Banking Competition and Efficiency:
A Micro-Data Analysis on the Czech Banking Industry

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Abstract:

Banking competition is expected to provide welfare gains by reducing monopoly rents and cost inefficiencies, favoring the reduction of loan rates and then investment. These expected gains are a major issue for transition countries in which bank credit represents the largest source of external finance for companies. With the use of exhaustive quarterly data for Czech banks, this paper aims at providing evidence on the effects of banking competition in the Czech Republic.

First, we measure the level and the evolution of banking competition between 1994 and 2005. Competition is measured by the Lerner index on the loan market, by using data on loan prices. We find no improvement in banking competition during the transition period. Second, we investigate the relationship and the causality between competition and efficiency. We perform a Granger-causality-type analysis which supports a negative causality only running from competition to efficiency. Therefore, our results reject the intuitive 'quiet life' hypothesis and indicate a negative relationship between competition and efficiency in banking.

Keywords: banks, competition, efficiency, transition countries.
JEL Classification: G21, L12, P20.

1. Introduction

As banks exert a fundamental role in the financing of the economy, banking competition impacts on economic development. A higher degree of competition in banking markets is expected to provide welfare gains through the reduction of prices of financial services and hereby accelerating investment and growth. These gains should in fact come from two channels of transmission. On the one hand, a higher degree of banking competition should result in a lower monopoly power of banks, and therefore a decrease of banking prices. On the other hand, a heightened competition should encourage banks to reduce their costs, i.e. their cost inefficiencies. This latter channel is particularly promising in terms of welfare gains, as the order of magnitude of cost inefficiencies in the banking sectors from European transition countries has been shown to average around 30 and 50% (e.g. Hasan and Marton, 2001; Fries and Taci, 2005). However, the literature emphasizes some potential negative effects of banking competition through excessive risk-taking of banks, which may hamper financial stability (Allen and Gale, 2004; Carletti and Hartmann, 2002).

The issues regarding banking competition and its effects are therefore of particular interest in transition countries, as bank credit there is by far the largest source of external finance for companies (Caviglia *et al*., 2002; Reininger *et al*., 2002). Since investment is particularly sensitive to the decrease of loan rates, the reduction of monopoly rents and cost inefficiencies would consequently impact on investment and economic growth.

Furthermore, the transition countries have undergone major changes of their banking sectors during the 1990s. Two main tendencies distinguished the transformation of the banking sectors of these economies: a considerable number of bank failures, and a banking sector gradually acquired by foreign investors. It is therefore of utmost interest to investigate how banking competition was influenced by these changes in transition countries. The Czech banking industry constitutes a relevant illustration of what happened in a transition country. It was considered at the beginning of the transition as a successful one before facing the same troubles as the other countries with bank failures and before opening widely its banking sector to foreign investors.

The aim of this research is twofold. First, we provide evidence on the level and the evolution of banking competition in this country between 1994 and 2005. A major contribution is the measurement of competition with the Lerner index, by using data on output prices. We are therefore able to measure the degree of monopoly power for each bank on the

loan market. The second aim is to investigate the relationship and the causality between competition and efficiency. Indeed, in spite of a commonly accepted view in favour of a positive relationship, the scarce empirical literature in banking on this issue supports rather a negative link (Berger, 1995; Goldberg and Rai, 1996; Weill, 2004). Furthermore, theoretical literature provides arguments for both signs of this relationship. Namely, the intuitive 'quiet life' hypothesis suggests that competition influences positively efficiency, whereas the 'efficient-structure' hypothesis, proposed by Demsetz (1973), predicts a negative impact of efficiency on competition, as the most efficient banks would benefit from lower costs and therefore higher market shares. Finally, the specificities of banking competition let expect that competition influences negatively efficiency, as reduced competition allows banks to benefit from scale economies in monitoring and from a higher length in customer relationship.

