Regulation and efficiency of banks in transition:
The case of Romania

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Abstract

This paper analyzes the impact of technical inefficiency and regulation-induced allocative distortion on cost using a model that combines the stochastic frontier model and the shadow cost function. Our results indicate that the proxy for the "one-size-fits-all" regulation aimed at stabilizing the industry does not correlate strongly with the improvements of the cost efficiency but it increases the allocative distortions. However, restructure and closure of inefficient banks at an early stage is found to be a better policy for reducing technical inefficiency. We found that the private domestic banks are less efficient than the state-owned and foreign banks as well as representative offices.

Keywords: Allocative distortions, Technical Efficiency, Stochastic Frontier, Financial Regulation and Supervision, Transitional Economies

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1. Introduction

Transition economies offer a unique opportunity to study regulation and its impact on resource allocation and cost efficiency. Economic theory suggests that a market economy has superior resource allocations compared to a centrally planned economy. On the transition path to a market economy, however, efficiency is greatly affected by a fast changing and unpredictable environment generated by restructuring and privatizations, frequent changes in regulation, competition from abroad and from foreign direct investment, etc. The Eastern European countries are in the process of creating institutions to foster a functioning market economy. In this context, regulation has the role of establishing the rules of the game and correcting for asymmetries in the market power generated by the former state monopolies. These frequent changes in regulations, however, impose additional constraints on firms.

Inefficiency can arise from overuse of inputs and from misallocation of resources due to various constrains faced by an optimizing firm besides production constraints (i.e., regulation). The objective of the paper is to develop a model that allows us to estimate the technical inefficiency and the distortionary effects of non-production constraints. Technical inefficiency is defined as the percentage by which all the inputs are overused to produce a level of outputs. Allocative distortion/inefficiency arises when effective input price ratios differ from their observed counterparts. Presence of these distortions results in misallocation of resources and therefore increases cost. Regulators can help reduce inefficiency of individual banks by setting up non-distortionary rules. For example, the restructuring of insolvent banks and the enforcement of some prudential regulation increase the stability of the system and may reduce the cost of technical inefficiency. However, some "one-size-fits-all" regulation can negatively affect the allocative efficiency of banks by distorting input or output prices. For example, restrictions on asset holdings or restriction of banks to engage in certain businesses can reduce the overexposure to risky assets while an increase of required reserves raises the opportunity cost of using deposits and acts as a tax on the price of deposits.

As an application of this model we use a disaggregated panel of Romanian banks for the period 1994–2002. Empirically we estimate the effects of two economic policies implemented by the National Bank of Romania. The first policy employed a tightening of regulation and supervision and the second policy consisted of restructuring and closure of inefficient banks. We estimate the impact of these policies on operating cost. We include the state of the economy as a determinant of bank performance in recognition of the fact that the major transformation of the economic system may have increased the transaction cost for banks. At the same time, we correlate the price distortions with proxies for regulation, ownership type and a time component. To estimate technical inefficiency and allocative distortions jointly, we use a mixture of a stochastic frontier model with a shadow price model.

While there is a large literature on bank efficiency for developed countries (see Berger and Humphrey, 1997), the study of transition economies is still in its infancy. Evidence from transitional economies show that foreign banks or banks with majority foreign capital have higher cost and profit efficiency and indicates that privatization to a large foreign bank or institutional investor improves the performance of banks (Hasan and Marton 2003, Bonin, Hasan and Wachtel, 2005). The study of fifteen Eastern European countries shows that banking systems with a large foreign presence have higher cost efficiency (Fries and Taci, 2005). While previous studies examine factors that are associated with higher relative efficiency across banks and across countries, they did not study the impact of government policy on efficiency. Moreover, previous banking efficiency studies for developed and developing economies focus on the effects of deregulation (i.e. Kumbhakar and Sarkar, 2003; Berger and Mester, 2001; Humphrey and Pulley, 1997; and Bauer, Berger and Humphrey, 1993). To our knowledge this is the first study of the effects of increased regulation on cost efficiency and the first estimation of regulation induced cost increase. Insights from this study may be informative to other transition countries. In a World Bank study, edited by Bokros et al. (2005), the authors report a similar evolution of the development of the regulation in all transition economies. Our model could be used to test whether regulations implemented by other countries in the process of building market institutions had similar distortionary effects.

Overall, our results of the cost of technical inefficiency are lower in magnitude than those reported in the previous literature. This could arise from having separated the cost of technical inefficiency from the cost of allocative distortions. We find that the domestic private banks are the most inefficient, followed by the state-owned banks, foreign banks and the representative office. This result is due to some characteristics of the Romanian banking industry, which we discuss below. We show that the increased "one-size-fits-all" regulation has had a small impact on improving the cost efficiency of the banking industry in Romania. This type of regulation, however, has had a distortionary effect on the prices of deposits. We calculate the cost increase generated by these distortions and show that distortionary regulatory measures have a negative impact on the quantity of financial intermediation. Since state-owned and private domestic banks are holding a larger share of deposits in domestic currency, they are affected by these distortions to a higher degree than foreign banks and representative offices.

The paper is organized as follows: in Section 2 we describe the present state of the Romanian economy and banking, Section 3 describes the econometric model, Section 4 describes the data, Section 5 reports the results and Section 6 concludes.

2. Banking in Romania

Romania started its transition much later than other Eastern European countries. Unlike the other countries in the region there had been practically no attempts to reform the Romanian economy before 1990. The state of the Romanian economy in 1990 spoke of its arrested development during the most restrictive regime in the communist block. The structure of the industry was skewed towards energy-intensive heavy industry such as machine building, metallurgy and chemicals at the expense of consumer goods industries. After the fall of communism, the government eliminated all the rules and constraints of the old system and gradually started to develop the rules of the game needed for a functioning market economy. In the absence of private-sector monitoring of banks, the National Bank of Romania (NBR) assumed the role of establishing the regulatory framework and supervision need for the stability of the banking sector. *Appendix A* reports a summary of regulatory development in Romania for the period 1990 to 2002. The year 1999 marks a major policy shift. The NBR was granted independence a year before and was given more supervision and regulation powers. As a result, the NBR was engaged in a comprehensive enhancement of the regulatory process and restructuring of the banking industry.

Table 1 reports the composition and the evolution of the Romanian banking system for the period 1994 to 2002. Until 1998 a small number of state-owned banks dominated the banking industry, holding 71.9% of total industry assets. The sharp deterioration of the financial situation of two state-owned banks and two banks with domestic private capital in 1998 prompted a tightening of regulation and bank restructuring. Despite these restructuring measures, several banks with fragile financial standing generally caused by mismanagement and risky practices still existed. For these banks, the NBR undertook a series of measures such as limitation of bank operations, interdiction or limitation to collect new household deposits and required these banks to submit recovery plans and report on the progress of their implementation. The total cost of restructuring the banking system was evaluated at approximately 5% of the GDP.

As a result of the regulatory and restructuring efforts of the NBR, the health of the banking system started to improve after 1999. The share of loans and interest under "doubtful" and "loss" in total loan portfolio decreased from 35.4% in 1999 to 2.5% in 2001 and 1.1% in 2002. The "doubtful" and "overdue" claims (net value) to equity decreased from 253.6% in 1998 to 2.66% in 2001 and 1.97% in 2002. Moreover, looking at the consolidated balance sheet of the banking system we can see a gradual improvement in the quality of the loan portfolio starting with 2000. With the privatization of two large state-owned banks (BRD and Banc Post) in 1999 as well as with the liquidation and transfer of the viable assets from the largest state-owned bank (Bancorex) to another large state-owned bank (BCR), the share of total assets held by state-owned banks fell to 47.1% in 1999 while the share of foreign banks increased from 19% in 1998 to 47% in 1999. This year also marks the beginning of the entry of large multinational banks, increasing the competition in the Romanian market. At the same time, the domestic private banks play an increasingly smaller role in the Romanian economy. Although the composition of the banking industry changed, the Romanian banking industry in 2002 was still dominated by a small number of large banks. For example, the top five banks in terms of total assets controlled 63% of total deposits at the end of 2002. Moreover, the banking system remained dominated by a large state-owned bank (BCR), which had a market share of almost twice the size of the second largest bank.

