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Banking Efficiency Determinants in the Czech Banking Sector

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Abstract

Paper examines determinants of efficiency in the Czech banking sector within 2001-2012. Employing the Data Envelopment Analysis we estimated efficiency of the Czech banking sector. Determinants of banking efficiency were estimated using panel data analysis. The level of capitalization, liquidity risk and riskiness of portfolio had a positive impact on banking efficiency. ROA, interest rate and GDP had a negative impact on efficiency in CCR model. In BCC model, the liquidity risk and riskiness of portfolio had a positive impact on efficiency and GDP had a negative impact on efficiency. Other determinants were not statistical significant.

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Keywords: Bank and market specific factors; banking sector; Czech Republic; Data Envelopment Analysis; efficiency;

1. Introduction

The Czech financial system can be characterized as a bank-based system and banks play an important role in the economy for corporations and businesses as well as for households. The transformation and consolidation of the Czech banking sector was carried out during the 1990s. From 1998–2001, a second round of privatization occurred with the sale to foreigners of majority equity interests in four large Czech banks: Československá obchodní banka (ČSOB), Česká spořitelna (ČS), Komerční banka (KB) and Investiční a poštovní banka (IPB). ČSOB, ČS and KB are still the dominant players in the market. The Czech Republic joined the European Union (EU) in 2004.

The aim of the paper is to examine the determinants of efficiency in the Czech banking sector over the period 2001-2012. First, we estimated the efficiency of the Czech banking sector. We employed the non-parametric approach, especially the Data Envelopment Analysis (DEA) on the data of the Czech commercial banks. We

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simultaneously use two alternative specifications of DEA approach, specifically CCR model and BCC model that differ in returns to scale assumption.

The structure of the paper is following. Next chapter presents empirical literature. Third section describes methodology (DEA approach). Section 4 presents data and selection of variables and fifth section shows empirical analysis and results. Last section concludes this paper.

2. Literature review

Empirical studies on the determinants of banking efficiency consider bank specific factors and macroeconomics factors. Stavárek (2005) estimated determinants of banking efficiency in Visegrad countries during the period 1999-2003. He found that bank-specific factors were significant and macroeconomics factor were not significant besides GDP. Košak and Zajc (2006) estimated determinants of efficiency in the new EU member countries. They found a negative relationship of the intermediation ratio and density of demand. The deposit per capita and population were positively associated with cost efficiency. ROA and ROE were positively related to efficiency.

As showed Akin et al. (2009) and Vu and Nahm (2013), bank-specific characteristics include bank size, equity over total assets, return on assets or equity, loans-to-total assets, type of ownership, bank configuration. Empirical literature review showed that there is no common consensus exists about effects of banking efficiency determinants.

Bank size is generally measured by banks' amount of assets. E.g. Grigorian and Manole (2002), Mercan et al. (2003), Williams and Nguyen (2005), Rezitis (2007) or Vu and Nahm (2013) found a positive relationship between bank size and banking efficiency. On the other hand, Isık and Hassan (2002), Chen et al. (2005) or Akin et al. (2009) discovered a negative effect of bank size on banking efficiency. Grigorian and Manole (2002), Altunbas et al. (2007), Chortareas et al. (2009) and Vu and Nahm (2013) found a positive relationship between the level of capitalisation and banking efficiency. In contrast, Pasiouras et al. (2007) and Cavallo and Rossi (2002) found that the level of capitalisation had a negative impact on efficiency. Ariff and Can (2009) and Sanchez et al. (2013) found that banks with higher ROE were more efficient.

As Vu and Nahm (2013) showed, some studies consider the influences of various types of risk, such as liquidity risk, credit risk and management risk. Berger and Mester (1997) found that banks with a higher ratio of loans to total assets (proxy for credit risk) were more profit efficient than other banks in the US banking sector. Yildirim and Philippatos (2007) also found a positive relationship between the ratio of loans to total asset and efficiency. In contrast, Brissimis et al. (2008) and Havrylchyk (2006) found a negative relationship between the credit risk and efficiency. Brissimis et al. (2008) found a negative relationship between the liquidity risk and bank efficiency. Ariff and Can (2008) found that it had a positive impact on efficiency.

