ACTA UNIVERSITATIS AGRICULTURAE ET SILVICULTURAE MENDELIANAE BRUNENSIS

Volume LXI 303 Number 7, 2013
http://dx.doi.org/10.11118/actaun201361072701

RELATIONSHIP BETWEEN COMPETITION AND EFFICIENCY IN THE CZECH BANKING INDUSTRY

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Received: April 11, 2013

Abstract

ŘEPKOVÁ IVETA, STAVÁREK DANIEL: *Relationship between competition and efficiency in the Czech banking industry.* Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis, 2013, LXI, No. 7, pp. 2701–2707

The aim of the paper is to estimate the relationship between competition and efficiency in the Czech banking industry in the period 2001–2010. The theoretical definition and literature review of the relationship between banking competition and efficiency is included. Lerner index and Data Envelopment Analysis were used to estimate the degree of competition and efficiency in the Czech banking sector. The market structure of the Czech banking industry was estimated as a monopolistic competition and it was found a slight increase in the competition in the banking sector. The efficiency of the Czech banks increased in the analysed period. Using a Johansen cointegration test, the paper contributes to the empirical literature, testing not only the causality running from competition to efficiency, but also the reverse effect running from efficiency to competition. The positive relationship between competition and efficiency was estimated in the Czech banking sector. These findings are in line with the Quiet Life Hypothesis and the suggestions that the increase of the competition will contribute to efficiency.

banking sector, competition, efficiency, Lerner index, Data Envelopment Analysis, Johansen cointegration test

The Czech financial system can be characterized as a bank-based system and banks play an important role in the economy. The transformation and consolidation of the Czech banking sector was realized during 1990s. In years 1998–2001 the second round of privatization were done with sales to foreigners of majority equity interests in four large Czech banks. The Czech Republic joined the European Union in 2004.

The aim of this paper is to examine the relationship between competition and efficiency in the Czech Republic banking industry during the period 2001–2010. First, the level of competition and efficiency was estimated in the Czech banking sector. Banking efficiency can be defined as a process that uses the lowest amount of inputs to create the greatest amount of outputs. We employ non-parametric method the Data Envelopment Analysis for measuring bank efficiency. The Lerner index of monopoly power is used as a non-structural indicator of the degree of market competition. Next, the relationship between competition and efficiency in the Czech banking sector is investigated using the Johansen's cointegration test.

The structure of the paper is following. The second section reviews the empirical literature regarding the relationship between competition and efficiency in the banking industry. Next section describes data and methodology applying in this paper. Empirical analysis, results and discussion are examined in the fourth section. The last section concludes results and findings.

Literature review

In the empirical literature there has not been consensus in the relationship between competition and efficiency in the banking sector. The existence of a relationship between market structure and efficiency was proposed by Hicks (1935) who defined the Quiet Life Hypothesis. Hicks argued that monopoly power allows managers a quiet life free from competition and thus increased

concentration should bring about a decrease in efficiency. Competition has a positive effect in the efficiency, or high market power enables efforts to reduce efficiency. This argument is described by Hicks phrase that the best of all monopoly profits is a quiet life.

Leibenstein (1966) argued that inefficiencies are reduced by increased competition as managers respond to the challenge. He claimed the main determinant of the reduction of inefficiencies is the increase of competitive pressures for two reasons. First, competition provides incentives to managers to exert a higher effort. Second, a higher number of firms on the market improve the possibilities for owners to assess firm performance, relative to other firms. Managers tend to exert a higher effort.

In contrast, the Efficient Structure Hypothesis described by Demsetz (1973) and Peltzman (1977) who expected a reverse relationship between competition and cost efficiency. They stated that more efficient firms have lower costs, which in turn lead to higher profits. Therefore, the most efficient firms are able to increase their market share, resulting in higher concentration. If higher market concentration lowers competition, according to the Efficiency Hypothesis there should be an inverse relationship between competition and efficiency. The Structure-conduct-performance (SCP) hypothesis (Bain, 1951) argues that greater concentration causes less competitive bank conduct and leads to greater profitability.

The relationship between competition and efficiency has been studied for the European banking sectors. In contrast, only one work has been done to examine this relationship in the Czech banking industry. Pruteanu-Podpiera (2007) found that competition negatively causes cost efficiency in the Czech banking sector. It means that heightened competition can lead to an increase in monitoring costs through a reduction in the length of the customer relationship and due to the presence of economies of scale in the banking sector. This result was consistent with the banking specificities hypothesis.