While the restructuring and regulatory measures may have helped improve the stability of the industry, some of the "one-size-fits-all" type of regulation imposed costly constraints on the banking industry. Required reserve ratios act as an implicit tax on the price of deposits, while, higher capital requirements constrain the quantity of financial intermediation (Berger et al., 1995). The size of a bank's capital can be an important buffer in absorbing portfolio losses. However, the new capital ratios were imposed at a time when the typical bank experienced a decrease in the internal capital generation rate and an increase in the growth rate of assets. Since the capital market in Romania is still in its infancy, most domestic banks had to rely on their internal sources to generate new capital. While the state-owned banks were periodically recapitalized by the central bank and while the large foreign banks used their parent company to meet the capital requirements, most of the domestic private banks had to restrict the growth of their assets to meet the new capital requirements set by the NBR.

In summary, the evolution of the Romanian economy and banking system until 1999 is characterized by the following: (1) inadequate restructuring and weak corporate governance in both enterprises and banks, missing and incomplete markets and institutions that contributed to a perpetuation of inefficiencies in both the corporate and banking sector; (2) mismanagement and "improper credit policy led by some bank managers, ranging from incompetence to fraud"[1]; (3) state-owned banks captivity to lending to some loss-making state-owned enterprises; (4) lack of judicial tools to implement the liquidation procedures and execution of bank's guarantees; (5) legislation favoring debtors and (6) lack of liquid market for the sale of assets backing the loans granted by banks. After 1999, although some of the problems mentioned above still persisted, there were several improvements in the Romanian economy and banking industry: (1) increased pace of privatization and restructuring of state-owned companies as well as banks, (2) increased competition among banks; (3) improvement in the general state of the economy and (4) increased regulatory and supervisory powers of the NBR.

3. Econometric Model

To estimate the cost of technical inefficiency, we use a cost minimization framework with multiple-output and multiple-input technology (Kumbhakar, 1996). We assume that the inputs are *nonallocable,* meaning that one observes the quantities of inputs used in the production process instead of quantities of each input allocated to a particular output. We use a radial measure of technical inefficiency, which is defined as the maximum rate ($\lambda \geq 0$) at which all the inputs can be reduced without reducing the output vector. The optimization problem becomes:

$$\min \ C = W'X$$
$$s.t. \ F(Y, X \cdot e^{-\lambda}, Z, t) = 0$$

[1] Annual Reports of the National Bank of Romania, 1996 - 2000, pg 357.

where, $W=(w_1,...,w_J)'\in\mathbb{R}^J_{++}$ is a $(J\times 1)$ vector of positive observed input prices, $X=(x_1,...,x_J)'\in\mathbb{R}^J_{+}$ is a $(J\times 1)$ vector of nonnegative variable inputs, $Y=(y_1,...,y_M)'\in\mathbb{R}^M_{+}$ is a $(M\times 1)$ nonnegative output vector (services provided by banks), $Z=(z_1,...,z_Q)'\in\mathbb{R}^Q_{+}$ is a $(Q\times 1)$ vector of nonnegative quasi-inputs, t is a trend variable capturing technical change and $\lambda\geq 0$ measures input-oriented technical inefficiency. The solution of the above problem gives $\ln C^a = \ln C^m + \lambda$, where C^m is the neoclassical cost function that gives the minimum cost without any inefficiency. Thus $C^m/C^a = e^{-\lambda} \leq 1$ is defined as the cost efficiency of a firm, or alternatively $\ln C^a - \ln C^m = \lambda \geq 0$ shows that the actual cost is increased by λ times 100 percent due to technical inefficiency.

However, if input markets and firms face constraints due to government regulations then firms must include these additional constraints in their optimization decisions (here we are assuming that all banks are technically efficient – this assumption will be relaxed later):

$$\begin{aligned}&\min\ C = W'X\\&s.t.\ F(Y,X,Z,t)=0\\&and\ R_s(Y,X,W,Z,t)=0,\quad s=1,...,S\end{aligned}$$

where R_s are quantitative or qualitative constraints due to regulation. In banking, for example, additional reserve requirements, deposits insurance fees and other regulatory burdens imposed additional cost on banks subject to those restrictions. These constraints may distort input prices, meaning that the effective (shadow) price of the jth input (w_j^*) may be different from the observed (actual) price of the jth input (w_j), for each j. The above optimization problem can be viewed as if banks are minimizing the total shadow cost $C^*(W^*,Y,Z,t) = \sum_j w_j^* x_j$ in choosing the optimum input quantities $x_j = x_j\left(W^*,Y,Z,t\right)$. The advantage of using C^* is that the Shephard's lemma can be used to obtain the optimum input demand functions, $\partial C^*(Y,W^*,Z,t)/\partial w_j^* = x_j$.

Following Atkinson and Halvorsen (1984) and Kumbhakar and Sarkar (2003), we can relate the actual cost C^a to the minimum shadow cost C^* as follows:

$$\ln C^a = \ln C^* + \ln H$$

where H = $\sum_{j=1}^{J}\left(\theta_j\right)^{-1} S_j^*$, $S_j^* = \partial \ln C^* / \partial \ln w_j^* \equiv w_j^* x_j / C^*$ and $w_j^* = \theta_j w_j$. In this model shadow price is expressed as the product of observed price and the distortion function. Since any kind of distortion increases cost, $C^a - C^0$ can be viewed as the increase in cost due to distortions or $\ln C^a - \ln C^0$ as the percentage increase in cost due to distortions, where C^0 is the neoclassical cost function (without allocative distortions).

We combine the stochastic frontier model with the shadow price model to account for both types of cost inefficiency. Thus, the actual cost can be higher than the minimum cost due to technical inefficiency as well as allocative distortions, viz.,

$$\ln C^a = \ln C^* + \ln H + \lambda \equiv \ln C^0 + (\ln C^* - \ln C^0 + \ln H) + \lambda .$$

From the above relationship, we can examine both the technical inefficiency (increase in cost due to technical inefficiency) for each firm (λ) and the percentage increase in cost due to allocative distortions (when multiplied by 100) as $\ln C^* - \ln C^0 + \ln H$ which is non-negative for a well-behaved cost function.

To estimate the above model, we use a multi-output translog cost function for $\ln C^*$. The translog cost frontier has several virtues: (i) it accommodates multiple outputs without necessarily violating curvature conditions; (ii) it is flexible, in the sense that it provides a second-order approximation to any well-behaved underlying cost frontier at the mean of the data; and (iii) it forms the basis of much of the empirical estimation and decomposition of cost efficiency based on a system of equations. Following Kumbhakar and Sarkar (2003), we specify $\ln C^*$ as:

$$\begin{aligned}
\ln \mathrm{C}_{it}^* &= \alpha_0 + \delta_i \mathrm{D}_i + \sum_m \alpha_m \ln \mathrm{y}_{mit} + \sum_j \beta_j \ln \mathrm{w}_{jit}^* + \sum_q \gamma_q \ln \mathrm{z}_{qit} + \beta_t t \\
&+ \frac{1}{2}\left\{ \sum_m \sum_l \alpha_{ml} \ln y_{mit} \ln y_{lit} + \sum_j \sum_k \beta_{jk} \ln \mathrm{w}_{jit}^* \ln \mathrm{w}_{kit}^* + \sum_q \sum_s \gamma_{qs} \ln \mathrm{z}_{qit} \ln \mathrm{z}_{sit} + \beta_{tt} t^2 \right\} \\
&+ \sum_m \sum_j \alpha_{mj} \ln y_{mit} \ln \mathrm{w}_{jit}^* + \sum_m \sum_s \alpha_{ms} \ln y_{mit} \ln \mathrm{z}_{sit} + \sum_m \alpha_{mt} \ln y_{mit} t + \sum_j \sum_q \beta_{jq} \ln \mathrm{w}_{jit} \ln \mathrm{z}_{qit} \\
&+ \sum_i \beta_{it} \ln \mathrm{w}_{iit} t + \sum_q \gamma_{qt} \ln \mathrm{z}_{qit} t
\end{aligned} \tag{1}$$

where i = 1, …, I is the index for banks and t = 1, …, T_i is the index for time. We use dummy variables for each bank (D_i) to capture cost differences due bank-specific effects (fixed). We also impose the following symmetry conditions in the above cost function, viz., $\alpha_{ml} = \alpha_{lm}$, $\beta_{jk} = \beta_{kj}$ and $\gamma_{qs} = \gamma_{sq}$. To ensure linear homogeneity (in prices) of the cost function, the following constraints must be imposed:

$$\sum_j \beta_j = 1;\ \sum_j \beta_{jk} = 0,\ \forall k;\ \sum_j \alpha_{mj} = 0,\ \forall m;\ \sum_j \beta_{jt} = 0;\ \sum_j \beta_{jq} = 0,\ \forall q\ .$$