Gross domestic product (GDP) was used as a market specific factor in empirical studies. Maudos et al. (2002), Hasan et al. (2009) and Vu and Nahm (2013) showed the positive relationship between GDP and banking efficiency. Perera et al. (2007) considered other factors as well and found that banking markets with high levels of market concentration, monetisation, interest rates and GDP growth rate tend to achieve higher efficiency in South Asian. In contrast, Thoraneenitiyan and Avkiran (2009) found that the overall level of economic development (GDP) had a negative effect on bank efficiency in East Asian countries. Furthermore, Brissimis et al. (2008) examined a positive relationship between profit efficiency and short-term interest rates. Also Vu and Nahm (2013) found that a low-inflation rate provide a favourable environment for banks to improve their profitability.

3. Methodology

The Data Envelopment Analysis is a mathematical programming technique that measures the efficiency of a decision-making unit (DMU) relative to other similar DMUs with the simple restriction that all DMUs lie on or below the efficiency frontier (Seiford and Thrall, 1990). DEA calculates the relative efficiency of each DMU in relation to all the other DMUs by using the actual observed values for the inputs and outputs of each DMU. It also identifies, for inefficient DMUs, the sources and level of inefficiency for each of the inputs and outputs (Charnes et al., 1995). The term DEA was first introduced by Charnes et al. (1978) based on the research of Farrell (1957). CCR model is the basic DEA model as introduced by Charnes et al. (1978). This model was modified by Banker et al. (1984) and became the BCC model which accommodates variable returns to scale. The CCR model presupposes that there is no significant relationship between the scale of operations and efficiency by assuming constant returns to scale (CRS) and it delivers the overall technical efficiency. The CRS assumption is only justifiable when all DMUs are operating at an optimal scale. However, firms or DMUs in practice might face either economies or diseconomies to scale. Thus, if one makes the CRS assumption when not all DMUs are operating at the optimal scale, the computed measures of technical efficiency will be contaminated with scale efficiencies. Banker et al. (1984) extended the CCR model by relaxing the CRS assumption. The resulting BCC model was used to assess the efficiency of DMUs characterized by variable returns to scale (VRS).

DEA begins with a fractional programming formulation. Assume that there are n DMUs to be evaluated. Each consumes different amounts of i inputs and produces r different outputs, i.e. DMUj consumes x_{ji} amounts of input to produce y_{ji} amounts of output. It is assumed that these inputs, x_{ji}, and outputs, y_{ji}, are non-negative, and each DMU has at least one positive input and output value. The productivity of DMU can be written as:

$$h_j = \frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}}. \quad (1)$$

In this equation, u and v are the weights assigned to each input and output. By using mathematical programming techniques, DEA optimally assigns the weights subject to the following constraints. The weights for each DMU are assigned subject to the constraint that no other DMU has efficiency greater than 1 if it uses the same weights, implying that efficient DMUs will have a ratio value of 1. The objective function of DMU_k is the ratio of the total weighted output divided by the total weighted input:

$$\max h_0(u,v) = \frac{\sum_{r=1}^{s} u_r y_{r0}}{\sum_{i=1}^{m} v_i x_{i0}}, \quad (2)$$

subject to

$$\frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \leq 1, j = 1,2 \dots, j_0, \dots, n, \quad (3)$$

$$u_r \geq 0, r = 1,2, \dots, s, \quad (4)$$

$$v_i \geq 0, i = 1,2, \dots, m, \quad (5)$$

where h_0 is the technical efficiency of DMU_0 to be estimated, u_r and v_i are weights to be optimized, y_{rj} is observed amount of output of the r^{th} type for the j^{th} DMU, x_{ij} is the observed amount of input of the i^{th} type for the j^{th} DMU, r indicates the s different outputs, i denotes the m different inputs, and j indicates the n different DMU_s.

