomposition of the error term and the separate analysis of the inefficiency of stochastic shock.

The SFA method proposes as form of expression of the production frontier;

$$\ln y_i = \beta_0 + \sum_n \beta_n \ln x_{ni} + v_i - \mu_i, \mu_i \geq 0 \tag{8}$$

where: $f(x_i;\beta)$ – production function; μ_i – technical inefficient component; v_i – random error component (statistic noise); β – input elasticity; x_i – inputs; y_i – outputs.

The variable v_i reflects the effects of the conditions independent from the analyzed decisional unit and the measurement errors and it is assumed that, in general, it follows a normal distribution. The second component of the error term μ_i is a variable controllable by the decisional unit, that represents inefficiency and it is assumed that it follows a semi-normal distribution.

According to Aigner, Lovell and Schmidt (1977), the production function for a set of panel-type data can be written as:

$$\ln y_i = \beta_0 + \sum_n \beta_n \ln x_{nit} + v_{it} - u_i, v_{it} \sim N(0,\sigma_v^2), v_{it} \sim N(0,\sigma_v^2) \tag{9}$$

Kumbhakar (1987) and Battese and Coelli (1988) generalized the hypothesis concerning the semi-normal distribution of u_i and proposed a truncated normal distribution for the panel-type series of data. The general form for the production function of a panel-type series of data can be written as:

$$y_{it} = x_{it}\beta + v_{it} - u_i \tag{10}$$

where: y_{it} –output vector; x_{it} –input vector; β –independent variable coefficient; v_{it} – random error $N(0,\delta_v^2)$; u_i – truncated error variable.

The production frontier (10) can be estimated by Maximum Likelihood Estimation (MLE). The resulting error component is decomposed into the “noise” error component and the stochastic inefficiency component, which is used in the estimation of the level of inefficiency for each decisional unit for the estimation of the frontier efficiency in the case of panel-type data series. Apart from the MLE, there can also be used the method of the least squares with fixed effect and the method of the generalized least squares with random effect.

A disadvantage of the models presented above is the fact that they imply that the inefficiency is stable over time, this presupposition being hard to accept when the number of analyzed periods is large enough. Over time, one may expect that managers learn from the past experience in the production process and modify their decisions so as the effects of inefficiency change their characteristics in time.

Cornwell, Schmidt and Sickles (1990) proposed a model in which the effects of technical inefficiency are specific to each company and vary in time:

$$u_{it} = u_i + r_i \tag{11}$$

The obtained model can be treated either as a fixed effect model, or as one with random effects and relaxes the invariance hypothesis of the effects of inefficiency. Kumbhakar (1990) suggested the use of a model in which the effects of technical inefficiency vary systematically in time, according to the relation:

$$u_{it} = \left[1 + \exp\left(bt + ct^2\right)\right]^{-1} u_i \tag{12}$$

where u_{it} are distributed semi-normally, and b and c are the parameters that must be estimated by the MLE method.

Battese and Coelli (1992) proposed an alternative model to the model developed by Kumbhakar (1990), in which the parameters of the model are estimated with the method of maximum likelihood and in which the terms vary exponentially over time according to the relation:

$$u_{it} = \{\exp[-\gamma(t - T)]\} u_i \tag{13}$$

where: γ -unknown parameter that must be estimated, $u_i \sim N(0, \sigma_u^2), v_{it} \sim N(0, \sigma_v^2)$

According to this model, technical efficiency can vary in time, but the evolution is the same for all the analyzed units.

The restrictions regarding the function of the stochastic frontier are more flexible when a functional form of the translog (TL) type production function is applied than when a functional Cobb-Douglas-type form is applied. The translog form does not impose the hypothesis regarding the constant elasticity of the production function or of the elasticity of substitution between inputs. Another advantage of the translog form is that it allows data to indicate the real value of the curvature of the function, rather than impose prior hypotheses regarding its value.