To increase efficiency of the above cost function we add $(J-1)$ cost share equations:

$$S_{jit}^{a} = S_{jit}^{*} / (H_{it}\theta_j) + \eta_{jit} \tag{2}$$

where $S_{jit}^{*} = \partial \ln C^{*} / \partial \ln w_j^{*} = \beta_j + \sum_k \beta_{jk} \ln w_{kit}^{*} + \sum_m \alpha_{mj} \ln y_{mit} + \sum_q \beta_{jq} \ln z_{qit} + \beta_{jt} t$ and

$S_j^a = (w_j x_j)/C^a$. Finally, we added classical error terms (v) to the cost function in equation (1) and (η) to the cost share equations in (2).

The above system can be estimated using the maximum likelihood method based on the following assumptions: (i) $\lambda_{it} \sim N(\mu_{it}, \sigma_\lambda^2)$, $\lambda_{it} \geq 0$ where μ_{it} is a function of determinants of technical inefficiency such as regulation, plus some micro and macro variables; (ii) $v \sim N(0, \sigma_v^2)$; (iii) $\eta \sim N(0, \Sigma)$ and (iv) λ and v are independent and each of them is independent with the elements of η. The likelihood function and estimates of technical inefficiency are derived in Kumbhakar and Lovell (2000) for a single output case. Its extension to the multiple output case is straightforward.

The maximum likelihood of the above model is quite complex. First, we have a system with distortion functions attached to input prices that make the model highly non-linear. Second, estimation of technical inefficiency in a system form is quite uncommon, especially when a flexible functional form is used. Because of these complications we used a two-step procedure, which gives consistent estimates of the parameters.

Step 1: The main objective of this step is to estimate the parameters associated with the distortion functions. For this we estimated the translog cost function and the cost share equations (dropping one equation to avoid the singularity problem), ignoring technical inefficiency. Since the mean (μ_{it}) of technical inefficiency (λ) is a function of some exogenous variables, we can write the translog cost function as follows:

$$\ln C_{it}^{a} = \ln C_{it}^{*} + \ln H_{it} + \mu_{it} + (\lambda_{it} + v_{it} - \mu_{it}) \ \equiv \ \ln C_{it}^{*} + \ln H_{it} + \mu_{it} + v_{it}^{*} \tag{3}$$

where $v_{it}^* = \lambda_{it} + v_{it} - \mu_{it}$ and $E(\lambda_{it}) = \mu_{it}$. Since $\mathrm{E}(\mathrm{v}_{\mathrm{it}}^*) = 0$ we can use the Non-linear Iterative Seemingly Unrelated Regression (***NLITSUR***) technique to estimate the system of equations in (2) and (3).[2]

Step 2: We used the estimated values of θ_j to obtain $w_j^* = \theta_j w_j$ and $H(\bullet) = \sum_j S_j^* / \theta_j$ which are plugged back into the cost function (3).[3] Thus, the second step regression becomes:

$$\ln Q_{it} = \ln C_{it}^* + \lambda_{it} + v_{it} \tag{4}$$

where $\ln Q_{it} = \ln C_{it}^a - \ln H(\bullet)$ and $\ln C_{it}^*$ is defined in (1). The equation (4) can be estimated using the maximum likelihood method based on the assumptions (i) and (ii) above. Once the parameters of μ_{it}, σ_λ^2 and σ_v^2 are estimated the cost inefficiency ($\hat{\lambda}_{it}$) can be estimated for each bank at every period using the formula (see Kumbhakar and Lovell, 2000):

$$\hat{\lambda}_{\mathrm{it}} = \mathrm{E}\left(\lambda_{it} \,|\, (\mathrm{v}_{\mathrm{it}} + \lambda_{it})\right) = \mu_{\mathrm{it}}^* + \sigma_{it}^* \left[\frac{\phi(\mu_{\mathrm{it}}^*/\sigma_{it}^*)}{\Phi(\mu_{\mathrm{it}}^*/\sigma_{it}^*)}\right],$$

where $\mu_{\mathrm{it}}^* = \dfrac{\sigma_\lambda^2(\lambda_{it} + \mathrm{v}_{\mathrm{it}}) + \mu_{\mathrm{it}}\sigma_v^2}{\sigma_\lambda^2 + \sigma_v^2}$, $\sigma_{\mathrm{it}}^{*2} = \dfrac{\sigma_\lambda^2 \sigma_v^2}{\sigma_v^2 + \sigma_v^2}$ and $\phi(\mu_{\mathrm{it}}^*/\sigma_{it}^*)$ and $\Phi(\mu_{\mathrm{it}}^*/\sigma_{it}^*)$ are the probability density and distribution functions of standard normal variables. The marginal effect of the k^{th} element of μ can be calculated using the formula:

$$\frac{\partial E(\lambda_{it})}{\partial \mu[k]} = \delta[k]\left[1 - \Lambda\left[\frac{\phi(\Lambda_{it})}{\Phi(\Lambda_{it})}\right] - \left[\frac{\phi(\Lambda_{it})}{\Phi(\Lambda_{it})}\right]^2\right] \tag{5}$$

where $\delta[k]$ is the parameter associated with k^{th} element of the μ function and $\Lambda_{it} = \dfrac{\mu_{it}}{\sigma_\lambda}$ (see Wang 2002 for details).

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[2] Note that if some of the variables in μ_{it} also appear in C^* the corresponding parameters cannot be identified from the first step regression. Even if, there are no common variables, one might want to estimate all the parameters in the v_{it}^* function from the second step regression.

[3] Since μ does not contain W_j^* the parameters of S_j^* will not be affected by the presence of technical inefficiency. Thus, we can obtain an estimate of the $H(.)$ function.

4. Data

We obtained the annual balance sheets and profit and loss statements for all commercial banks for the period 1994 to 2002 from the Ministry of Finance of Romania. Since the tax authorities use these reports to determine the annual tax liabilities of each bank, we believe that this data set is of high quality. Moreover, we checked the aggregated values for the entire banking system against the values reported by the National Bank of Romania and found only a few insignificant differences. Although we have the entire population of Romanian banks, we dropped some of the observations that were inappropriate for our analysis, such as: banks with fewer than two years of activity and the first year of activity for all banks in our sample. This resulted in a sample of 305 observations, which is approximately 90% of all total observations of the population. In defining the banking production function, we used the intermediation approach (Sealey and Lindley, 1977).[4] This approach treats loans as outputs and deposits and labor as inputs. We prefer this approach since it allows us to determine the impact of regulation on the price of deposits. From the balance sheet data, we define the following output variables (Y): real current loans (L), real portfolio investment (I), real fee and commission income (F) as a proxy of non-interest services offered by a bank and number of branches (B) as a proxy for the quality and convenience that a bank offers to its customers. To avoid the "zero-output" problem in the translog cost function we aggregate the loans and portfolio investment outputs as follows: $\ln y_{LI} = \ln\left[a_1 L(1 + reg\_Y * REGIME) + (1 - a_1)I\right]$. This specification accommodates zero values of outputs and also corrects for potential measurement problems and/or differences in quality of loans in the pre-regulation period. The dummy $REGIME$ takes the value one during the period

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[4] The literature disagrees about the definition of bank output. The first approach, the intermediation framework (Sealey and Lindley 1977) defines deposits or deposit costs as inputs. Here deposits are interpreted as a supply of funds which is used to create deposits. The second approach, the value added framework (Berger, Hanweck, and Humphrey, 1987) classifies deposits as an output. This approach recognizes that banks do not passively collect deposits but provide services related to deposits (check clearing, withdrawals, etc). The third approach, the user cost framework (Hancock, 1985 and Fixler and Zieschang, 1990) defines outputs and inputs based on the net contribution to the revenue. If the financial returns on an asset exceed the opportunity cost of funds or if the financial costs of a liability are less than the opportunity cost, then the instrument is considered to be a financial output. Otherwise, it is considered to be a financial input.