Theoretical arguments of Hicks and Leibenstein support the idea that competition is an advantage for the effectiveness of the company. Also Yildirim and Philippatos (2007a) found that greater competition was associated with higher efficiency in the banking sector. The negative relationship between competition and efficiency was confirmed by e.g. Maudos and Fernandez de Guevara (2007), Casu and Girardone (2009a). Casu and Girardone (2006) found that increased competition had forced banks to become more efficient and increased efficiency was resulting in more competitive European banking systems. Furthermore the result of Casu and Girardone (2009b) regarding causality running from efficiency to competition indicated increasing efficiency to support market power. Based on the European banking data also Weill (2004) suggested that the most efficient banking systems are also the least competitive.

The main findings of the literature review can summarized that empirical studies have not achieved a unified view in the relationship between competition and efficiency in the banking industry. More recent studies (also including the Czech banking sector) found a negative relationship between competition and cost efficiency. Reasons are banking specificities, the increase in competition increases the cost of monitoring.

METHODOLOGY AND DATA

Next sections describe the approaches applying for estimation the competition and efficiency in banking sector, especially the Lerner index and the Data Envelopment Analysis.

Lerner index

The Lerner index (LI) of monopoly power is an indicator of the degree of market power which is a well-established measure of competition in the banking literature (Casu and Girardone, 2009a). It is a level indicator of the proportion by which price exceeds marginal cost, and is calculated as:

$$LI_{it} = \frac{P_{it} - MC_{it}}{P_{it}}, \tag{1}$$

where P_{it} is the price of banking outputs (it is the price of total assets proxied by the ratio of total revenues (interest and noninterest income) to total assets) for bank i at time t, and MC_{it} is the marginal costs for bank i at time t, which is derived from the translog cost function Eq. (2). The resulting LI_{it} is averaged over the period under study for each bank i.

Following the approach in Fernandez de Guevara *et al.* (2005), Berger *et al.* (2009), Demirguc-Kunt and Peria (2010) or Fungáčová *et al.* (2010), who proxy banking production by total assets, P is calculated as ratio of total bank revenues to total assets. MC is estimated on the basis of a translog cost function with one output (total assets) and three input prices (price of labour, price of physical capital, and price of borrowed funds). Symmetry and linear homogeneity restrictions in input prices are imposed. First, we estimated the cost function (Eq. 2). It was necessary estimated coefficients in regression cost equation to estimate marginal cost (Eq. 3). The cost function is specified as follows:
ln

$$\ln TC = \alpha_0 + \alpha_1 \ln ASSET + \frac{1}{2}\alpha_2 (\ln ASSET)^2 + \tag{2}$$

$$+ \sum_{j=1}^{3} \beta_j \ln w_j + \sum_{j=1}^{3}\sum_{k=1}^{3} \beta_{jk} \ln w_j \ln w_k + \sum_{j=1}^{3} \gamma_j \ln ASSET \ln w_j + \varepsilon,$$

where TC denotes total costs, α, β and γ are coefficients, $ASSET$ total assets, w_j, w_k (w_1, w_2 and w_3) indicate three input prices (i.e. labour, capital and

funds). The price of labour indicate w_1, which is the ratio of personnel expenses to total assets, w_2 is the price of physical capital, which is the ratio of other non-interest expenses to fixed assets and w_3 is the price of borrowed funds, which is the ratio of interest expenses to total funds.

Total cost is the sum of personnel expenses, other non-interest expenses and interest expenses. The indices for each bank have been excluded from the equation for the sake of simplicity. The estimated coefficients of the cost function ($\alpha_{\downarrow}1$, $\alpha_{\downarrow}2$ and $\gamma_{\downarrow}$?) are then used for computing the marginal cost (Eq. 3). The derivative of the logarithm of the total cost with respect to the logarithm of output is computed using the cost function specified in Eq. (2). The marginal cost is based on the estimation of the cost function. We estimate a translog cost function with one output and three input prices.