The production frontier variable in time can be expressed in translog form thus:

$$\ln y_{it} = \beta_0 + \sum_n \beta_n \ln x_{nit} + \beta_t t + \frac{1}{2}\sum_n \sum_k \beta_{nk} \ln x_{nit} \ln x_{kit} + \frac{1}{2}\beta_{tt} t^2 + \sum_n \beta_{nt} \ln x_{nit} t + v_{it} - u_{it} \tag{14}$$

where: y_{it} –output vector; x_{it} –input vector; β – coefficient of the independent variable; v_{it} – random error $N(0, \delta_v^2)$; u_i – error variable that follows a normal-truncated distribution; t –time component.

The translog form (14) can be written more simply in the form:

$$\ln y_{it} = TL(x_{it}, t) + v_{it} - u_{it} \quad (15)$$

Battese and Coelli (1995) introduced a model for the frontier of a set of panel-type data that quantifies the effect of inefficiency in μ_{it}. The authors advance as hypothesis the fact that the term non-negative technical efficiency follows a truncated distribution with different averages for the analyzed units.

$$\mu_{it} = Z_{it}\delta + \omega_{it} \quad (16)$$

where: Z_{it} – variable inefficiency .

In the analysis, we shall use the model developed by Battese and Coelli (1995) to determine the stochastic production frontier.

When the prices of inputs are available and an objective of the company is constituted by minimization of costs, the cost efficiency can be estimated by using a cost frontier. The cost frontier indicates the minimum cost, ci, which a decisional unit can take in order to produce a quantity of outputs, yi, considering the prices of inputs, pi. The cost frontier can be expressed as:

$$\ln c_i = \beta_0 + \sum_{n=1}^{N} \beta_n \ln p_{ni} + \sum_{m=1}^{M} \phi_m \ln y_{mi} + v_i + u_i \quad (17)$$

where: u_i represents inefficiency and is non-negative. This function is non-decreasing, linearly homogeneous and concave in inputs if β_n is non-negative and satisfies the condition $\sum_{n=1}^{N} \beta_n = 1$ (18)

By introducing condition (18) in model (17), we obtain:

$$\ln(\frac{c_i}{p_{Ni}}) = \beta_0 + \sum_{n=1}^{N-1} \beta_n \ln(\frac{p_{ni}}{p_{Ni}}) + \sum_{m=1}^{M} \phi_m \ln y_{mi} + v_i + u_i \quad (19)$$

The cost efficiency level is given by the ratio of the minimum cost to the cost registered by the decisional unit, and is calculated as: $EC = \exp(-u_i)$ (20)

The SFA method assumes that the inefficiency component of the error term is positive and, thus, the high costs are associated with a high level of inefficiency. In the estimation of the cost efficiency level, we used the model developed by Battese and Coelli (1992). The estimation of the technical efficiency level and cost efficiency through the SFA method will be made using the Frontier Version 4.1.

3. Data and variables used

We intend to analyze the efficiency of the intermediation activity performed by the main banks in Romania, the Czech Republic and Hungary.

The data used in the analysis were taken from the annual reports of the banks for the period 2000-2006 and from the Fitch IBCA`s BankScope database. The data set comprises 6 banks from Romania: Banca Transilvania, Banca Comercială Română, Banca Română pentru Dezvoltare, CEC, Raiffeisen Bank, UniCredit Tiriac Bank; 6

banks from the Czech Republic: Ceska Sporitelna, Citibank Cehia, CMSS, CSOB, GE Money Bank, Komercni Banka; and 6 banks from Hungary: CIB Közép, K&H Bank, MKB Bank, OTP Bank, RaiffeisenBank Ungaria, UniCredit Bank Hungary.

The structure of the sample was determined by the availability of data on the banks in the three national banking systems, the selected banks own more than 60% of the assets of the national banking systems. In the case of the Romanian banking system, the 11 selected banks owned 60.48% of the net balance sheet assets of the banking system at the end of 2007. The data set is unbalanced; this is caused by the fact that in the case of some banks the information afferent to some years from the analyzed period is not available.