We aim at providing evidence on the sign of this relationship for the Czech banking industry. The computation of Lerner indices, which provides measures of competition at the firm level, allows investigating the causality between competition and efficiency at the firm level. We perform Granger-causality type estimations in order to get information on the sense of causality between competition and efficiency in banking. This is an issue of considerable interest for the Czech banking industry, and also for the empirical banking literature as a whole. Indeed, this is the first work to our knowledge which investigates the causality between competition and efficiency in banking. We then contribute to the literature on banking in transition countries by providing the first investigation on the link between competition and efficiency in banking in a transition country. Evidence on this issue will enrich the information on the conflicting assumptions on this topic. Such evidence is helpful to provide normative implications on the competition policy in the banking industry. Namely, a negative relationship between competition and efficiency would mean a trade-off between these both objectives.

The structure of the paper is as follows. Section 2 describes the recent evolution of the Czech banking industry and surveys the theoretical and empirical background of the relationship between competition and efficiency in banking. The methodology is described in section 3, followed by data and variables in section 4. Section 5 develops the empirical results. Finally, we provide some concluding remarks in section 6.

2. Background

2.1 The evolution of the Czech banking industry

The Czech Banking industry underwent massive structural changes during economic transition period. The final outcome is fairly similar with the one of the banking sectors in the other Central European transition countries, with foreign owners now dominating the banking sector.

Under the communist regime, the banking system was dominated by a monobank combining the functions of a central bank and commercial banks. The Czech authorities decided quickly after the collapse of the old regime to separate the activities of the former monobank. After the formation of the two-tier banking system in 1990, the large Czech banks were transformed into joint-stock companies in 1992 and partially privatized with in the first wave of "voucher privatization" with the state, nevertheless, keeping controlling stakes in the large banks (Tuma, 2003). In the early 1990s, licences were granted quite freely to newly created banks and the market was opened to foreign bank branches in 1992. This led to a fast increase in the number of banks during the early 1990s (from 9 in 1990 to 52 in 1993). The liberal licensing policy was primarily motivated by a desire to quickly increase competition in the banking sector. However, the progress in bank regulation did not keep the same pace. The banking sector had been formed at a time when banking supervision was defined and conceived but when no appropriate supervisory activities had been developed yet. .

However, after 1993, the Czech authorities have strengthened the prudential measures to avoid a mass bankruptcy of the banking system because of the high amount of non-performing loans owned by the major banks, and of the poor financial situation of the newly created banks. During the period of economic boom and high credit growth (1994-1996), serious problems were already starting to emerge, especially in small banks. The Czech National Bank thus developed a comprehensive programme for consolidating small banks (Consolidation Programme II) at the end of 1995, with implementation commencing at the beginning of 1996. Of the 18 small banks, 15 were included in Consolidation Programme II, with radical solutions (revocation of licenses, imposition of forced administration or take-over by another bank) adopted in nine of them.

To resolve the problem of the increasing amount of non-performing loans, the Czech government decided in 1993 to transfer the main part of non-performing loans from major

banks to a special institution created for this purpose, Konsolidacní Banka. This procedure cleaned the loan portfolio of the main Czech banks with the intention of privatization.

Furthermore, the difficulties of the Czech economy, accompanied by the inefficiencies of bank management partly due to the remaining links between major state-owned banks and state-owned firms, led to a share of 30% of non-performing loans in the total of loans in 1997 (CNB, 1998). The Czech government finally adopted a program for the privatization of banks in 1998 leading to a banking sector gradually acquired by foreign investors as they were expected to stabilize banks financially, improve their efficiency and supply expertise in modern banking.

Consequently, the period from 1994 to 2005 was characterized by two main trends. The first trend is the failure of several banks. Out of the 48 banks operating in 1994 and another 6 licensed later on, 21 banks had failed by 2003. Most of the failures took place between 1994 and 2000.[4] Only 2 failures happened after 2000, both in 2003. We can then distinguish two periods regarding the bank failures: the "troubled" sub-period 1994-2000, and the "quiet" subperiod 2001-2005. As a consequence of the bank failures, the number of banks decreased in the Czech market from 48 in the beginning of 1994 to 36 at the end of 2005.