1994 – 1999 and zero afterward[5]. In this aggregator/hedonic output function, the a_1 parameter indicates the share of real current loans used in bank production and the reg_Y coefficient indicates the degree of mis-measurement or the proportion by which the real loans are overstated/understated due to the quality difference. Assuming that the loans prior to 1999 were overstated compared to those after 1999, one would expect *a priori* a negative value for the quality correction parameter, reg_Y. Our input variables are: (i) total real deposits (D) including demand deposits, time deposits and inter-bank deposits and (ii) number of employees (E). In addition, we consider three quasi-fixed inputs (Z): (i) real share capital (K), (ii) real fixed assets (A) and (iii) real all expenses except interest and labor costs (O). The size of a bank's share capital can be an important buffer in absorbing portfolio losses and is an important variable to account for when studying efficiency. The cost used in estimation is the sum of the cost of the two inputs: interest cost and labor cost (COST). We obtained the price of labor (W_L) by dividing total labor expenses to number of employees and the price of deposits (W_D) by dividing total interest expense to total deposits.

Table 2 reports the summary statistics of the variables used in the model. The median value of loans adjusted to inflation increased from 264 million Romanian Leu (ROL) in 1994 to 15,819 million ROL in 2002; while the median value of portfolio investment adjusted for inflation had a spectacular increase from 3 million ROL in 1994 to 1,342 million ROL in 2002. Following the major restructuring of the banking system, privatizations, increased competition from foreign banks and the improvement in the business environment, the median number of branches increased from 1 in 1994 to 15 in 2002. As the banking system expanded, the sum of interest and labor cost adjusted for inflation increased from 198 million ROL in 1994 to 2,110 million ROL in 2002. Looking at the industry solvency ratios, we can see that around 1998 the banking industry as a whole was in danger of collapse. If we adjust the solvency ratios with the expected earnings and the overall riskiness of a bank, as measured by the probability of insolvency[6], we see that the median bank was in a bad shape as well. As a matter of fact the central bank describes the state of the Romanian industry in 1998 as in "virtual bankruptcy". The imminent collapse of a small number of banks prompted the fear of a domino effect that would

[5] We thank an anonymous referee for this suggestion.

[6] See Hannan and Hanweck (1998).

generate a systemic failure. In this paper, we investigate whether cost inefficiency is correlated with the state of the banking industry, among other things.

We consider the following factors that may affect technical efficiency of banks: (i) managerial performance, (ii) regulation and (iii) macroeconomic environment. We use the Capital Assets Management Profitability and Liquidity (CAMPL) scores as a proxy for managerial performance. The median CAMPL score and the median values of selected financial ratios used to calculate it are reported in *Table 2*. Based on the methodology used by the NBR as part of the Early Warning System, we calculated the score for each component of the CAMPL model. This methodology assigns scores between one and five, where one stands for a financial indicator that describes a strong financial standing and a score of five for a poor financial standing[7]. The definitions of selected financial ratios, used in the paper, are given in the note to *Table 2*. To obtain the final CAMPL score we averaged these scores for each bank in every year. We use the required reserves as a proxy of the regulation constraints since it best mirrors the evolution of regulation enacted by the NBR over the period studied. In addition, the macroeconomic environment may affect the bank efficiency through the transaction cost associated with the uncertainty generated by the transition to a new economic system.

5. Results

Since the coefficients of the translog cost function are not of direct interest we report them in Appendix B. Out of the 47 parameters of the cost function (excluding the banks specific parameters and the determinants of inefficiency parameters), 22 parameters are statistically significant at the 10% or better level of significance. We assume that the mean of inefficiency (lambda) in equation (4) is a function of twelve variables labeled as correlates of inefficiency. The coefficients associated with these correlates of inefficiency and are used in *Section 5.2* to determine the marginal effect of these variables on the mean cost inefficiency. Four out of twelve of these parameters are statistically significant at the 10% level of significance. While these parameters are not of direct interest, they are used in calculating the cost of technical inefficiency and the cost of allocative distortions. Out of the 45 bank specific dummies 30 parameters are statistically significant at the 10% level of significance. It is worth mentioning that the

[7] Details on the CAMPL methodology can be obtained from the authors upon request.

coefficient corresponding to the share of loans in the hedonic aggregation of loans and portfolio investment (a_1) equals 0.999 and is highly significant which seems to confirm the propensity of most of the Romanian banks for producing loans and little or no portfolio investment for most of the period studied. Thus the simple sum of these two outputs in a common aggregate would assume that the two weights are equal and would not be appropriate for our data set. The estimation results show that the loan quality adjustment coefficient reg_Y is negative with a value of 0.59 and is statistically significant at the 1% level of significance. This suggests that loans prior to 1999 were overstated or/and had a lower quality, compared to the loans granted after 1999.

5.1. Technical Inefficiency

We report in *Table 3* the median values of the cost of technical inefficiency for all banks in our sample and the median values for each ownership group: state-owned, domestic private, foreign banks and representative offices. These values show in percentage terms by how much the actual cost is higher than the benchmark minimum cost. The average cost of technical inefficiency for the median bank for the period 1994 – 2002 is 17.4%. This is the average annual rate by which the median bank could have reduced its cost by matching the practices of the best-performance bank. In our study, the most inefficient banks are the domestic private banks for which the cost of technical inefficiency is 26.4%; followed by the state-owned banks (21.9%), the foreign banks (19.3%) and representative offices (10.2%). For Romania, the higher estimates of the cost of technical inefficiency for the domestic private banks are explained best by "improper credit policy led by some bank managers ranging from incompetence to fraud"[8]. A number of these domestic private banks were closed during the period 1994 -2000.[9] The lower cost of technical inefficiency for state-owned banks relative to private domestic banks can also be justified by the following facts. First, these banks have become tougher with loss-making firms especially in the post-regulation period. Second, the balance sheet and the profit and loss

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[8] Annual Reports of the National Bank of Romania, 1996 - 2000, p. 357.

[9] During the period 1998-2000, the NBR initiated the closure and the bankruptcy procedures of a number of private domestic banks such as Credit Bank, Banca Internationala a Religiilor, Bancoop and Banca Columna as well as the restructuring of Banca Dacia Felix.

statements do not reflect the real magnitude of the cost inefficiency at the bank level. The balance sheets of some state-owned banks look healthier in terms of their book value as a result of periodic restructuring of loan portfolio and the transferring of non-performing loans to the Banking Asset Recovery Agency and refinancing from the NBR. We believe that the lower estimates for the foreign banks and representative offices were mostly due to the fact that these banks were bringing better know-how and lending practices of their parent company and for most of the period studied they were concentrating on serving the local branches of other multinational companies in Romania.

Overall, the costs of technical inefficiency estimates that we report in Table 3 are lower than those reported in the literature. For Hungary, Hasan and Marton (2003) found cost of technical inefficiency to the order of 33.84% for domestic and 26.07% for foreign banks. The results are not directly comparable, however. We have separated the cost of technical inefficiency from the cost of allocative distortions. Moreover, as Berger and Humphrey (1997) point out, the comparability of these estimates across countries is limited by the fact that each country's efficiency estimate is determined relative only to the frontier of that country. Since frontiers may differ across countries, these estimates show the average dispersion of banks in each country away from that country's own measured best-practice frontier, rather than banks efficiency measured relative to any global best-practice frontier.