Second, the estimated coefficients of the cost function are then used to compute the marginal cost (MC):

$$MC = \frac{TC}{ASSET}(\alpha_1 + \alpha_2 \ln ASSET + \sum_{j=1}^{3} \gamma_j \ln w_j). \quad (3)$$

Once marginal cost is estimated and price of output computed, we can calculate the Lerner index (Eq. 1) for each bank for each year and obtain a direct measure of bank competition.

The Lerner index ranges between zero and one. When $P = MC$, the Lerner index is zero and the firm has no pricing power. A Lerner index closer to one indicates the higher mark-up of price over marginal costs and hence market power for the firm (Ariss, 2010). In general, perfect competition is in the case when $LI = 0$, while $LI = 1$ indicates monopoly. The Lerner index is an inverse measure of competition, i.e., a greater Lerner index means lower competition (Pruteanu-Podpiera *et al.*, 2007).

Data Envelopment Analysis

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 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 (Charnes, Cooper and Rhodes) 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 (Banker, Charnes, Cooper) model which accommodates variable returns to scale (VRS). 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.

DEA begins with a fractional programming formulation. Assume that there are n DMUs to be evaluated. DMU_j consumes x_{ij} amounts of input to produce y_{rj} amounts of output. It is assumed that these inputs, x_{ij}, and outputs, y_{rj}, are non-negative, and each DMU has at least one positive input and output value. The efficiency of a DMU (DMU is in this paper the Czech commercial banks) can be written as:

$$h_j = \frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}}. \quad (4)$$

In this equation, u and v are the weights assigned to each input and output. 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 is the ratio of the total weighted output divided by the total weighted input:

$$\max h_0(u,v) = \frac{\sum_{r=1}^{s} u_r y_{r0}}{\sum_{i=1}^{m} v_i x_{i0}}, \quad (5)$$

subject to

$$\frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \leq 1, \; j = 1, 2, \ldots, j_0, \ldots, n, \quad (6)$$

$$u_r \geq 0, \; r = 1, 2, \ldots, s, \quad (7)$$

$$v_i \geq 0, \; i = 1, 2, \ldots, m, \quad (8)$$

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 the 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 denotes the s different outputs, i denotes the m different inputs and j indicates the n different DMU.

Data and selection of variables

The data set used in this paper was obtained from the annual reports of commercial banks in the Czech Republic and BankScope database for the period 2001–2010. All the data is reported on unconsolidated basis. The data set consists of data of banks that represent almost 75% of the assets of the national banking sector. We analysed only the Czech commercial banks that are operating as independent legal entities due to the homogeneity of the data set. All foreign branches, building societies, specialized banks or credit unions were excluded from the estimation data set. As we have reliable data extracted directly from annual reports

I: *Descriptive statistics of variables (in mil. CZK)*

Variable	Mean	Median	Minimum	Maximum	Std. Dev.
ASSET	175624	57518	931	788177	227701
TC	8614	2457	36	46017	11958
TREV	0.06506	0.05826	0.02623	0.26184	0.02971
w_1	0.78964	0.71101	0.32671	2.26230	0.29520
w_2	2.52453	1.44887	0.32671	13.44706	2.31516
w_3	0.02476	0.02000	0.00285	0.12253	0.01878
TD	122545.5	41410.8	332.8	568199	163230.9
PC	1765.221	543.65	20	8525	2339.35
TL	77901.16	29827	107.1	422468	96981.29
NII	4688.762	1230	32.9	28332	6528.981

Source: Authors' calculations

II: *Estimation of the competition conditions of the Czech banking sector*

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Mean
LI	0.42	0.42	0.49	0.39	0.48	0.44	0.43	0.37	0.25	0.52	0.42

Source: Authors' calculations

we eliminate the risk that incomplete or biased data may distort the estimation results.

In order to conduct a DEA estimation, inputs and outputs need to be defined. In the empirical literature four main approaches have been developed to define the input-output relationship in financial institution behaviour (intermediation, production, asset and profit approach). The intermediation approach is considered relevant for the banking industry, where the largest share of activity consists of transforming the attracted funds into loans. We adopt intermediation approach which assumes that the banks' main aim is to transform liabilities (deposits) into loans (assets). Consistently with this approach, we assume that banks use the two inputs and produce two outputs. The bank collects deposits to transform them, using labour, in loans. We employed two inputs (labour and deposits), and two outputs (loans and net interest income). We measure labour by the total personnel costs (*PC*) covering wages and all associated expenses and deposits (*TD*) by the sum of demand and time deposits from customers, interbank deposits and sources obtained by bonds issued. Loans (*TL*) are measured by the net value of loans to customers and other financial institutions and net interest income (*NII*) as the difference between interest incomes and interest expenses. Descriptive statistics of inputs and outputs using for estimation of efficiency and competition are presented in Tab. I.