The second trend was the increasing share of foreign investors in the banking industry. After the privatization of one public bank, Zivnostenka Banka, sold to foreign investors in 1992, the foreign branches and subsidiaries specialized in investment banking and services to companies and households progressively developed in the Czech market. However the biggest change happened between 1999 and 2002 with the privatization and the sale of the three largest banks[5] to foreign banks. Failures of domestic-owned banks and sales to foreign investors progressively led to the fact that, at the end of 2005, foreign investors controlled 96.2% of assets in the banking sector (CNB, 2006).

These both tendencies in the Czech banking sector have been also observed in most transition countries at various degrees, so that they can be considered as general characteristics of the banking sector transformation in transition countries.

[4] The precise number of bank failures for each year from 1994 to 2000 was: 1, 3, 2, 5, 3, 3, 2, respectively.
[5] ČSOB, Česká Spořitelna, Komerční Banka.

2.2 A brief survey on the link between competition and efficiency in banking

Relatively little theoretical literature has been done on the link between competition and efficiency. As observed by Caves (1980, p.88), economists have « a vague suspicion that competition is the enemy of sloth ». This suspicion is nonetheless supported by a couple of arguments in the literature. First, Hicks (1935) considers that monopoly power allows relaxing efforts.[6] This *'quiet life'* hypothesis resorts to the idea that monopoly power allows managers to grab a share of the monopoly rents through discretionary expenses or a reduction of their effort. However, the existence of a monopoly rent does not explain its appropriation by managers. Indeed, there is no obvious reason why owners of monopolistic firms would exert a weaker control of managerial effort than those of competitive firms. Therefore, complementary theories have been suggested by Leibenstein (1966) and Demsetz (1973).

Leibenstein (1966) explains why inefficiencies inside firms (the "X-inefficiencies") exist, and why they are reduced by the degree of competition in product markets. X-inefficiencies would result from the existence of imperfections in the internal organization of firms: those imperfections have an impact on the level of information asymmetries between owners and managers. Indeed, the incompleteness of labor contracts makes the effort of managers at least partially discretionary. The discretionary share of the effort would not be the source of any problem if the owners would have means to control firm performance. But the production function is not known entirely. Therefore, owners can not check the level of effort exerted by managers. Leibenstein then considers that 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. As they are aware of the increase of competition, managers have to improve their performance unless their firm leaves the market. Thus, managers are motivated by their will to avoid the personal costs of bankruptcy. Second, a higher number of firms on the market improves the possibilities for owners to assess firm performance, relative to other firms. They acquire in this way a better knowledge about the production function of the firm. Owners are then able to make a better assessment of managerial performance and consequently to proceed to changes in management if necessary. Being informed about the comparative possibilities of competition, managers are inclined to exert a higher effort. Following Leibenstein's works, a few studies have proposed a formalization of his ideas (Hart, 1983, Selten, 1986, Scharfstein, 1988). The X-efficiency

[6] This argument is summarized in the famous sentence from Hicks: "The best of all monopoly profits is quiet life."

theory from Leibenstein lies in fact within the scope of the "Structure – Conduct - Performance" (SCP) paradigm proposed by Bain (1951). According to this paradigm, the market structure would influence firm behavior in terms of prices and quantities, and therefore firm profits.

An alternative assumption has however been proposed by Demsetz (1973), which predicts a reverse causality between competition and cost efficiency: the *'efficient-structure'* hypothesis. He considers that the best-managed firms have the lowest costs and consequently the largest market shares, which leads to a higher level of concentration. Thus, the causality of the relationship between competition and efficiency is reversed in comparison to the SCP paradigm: efficiency determines competition. As concentration can be considered as an inverse measure of competition, there should then exist a negative link between competition and efficiency.