In the literature in the field, there is no consensus regarding the inputs and outputs that have to be used in the analysis of the efficiency of the activity of commercial banks (Berger and Humphrey, 1997). In the studies in the field, five approaches for defining inputs and outputs in the analysis of the efficiency of a bank were developed, namely: the intermediation approach; the production approach; the asset approach; the user cost; the value added approach. The first three approaches are developed according to the functions banks fulfill (Favero and Papi, 1995). The production and the intermediation approaches are the best known ones and the most used in the quantification of bank efficiency (Sealy and Lindley, 1997).

In the production-type approach, banks are considered as deposit and loan producers and it is assumed that banks use inputs such as capital and labor to produce a number of deposits and loans.

According to the intermediation approach, banks are considered the intermediaries that transfer the financial resources from surplus agents to the fund deficit ones. In this approach it is considered that the bank uses as inputs: deposits, other funds, equity and work, which they transform into outputs such as: loans and financial investments.

The opportunity for using each method varies depending on circumstances (Tortosa-Ausina, 2002). The intermediation approach is considered relevant for the banking sector, where the largest share of activity consists of transforming the attracted funds into loans or financial investments.

In this paper we will use the intermediation approach for two reasons: a) the scope of the analysis is to determine the efficiency of banks in the financial intermediation activity that entails the transfer of funds from the surplus agents to the ones with deficit; b) the database is not suitable for the production-type approach because we have no information regarding the number of deposits and loans created by the banks.

In the analysis we will use the following set of inputs and outputs to quantify the efficiency of banks in Romania, the Czech Republic and Hungary:

- Outputs: loans in mil. EUR; loans and advancesti banks in mil. EUR; investments in mil. EUR.
- Inputs: fixed assets in mil. EUR; personnel expenses in mil. EUR; operational expenses in mil. EUR; financial capital in mil. EUR.

- Price of inputs: Personnel expenses / Number of employees; Depreciations and amortisations / Fixed assets ; General expenses / Financial capital; Interest expenses / Financial capital.

4. Empirical results regarding the efficiency of banks

Considering that our database is a panel-type one we can estimate the frontier efficiency for all banks during the entire analyzed period of time or we can estimate an efficiency frontier separately for each year. In the literature it is claimed that constructing some separate frontiers for each year offers a higher flexibility than one multi-annual frontier (Bauer, Berger and Humphrey 1993). Constructing some separate frontiers allows for the analysis of the evolution of the degree of efficiency at the level of each bank in time, a very important aspect especially in the situation when the market conditions change.

4.1. Quantification of the efficiency of banks through the DEA Method

In our analysis we estimated the technical efficiency and the cost efficiency of the 18 banks from the selected sample for all the years the data were available for in the period 2000-2006. By applying the DEA method we obtained the following values of the technical efficiency and of the cost efficiency at the level of the banks in Romania, Czech Republic and Hungary:

Table 1

Technical efficiency and cost efficiency of the banks in Romania, the Czech Republic and Hungary for the period 2000 – 2006 obtained through the DEA method

Banking sector	Year	Romania	Czech Republic	Hungary	Total
Technical efficiency	2000	0.796	0.955	0.971	0.921
	2001	0.790	0.968	0.997	0.934
	2002	0.800	0.979	0.996	0.925
	2003	0.815	0.996	0.995	0.935
	2004	0.726	1.000	0.977	0.901
	2005	0.738	0.996	0.973	0.903
	2006	0.791	0.990	0.962	0.915
Cost efficiency	2000	0.210	0.711	0.782	0.613
	2001	0.189	0.665	0.773	0.586
	2002	0.175	0.628	0.693	0.498
	2003	0.184	0.590	0.601	0.458
	2004	0.203	0.596	0.663	0.487
	2005	0.226	0.622	0.563	0.470
	2006	0.264	0.591	0.501	0.452
Technical efficiency	Mean	0.780	0.984	0.982	0.919
Cost efficiency	Mean	0.207	0.629	0.654	0.509

