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DETERMINANTS OF BANK EFFICIENCY: EVIDENCE FROM CZECH BANKING SECTOR

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Abstract

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The paper identifies bank-specific determinants of Czech commercial bank efficiency during the period 2000–2012. The paper employs a panel version of a stochastic efficiency frontier model with time variant efficiency to identify the impact of bank size and the structure of bank's portfolio on the bank's cost and profit efficiency. The results of the estimation show that bank size has no impact on cost efficiency but it negatively influences the bank's ability to generate revenue. Cost efficiency increases with deposit-to-assets ratio and profit efficiency increases with loans-to-assets ratio. During the examined period average bank lost one fourth of its profit compared to best-practice bank.

Keywords: stochastic frontier analysis, Czech banking sector, cost efficiency, profit efficiency

INTRODUCTION

The paper provides contribution to the literature that identifies possible factors explaining the observed differences of efficiency between banks. The aim of the paper is to identify bank-specific determinants of cost and profit efficiency of banks in Czech Republic during the period 2000–2012. This problem can be of particular interest not only to academics but also to regulators as well as bank's management. For example regulators can be interested if large banks are more efficient than small banks or how does the composition of bank's portfolio influences efficiency. Banking industry plays a prominent role in Czech financial market. Therefore Czech banks are relevant source of investigation as a model of bank-based financial system.

The investigation of bank efficiency has fueled a large body of literature in recent years. Majority of bank efficiency studies address the question of cost and profit efficiency estimation. Minor part of the literature tries to find some exogenous bank-specific variables which could explain some of the differences in the efficiencies across banks. The seminal paper by Berger and Mester (1997) provides estimation of cost and profit efficiency on the sample of U.S. commercial banks during period 1990–1995 and show that profit and cost efficiency are negatively correlated. This result implies that profit and cost inefficiency can be caused by different factors. They suggest that bank inefficiency can be explained by bank size, market characteristics and bank characteristics. They find that bank size and loans-to-assets ratio influences profit efficiency positively. Maudos *et al.* (2002) use two-stage stochastic frontier approach to find determinants of inefficiency on the sample of European banks during period 1993–1996. Their explanatory variables include size variables, specialization dummies and other bank characteristics. They find that medium sized banks and banks with higher loans-to-assets ratio were more cost and profit efficient. Kasman and Yildirin (2006) examine the efficiency of banks in eight Central and Eastern European countries that became new members of EU in 2004. They use one-stage stochastic frontier estimation and find that foreign-owned and larger banks are more cost and profit efficient. The result that foreign-owned banks were more efficient than domestic banks in post-communist countries during the transition is confirmed also by Fries and Taci (2005) and Weill (2003). Yildirin and Philippatos (2007) use a two-stage approach to estimate determinants of cost and profit efficiency in twelve countries from Central and Eastern Europe. They estimate efficiency score by stochastic frontier method as well as by data envelopment analysis and they find that efficiency is positively associated with size and equity level. They also find that foreign owned banks are more cost but less profit efficient.

Several papers are more closely related to the analysis of determinants of cost or profit efficiency of Czech banks. Andries and Cocris (2010) estimate cost inefficiency of Czech banks during period 2000–2006. The inefficiency estimates are then regressed on a set of variables including bank-specific variables. They find that cost efficiency is negatively influenced by non-performing loans. Pančurová and Lyócsa (2013) estimate cost and revenue inefficiency by data envelopment analysis on the sample of 11 Central and Eastern European countries over the period 2005–2008. They found that bank size increases both: cost and revenue efficiency. On the other hand, loans to assets ratio increases revenue efficiency but decreases cost efficiency. Stavárek and Řepková (2012) and Řepková (2013) come to a different conclusion. They find that large Czech banks perform worse than medium-sized and small banks. Řepková (2013) uses dynamic data envelopment analysis to estimate productive efficiency of Czech commercial banks during the period 2001–2011. The results of the analysis show that the three largest banks have the lowest efficiency score under the assumption of constant returns to scale technology. Similarly, Stavárek and Řepková (2012) show that efficiency of large Czech commercial banks is comparable with efficiency of small banks only if we assume that bank technology has decreasing returns to scale. As we can see, the evidence about the impact of bank size on efficiency of Czech banks is mixed. Also, there is a lack of studies investigating the impact of portfolio structure on bank inefficiency in Czech banking industry.