In response to the challenges presented by the banking industry, the central bank implemented a number of policies. For example, it restructured or closed a number of highly inefficient banks, increased the required reserves for demand deposits, increased the capital adequacy ratios, set up the Deposit Guarantee Fund, the Credit Bureau, the Early Warning System, and increased the frequency of on-site auditing. To check for differences in cost efficiency due policy change, we divide the sample in two periods: pre-regulation (1994 to 1999) and post-regulation (2000 to 2002). The cost of technical inefficiency of all banks decreases from 19.7% in the pre-regulation period to 12.9% in the post-regulation period, which may be due to regulation or the restructure and closure of the problem banks. This pattern is present for both types of foreign banks but not for state-owned and domestic private banks. In the remainder of this section, we investigate whether the changes in cost inefficiency for the second period can be explained by (i) the additional "one-size-fits-all" type of regulation such as increased required reserves, or (ii) by the restructuring and closure of the inefficient banks.

To determine the effects of increased regulation, we estimated equation (4) with the mean inefficiency as a function of regulation, controlling for managerial practices and for changes in macroeconomic environment, distinctly for each type of ownership**.** *Table 4* reports the marginal effects of the correlates of technical inefficiency calculated using formula (5). These marginal effects have the same interpretation as OLS coefficients. The increase in regulation seems to have a weak correlation or no correlation at all to the relative decline of technical inefficiency in the post regulation period. Although the marginal effect of the required reserves has the expected sign, the underlying coefficients of the correlates of inefficiency are statistically insignificant. In fact, the improvement in the managerial practices had the largest effect on improving the cost efficiency for state-owned and domestic private firms. As described earlier, a CAMPL score of 1 describes the best-practices bank and a score of 5 the worst-practices bank. Our estimates reported in *Table 4* shows that a decrease in the CAMPL by one point (in the 5 point scale) improves the mean of the cost of technical inefficiency by 1.05 percentage points for state-owned and 0.21 percentage points for domestic private banks. The underlying coefficients used for calculating the marginal effect of the managerial practices for the foreign and representative offices are not statistically significant. Mostly the domestic private and representative banks had used the positive changes in the general business environment to their advantage. An increase of 1% in the real GDP growth rate can help decrease the mean of the cost of technical inefficiency by 0.06 percentage points for domestic and by 0.04 percentage points for representative offices.

To determine the hypothetical benefits of the restructuring and closing of the highly inefficient banks, we re-estimated the model assuming that these banks were closed at an earlier stage before entering bankruptcy. Therefore, we identify the banks that were closed and we delete the data for two years prior to bankruptcy[10]. We chose two years prior to bankruptcy after studying the evolution of the CAMPL scores of these banks and identifying year two as the cut-off for the significant worsening of the CAMPL score. We re-estimated the model and report the mean of the new estimates of the cost of technical inefficiency in *Table 3.* We can see that the cost of technical inefficiency for the median bank went down from 21.9% to 18.7% for state-

[10] These banks with the last date of data included our sample after the adjustments were: Banca Internationala a Religiilor (1997), Banca Romana de Scont (1999), Banca Turco-Romana (1999), Bankcoop (1997), Bancorex (1996), Credit Bank (1996), Banca Dacia Felix (1998), Banca Columna (1996) and Banca Anglo-Romana (dropped).

owned banks, from 26.4% to 12.7% for domestic private, from 19.3% to 15.9% for foreign banks and from 10.2% to 8.5% for representative offices.

These results show that the implementation of "one-size-fits-all" distortionary regulation such as required reserves had a small impact on improving the cost efficiency of the banking industry in Romania. The central bank can help decrease the cost of technical inefficiency for all types of banks in the system by restructuring and closing the problem banks at an early stage in their bankruptcy before they have negative spillover effects on the rest of the banks in the industry. The relatively high correlation between the CAMPL score and the cost of technical inefficiency suggests that the central bank can use this tool in identifying potential problem banks at an early stage and impose corrective measures on these banks alone.

5.2. Allocative Distortions

Results reported in the preceding section show that the increased distortionary regulation resulted in small improvements in bank's efficiency and could not target problem banks. Economic theory postulates that regulation affects all banks and acts as a tax if it is binding. In this section we describe the effects of the regulation on the price of deposits (allocative distortions) and estimate the cost of these allocative distortions. Our model allows us to specify the distortion component (θ_j) as a function of regulation and some bank specific variables. However, it is not possible to obtain separate values of θ_j for all inputs $j = (1,...,J)$ because the shadow cost function is homogeneous of degree one in shadow prices. Thus, it is necessary to normalize one of the θ_j parameters and estimate the remaining $\left(J-1\right)$ of the θ_j. Since we consider only two inputs in our specification (deposits and labor), we set the distortion parameter for labor (θ_L) equal to unity. Therefore, we can interpret θ_D as the distortion of deposit prices relative to wage. Moreover, to estimate the impact of some relevant variables on price distortions we specify θ_D as follows:

$$\theta_D = 1 + \theta_0 + \theta_f D_f + \theta_p D_p + \theta_{ro} D_{ro} + \theta_R R + (\theta_t + \theta_{ft} D_f + \theta_{pt} D_p + \theta_{rot} D_{ro} + \theta_{Rt} R)t,$$

where the distortion is a function of a constant, dummy variables for foreign banks (D_f), domestic private banks (D_p), representative offices (D_{ro}), a proxy for regulation (R), a time trend (t) and the interaction between these variables and time. In this framework, θ_0 measures the distortion of the price of deposits relative to the price of labor in the first year of the period studied, θ_f, θ_p and θ_{ro} measure whether the distortions were different for foreign, domestic private banks and representative offices relative to the state-owned banks, θ_R measures the distortionary impact of regulation while θ_t measures the changes over time. This specification allows θ_D to vary over time and across banks.

We report in *Table 5* the estimated parameters of the distortion function θ_D. This specification allows us to test the following hypotheses of interest:

H1. $\theta_D = 1$, meaning that there are no distortion in the price of deposits relative to that of labor. This can be tested from the null hypothesis $\theta_0 = \theta_f = \theta_p = \theta_{ro} = \theta_R = \theta_t = \theta_{ft} = \theta_{pt} = \theta_{rot} = \theta_{Rt} = 0$.

H2. θ_D is not affected by required reserves and is time-invariant but varies across ownership types. This can be tested from the null hypothesis $\theta_R = \theta_t = \theta_{ft} = \theta_{pt} = \theta_{rot} = \theta_{Rt} = 0$.

H3. θ_D is affected by required reserves and varies across ownership types but it is time invariant, i.e., $\theta_t = \theta_{ft} = \theta_{pt} = \theta_{rot} = \theta_{Rt} = 0$.

H4. θ_D is not affected by required reserves and does not vary across ownership types but it varies over time, i.e., $\theta_f = \theta_p = \theta_{ro} = \theta_R = \theta_{ft} = \theta_{pt} = \theta_{rot} = \theta_{Rt} = 0$

H5. θ_D is affected by required reserves and does not vary across ownership types and does not vary over time, i.e., $\theta_0 = \theta_f = \theta_p = \theta_{ro} = \theta_t = \theta_{ft} = \theta_{pt} = \theta_{rot} = 0$

Our data rejects each and every one of the above hypotheses using a likelihood ratio test at the 1% level of significance. This suggests that some regulation had distortionary effects and that these effects vary over time and across ownership types. Using the parameters reported in *Table 5* we computed the value of the distortion function θ_D and the cost of these distortions, which we also report in *Table 5*. We normalized the theta parameter to unity for the first year of the sample. The median value of the distortion function is greater than unity for the entire period, which implies that the effective (shadow) price of deposits relative to labor was greater than their observed counterparts. These results are consistent with the economic theory that suggests that regulation acts as a tax and increases the effective price of inputs on which the tax is levied. A value of the distortion function greater than one also suggests that because of these distortions the banks underused deposits relative to labor, and that the enhanced regulation had a negative effect on the quantity of financial intermediation performed by the Romanian banks. Moreover, the statistically significant positive parameter associated with required reserves (θ_R) in *Table 5* shows that there is a positive association between required reserves and the wedge between the effective and observed prices. *Table 5* reports a sharp increase in distortions in 2000, which coincides with the largest increase in the required reserves for deposits for the period studied. It is worth mentioning that the distortion parameter estimate is a result of all binding regulatory constraints including required reserves, deposits insurance fees, etc. The estimated parameters corresponding to the ownership types, viz., $\theta_f, \theta_{ft}, \theta_p$, θ_{pt}, θ_{ro}, θ_{rot} show that the foreign banks and representative offices were less affected by regulation than the state-owned banks; and that in the case of foreign banks this difference was increasing over time. They also show that domestic private banks were more affected by these distortions than state-owned banks but no significant change over time is apparent. These differences across ownership type might be the result of a larger share of deposits in domestic currency held by state-owned and private domestic banks and a better management of the input mix used by foreign banks. The median percentage increase in cost due to allocative distortions, reported in *Table 5,* shows that the effective cost is increased up to 25 percent depending on the magnitude of the price distortions. For example, as the central bank increased the average required reserves from 18.8% to 30.0% in 2000, the cost of the price distortions increased by 9.6 percentage points.