In Table 1 it is noticed that the banks in Romania register for the analyzed period a level of technical efficiency much lower than the banks in Hungary and the Czech Republic. An explanation of this phenomenon could be the fact that the great banks in the Czech Republic and especially in Hungary were privatized much earlier than the Romanian banks. The cost efficiency registers at the level of the 3 banking systems very low levels which means that the bank products and services offered by these banks are very expensive. At the level of the cost efficiency it is noticed that Romanian banks register a level of 0.2071, much lower than the average level registered by the banks in the Czech Republic and Hungary, 0.6289 and 0.6536, respectively. An explanation for this situation could be the very high cost of capital in Romania, the very high level of operational expenses and of personnel expenses registered by Romanian banks, especially BCR and BRD.

4.2. Quantification of the efficiency of banks through the SFA Method

From the data presented in Table 2 one may see that the level of efficiency, both technical and cost, of the banks in Romania is much lower than the one of the banks in the Czech Republic and Hungary. The average technical efficiency level of 0.2511 obtained by the banks in Romania signifies the fact that they should reduce the volume of inputs on average by approximately 75% in order to become efficient. The results regarding the cost efficiency of the banks in Romania (0.11588) indicate the fact that Romanian banks must reduce their costs by more than 88% in order to become efficient.

Table 2

Technical efficiency and cost efficiency of the banks in Romania, the Czech Republic and Hungary for the period 2000-2006 obtained through the SFA method

	Year	Romania	Czech Republic	Hungary	Total
Technical efficiency	2000	0.116	0.444	0.552	0.402
	2001	0.120	0.489	0.666	0.463
	2002	0.110	0.533	0.714	0.452
	2003	0.177	0.595	0.761	0.511
	2004	0.243	0.715	0.798	0.585
	2005	0.311	0.777	0.831	0.640
	2006	0.607	0.835	0.889	0.777
Cost efficiency	2000	0.045	0.109	0.267	0.153
	2001	0.063	0.125	0.278	0.167
	2002	0.100	0.143	0.288	0.177
	2003	0.121	0.161	0.296	0.193
	2004	0.141	0.179	0.305	0.208
	2005	0.161	0.197	0.312	0.223
	2006	0.180	0.215	0.319	0.238
Technical efficiency	Mean	0.251	0.627	0.744	0.541
Cost efficiency	Mean	0.116	0.161	0.295	0.194

The level of the cost efficiency registered significant increases for the analyzed period at the level of the 3 banking systems. The largest increase was registered by the banks in Romania, at the level of which there was registered an increase of more than 4 times from a level of 0.045379 in 2000 to a level of 0.180413 in 2006.

5. Comparing the results obtained through the two methods

In this subchapter we will try to analyze the robustness of the results obtained by applying the 2 methods (the DEA Method and the SFA Method). The use of both methods was motivated by the fact that in the literature there was no consensus regarding which is the most appropriate method in the analysis of the efficiency of bank institutions and because by using different methods in the estimation of the level of efficiency the potential errors of estimation are reduced and the testing of the robustness of the obtained results can be achieved through alter methods. Previous studies show that applying some other models different empirical results can be generated (Berger and Mester (1997) and Bauer *et al*. (1998)).

Although there is a significant number of studies regarding bank efficiency, only a small number applies 2 or more parametric and nonparametric methods of estimation on the same set of data (see Ferrier and Lovell (1990), Bauer *et al*. (1998), Casu and Girardone (2002) Casu *et al*. (2004), Weill (2004), Beccalli, Casu and Girardone (2006) and Fiorentino, Kaufmann and Koetter (2006)).

Most studies used for the analysis of the consistency of the two methods Spearman (θ) and Kendall (τ) rank correlation coefficients. Both coefficients are coefficients of the nonparametric correlation and are determined independently from the form of the connection.