Therefore, the paper identifies bank-specific factors such as banks size, business strategy and portfolio structure that can explain observed differences of cost and profit efficiency between Czech banks. Concretely, the paper investigates the effect of bank size, bank specialization and composition of bank's portfolio on the cost and profit efficiency of Czech commercial banks. Estimation of both types of efficiency enables to decide whether the main inefficiency lies in the bank's inability to control its costs or create revenue.

The efficiency estimates are obtained by means of stochastic frontier analysis. A number of empirical studies investigate determinants of efficiency by regressing predicted inefficiency, obtained from estimated stochastic frontier, on some explanatory variables. There is, however inconsistency in this two-stage approach. In the first stage, the inefficiencies are assumed to be independently distributed, while in the second stage they are assumed to be a function of some explanatory variables. In order to avoid this inconsistency, the paper employs one-stage stochastic frontier approach proposed by Battese and Coeli (1995). This approach permits to estimate the time-varying and bank specific inefficiencies as well as determinants of inefficiency. Moreover, the paper incorporates equity level into the stochastic frontier estimation in order to control for different risk position taken by each bank.

METHODOLOGICAL ISSUES

Bank Efficiency Measures

The paper estimates two kinds of inefficiency: cost inefficiency and alternative profit inefficiency. The concept of cost inefficiency is derived from the common microeconomic cost minimization problem. Cost inefficiency therefore measures whether the bank incurs the least cost given the factor prices and output quantities. In order to estimate profit efficiency, the paper employs alternative profit efficiency concept introduced by Humphrey and Pulley (1997). Alternative profit efficiency concept is derived from the profit maximizing problem and it assumes that banks choose quantities on the input markets and prices on the output market. Alternative profit inefficiency then measures if the bank achieves the highest possible profit given the input prices and output quantities. The main advantage of the alternative profit efficiency over standard profit efficiency is lower data demand. Estimation of standard profit efficiency requires data on output prices which are rarely available. On the other hand, alternative profit inefficiency can be estimated using the same data as for an estimation of cost inefficiency, i.e. output quantities and input prices.

Inefficiency measures are estimated using the stochastic frontier analysis. Stochastic frontier approach specifies a functional form of the profit or cost efficiency frontier and allows for random error. The estimated profit or cost function is assumed to characterize the profit or cost function of the best-practice bank, while any inefficiency is captured in the error term. The bank is then labeled as profit inefficient if its profits are lower than those predicted for a best-practice bank and the difference cannot be explained by statistical noise. Main problem in measuring inefficiency is to separate inefficient behavior from random factors. In order to do this, the error term is assumed to be composed from random error component and component accounting for inefficiency. The stochastic alternative profit function in logarithmic transformation is then given by the following equation:

$$\ln(\Pi_{i,t} + c) = \ln f(w_{i,t}, y_{i,t}, k_{i,t}) + v_{i,t} - u_{i,t}, \tag{1}$$

where Π is observable profit and c is a constant added to every bank's profit so as natural logarithm to be taken from positive number. The term y is output vector, w is vector of input prices and k is equity. The term v represents random error, whereas

u represents inefficiency. Similarly the stochastic cost function model is given by equation (2).

$$\ln TC_{i,t} = \ln f(w_{i,t}, y_{i,t}, k_{i,t}) + v_{i,t} - u_{i,t}. \qquad (2)$$

All terms have the same meaning as before and TC represents actual total costs. In both cases, random error component and inefficiency component are separated by making explicit assumption about their distribution. It is assumed that u and v are independently distributed. Following Coelli *et al.* (2005) the random error v is assumed to be distributed as two-sided normal with zero mean and variance σ_v. Inefficiency term is assumed to have normal distribution truncated at zero with mean U and variance σ_u.