6. Conclusions

In this paper we estimate cost of technical inefficiencies and the cost of regulation induced distortions in resource allocation. We use a mixture of the shadow price model and the stochastic frontier approach. In defining bank outputs, we use an intermediation approach in the sense of banks collecting deposits to create loan services. The technical inefficiency is specified as a function of a series of bank-specific, regulation and macroeconomic variables and the distortions are a function of proxies for regulation, ownership type and time trend. We find that the “one-size-fits-all” type of regulation imposed significant constraints on banks, limiting the quantity of financial intermediation while the early restructuring or closure of inefficient banks is a more efficient policy instrument. The restructuring of the problem banks was more successful in reducing technical inefficiencies while increasing of distortionary regulation had little effect on decreasing the bank inefficiencies. The extent of distortion is positively correlated with the proxy for regulation, required reserve ratio. The effective cost of interest increases up to 25 percent depending on the magnitude of the price distortions.

We conclude that the evidence for the Romanian banking system shows that the "one-size-fits-all" type of regulation aimed at stabilizing the banking industry is less effective than customized supervision and early restructuring. The restructure of the inefficient banks contributes to a greater extent to the stability of the industry with positive results on bank performance. As Mishkin (2000) points out, a more effective policy would be a move away from the rule-based prudential supervision, "the regulatory approach", towards a more forward-looking "supervisory approach". Regulators should focus less on compliance with specific regulatory rules and more on assessing the soundness of management practices with regard to controlling the risk, even in the context of a transition economy such as Romania.

References

Aigner, D.J., Lovell, C. A. K., Schmidt, P., 1977. Formulation and Estimation of Stochastic Frontier Production Function Models. Journal of Econometrics 6:1, pp. 21--37.

Atkinson S. E., Halvorsen, R., 1984. Parametric Efficiency Tests, Economies of Scale and Input Demand in U.S. Electric Power Generation. International Economic Review 25:3, pp. 647 -- 662.

Bauer P.W., Berger, A.N., Humphrey, D.B., 1993. Efficiency and Productivity Growth in U.S. Banking, in The Measurement of Productive Efficiency: Techniques and Applications, edited by H.O. Fried, C.A. K. Lovell, and S.S. Schmidt, pp. 386 -- 413. Oxford: Oxford University Press.

Berger, A.N., Hanweck, G.A. and Humphrey, D.B., 1987. Competitive Viability in Banking: Scale, Scope and Product Mix Economies. Journal of Monetary Economics 20, pp. 501 -- 520.

Berger, A.N., Herring, R.J., Szego, G.P., 1995. The role of capital in financial institutions. Journal of Banking and Finance 19, pp. 393 -- 430.

Berger, A.N., Humphrey, D. B., 1997. Efficiency of Financial Institutions: International Survey and Directions for Future Research. European Journal of Operational Research 98, pp. 175--212.

Berger, A. N., Mester, L.J., 2001. Explaining the dramatic changes in Performance of U.S. Banks: Technological Change, Deregulation, and Dynamic Changes in Competition. Working Paper, University of Pennsylvania.

Bonin, J. P., Hasan, I., Wachtel, P., 2005. Bank performance, efficiency and ownership in transition countries. Journal of Banking and Finance 29, pp. 31 -- 53.

Farrell, M. J., 1957. The Measurement of Productive Efficiency. Journal of the Royal Statistical Society, Series A, General, 120, Part 3, 253--81.

Fixler, D. J., Zieschang, K.D., 1991. Measuring the Nominal Value of Financial Services in the National Income Accounts. Economic Inquiry 29 (January): pp. 53 – 68.

Fries, S., Taci, A., 2005. Cost efficiency of banks in transition: evidence from 289 banks in 15 post-communist countries. Journal of Banking and Finance 29, pp. 55-- 81.

Grigorian, D., Manole, V., 2002. Determinants of commercial bank performance in transition: An application of data envelopment analysis. World Bank Policy Research Working Paper, 2850.

Hannan, T. H., Hanwek, G.A., 1988. Bank Insolvency Risk and the Market for Large Certificates of Deposit. Journal of Money, Credit and Banking, May, pp. 203--211.

Hancock, D. 1985. The Financial Firm: Production with Monetary and Nonmonetary Goods. Journal of Political Economy 93:859-80.

Hasan, I., Marton, K, 2002. Development and efficiency of the banking sector in a transitional economy: Hungarian experience. Journal of Banking and Finance 27, pp. 2249--2271.

Humphrey, D.B. , Pulley, L.B., 1997. Banks' responses to Deregulation: Profits, technology, and Efficiency. Journal of Money, Credit and Banking 29, pp. 73--93.

Johnston, B. R., Pazarbasioglu, C., 1995. Linkages Between Financial Variables, Financial Sector Reform, And Economic Growth And Efficiency. Working paper, Wp/95/103, International Monetary Fund, Washington, D.C.

Kumbhakar, S. C., 1996. Efficiency Measurement with Multiple Outputs and Multiple Inputs, Journal of Productivity Analysis 7, pp. 225--255.

Kumbhakar, S.C., Lovell, C.A.K., 2000. Stochastic Production Frontier. Cambridge University Press.

Kumbhakar, S.C., Sarkar, S., 2003. Deregulation, Ownership, and efficiency Change in Indian banking: An Application of Stochastic Frontier Analysis. Journal of Money Credit and Banking 35, 3, pg. 403 -- 424.

Lau, L.J., Yotopolous, P.A., 1971. A Test for Relative Efficiency and Application to Indian Agriculture. American Economic Review 61:1, pp. 94 -- 109.

Meeusen, W., Van den Broeck, J., 1977. Efficiency Estimation From Cobb-Douglas Production Functions with Composed Error. International Economic Review 8, pp. 435 -- 444.

Mishkin, Frederic, S., 2000. Prudential Supervision: Why is it Important and What are the Issues. NBER Working paper 7926.

Sealey, C.W. and Lindley, J.T., 1977. Inputs, Outputs, and a Theory of Production and Cost at Depository Financial Institutions. Journal of Finance 32, No.4.

Wang, H.J., 2002. Heteroscedasticity and Non-Monotonic Efficiency Effects of a Stochastic Frontier Model. Journal of Productivity Analysis 18(3), pp. 241 -- 253.

Yildirim, H.S., Philippatos, G. C., 2002. Efficiency of banks: recent evidence from transition economies of Europe, 1993 – 2003, Unpublished paper, University of Tennessee.

Yotopolous, P.A., Lau, L.J., 1973. A Test for Relative Economic Efficiency: Some Further Results. American Economic Review 63:1, pp. 214 -- 223.