Table 3

The indicators of descriptive statistics regarding the level of efficiency obtained through the DEA method and the SFA method

	Minimum	Maximum	Mean	Std. Deviation
Technical efficiency SFA method	0.014	0.957	0.551	0.285
Cost efficiency SFA method	0.000	0.359	0.195	0.113
Technical efficiency DEA method	0.607	1.000	0.919	0.117
Cost efficiency DEA method	0.116	1.000	0.506	0.297

It is seen in Table 3 that the average levels of efficiency, both technical and cost, and the standard deviations obtained through the SFA method are lower than the ones obtained through the DEA method.

The Spearman correlation coefficients show that there is a moderate correlation both between the levels of technical efficiency (θ = 0.472), and between the levels of cost efficiency (θ = 0.509) obtained through the DEA and SFA methods, and the Kendall correlation coefficients confirm the existence of a correlation between the levels of efficiency obtained through the 2 methods and show that there is a pretty low probability that both the level of technical efficiency (τ = 0.345), and those of the cost efficiency (τ = 0.339) have the same rank.

Table 4

The Kendall and Spearman correlation coefficients regarding the levels of efficiency obtained through the SFA and DEA method

		Technical efficiency SFA method	Technical efficiency DEA method	Cost efficiency SFA method	Cost efficiency DEA method
Kendall's tau_b	Technical efficiency SFA method	1.000	.345(**)		
	Technical efficiency DEA method	.345(**)	1.000		
Spearman's rho	Technical efficiency SFA method	1.000	.472(**)		
	Technical efficiency DEA method	.472(**)	1.000		
Kendall's tau_b	Cost efficiency SFA method			1.000	.339(**)
	Cost efficiency DEA method			.339(**)	1.000
Spearman's rho	Cost efficiency SFA method			1.000	.509(**)
	Cost efficiency DEA method			.509(**)	1.000

*** Correlation is significant at the 0.01 level.*

6. Factors influencing the efficiency of banks

The empirical results of the analysis of the efficiency of banks in the three countries show that the level of efficiency differs in time and from bank to bank, which means that the level of efficiency of a bank is influenced by a series of micro and macroeconomic factors. The performances of a bank are determined by a series of internal factors that are specific to the bank and external factors that are specific to the environment where the bank performs its activity in, these factors influence the degree of efficiency of that bank.

Thus, recognizing and using the factors that have a significant influence on the performance of banks are necessary conditions for improving efficiency.

Microeconomic factors have an influence only in a certain area of activity and it includes endogen factors, such as the utilized resources, the technology used, the size of assets, invested capital, organization and management method which are controllable by the bank and exogenous factors such as the specific legislation, market share, price and availability of resources that do not depend only on the bank's management. The macroeconomic factors (level of inflation, level of economic growth, GDP/inhabitant, population, etc.) influence the efficiency for all firms regardless of the area of activity in which they perform their activity.

In the literature in field, the studies regarding the factors influencing the efficiency of banks used the following variables:

- Microeconomic factors: total assets (Favero and Papi (1995), McKillop, Glass and Ferguson (2002)), profitability (Casu *et al*. (2004)), capital rate (, Casu *et al*. (2004)), loans/ total assets ratio (McKillop, Glass and Ferguson (2002)), subprime loans (McKillop, Glass and Ferguson (2002)), degree of liquidity (McKillop, Glass and Ferguson (2002));
- Macroeconomic factors: rate of inflation (Grigorian and Manole, 2002), GDP/inhabitant (Grigorian and Manole, 2002);
- Other factors: form of ownership (Favero and Papi, 1995), location ((Favero and Papi (1995*),* Casu *et al*. (2004)*).*

Previous studies applied 3 techniques for the analysis of the factors influencing the estimated level of efficiency: a) the multivariate regression analysis that uses the estimated levels of efficiency through parametric or nonparametric methods as dependent variable and a series of other factors as explicative variables (Favero and Papi (1995), Grigorian and Manole (2002)); b) the longitudinal graphic approach through which the long-term trend of the levels of efficiency is analyzed and it uses graphic representation to show the relation between the estimated efficiency and each factor (Barr, Killgo, Siems and Zimmel, 1999); c) the analysis of the main components (Lensink, Meesters and Naaborg (2008), Sturm and Williams (2008)).