Note that both functions contain as a variable not only output quantities and input prices, but also equity. The level of equity is included to control for different risk preferences. Koetter (2008) lists two reasons why equity level should be included into the specification of efficiency frontier. First, banks with higher risk aversion will want to have higher level of financial equity than is optimal for risk neutral profit maximizing firm. If equity is not included, the inefficiency of more risk-averse banks will be overestimated. Second, equity captures also bank's insolvency risk. A bank's insolvency risk depends on the amount of equity available to absorb potential portfolio losses. Consider two otherwise identical banks that differ only in the level of equity holding. The bank with higher level of equity takes lower insolvency risk and should be considered as more profit efficient when generating the same profit.

The identification of the relationship between efficiency and explanatory variables is based on one-stage estimation procedure proposed by Battese and Coelli (1995). In one-stage model, the mean of inefficiency term is expressed as a linear function of bank-specific variables:

$$U_{i,t} = \delta_0 + \delta \cdot z_{i,t}, \qquad (3)$$

where z is a vector of firm-specific explanatory variables and δ is a vector of parameters to be estimated. The model is then estimated by maximum likelihood method. The log-likelihood function of the model can be found in Kumbhakkar and Lovell (2003).

Alternative profit efficiency (APE) is measured as a ratio of actual profits to the profits of a hypothetical best-practice bank.

$$APE = \frac{\Pi}{\exp(\ln f(w,y,k)+v)} =$$

$$= \frac{\exp(\ln f(w,y,k)+v-u)}{\exp(\ln f(w,y,k)+v)} = \exp(-u). \qquad (4)$$

As is obvious the value of alternative profit efficiency lies between 0 and 1. This measure has an appealing interpretation. The higher the value of alternative profit efficiency, the more efficient the bank is. If the value of alternative profit efficiency is equal to 1 than this indicates fully efficient bank. Moreover, the difference between 1 and alternative profit efficiency denotes the amount of profit that is not being earned compared to the maximum profit that could be earned if the bank were fully efficient. Cost efficiency (CE) is defined as a ratio of costs of best-practice bank to actual costs.

$$CE = \frac{\exp(\ln f(w,y,k)+v)}{TC} =$$

$$= \frac{\exp(\ln f(w,y,k)+v)}{\exp(\ln f(w,y,k)+v+u)} = \exp(-u). \qquad (5)$$

Again, the cost efficiency takes a value between 0 and 1. The cost efficiency states what percentage of actual costs would have been sufficient to produce actual output if the bank were fully efficient. Therefore, the value of 1 indicates fully efficient bank. The difference between 1 and cost efficiency represents costs that are wasted.

MODEL AND DATA

Next step in the formulation of the model is to define inputs and outputs of the banking firm. The paper adopts the intermediation approach which assumes that the main activity of a bank is to transform liabilities into loans and securities. From the perspective of the intermediation approach bank produces two kinds of outputs (loans and investment assets) using two kinds of inputs (loanable funds and aggregate of labor and physical capital). Input prices, that enter the estimation of cost and profit efficiency function, are approximated in the following way: price of loanable funds is calculated by dividing interest expenses by liabilities; price of labor and physical capital is calculated by dividing operating cost by total assets.