***Table 1** – Composition of Romanian Banking System*

VARIABLE	Units	1994	1995	1996	1997	1998	1999	2000	2001	2002
SIZE AND COMPOSITION										
Number of Banks	**#**	**20**	**27**	**30**	**38**	**40**	**39**	**38**	**38**	**35**
- state-owned	*#*	*7*	*7*	*7*	*7*	*7*	*4*	*4*	*3*	*3*
- private	*#*	*4*	*8*	*8*	*12*	*12*	*10*	*7*	*5*	*4*
- foreign	*#*	*9*	*12*	*15*	*19*	*21*	*25*	*27*	*30*	*28*
Total Assets	**bil. usd**	**10.6**	**11.3**	**12.5**	**10.8**	**12.0**	**9.2**	**9.0**	**10.8**	**13.6**
- state-owned	*%*	*78.4*	*75.5*	*75.9*	*73.5*	*71.9*	*47.1*	*46.2*	*42.2*	*41.6*
- private	*%*	*15.5*	*16.0*	*12.9*	*9.3*	*9.1*	*5.6*	*2.9*	*2.8*	*3.3*
- foreign	*%*	*6.1*	*8.5*	*11.2*	*17.2*	*19.0*	*47.3*	*50.9*	*55.0*	*55.1*

***Table 2** – Selected Statistics of Romanian Banking System*

VARIABLE	Units	1994	1995	1996	1997	1998	1999	2000	2001	2002
COST FUNCTION VARIABLES (median values)										
Real Interest and Labor Cost (COST)	**mil. rol /cpi**	**198**	**98**	**185**	**342**	**924**	**1,086**	**1,215**	**1,476**	**2,110**
Outputs										
Real Loans (L)	mil. rol /cpi	264	514	774	674	1,314	2,366	3,972	5,998	15,819
Real Portfolio Investment (I)	mil. rol /cpi	3	3	4	114	271	381	420	1,155	1,342
Real Income from Fees and Commissions (F)	mil. rol /cpi	43	52	70	74	77	100	155	273	567
Number of Branches (B)	#	1	2	5	5	7	7	8	10	16
Quasi-Inputs										
Real Other Cost (O)	bil. rol /cpi	12.6	6.0	23.8	37.4	89.7	190	313	454	465
Real Share Capital (K)	bil. rol /cpi	11.1	12.7	15.0	15.0	30.0	44	67	128	170
Real Property and Equipment (A)	bil. rol /cpi	8.4	8.8	15.1	25.0	50.5	77	150	254	400
Price of Inputs										
Price of Deposits (W_D)	%	15.7	10.5	16.1	16.0	16.6	15.2	10.8	5.9	5.2
Real Price of Labor (W_L)	thu. rol /cpi	42	80	142	237	629	1,078	1,843	2,588	3,483
CAMPL score and selected components of CAMPL score (median values)										
CAMPL score	**1-5**	**2.1**	**2.3**	**2.4**	**2.3**	**2.1**	**2.1**	**2.3**	**2.4**	**2.3**

VARIABLE	Units	1994	1995	1996	1997	1998	1999	2000	2001	2002
Capital Adequacy										
Median Solvency Ratio 1	%	6.8	5.4	14.4	18.2	42.8	39.2	38.7	42.5	35.0
Industry Solvency Ratio 1	*%*	*5.1*	*-1.8*	*2.0*	*2.2*	*17.3*	*18.8*	*26.3*	*34.4*	*33.9*
Asset Quality										
Median General Risk Ratio	%	21.7	49.9	42.2	35.4	36.8	35.4	38.8	49.2	51.8
Median Overdue Loans to Total Loans Ratio	%	-	3.4	5.3	5.8	4.3	2.4	0.8	1.1	0.3
Management										
Median Probability of Insolvency	%	21.5	26.9	21.0	62.4	28.0	40.6	29.5	31.4	21.2
Profitability										
Median ROA	%	3.0	5.1	3.6	4.0	3.2	2.4	1.7	2.5	2.8
Median ROE	%	29.5	38.9	33.8	31.6	19.5	16.3	12.8	15.0	14.0
Liquidity										
Median Immediate Liquidity Ratio	%	75.0	45.0	21.4	55.0	50.0	53.9	53.0	8.4	10.5

Notes. The above statistics do not include the data for the first year of activity of all banks and banks with fewer than three observations. A CAMPL score of one describes a bank in strong financial standing. Solvency Ratio 1 (legal limit ≥ 12%) = Total risk-based capital (own funds) / Risk-weighted assets. Core Capital (Tier-1) consists of common shareholders equity, perpetual preferred shareholders equity with non-cumulative dividends, retained earnings, and minority interests in the equity accounts of consolidated subsidiaries. Supplementary Capital (Tier-2) consists of subordinate debt, intermediate-term preferred stock, cumulative perpetual, long-term and convertible preferred stock, perpetual debt and other hybrid debt/equity instruments and a proportion of the bank's allowance for loan and lease losses (general reserves only). Deductions from total capital consist of investments in unconsolidated banking and finance subsidiaries, reciprocal holdings of capital securities, and other deductions as determined by supervisory authority with handling on a case-by-case basis or as matter of policy after formal rulemaking. Total risk-based capital = Tier-1 + Tier-2 – Deductions. Due to the lack of more detailed data we constructed the Risk-Weighted Assets[11] variable based on the following risk category and weights: (1) cash and equivalents, zero percent, (2) portfolio investment: securities and government T-bills, fifty percent and (3) loans, one hundred percent. The total of Tier-2 capital is limited to 100 percent of Tier-1 capital. ROE = return on equity. ROE = Net profit / Own capital. General Risk Ratio = Risk-weighted assets / Total assets (book value, including off-balance sheet elements). For probability of insolvency see Appendix 1. Return on assets (ROA) = Net profit / Total assets. Immediate liquidity = Demand and time deposits of banks at other financial institutions / Attracted and borrowed sources.

[11] In defining these variables we used the regulations set by the NBR in Norm 8/1999.

Table 3 – *Cost of Technical Inefficiency (%)*

Year	***All banks***	***State-owned***	***Domestic private***	***Foreign***	***Representative Offices***
1994	12.42	8.86	10.88	13.92	13.27
1995	7.81	5.58	11.25	8.61	14.91
1996	9.20	6.68	11.19	10.06	13.89
1997	20.76	19.00	21.66	26.98	15.26
1998	35.19	24.75	47.00	40.63	9.10
1999	32.69	56.82	50.99	32.69	7.96
2000	15.12	32.02	23.40	16.81	4.52
2001	11.01	31.89	24.03	10.83	6.34
2002	12.71	11.76	37.12	13.49	6.14
Mean Cost of Technical Inefficiency (%)					
1994 - 2002	17.43	21.93	26.39	19.34	10.15
Pre 2000	19.68	20.28	25.49	22.15	12.40
Post 2000	12.94	25.22	28.18	13.71	5.67
Mean Cost of Technical Inefficiency after Hypothetical Restructuring (%)					
1994 - 2002	14.01	18.71	12.66	15.91	8.46

Notes: These values show in percentage terms by how much the actual cost is higher than the benchmark minimum cost. We report the median values of cost of technical inefficiencies in percentage terms for all banks in the sample and separately for each type of ownership. We calculated the mean of the values reported for each year for the entire period and separately for the pre-regulation and post-regulation period. The adjusted mean cost of technical inefficiency was calculated after re-estimating the model without the last two years of activity of the banks that were closed for bankruptcy.

Table 4 - *Marginal Effects of the Correlates of Technical Inefficiency*

Determinants of Technical Inefficiency	***Managerial Practices***	***Regulation Proxy***	***Macroeconomic Environment***
Ownership Type	*CAMPL Score*	*Required reserves*	*GDP growth rate*
State-owned	1.0479**	-0.0675	-0.3321
Domestic	0.2115*	-0.2477	-0.0555*
Foreign	0.0554	-0.1011	-0.0312
Representative Office	0.0514	-0.0563	-0.0374***

Note: These values have been calculated using equation (5) and the coefficients of the determinants of inefficiency. The interpretation of these values is similar to the interpretation of the OLS coefficients. Underlying coefficient statistically significant at 1% (***), at 5% (**) and at 10% (*), using a two-sided t-test.

Table 5 – *Coefficient Estimates, the Allocative Distortions Function and the Percentage Cost Increases due to Allocative Distortions*

Parameter	Estimate	Standard Error	Year	Allocative Distortion (θ_D)	Percentage Cost Increase	Average Required Reserves
θ_0	-0.3086**	0.1406	1994	1.00	0.00	10.00
θ_f	-0.1105***	0.0323	1995	1.19	1.63	7.81
θ_p	0.3073**	0.1349	1996	1.16	1.45	7.50
θ_{ro}	-0.0967***	0.0348	1997	1.11	0.74	8.75
θ_R	0.0149***	0.0025	1998	1.07	0.30	13.33
θ_t	-0.0342	0.0408	1999	1.17	1.79	18.75
θ_{ft}	0.2091***	0.0391	2000	1.58	15.05	30.00
θ_{pt}	-0.0238	0.0436	2001	1.80	24.51	28.00
θ_{rot}	0.1294**	0.0642	2002	1.76	22.84	22.08
θ_{Rt}	-0.0805***	0.0140				

Note: Coefficient statistically significant at 1% (***), at 5% (**) and at 10% (*), using a two-sided t-test. We report the coefficient estimates and standard errors for equation 1.6, the median computed values of the allocative distortions function, the median percentage cost increases due to allocative distortions and the mean required reserves for the demand deposits in local currency.