In the analysis regarding the factors influencing the efficiency of banks we will use the multivariate regression method. The empirical models in the literature employ a two stage procedure: in the first stage the level of efficiency is estimated through parametric or nonparametric methods and in the second stage the regression analysis in which the levels of efficiency are dependent variables is applied.

According to Xue and Harker (1999), regression analysis is among the most useful and most widely used statistical methods. It is reliable and easy to use in order to determine whether or not certain factors influence the decision-making unit (DMUs) efficiency scores. However, because efficiency measures range between 0 and 1, it is argued to apply a two-tailed Tobit model in place of OLS regression to explore factors correlated with inefficiency thus, given that the dependent variable, the efficiency scores, is distributed over a limited interval, it is appropriate to use a censored (Tobit) regression model to analyze the relationships with other variables. Furthermore, in smaller samples there is some concentration of the values of the dependent variable at the upper margin.

Thus, according to this view, Ordinary Least Squares (OLS) regression, however, is not a valid method to use when the dependent variable is the DEA efficiency score. The dependent variable has an upper limit of 100 %, and therefore is a censored variable. If such censoring were the only concern, then Tobit regression could be used. But, because we also have to deal with biases caused by inefficiency, Tobit regression is not valid either (Kumbhakar and Lovell, 2000).

Because efficiency measures range between 0 and 1, it is argued to apply a two-tailed Tobit model in place of OLS regression to explore factors correlated with inefficiency thus, given that the dependent variable, the efficiency scores, is distributed over a limited interval, it is appropriate to use a censored (Tobit) regression model to analyze the relationships with other variables (Hoff, 2007). McDonald (2009) advocates not using Tobit; he argued that Tobit estimation is inappropriate in the 2-stage of DEA, while, in contrast, the OLS is a consistent estimator. However, theoretical literature provides opposing arguments with respect to the use of OLS and Tobit in the second stage of the DEA-based analysis. In our study, the focus is to measure the technical efficiency which is regressed by estimating OLS model.

In order to determine which factors can affect the efficiency scores, we examine some aspects of bank's structure which is related to efficiency estimates. For this purpose, efficiency scores are regressed on a set of common explanatory variables; a positive coefficient implies efficiency increase whereas a negative coefficient means an association with an efficiency decline.

We will use the EViews program to perform 4 separate regression analyses, estimated based on the levels of technical and cost efficiency obtained through the DEA and SFA methods. We used the variables presented in Table 5 to analyze the relation between the level of efficiency of the banks and certain characteristics of the banks: quality of assets (Impaired loans / Total loan portfolio);; net interest margin; administrative costs (Non-interest expenses/Average assets); bank size (Total Assets), ownership form and banking reform and interest rate liberalisation indicator.

Table 5

The variables used in the regression analysis

Category	Symbol	Variable
Dependant variable	DEA_T	Technical efficiency DEA method
	DEA_C	Cost efficiency DEA method
	SFA_T	Technical efficiency SFA method
	SFA_C	Cost efficiency SFA method
Independent variables (microeconomic)	CR_TC_A	Impaired loans/ Total loan portfolio (%)
	MND_O	Net interest margin (%)
	CN_AM_O	Non-interest expenses/Average assets (%)
	ROAE_O	Return of the average equity (ROAE) (%)
	TA	Total Assets (mld. EUR)
Independent varia-bles (macroeconomic)	IPC	Annual inflation rate (%)
Qualitative independent variable	FP	Ownership form (0 – state owned; 1 – private owned)
	BANK_REF	Banking reform and interest rate liberalization indicator

The average values and the standard deviations of the variables show us that there are no outliners among the explicative variables that affect the estimated regression coefficients. Also, the correlation coefficients show us that there is a weak correlation between the variables of the model, which means that there is no multi-colinearity among the variables used in the regression analysis.