4. Data and selection of variables

The data set used in this paper was obtained from the database BankScope and the annual reports of commercial banks during the period 2001–2012. All the data is reported on an unconsolidated basis. We analyze only commercial banks that are operating as independent legal entities. We use unbalanced panel data from 15 Czech commercial banks (with regard to mergers and acquisitions of banks). Due to some missing observations we have an unbalanced panel of 151 bank-year observations.

In order to conduct a DEA estimation, inputs and outputs need to be defined. Four main approaches (intermediation, production, asset and profit approach) have been developed to define the input-output relationship in financial institution behavior. We adopted an intermediation approach and consistent with this approach, we assume that banks collect deposits to transform them, using labor, in loans. We employed two inputs (labor and deposits), and two outputs (loans and net interest income). We measure labor by the total personnel costs covering wages and all associated expenses and deposits by the sum of demand and time deposits from customers, interbank deposits and sources obtained by bonds issued. Loans are measured by the net value of loans to customers and other financial institutions and net interest income as the difference between interest incomes and interest expenses.

We selected several bank and market specific factors which can influenced the efficiency of the Czech banking sector. We included the bank size, level of capitalization, ROA, credit risk and liquidity risk, interest rate, riskiness of the bank's overall portfolio, number of branches of individual bank, market concentration and GDP. The bank size is a measure as total assets. The level of capitalization is the ratio of equity to total assets. ROA is return on assets ratio and it is proxy for profitability of the banking sector. ROA is determined as total profit (loss) after tax to total assets. The ratio of loans to assets was used as a proxy for credit risk. Liquidity risk is represented by the ratio of loans to deposits. Interest rate is measure as a ratio of interest income to total loans. Riskiness of the bank's overall portfolio is computed as a ratio of the loans loss provision to total assets. For measure the market concentration is used the Herfindahl-Hirschman index.

5. Empirical analysis and results

DEA can be used to estimate efficiency under the assumptions of constant and variable returns to scale. For empirical analysis we used MaxDEA software. The results of the DEA efficiency scores based on constant return to scale (CCR model) and variable returns to scale (BCR model) for each year are presented in Table 1.

Table 1. Efficiency estimation of the Czech commercial banks in CCR and BCC models

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
CCR	71	73	69	79	77	78	73	76	61	72	86	90
BCC	87	93	88	91	92	94	95	96	92	85	97	96

Table 1 presents the results the average score of efficiency using the CCR model and the BCR model in the period 2001–2012. The development of average efficiency was almost constant in the period 2001–2012. During the period 2001–2012, the average efficiency computed using the constant returns to scale (CCR model) ranges from 61 to 90% and the average efficiency computed using the variable returns to scale (BCR model) ranges from 85 to 97%. It shows that the Czech banks are in average considered to be highly efficient with only marginal changes over time. The development trend of the efficiency is similar in both models. We can see that average efficiency was increased during the period 2001 to 2008. In 2009 the average efficiency decreased, which was as a result of the financial crisis. And then the average efficiency increased in the period 2010-2012.

For estimation of the determinants of banking efficiency we used the analysis of panel data:

$$\ln EF_{it} = \ln BS_{it} + \ln CAP_{it} + \ln ROA_{it} + \ln CR_{it} + \ln LR_{it} + \ln IR_{it} + \ln RISKASS_{it} + \ln BR_{it} + \ln HHI_{it} + \ln GDP_{it}, \quad (6)$$

where *EF* is banking efficiency, *BS* is size of bank, *CAP* is the level of capitalization, *ROA* is return on assets, *CR* is credit risk, *LR* is liquidity risk, *RISKASS* is riskiness of the bank's overall portfolio, *BR* is the number of bank's branches, *HHI* is market concentration and i denotes the bank ($i = 1, \ldots, N$), t denotes time ($t = 1, \ldots, T$).