RESULTS AND DISCUSSION

Following section estimates the degree of competition and efficiency in the Czech banking sector within the period 2001–2010. Next, the relationship between competition and efficiency is assessed in the Czech banking industry.

Estimation of the competition

For the analysis, we calculate the Lerner index for the Czech banking sector as well as for the Czech credit and deposit market. First, we estimate Eq. (2) and Eq. (3), and then we can calculate the Lerner index as in Eq. (1). The cost function is estimated for each year so as to allow the coefficients of the cost function to evolve over time. The cost function is estimated introducing fixed effects for banks. The results of the Lerner index for each year are presented in Tab. II, we compute mean of the Lerner index. Podpiera (2007) argued that the Lerner index is an inverse measure of competition, i.e. a greater Lerner index means lower competition. The statistics of Lerner indices per year concern all the Lerner indices of the year for all analysed banks, where the banks have equal weights.

At first sight the results cannot distinguish a clear-cut trend in the evolution of the Lerner index. During the period 2001–2005 the Lerner index increased, signalling a slight decrease in competition. This episode was followed by a decrease in the Lerner index; hence a slight increase in competition, during 2006–2009. In 2010 the value of the Lerner index is also increased, which show decrease in competitive conditions. The argument for this decreased in competition is that price of fund and capital significantly decreased in 2010.

The Lerner index computed for the full sample is 0.42 (42%), which do not confirm either monopoly or perfect competition. In addition, we can identify two sub-periods of divergent development of market competition. Whereas the competition decreased during 2001–2005 it increased during the period 2006–2010. More concretely, mean of the Lerner index for total assets for the first periods is 0.44 and for the second period is 0.40. The Czech banking

III: *Efficiency estimation of Czech banks in CCR and BCR model (in %)*

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

Source: Authors' calculations

IV: *Johansen cointegration test illustrating the relationship between the competition and efficiency in the Czech banking sector*

	Trace Stat.	Critical value 5%	Max-Eigen Stat.	Critical value 5%
r = 0	22.83047[a]	20.26184	17.92008[a]	15.8921
r = 1	4.910387	9.164546	4.910387	9.164546

[a] denotes the existence of cointegration relationship at a significance 5% level
r denotes number of cointegration equations
Source: Authors' calculations

sector operates in a structure of a monopolistic competition.

Estimation of the efficiency in the Czech banking sector

DEA can be used to estimate efficiency under the assumptions of constant and variable returns to scale. For empirical analysis we use EMS 1.3.0 software (Efficiency measurement system) created by Holger Scheel and DEAP 2.1 software (A Data Envelopment Analysis Computer Program), which was written by Tim Coelli. The DEA method is suitable in the banking sector because it can easily handle multiple inputs-outputs producers such as banks and it does not require the specification of an explicit functional form for the production frontier or an explicit statistical distribution for the inefficiency terms unlike the econometric methods (Singh *et al.*, 2008).

The banking efficiency have been estimated using the DEA models, input-oriented model with constant returns to scale and input-oriented model with variable returns to scale. The reason for the using of both techniques is the fact that the assumption of constant returns of scale is accepted only in the event that all production units are operating at optimum size. This assumption, however, in practice it is impossible to fill, so in order to solve this problem we calculate also with variable returns of scale.

The results of the DEA efficiency scores based on constant returns to scale (CCR model) and variable return to scale (BCC model) are presented in Tab. III.

During the period 2001–2010, the average efficiency calculated using the CRS ranges from 61 to 79% and the average efficiency computed using the VRS ranges from 85 to 95%. It shows that the Czech banks are in average considered to be efficient with only marginal changes over time.

The results of the CCR model and the BCC model show that the model with VRS achieves higher degree of the efficiency than the model with the CRS. Number of efficient banks is higher in the model with VRS, because the BCC model decomposes inefficiency of production units into two components: the pure technical inefficiency and the inefficiency to scale. The values of efficiency computed by the BCC model reach higher values than efficiency computed by the CCR model by eliminating the part of the inefficiency that is caused by a lack of size of production units.