This survey has until now only presented some theoretical references about the link between competition and efficiency, which are not necessarily specific to the banking industry. However, the banking markets have some specific characteristics in comparison to other markets. First, banking markets have a structure of imperfect competition, as observed in most studies on banking competition (e.g. De Bandt and Davis, 2000, Bikker and Haaf, 2002, Weill, 2004). In fact, theoretical literature in banking suggests that imperfect competition may result from the information asymmetries between the bank and the borrower in the credit activity. As a consequence, banks have to implement some mechanisms to solve the resulting problems such as adverse selection and moral hazard. One way out is the implementation by the bank of a customer relationship, meaning a long-term repeated relationship, to gain some information on the borrower. Banks can then reduce the problems related to information asymmetries. Nevertheless, an increase in banking competition may reduce the length of customer relationship. These specific characteristics of the banking industry may consequently modify the relationship between competition and efficiency in banking. Also, according to Diamond (1984), banks have a comparative advantage in the ex post monitoring of borrowers, in comparison to investors, because of the existence of scale economies resulting from their role of delegated monitor.

As a consequence, competition may increase monitoring costs because of the existence of scale economies, and of potential reduction of the length of the customer relationship, further decreasing cost efficiency of banks. In other words, the specificities of the banking industry provide some additional arguments in favor of a negative relationship between competition and cost efficiency. This assumption will be called the *'banking specificities'*

hypothesis in the following. It can be argued that this assumption should be more validated in transition countries than in developed countries. Indeed, banks are supposed to suffer more from information asymmetries in transition countries, because of the uncertainties of accounting information, and of the relative lack of know-how of bank employees in the analysis of credit risk in connection with the short history of market economy.

We now turn to the empirical studies on the relationship between competition and efficiency in banking. Only a few works have been performed on this issue, most of them regressing cost efficiency on a set of variables for market structure: Berger (1995) and Berger and Hannan (1997) on US banks, Lang (1996) on Western German banks, Goldberg and Rai (1996) and Punt and Van Rooij (2003) on European banks. In these works, cost efficiency is measured most of the time with stochastic frontier approach, while market structure is taken into account through market share or concentration indices into account. These papers tend to support a positive relationship between cost efficiency and concentration / market share. Therefore, they are rather in favor of the *'efficient-structure'* hypothesis. In a paper devoted to Western European banks, Weill (2004) also supports this view but by regressing efficiency scores on the non-structural measure obtained with the Rosse-Panzar model.

In summary, the theoretical literature provides conflicting arguments with respect to the relationship between competition and efficiency, while the empirical literature is rather in favor of a negative relationship. It therefore seems relevant to provide new empirical evidence with respect to the relationship between competition and efficiency by measuring competition with the Lerner index and by investigating the sense of causality of this link. Furthermore, as no former empirical paper has been done on this issue in a transition country, it is also of utmost interest to investigate whether the specificities of such an economy influence this relationship.

