Relationship between Profitability and Efficiency in the Czech Banking Sector

Iveta Palečková
Silesian University
School of Business Administration, Department of Finance and Accounting
Univerzitní náměstí 1934/3
Karviná, 733 40
Czech Republic
e-mail: paleckova@opf.slu.cz

Abstract
The aim of the paper is to estimate the relationship between profitability and efficiency in the Czech banking sector during the period 2004 – 2014. First, the profitability and efficiency of the Czech banks were estimated. We used two ratios for banking profitability, namely Return on Assets and Return on Equity. For estimation of banking efficiency we used the non-parametric approach, the Data Envelopment Analysis, slack-based model with variable return to scale. We calculated relationship between profitability and efficiency using Granger causality and correlation coefficient. The models did not confirm the relationship between profitability and efficiency.

Keywords: Czech banking sector, Data Envelopment Analysis, Return on Assets, Return on Equity, Granger causality
JEL codes: G21

1. Introduction

The aim of the paper is to estimate the relationship between profitability and efficiency in the Czech banking sector within the period 2004 – 2014. The data set consist only of commercial banks. We calculated two common measures of banking profitability, namely Return on Assets (ROA) and Return on Equity (ROE). We also examined banking efficiency using the Data Envelopment Analysis. We estimated efficiency of the Czech commercial banks due to the homogeneity of the data set and we used slack-based model with variable return to scale that is called BCC model.

Most of literature estimated the determinants of banking efficiency where is one of factors the Return on Assets or Return on Equity or examined the determinants of banking profitability where the banking efficiency is included. Košak and Zajc (2006) estimated determinants of efficiency in the new EU member countries. They found that ROA and ROE were positively related to efficiency. Opposite Palečková (2015) estimated the determinants of banking efficiency in the Czech banking industry and found a negative relationship between ROA and efficiency. Kosmidou et al. (2008) estimated the determinants of profitability of commercial banks in UK. They found that the coefficient of the cost to income ratio that was a proxy for efficiency was negative and significant. That suggested that efficiency in expenses management is a robust determinant of UK bank profits. Kosmidou (2008) and Pasiouras et al. (2006) also confirm this inverse relationship for Malaysia, Greece and Australia. The relationship between profitability and efficiency in the Czech banking sector is not estimated in empirical literature and it gives the motivation for this paper.

The structure of the paper is following. Next section describes the methodology and data and selection of variables. Third section presents empirical analysis and results and last section concludes the findings.

2. Methodology and Data

Profitability measures the extent to which a business generates a profit from factors of production. Profitability analysis focuses on the relationship between revenues and expenses and on the level of profits relative to the size of assets, capital or investments in the business. Efficiency measures the degree of the efficacious use of the factors of production. Efficiency analysis deals with the

relationship between inputs and outputs. Profitability and productivity can be characterized as performance indicators of a single unit calculated without the need for benchmarks. On the other hand, efficiency is based on relativity and can only be calculated with respect to a reference point. The differences are also very clearly apparent considering methods used in measuring both variables.

2.1 Profitability of Banks

Profitability is the supreme indicator of management‘s success or failure in its strategic and leadership activities. Return on Assets (ROA) is a profitability indicator that measures the bank‘s ability to efficiently employ its assets. As such, it is considered by many analysts to be one of the best single ratios for evaluating the performance of management. ROA equals net income divided by total assets and thus measures net income per currency unit of average assets owned during the period. Table 1 presents the relationship between the value of ROA and Return on Assets.

$$ROA = \frac{net\ income}{total\ assets} \quad (1)$$

Table 1: The Relationship between the Value of ROA and Return on Assets

Value of ROA (in %)	Return on assets
< 0.75	weak
0.75 – 1.00	below the standard
1.00 – 1.25	Good
1.25 – 1.75	very good
> 1.75	excellent

Source: author’s compilation

Return on Equity (ROE) equals net income divided by total equity and thus measures the percentage return on each currency unit of shareholders’ equity. It is the aggregate return to shareholders before dividends. The higher the return the better, as banks can add more to retained earnings and pay more in cash dividends when profits are higher.

$$ROE = \frac{net\ income}{equity} \quad (2)$$

Each of the ratios looks as a slightly aspect of profitability. We can summarized that Return on Assets indicates how capable management has been in converting assets into net earnings. Return on Equity is a measure of the rate of return flowing to shareholders. It approximates the net benefit that the stockholders have received from investing their capital in the financial firm (Rose and Hudgins, 2013).