The dataset used in this paper includes data from 14 Czech commercial banks and it covers the period from the year 2000 to the year 2012. The data sample includes only commercial banks that are operating as independent legal units. The dataset comes from balance sheets and income statements reported in publicly available annual reports. All the data is reported on an unconsolidated basis. The estimation methodology does not require a bank to have existed throughout the whole period to be included in the sample. Because the number of bank varies and some data are not available, there are in fact 158 observations. Tab. I reports definition, mean, standard deviations and median of variables in alternative profit and cost function. The stationarity of panel data was tested by Maddala-Wu test that combines p-values for a unit root test in each cross-section (Maddala and Wu (1999)). The null hypothesis that the data are non-stationarity

I: *Descriptive statistics of variables*

Variable		Median	Mean	Standard deviation
Total Profit (mil. CZK)	Π	496	2697	4507
Total Cost (mil. CZK)	TC	2353	9234	15293
Price of funds (total interest expenses/total funds)	w_1	0.0202	0.0236	0.0142
Price of labor and physical capital (operating cost/total assets)	w_2	0.0204	0.0236	0.0171
The value of total loans (mil. CZK)	y_1	29487	72336	91318
The value of total securities (mil. CZK)	y_2	2548	35808	84302
The value of equity (mil. CZK)	k	3529	12619	16760

Source: Calculation based on bank's annual reports

can be rejected according to this test as the p-value is less than 0.001.

The stochastic frontier is estimated using translog specification of alternative profit and cost function. Translog specification is sufficiently flexible form to accommodate data. Koetter (2008) shows that less flexible specification, such as Cobb-Douglas form, impose a substantial structure on the data and do not approximate them well. Moreover, Berger and Mester (1997) find that functions more flexible than translog function improve the fit of the model only very small. The translog specification of alternative profit function that is estimated is given by equation (6).

$$\ln(\Pi+\Pi^{\min}+1)=\alpha+\sum_{i=1}^{2}\beta_i\cdot\ln w_i+\frac{1}{2}\sum_{i=1}^{2}\sum_{j=1}^{2}\beta_{ij}\cdot\ln w_i\cdot\ln w_j+$$
$$+\sum_{i=1}^{2}\gamma_i\cdot\ln w_i+\frac{1}{2}\sum_{i=1}^{2}\sum_{j=1}^{2}\gamma_{ij}\cdot\ln y_i\cdot\ln y_j+\frac{1}{2}\sum_{i=1}^{2}\sum_{j=1}^{2}\rho_{ij}\cdot\ln y_i\cdot\ln w_j+$$
$$+\tau_1\cdot\ln k+\frac{1}{2}\tau_2\cdot\ln k+\sum_{i=1}^{2}\mu_i\cdot\ln w_i\cdot\ln k+\sum_{i=1}^{2}\varepsilon_i\cdot\ln y_i\cdot\ln k+v-u. \quad (6)$$

In the alternative profit function we add to each individual profit the constant which is given by maximum loss plus one. This ensures that the transformed variable is of positive value. Further, the translog specification imposes is a symmetry restriction which is given by the following condition.

$$\beta_{ij}=\beta_{ji},\ \gamma_{ij}=\gamma_{ji}. \quad (7)$$

Similarly, the translog specification of the estimated cost function is given by the equation (8).

$$\ln TC=\alpha+\sum_{i=1}^{2}\beta_i\cdot\ln w_i+\frac{1}{2}\sum_{i=1}^{2}\sum_{j=1}^{2}\beta_{ij}\cdot\ln w_i\cdot\ln w_j+$$
$$+\sum_{i=1}^{2}\gamma_i\cdot\ln w_i+\frac{1}{2}\sum_{i=1}^{2}\sum_{j=1}^{2}\gamma_{ij}\cdot\ln y_i\cdot\ln y_j+\frac{1}{2}\sum_{i=1}^{2}\sum_{j=1}^{2}\rho_{ij}\cdot\ln y_i\cdot\ln w_j+$$
$$+\tau_1\cdot\ln k+\frac{1}{2}\tau_2\cdot\ln k+\sum_{i=1}^{2}\mu_i\cdot\ln w_i\cdot\ln k+\sum_{i=1}^{2}\varepsilon_i\cdot\ln y_i\cdot\ln k+v+u. \quad (8)$$