Table 6

Regression coefficients

Method: Least Squares						
Sample: 2000 2006						
Included observations: 118						
Dependent Variable: DEA_T				**Dependent Variable: SFA_T**		
	Coefficient	t-Statistic	Prob.	Coefficient	t-Statistic	Prob.
CR_TC_A	0.002425	1.124052	0.2634	-0.010016	-2.32088	**0.0221**
MND_O	0.008811	1.728517	0.0867	-0.006090	-0.59735	0.5515
CN_AM_O	-0.011258	-1.84015	0.0684	-0.011590	-0.94720	0.3456
ROAE_O	-0.002491	-2.27351	**0.0249**	-0.000965	-0.44041	0.6605
TA	-6.88E-07	-0.48362	0.6296	1.20E-05	4.228826	**0.0000**
IPC	0.003009	2.411566	**0.0175**	-0.005937	-2.37900	**0.0191**
FP	0.032742	1.222677	0.2241	-0.015234	-0.28441	0.7766
BANK_REF	0.256030	30.78722	**0.0000**	0.195497	11.75337	**0.0000**
Dependent Variable: DEA_C				**Dependent Variable: SFA_C**		
	Coefficient	t-Statistic	Prob.	Coefficient	t-Statistic	Prob.
CR_TC_A	0.002113	0.481866	0.6309	-0.013033	-7.70412	**0.0000**
MND_O	-0.018318	-1.76847	0.0798	-0.016088	-4.02548	**0.0001**
CN_AM_O	-0.052808	-4.24787	**0.0000**	0.011846	2.469754	**0.0151**
ROAE_O	-0.003167	-1.42241	0.1577	0.000293	0.341126	0.7337
TA	-1.68E-05	-5.81037	**0.0000**	-5.94E-06	-5.32453	**0.0000**
IPC	0.005576	2.199284	**0.0300**	-0.001445	-1.47751	0.1424
FP	0.169963	3.123368	**0.0023**	-0.039673	-1.88953	0.0615
BANK_REF	0.229016	13.55224	**0.0000**	0.098468	15.10189	**0.0000**

For all four models, the value of F-statistics shows us that the overall significance of the regression is high enough to reject the null hyphothesis of of insignificance of all slope coefficients (p-value for all 4 models is 0).

Based on probability associated with t-Statistics, the performed analysis shows that the technical efficiency is influenced by the following variables: quality of assets, return on equity, bank size, annual inflation rate and banking reform and interest rate liberalisation level. The cost efficiency is influenced by the evolution of the following variables: quality of assets; net interest margin; administrative costs; bank size, ownership form and banking reform and interest rate liberalisation level.

7. Conclusions

In this study we performed an analysis of the efficiency of the main banks in Romania, the Czech Republic and Hungary for the period 2000-2006 by using a parametric method – the SFA Method and a nonparametric method – the DEA Method.

The results of the analysis performed show that in the analyzed period the banks in Romania were registering a much lower level of technical efficiency than the banks in Hungary and the Czech Republic. The banks in the three East European states are inefficient from the perspective of costs, which means that the bank services and products offered by these banks are very expensive. At the level of cost efficiency it is to notice that Romanian banks register a much lower level than the average levels registered by the banks in the Czech Republic and Hungary.

The level of the cost efficiency increased significantly over the analyzed period in the three banking systems. The largest increase was registered by the banks in Romania - by more than 4 times, from a level of 0.045379 in 2000 to a level of 0.180413 in 2006.

Analysis results achieved are very important in terms of banks and governmental authorities' perspectives. Thus, to improve the efficiency banks need to improve the quality of assets owned by improving the lending process and reduce the share of nonperforming loans, also banks need to reduce administrative costs that have a negative impact on cost efficiency. A topic of interest in the current context of international economic and financial crisis is the optimal size of banks, the analysis results as an increase in bank size, gauged by total assets held, results in an increase in technical efficiency and a reduction in cost efficiency. To facilitate an increase in the efficiency of banks, the Romanian government authorities must accelerate the process of liberalization and reform of the banking system and make every effort to ensure a low inflation rate.

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