2.2 Data Envelopment Analysis

The Data Envelopment Analysis (DEA) 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). The DEA measures the relative efficiency of a homogeneous set of decision-making units in their use of multiple inputs to produce multiple outputs. DEA 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) is model with assumption of constant return to scale (CRS). This model was modified by Banker et al. (1984) and became the BCC model which accommodates 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:

$$h_j = \frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}}. \quad (3)$$

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:

$$\max h_0(u, v) = \frac{\sum_{r=1}^{s} u_r y_{r0}}{\sum_{i=1}^{m} v_i x_{i0}}, \quad (4)$$

$$\text{subject to } \frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \leq 1, j = 1,2 \dots, j_0, \dots, n, \quad (5)$$

$$u_r \geq 0, r = 1,2, \dots, s, \quad (6)$$

$$v_i \geq 0, i = 1,2, \dots, m, \quad (7)$$

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. Detailed description of DEA model is presented in Stavárek and Řepková (2012).

2.3 Granger Causality and Correlation Coefficient

Granger (1969) developed a relatively simple test that defined causality as follows: a variable Y_t is said to Granger cause X_t if X_t can be predicted with greater accuracy by using past values of the Y_t variable rather than not using such past values, all other terms remaining unchanged. In the other words, Kar et al. (2011) summarized that the Granger causality means that the knowledge of past values of one variable (X) helps to improve the forecasts of another variable (Y). For more information about Granger causality test described Asteriou and Hall (2011).

Correlation is a statistical technique that determine whether and how strongly pairs of variables are related. The result of a correlation is called the correlation coefficient. Correlation coefficient ranges <-1;1>. If correlation coefficient is close to 0, it means there is no relationship between the variables. If it is positive, it means that there is positive relation. If correlation coefficient is negative it shows the negative relation.

2.4 Data and Selection of Variables

The data set used in this paper was obtained from the annual reports of the Czech commercial banks during the period 2004–2014. 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 17 Czech commercial banks (with regard to mergers and acquisitions of banks). Due to some missing observations we have an unbalanced panel of 149 bank-year observations.

In order to conduct the efficiency 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.

3. Empirical analysis and Results

First, the profitability of the Czech commercial banks was examined. We used the Return on Assets and Return on Equity. The efficiency of the Czech commercial banks was estimated using the Slack-Based Model (SBM) with variable return to scale. For empirical application we used MaxDEA software.

Table 2: The Descriptive Statistics of ROA of the Czech Banking Sector

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Mean	0.84	1.17	1.05	1.13	0.97	0.32	0.61	-0.33	0.56	0.55	0.89
Median	0.53	0.98	0.70	0.88	0.73	1.03	0.98	0.53	0.99	0.49	0.91
Maximum	3.75	4.16	4.19	2.79	3.02	2.31	2.93	3.11	3.10	2.84	2.80
Minimum	-1.95	0.00	-0.43	-0.54	-1.82	-4.60	-3.30	-8.41	-4.93	-2.16	-1.02
St. Dev.	1.26	1.05	1.14	0.85	1.25	2.06	1.70	3.12	1.92	1.24	0.91

Source: author's calculations

Table 2 presents results of Return on Assets of the Czech commercial banks during the period 2004-2013. We found that the average value of ROA was in range between -0.33 to 1.17%. The average return on assets in the Czech banking sector is weak. The three largest banks were the value above 1.5% that showed very good return on assets. But most of small and medium-sized banks reach the value lower than 1% or negative value that indicated weak return on assets.