Translog specification imposes two restrictions on the cost function: symmetry restriction (7) and restriction of linear homogeneity in input prices (9). The linear homogeneity restrictions are imposed by normalizing all factor prices and dependent variable by one factor price, namely by w_2.

$$\sum_{i=1}^{2}\alpha_i=1,\ \sum_{i=1}^{2}\sum_{j=1}^{2}\beta_{ij}=0,\ \sum_{i=1}^{2}\rho_i=0,\ \sum_{i=1}^{2}\mu_i=0. \quad (9)$$

Last part of the model specifies the relationship between efficiency estimates and firm-specific factors which may explain the differences in bank efficiency. Previous studies isolated three groups of potential correlates: bank-specific characteristics, market characteristics and regulatory characteristics. Due to the nature of the data, this paper focuses on bank-specific explanatory variables only. The relationship between bank-specific variables and the mean of inefficiency is given by equation (10).

$$U=\delta_0+\delta_1\cdot LARGE+\delta_2\cdot MEDIUM+\delta_3\cdot L/A+$$
$$+\delta_4\cdot D/A+\delta_5\cdot MORT. \quad (10)$$

Explanatory variables included in equation (10) can be divided into three groups: size, portfolio composition and specialization.

The size of each bank is measured by total assets. However, in order to allow for non-linearity and non-monotonicity in the relationship between bank size and inefficiency, dummy variables are used. The equation contains dummy variable LARGE for large bank and a dummy variable MEDIUM for a medium-sized bank. A bank with a total assets of 200 billion CZK or more is considered as a large bank. Medium-sized bank is a bank holding total assets of 40 billion to 200 billion CZK. There are at least two reasons why bank size can be correlated with bank's cost as well as profit efficiency. First, there can be economies of scale in banking industry due to banking technology. If banking technology exhibits increasing economies of scale, then larger bank will be more cost efficient. Second, bank size can affect bank's cost and profit efficiency due to diversification effect. As a bank's scale increases, the portfolio of a bank may become better diversified. Better diversification can be correlated with higher cost and profit efficiency.

One of the main characteristic specific to each bank is portfolio composition. Therefore, the loans-to-total assets ratio (L/A) and deposits-to-assets ratio (D/A) are included among explanatory variables. If higher profit efficiency is associated with higher loan-to-assets ratio, then this indicates that loans are more profitable than securities or banks have higher market power in loan market compared to other markets at which they operate. Also the bank's reliance on deposits or purchased funds can be related to the cost or profit efficiency because the price of deposits and purchased funds differ. If the price of deposits is lower, we can expect that banks with higher deposits to assets (D/A) ratio will be more cost and profit efficient.

The data sample includes universal and specialized mortgage banks. Dummy variable MORT is used to distinguish between universal and mortgage banks. It takes the value 1 if the bank is mortgage bank and 0 otherwise. There are two mortgage banks in the sample as these are included in the sample for the whole period, nearly one sixth of observations comes from mortgage banks. There are theoretical arguments for higher effectivity of universal as well as mortgage banks. Universal banks can be more efficient because of economies of scope. Banking industry is characterized by searching and monitoring information and universal banks can gain information advantage by offering checking account to potential borrowers. Consequently, universal banks can employ accumulated information to achieve economies of scope which makes them more profit and cost efficient. On the other hand, mortgage banks can be more efficient because of specialization.

RESULTS

Tab. II reports average values of cost efficiency and profit efficiency for the whole sample and for different bank types. In addition, Tab. II reports estimation of total standard deviation $\sigma^2 = \sigma_v^2 + \sigma_u^2$ and ratio of standard deviation due to inefficiency over total standard deviation $\lambda = {\sigma_u}^2/(\sigma_v^2 + \sigma_u^2)$. Notice that parameter λ is in both cases very close to 1 which means that nearly all deviations from the efficiency frontier are due to inefficiency and not due to noise. Therefore, we can reject the hypothesis that inefficiency effects are absent from the model.