Relationship between competition and efficiency

The Johansen cointegration test is used to determine the relationship between competition and efficiency in the Czech banking sector. First, time series have tested for stationarity. For testing stationarity augmented Dickey-Fuller (1981) test (include trend and intercept in the test equation) has been used. Unit root test has found that the time series are stationary at the first difference $I(1)$, and results can perform testing the cointegration relationship between variables. Next, to estimate the cointegration relationship VAR model has been estimated to determine the optimal lag to eliminate residual autocorrelation vector components. Based on the Akaike information criterion the optimal lag has been selected one year for the relationships. As the optimal model we have picked up the model assuming no deterministic trend in data with intercept and no trend in cointegration equation and no intercept in VAR.

The finding of long-term relationships between variables in the Johansen cointegration test it has been identified using the Trace test and Maximum Eigenvalue test. The result of estimating the cointegration relationship between competition and efficiency in the Czech banking sector is presented in Tab. IV.

The Johansen cointegration test indicates one cointegration equation at the 0.05 level. The relationship between competition and efficiency in the Czech banking sector shows cointegration Eq. (9) which indicates the effect of competition to efficiency.

$$\text{Efficiency} = -0.103575 + 1.786236\ \text{competition}. \quad (9)$$

$$(0.15633) \qquad (0.27143)$$

Standard error is in parentheses. The cointegration equation (9) indicates that competitive conditions have a positive influence to efficiency. Thus, the increase of the competitive conditions will contribute to banking efficiency. Eq. (10) indicates the effect of efficiency to competition:

$$\text{Competition} = 0.057985 + 0.559836\ \text{efficiency}. \quad (10)$$
$$(0.23537) \qquad (0.25530)$$

Eq. (10) shows that efficiency affect competition positively in the Czech banking sector. The cointegration equations (9) and (10) show that competition has a positive effect on efficiency and vice versa.

The results confirm the competition-efficiency hypothesis, which argues increases in competition precipitate increases in efficiency. As Schaeck and Čihák (2007) claimed efficient banks (i.e. those with superior management and production technologies, which translate into higher profits) will increase in size and market share at the expense of less efficient banks. The results also confirm findings of e.g. Philippatos and Yildirim (2007b) who found a positive relationship between competition and efficiency in the European banking sectors.

We found a positive causation running from competition to efficiency and also from efficiency to competition in the Czech banking sector. These results are in line with the Quiet Life Hypothesis suggesting that the banks acting in more competitive markets will contribute to higher efficiency. Also this hypothesis claim that monopoly power allows managers to grab a share of the monopoly rents through discretionary expenses or a reduction of their effort.

We can conclude that the positive impact of competition to efficiency is supported by conclusions of Hicks (1935) and Leibenstein (1966) who claimed that the growth of efficiency can be done by the growth of competition due to managers' motivation to improve their performance. It is possibilities for banks' owners to better bank assess performance relative to other banks through greater competition and their ability to proceed to changes in inefficient management if necessary. Bušek *et al.* (2012) added that a healthy competitive environment leads to the increase in efficiency, higher pressure for innovation and greater orientation to customers and of course, the pressure on prices and expanding products offering.

SUMMARY

The aim of the paper was to examine the relationship between competition and efficiency in the Czech banking industry within the period 2001–2010. First, the level of competition and efficiency was estimated in the Czech banking sector. The degree of competition was assessed applying the Lerner model. For measuring the efficiency of the Czech commercial banks we employed Data Envelopment Analysis. The relationship between competition and efficiency was examined using the Johansen cointegration test.

The cointegration analysis found the positive relationship between competition and efficiency in the Czech banking sector during the period 2001–2010. We estimated a monopolistic structure in the Czech banking sector and findings showed the competitive conditions increased in the Czech banking sector within the analysed period. Efficiency of commercial banks increased from 2001 to 2010. Thus, we found that the increased of the competitive conditions will contribute to higher banking efficiency. We found the positive relationship between competition and efficiency running from competition to efficiency and also from efficiency to competition in the Czech banking industry. The positive impact of competition to efficiency is supported by Quiet Life Hypothesis.

Acknowledgement

This paper was support 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'.

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