Table 3: The Descriptive Statistics of ROE of the Czech Banking Sector

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Mean	7.22	11.32	9.40	13.07	10.94	6.67	8.44	3.23	5.49	3.91	7.54
Median	7.82	11.39	10.08	11.27	11.45	7.15	9.61	5.77	9.80	5.54	8.80
Maximum	22.50	20.93	21.18	24.31	24.13	24.93	20.60	18.32	20.61	16.97	17.24
Minimum	-28.74	0.03	-8.47	-0.97	-5.69	-27.68	-10.50	-28.78	-34.26	-23.87	-15.36
St.dev.	12.39	6.99	8.28	7.64	8.97	14.44	9.93	14.60	14.52	11.28	8.15

Source: author's calculations

Table 3 presents the results of Return on Equity of the Czech commercial banks within the period 2004-2014. The quality level for ROE is in range between 15 to 20%. The average values of ROE were 3.91-13.07. The Return on Equity in was low the Czech banking sector. Especially the group of large banks reached the value above 15%, but the small and medium-sized banks reached the value of ROE under 15% or negative value of ROE.

Table 4: The Descriptive Statistics of Efficiency of the Czech Banking Sector

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Mean	85	82	84	87	95	95	89	89	89	93	94
Median	94	90	100	100	100	100	100	100	100	100	100
Maximum	100	100	100	100	100	100	100	100	100	100	100
Minimum	46	46	39	32	68	71	64	58	47	59	59
St. Dev.	19.15	20.47	24.19	25.57	11.39	11.25	14.56	16.94	19.50	13.94	14.98

Source: author's calculations

Table 4 presents the descriptive statistics of efficiency of the Czech commercial banks during the period 2004-2014. The average efficiency was increased in the period 2004-2009. In the years 2010-2012 it decreased as a result of financial crises. We registered the decrease in total loans and net interest income in the balance sheet of most of the Czech banks. In the period 2013-2014 the average efficiency again increased.

3.1 Granger Causality between Profitability and Efficiency

Next, we calculate Granger causality between efficiency and ROE and efficiency and ROA. 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 (level) 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 Granger causality panel data analysis. The Granger causality results are presented in Table 5.

Table 5: The Results of Granger Causality

Null hypothesis	F-statistic	Probability
ROA does not Granger Cause EFFICIENCY	2.45197	0.0909
EFFICIENCY does not Granger Cause ROA	1.53694	0.2197
ROE does not Granger Cause EFFICIENCY	1.05537	0.3516
EFFICIENCY does not Granger Cause ROE	4.9291	0.0089

Source: author's calculations

The result of Granger causality indicates that we cannot reject the null hypothesis that ROA does not cause efficiency and efficiency does not cause ROA and as well as that ROE does not cause efficiency at the significance level of 5%. The result shows that the model did not confirm the relationship between efficiency and profitability in the Czech banking sector.

Table 6: The Correlation Coefficient between Profitability and Efficiency

	Efficiency
Return on Assets	0.304495[a]
Return on Equity	0.279323[a]

Note: [a] show the significance level of 5%

Source: author's calculations

We confirmed these findings using the correlation coefficient that showed us that the correlation coefficient (Table 6) was very low between efficiency and ROA or ROE. This paper do not confirm the results of the previous paper that estimated the positive or negative relationship between profitability and efficiency in the banking sector. But we remind that empirical literature did not estimate the relationship between profitability and efficiency, but only determinants of efficiency or profitability of banking sector.

4. Conclusion

The aim of the paper was to estimate the relationship between profitability and efficiency in the Czech banking sector during the period 2004 – 2013. We calculated two common measures of profitability, namely Return on Assets and Return on Equity of the Czech banking sector. We also estimated efficiency of the Czech commercial banks using the Data Envelopment Analysis. In the paper it was found that the average value of ROA and ROE reached very low values in the Czech banking sector. The Return on Assets and Return on Equity was very low in the Czech banking sector. It was also found that the average efficiency reached the value in range 82-95%. It shows that the Czech commercial banks were efficient during this period.