The average cost efficiency for Czech banks is 0.74, which implies that average bank wasted nearly 26% of its costs compared to a best-practice bank. It is worth noting that this level of cost inefficiency is similar to previous international studies on bank efficiency. For example, Altunbas *et al.* (2001) state that the average cost efficiency of European banks between years 1989 and 1997 was from 0.75 to 0.8. We can observe important differences in cost efficiency between different types of banks. The cost efficiency of large banks is 0.67, which is significantly less than the efficiency of medium and small banks.

The average alternative profit efficiency takes a value of 0.74. This result implies that average bank lost approximately one fourth of profits due to inefficiency. The alternative profit efficiency estimates are approximately the same as cost efficiency which raises question whether the profit inefficiency is not caused only on the cost side. Correlation between cost and profit efficiency is 0.31, which suggests that cost inefficiency is not the only source of profit inefficiency and there are another important inefficiencies on the revenue side. We can also see that small banks are more profit efficient than medium-sized banks and these are more profit efficient than large banks. The results also suggest that mortgage banks are more cost and profit efficient than universal banks. Recall, however, that there are just two mortgage banks included in the sample. Therefore, this result has to be taken cautiously as it is possible to explain this result by some different unobserved characteristics which makes these two banks systematically more efficient.

The development of efficiency scores is reported in Tab. III. We can see that cost efficiency is increasing during the period. Cost efficiency scores, and consequently also profit efficiency scores, were exceptionally low in years 2000 and 2001. This can be explained by the fact that Czech banks were privatized in these years and new managers and owners needed some time to adapt to the environment. Another reason for low efficiency

II: *Efficiency estimates*

	Cost efficiency		Profit efficiency	
Mean efficiency	0.74		0.74	
Mean efficiency – large	0.67		0.64	
Mean efficiency – medium	0.79		0.74	
Mean efficiency – small	0.76		0.81	
Mean efficiency – mortgage	0.95		0.84	
	Coefficient	**Standard error**	**Coefficient**	**Standard error**
λ	0.92***	0.03	0.99***	$0.9 \cdot 10^{-7}$
σ^2	0.17***	0.03	1.79***	0.15

*** denotes 1% significance level
Source: Author's estimate

III: *Development of efficiency*

Year	Average cost efficiency	Average profit efficiency
2000	0.41	0.64
2001	0.47	0.69
2002	0.62	0.80
2003	0.67	0.84
2004	0.77	0.83
2005	0.77	0.78
2006	0.81	0.81
2007	0.82	0.81
2008	0.82	0.75
2009	0.78	0.68
2010	0.79	0.68
2011	0.79	0.67
2012	0.84	0.68

Source: Author's estimate.

scores from the beginning of the century can be found in high share of non-performing loans. According to the Czech National Bank the share of non-performing loans in Czech banking sector was 32% at the beginning of the year 2000 and it declined to 21% at the beginning of the year 2002. The explanation that high share of non-performing loans causes cost inefficiency is in accordance with the findings of Andries and Cocris (2010). Average profit efficiency scores were particularly stable in the period 2002–2008 but it declined in the year 2009 and remained low until the end of the period. It is possible to speculate that this development is a result of the financial crisis.

Tab. IV shows the result of the estimation of equation (10), i.e. it shows the relationship between inefficiency mean and bank characteristics. Note, that positive value of the coefficient indicates that the variable is negatively associated with efficiency. On the other hand, negative value of the coefficient means that the explanatory variable is positively associated with efficiency.