Appendix A: Major Regulatory and Related Developments in the Romanian Banking System

Year	Major change	Details
Until 1990	*One-tier banking system*	National Bank of Romania (NBR) plus 4 specialized banks: the Romanian Foreign Trade Bank, the Investment Bank (which financed long-term projects), the Bank for Agriculture and Food Industry, and the Savings Bank (CEC). Also 860 Credit Unions and 4 foreign banks.
1991	*Basic institutional framework and structural regulation for two-tier banking system.*	Domestic banks as well as foreign banks and subsidiaries of foreign banks are licensed to function as universal banks. No restrictions of entry of sound domestic and foreign banks. The NBR is the supervisory authority of banking. The commercial activities of the NBR are transferred to the Romanian Commercial Bank (BCR).
1992	*Setting up the basic conduct and prudential regulation*	Required capital is set to the equivalent of ECU 5 million. Banks are required to set up reserve accounts at the central bank. Restricts connected lending and sets limits on the exposure to a single borrower. No limitations on lending and deposits interest rates or fee restriction. No restriction in branch expansion.
1993		Bans equity investments of state-owned companies and *regies autonomes* in banks.
1994		Restricts bank activity in the capital markets
1995	*Bankruptcy procedures for all types of enterprises*	Details the judicial reorganization procedures and allows the NBR to withdraw the license of insolvent banks.
1996	*Bankruptcy procedure for banks*	Banks which stop payments are subject to the recovery and judicial liquidation proceedings, while the banks whose licenses have been withdrawn by the NBR will begin the liquidation procedure.
	Set up the Bank Deposit Guarantee Fund	All banks are required to insure their deposits. The Fund changes the limit every year to keep up with inflation. 15 July – 24 august 1999 the Bank Deposit Guarantee Fund made first payments since its set-up.
	NBR - lender of last resort	The NBR can lend troubled banks to accommodate request of individual withdrawals to a specific limit.
1997	*Privatization law for state-owned banks*	It is carry out either by (1) increase in capital through the sales of shares through public offering or from direct purchase, (2) sale of shares held by the State Ownership Fund and (3) a mix of the two methods.
	Refining of prudential regulation	Calculation formula for own funds. Own funds are used in calculation the required solvency ratios.
1998	*Major policy shift*	Independence and increased supervision powers of the central bank.
	New capital requirements	The NBR raises capital adequacy requirements to 12% and regulates off-balance sheet activities.
	Bank Asset Recovery Agency	Legal framework for the recovery of some non-performing assets on the balance sheets of state–owned banks.
1999	*Tightening of prudential regulation, capital requirements and supervision*	Banks are required to calculate the amount of own funds on a monthly basis and submit the forms to the Supervision Department at the NBR. Financial reports are designed to help detect insolvent banks and serve as a trigger for bankruptcy procedures. The NBR monitors the solvency, large exposures and connected loans. It specifies the calculation procedure of selected indicators and sets their upper and lower bounds for supervision purposes.
	Credit Risk Information Bureau (CRIB) and Early Warning System	CRIB collects and disseminates information of bank debtors. Started operations in 2000. Early Warning System uses a variant of CAMEL bank-rating system to identify potential financial problems.
2000	*Refining prudential regulation*	Classification of loans based on the degree of risk. Changes the conditions for provisioning for credit risk. Specifies the coefficients assigned to each risk category of credit and the provisioning for each category.
	Regulation of new operations	Mortgage loans regulation. Mergers and acquisition. Settlement of interbank operation for bankruptcies.
2001	*Refining of prudential regulation*	New liquidity ratio requirements. Changes to exposure limits and calculations of solvency ratio
2002		Changes to classifications of credit risk.
	Regulation of new operations	Regulates the types of operations with derivatives. Requires banks to collect a database about their clientele in order to better assess risks.

Appendix B: Maximum Likelihood Estimates of the Translog Cost Function

Parameter	Estimate	Std. Error	Parameter	Estimate	Std. Error
a_1	0.99984***	0.0002	α_{FC}	0.13625***	0.0531
α_0	8.79035***	2.4730	α_{FA}	-0.01093	0.0483
α_{LI}	0.64147**	0.3252	α_{FK}	-0.01044	0.0116
α_F	-0.71238*	0.3710	α_{BC}	0.04337	0.0342
α_B	-0.31085	0.3530	α_{BA}	0.00778	0.0370
β_D	0.61622***	0.0731	α_{BK}	-0.01176	0.0073
γ_C	0.56938	0.4536	α_{LIT}	-0.01927	0.0263
γ_A	-0.05084	0.3718	α_{FT}	-0.04532	0.0364
γ_K	-0.29217***	0.1028	α_{BT}	-0.03246	0.0220
β_t	-0.03780	0.3534	β_{CD}	0.03782***	0.0053
α_{LILI}	0.01787	0.0364	β_{AD}	-0.00674**	0.0034
α_{LIF}	-0.00011	0.0343	β_{KD}	-0.01277***	0.0011
α_{LIB}	-0.09622***	0.0355	β_{DT}	0.02316***	0.0056
α_{FF}	-0.07855*	0.0474	γ_{CT}	0.12408***	0.0363
α_{FB}	0.08211*	0.0446	γ_{AT}	-0.01871	0.0292
α_{BB}	-0.00376	0.0291	γ_{KT}	0.00196	0.0085
β_{DD}	0.09570***	0.0048	*reg_Y*	-0.58951***	0.2037
γ_{CC}	-0.22595***	0.0757	$\delta_{S\text{-}CAMPL}$	1.89424**	0.9000
γ_{CA}	0.03933	0.0427	$\delta_{D\text{-}CAMPL}$	0.38227*	0.2099
γ_{CK}	-0.01135	0.0122	$\delta_{F\text{-}CAMPL}$	0.10020	0.1585
γ_{AA}	0.00573	0.0109	$\delta_{R\text{-}CAMPL}$	0.09289	0.0774
γ_{AK}	0.01484	0.0110	$\delta_{S\text{-}REQ\text{-}RES}$	-0.12208	0.3525
γ_{KK}	-0.00104	0.0089	$\delta_{D\text{-}REQ\text{-}RES}$	-0.44787	0.2401
β_{tt}	-0.02804	0.0384	$\delta_{F\text{-}REQ\text{-}RES}$	-0.18280	0.1777
α_{LID}	0.04682***	0.0036	$\delta_{R\text{-}REQ\text{-}RES}$	-0.10169	0.1031
α_{FD}	-0.01070***	0.0025	$\delta_{S\text{-}GDP}$	-0.06003	0.0431
α_{BD}	-0.02469***	0.0048	$\delta_{D\text{-}GDP}$	-0.10028**	0.0415
α_{LIC}	0.03443	0.0514	$\delta_{F\text{-}GDP}$	-0.05635	0.0415
α_{LIA}	-0.03809	0.0449	$\delta_{R\text{-}GDP}$	-0.06767***	0.0213
α_{LIK}	0.01603*	0.0087			

Note: Coefficient statistically significant at 1% (***), at 5% (**) and at 10% (*), using a two-sided t-test. The following subscripts are corresponding to the following output variables: (LI) - the hedonic aggregation of loans and portfolio investment, (F) – fee income, (B) – number of branches; price of inputs: (D) price of deposits relative to price of labor; quasi-fixed inputs: (C) – other operating costs, (A) – fixed assets, (K) – share capital; time – (t). We assume that the mean of lambda in equation (4) is a function of twelve variables labeled determinants of inefficiency: CAMPL score, required reserves and GDP growth rate for each ownership type. Delta-parameters are associated with these determinants of inefficiency and are used in *Section V.1* to determine the marginal effect of the determinants of inefficiency.