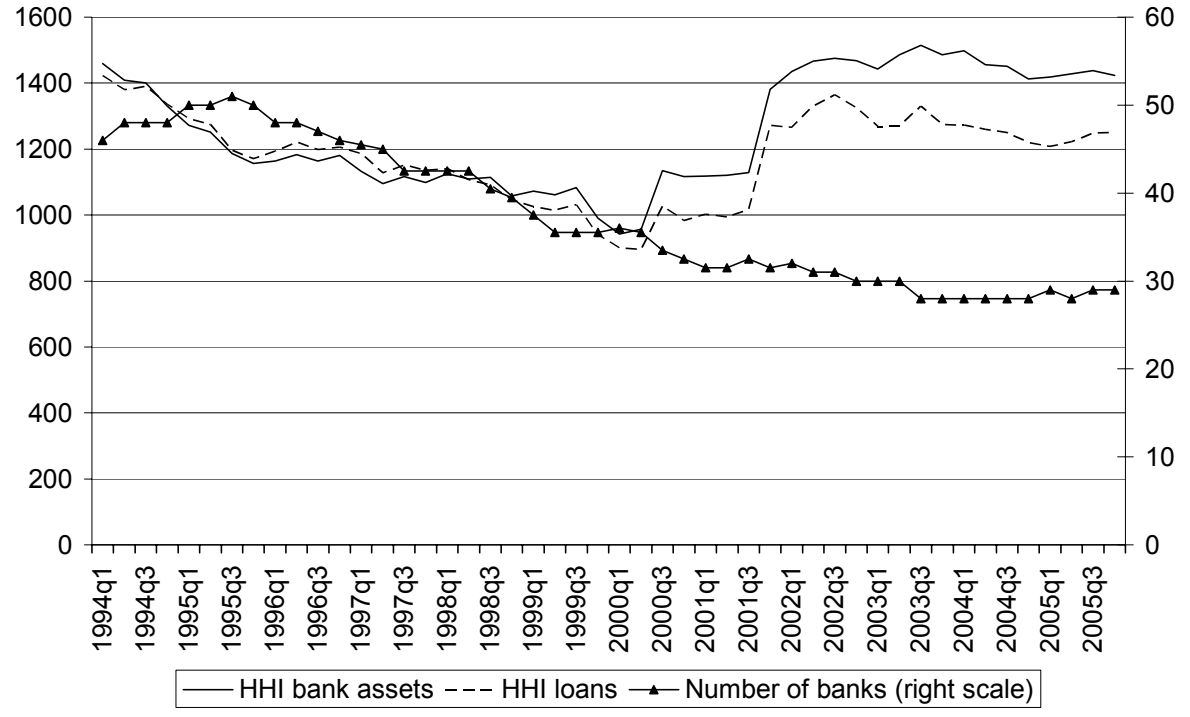
3. Methodology

Our aim is to investigate the relationship between competition and efficiency in the Czech banking industry. We therefore explain in this section how we estimate both variables.

3.1. Measurement of competition

Empirical research on the measurement of banking competition provides several tools, which can be subdivided into the traditional Industrial Organization (IO) and the new empirical IO approaches. The traditional IO approach proposes structural tests to assess banking competition based on the SCP model suggested by Bain (1956). The SCP hypothesis argues that greater concentration causes a less competitive bank conduct and leads to greater profitability (meaning lower performance in terms of social welfare). According to this, competition can be measured by concentration indices such as the market share of the five largest banks, or by the Herfindahl index. These tools were widely applied until the 1990s. Figure 1 shows the evolution of the Herfindahl index of the Czech banking sector calculated for total bank assets and loans, respectively from 1994 to 2005 and the number of banks which were reporting to the central bank. According to the Herfindahl index, concentration continuously decreased from 1994 to 2000 and then strongly increased from 2000 until 2002 before a stagnation from 2002 to 2005, whereas the number of banks continuously decreased over this time period.

Figure 1: Herfindahl index and number of banks
in the Czech Republic 1994-2005



The new empirical IO approach provides non-structural tests to circumvent the problems of measuring competition provided by the traditional IO approach. Namely, these latter measures suffer from the fact that they infer the degree of competition from indirect proxies such as market structure or market shares. In comparison, the new empirical IO approach infers banks' conduct directly. Furthermore, the latter approach allows considering the actual behaviour of the banks by taking contestability into account. Indeed, as observed by Claessens and Laeven (2004), the actual behavior of a bank is not only related to market structure but also to the barriers to entry influencing the likelihood of the entry of new competitors and therefore the behavior of incumbents forecasting such an entry.

The most commonly applied tool to assess competition emanating from the New empirical IO approach is the Rosse-Panzar model. This non-structural test is based upon the estimation of the H-statistic, which aggregates the elasticities of total revenues to input prices. It has been applied in Western European countries by several authors (Bikker and Haaf, 2002; Hempell, 2002; Weill, 2004), and also by Gelos and Roldos (2004) to eight emerging countries including three transition countries (the Czech Republic, Hungary and Poland). This latter study concludes to monopolistic competition in these three countries, and also to the absence of a significant change in banking competition between 1994 and 1999. However this paper does not use the exhaustive information on banks, as it obtains information from the Bankscope database in which a substantial number of banks is missing. Furthermore, the Rosse-Panzar model provides merely a characterization of the degree of competition for the banking industry as a whole. Another approach is the Bresnahan-Lau test based on the estimation of a structural model with separate demand and supply equations (Bresnahan, 1982, 1989; Lau, 1982). This test therefore estimates the mark-up on aggregate data. To our knowledge, this approach has only been applied on banking sectors from Western countries (e.g. Shaffer, 1993).