The coefficients on bank size (Large, Medium) are not significant except the profit efficiency coefficient for large banks. This result indicates that there are no economies of scale in Czech banking industry because size does not bear any relationship to cost efficiency after controlling for other factors. Regarding profit efficiency, there is no significant difference between small and medium-sized banks, but large banks are less profit efficient. Because large banks are not cost inefficient, the source of their profit inefficiency has to rest on the revenue side. Although this finding is quite rare in banking efficiency literature (Berger and Mester (1997) or Yildirim and Philippatos (2007) find just the opposite), it is consistent with lower productive efficiency of large Czech banks find by Stavárek and Řepková (2012) and Řepková (2013). One possible theoretical explanation for this results is offered by Strahan (2008) that argues that large banks often concentrate on large and well-established borrowers. Small banks, in contrast, seem to devote more of their business lending to smaller and less well-established borrowers that cannot switch to alternate source of credit so easily. Small banks thus have higher market power and they can use this power to earn higher profits.

The loans-to-assets ratio (Loans/Assets) is significant and negative for profit efficiency, suggesting that on average, banks with higher loans-to-assets ratio are more profit efficient. This finding indicates that providing loans is more profitable than holding securities. This conclusion is robust across many studies undertaken for different regions such as Berger and Mester (1997), Maudos *et al.* (2002) or Pančurová and Lyócsa (2013). The deposit-to-assets ratio is significant and negative for both cost and profit efficiency. The positive relationship between cost efficiency and deposit-to-assets ratio can indicate that deposits are relatively cheap input or it can indicate that cost effective bank are able to attract more client deposits. The relationship between deposit-to-assets ratio and profit efficiency simply reflects the fact that cost minimization is necessary condition for profit maximization. Hence, a bank that is cost inefficient has to be also profit inefficient. Tab. IV also confirms previous result that mortgage banks are more cost and profit efficient than universal banks.

IV: *Determinants of efficiency*

Explanatory variable	Cost efficiency		Profit efficiency	
	Coefficient	t-values	Coefficient	t-values
Constant	2.85***	7.3	0.84	1.25
Large	0.18	0.75	1.65***	2.8
Medium	−0.02	0.09	0.04	0.06
Loans/Assets	−0.36	0.77	−4.06***	4.32
Deposits/Assets	−4.77***	9.94	−3.67***	4.22
Mortgage	−1.21**	2.16	−3.87***	4.5
McFadden R^2	0.36		0.39	

*** denotes 1% significance level, ** 5% significance level

Source: Author's estimate

CONCLUSION

The aim of the paper is to find the bank-specific determinants of cost and profit efficiency of Czech banks during the period 2002–2012. For this purpose, the paper employs one-stage estimation of stochastic frontier function which allows for simultaneous generation of inefficiency scores and the regression of these scores on a series of potential explanatory variables in a statistically consistent manner. The estimation reveals that nearly all deviations from the efficiency frontier can be explained by inefficiency and not by some random factors.

The average cost efficiency for Czech banks is 0.74, which implies that average bank wasted nearly 26% of its costs compared to a best-practice bank. The average alternative profit efficiency takes a value of 0.74. This result implies that average bank lost approximately one fourth of profits due to inefficiency. The average cost efficiency in the Czech banking sector move from 0.41 to 0.82 and the average profit efficiency moved from 0.64 to 0.84 during the period of estimation. The computed efficiency scores were low in years 2000 and 2001. Profit efficiency also slightly declined in year 2009, which suggest that there is negative effect of financial crisis in this year.

The analysis of potential correlates of bank inefficiency covers bank size, bank specialization, deposit-to-assets ratio and loans-to-assets ratio. The estimation reveals following results. Mortgage banks seems to be more cost and profit efficient than universal banks. But this result is subject to considerable uncertainty as the sample of mortgage banks is small. Bank size does not influence cost efficiency. Profit efficiency depends on bank size in a non-linear way. There is no statistically significant difference between small and medium-sized banks, but large banks are less efficient. This indicates that large banks are not able to generate revenue so efficiently as small and medium-size banks. Deposit-to-assets ratio increases both cost and profit efficiency. Loans-to-assets ratio increases profit efficiency and has no significant effect on cost efficiency. These two results indicate that deposits are relatively cheap input and loans are more profitable than other assets.

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