Before estimating the model we tested the time series for the stationarity. We applied Levin, Lin and Chu test to test the individual variables for the existence of the unit roots. Test indicates that the variables are stationary on the values so that the null hypothesis of a unit root can be rejected for any of the series. All times series are stationary and can be used in panel regression analysis. The method applied to estimate of equation (6) is Ordinary Least Squares (OLS). For correction of heteroscedasticity is used White (1980) test and heteroscedasticity was rejected. For detecting multicollinearity we used correlation coefficient. From the correlation matrix it is obvious that any variables are not correlated together. To allow for heterogeneity across the banks, we use an error-component model, with the bank and market-specific error components estimated as fixed effects. The regression results of equation (6) are presented in Table 2. To conserve the space only final estimations are presented.

Table 2. Determinants of banking efficiency in CCR and BCC models in the Czech banking sector

	CCR model			BCC model	
Variable	Coefficient	Std. Error	Variable	Coefficient	Std. Error
C	8.123201[a]	2.063302	*C*	3.603354[a]	1.372328
ln*CAP*	0.293681[a]	0.085872	ln*LR*	0.203264[a]	0.045494
ln*ROA*	-0.053081[b]	0.022151	ln*RISKASS*	0.030217[a]	0.006404
ln*LR*	0.318393[a]	0.081272	ln*GDP*	-0.270789[b]	0.106954
ln*IR*	-0.111644[a]	0.042527			
ln*RISKASS*	0.029856[a]	0.009343			
ln*GDP*	-0.642379[a]	0.159504			
Adjujsted R^2 = 0.6166, Prob(F-stat.) = 0.0000, DW = 2.1555			Adjujsted R^2 = 0.4326, Prob(F-stat.) = 0.0000, DW = 1.9215		

Table 2 presents the determinants of banking efficiency in models with constant and variable return to scale in the Czech banking sector during the period 2001-2012. The results show that the level of capitalization, liquidity risk and riskiness of portfolio have a positive impact on efficiency measured in assumption of constant return to scale. Return on assets (ROA), interest rate and GDP had a negative impact on banking efficiency in the Czech banking sector. Other determinants, i.e. bank size, credit risk, number of branches and concentration of the banking sector, were not statistical significant in this model.

We found that only liquidity risk, riskiness of overall portfolio and GDP were statistical significant in BCC model. Other estimated determinants included in this model were not statistical significant. It can be seen that liquidity risk and riskiness of overall portfolio had a positive impact on efficiency in the Czech banking sector. On the other hand, GDP had a negative impact on banking efficiency.

We can concluded that banks with a higher ratio of loans to deposit were more efficient than other Czech commercial banks. We found a positive relationship between the level of capitalization of the Czech commercial bnaks and banking efficiency. This result confirm the conclusion of Grigorian and Manole (2002), Altunbas et al. (2007), Chortareas, Girardone, and Ventouri (2009) and Vu and Nahm (2013) in banking sectors.

6. Conclusion

The aim of the paper was to examine the determinants of banking efficiency and inefficiency in the Czech banking sector over the period 2001-2012. First, we employed the Data Envelopment Analysis to estimate the efficiency of the Czech commercial banks during. Next, we estimated determinants of banking efficiency using panel data analysis. We found that in both model the liquidity risk and riskiness of portfolio had a positive impact on banking efficiency and GDP had a negative influence on efficiency of the Czech commercial banks. The level of bank's capitalization had a positive impact on banking efficiency in model with constant return to scale. The results show a negative relationship between interest rate and ROA and efficiency in CCR model. Banks with a higher ratio of loans to deposit, higher ratio of equity to total assets or lower value of ROA were more efficient than other commercial banks in the Czech banking sector. The impact of the bank size, credit risk, number of branches or concentration of banking sector were not statistical significant during the analyzed period.

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