For estimation of relationship between profitability and efficiency in the Czech banking sector we used the Granger causality test. The Granger Causality do not confirm the relationship between Return on Equity and efficiency. We cannot reject the hypothesis that ROA does not cause efficiency. But the relationship between efficiency and Return on Assets cannot be confirm. This paper do not confirm the relationship between profitability and efficiency which was confirmed using correlation coefficient. Correlation coefficient was very closed to zero that confirm that causation between

profitability and efficiency is very low. The results of the paper show that we can recommend to divide the Czech banks to the groups according the size. Because e.g. the group of large banks were most profitable and they reached low value of efficiency. For further research we recommend to estimate the relationship between individual groups of banks.

Acknowledgement

Research behind this paper was supported by the Czech Science Foundation within the project GAČR 13-03783S 'Banking Sector and Monetary Policy: Lessons from New EU Countries after Ten Years of Membership'.

References

ASTERIOU, D., HALL, S.G. (2011). Applied Econometrics. Hampshire: Palgrave Maxmillan.
BANKER, R.D., CHARNES, A., COOPER, W.W. (1984). Some Models for Estimating Technical and Scale Inefficiencies in Data Envelopment Analysis. *Management Science*, vol. 30, pp. 1078–1092.
ENGLE, R.F., GRANGER, C.W.J. (1987). Cointegration and Error Correction: Representation, Estimation, and Testing. *Econometrica*, vol. 55, pp. 251–276.
FARRELL, M.J. (1957). The Measurement of Productive Efficiency. *Journal of the Royal Statistical Society (Series A*), vol. 120, no. 2, pp. 253–281.
GRANGER, C.W.J. (1986). Developments in the Study of Cointegrated Economic Variables. *Oxford Bulletin of Economics and Statistics*, vol. 48, pp. 213–228.
HENDRY, D. (1986). Econometric Modelling with Cointegrated Variables: an Overview. *Oxford Bulletin of Economics and Statistics*, vol. 48, pp. 201–212.
CHARNES, A., COOPER, W.W., RHODES, E. (1978). Measuring the Efficiency of Decision Making Units. *European Journal of Operational Research*, vol. 2, pp. 429–444.
CHARNES A., COOPER, W.W., LEWIN, A.Y., SEIFORD, L.M. (1995). *Data Envelopment Analysis: Theory, Methodology and Applications*. New York: Springer-Verlag.
KAR, M., NAZLIOĞLU, S., AĞIR, H. (2011). Financial development and economic growth nexus in the MENA countries: Bootstrap panel granger causality analysis. *Economic Modellin*g, vol. 28, pp. 685–693.
KOSMIDOU, K. (2008), The Determinants of Banks' Profits and Margins in Greece during the period of EU financial integration. *Managerial Finance*, vol. 34, no. 3, pp. 146–159.
KOSMIDOU, K., TANNA, S., PASIOURAS, F. (2008). *Determinants of profitability of domestic UK commercial banks: panel evidence from the period 1995-2002*. Economics, finance and accounting applied research working paper series no. RP08- 4. Coventry: Coventry University.
KOŠAK, M. ZAJC, P. (2006). *Determinants of bank efficiency differences in the new EU member countries*. Financial Stability Report, Expert Papers. Ljubljana: Bank of Slovenia.
PALEČKOVÁ, I. (2015). Estimation of banking efficiency determinants in the Czech Republic. *Journal of Applied Economic Sciences*, vol. 10, no. 2, pp. 234–242.
PASIOURAS, F., KOSMIDOU K., GAGANIS, CH. (2006). *A Pooled Study of the Internal and External Determinants of Australian Banks Profits and Margins*. Working Paper of Financial Engineering Laboratory. Chania: Technical University of Crete.
ROSE, P.S., HUDGINS, S.C. (2013). *Bank Management and Financial Services*. New York: McGraw-Hill.
SEIFORD, L.M., THRALL, R.M. (1990). Recent developments in DEA: the mathematical programming approach to frontier analysis. *Journal of Econometrics*, vol. 46, pp. 7–38.
STAVÁREK, D., ŘEPKOVÁ, I. (2012). Efficiency in the Czech banking industry: A non-parametric approach. *Acta Universitatis Agriculturae et Silviculturae Mendeleianae Brunensis*, vol. 60, no. 2, pp. 357–366.