However, our research requires individual measures of competition for each bank of our sample through the period 1994-2005 instead of aggregate measures for the full sample. Therefore, we compute the Lerner index for each bank of the sample instead of estimating the Rosse-Panzar model and the Bresnahan-Lau test.

The Lerner index has been computed in several empirical studies on banking competition (e.g. Angelini and Cetorelli, 2003; Maudos and Fernandez de Guevara, 2004; Fernandez de Guevara *et al*., 2005). It is defined as the difference between price and marginal cost divided by price. In this study we focus exclusively on the loan market, which represents by far the greatest share of assets for Czech banks.

The price of loans is computed as 'Total interest revenues' divided by 'Total net loans', where 'Total net loans' represents 'Total loans' from which the non-performing loans were subtracted because revenues are not likely to come from the non-performing loans, so not subtracting the non-performing loans would understate the price for banks having important proportions of non-performing loans.

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 which are described in section 4. One cost function is estimated for each year by introducing fixed effects for banks. We impose the restriction of linear homogeneity in input prices by normalizing total costs and input prices by one input price. The cost function is specified as follows.

$$\begin{aligned}\ln\left(\frac{TC}{w_3}\right) &= \alpha_0 + \alpha_1 \ln y + \frac{1}{2}\alpha_2 (\ln y)^2 + \alpha_3 \ln\left(\frac{w_1}{w_3}\right) + \alpha_4 \ln\left(\frac{w_2}{w_3}\right) \\ &+ \alpha_5 \ln\left(\frac{w_1}{w_3}\right)\ln\left(\frac{w_2}{w_3}\right) + \frac{1}{2}\alpha_6\left(\ln\left(\frac{w_1}{w_3}\right)\right)^2 + \frac{1}{2}\alpha_7\left(\ln\left(\frac{w_2}{w_3}\right)\right)^2 \\ &+ \alpha_8 \ln y \ln\left(\frac{w_1}{w_3}\right) + \alpha_9 \ln y \ln\left(\frac{w_2}{w_3}\right) + \varepsilon\end{aligned} \quad (1)$$

Where TC total costs, y loans, w_1 price of labor, w_2 price of physical capital, w_3 price of borrowed funds. Indices for each bank have been dropped in the presentation for simplicity.

The estimated coefficients of the cost function are then used for computing the marginal cost. Indeed, as marginal cost is the derivative of total cost to output (here loans), it can be derived that the derivative of the logarithm of total cost to logarithm of output is the ratio of marginal cost to total cost multiplied by output. As a consequence, marginal cost is equal to the product of the derivative of the logarithm of total cost to output (i.e. the derivative of equation (1) to loans y) multiplied by the ratio of total cost to output.

3.2 Measurement of efficiency

We compute cost efficiency which measures how close a bank's cost is to what a best-practice bank's cost would be for producing the same bundle of outputs. It then provides information on wastes in the production process and on the optimality of the chosen mix of inputs. Several techniques have been proposed in the literature to measure efficiency with frontier approaches. While nonparametric approaches, e.g. DEA, use linear programming techniques, parametric approaches, such as stochastic frontier approach (SFA) or distribution-

free approach (DFA) apply econometric tools to estimate the efficiency frontier. In our study, we adopt a distribution- free approach circumventing in this way the main critic attached to the widely used SFA, namely its reliance on distributional assumptions. Considering the cost function TC = f(Y, P) + ε, where TC represents total cost, Y is the vector of outputs, P the vector of input prices and ε the error term, the SFA would suppose that error term is the sum of *u* and *v* where *u* is a one-sided component representing cost inefficiencies, meaning the degree of weakness of managerial performance and *v* is a two-sided component representing random disturbances, assumed to have a normal distribution to reflect luck or measurement errors. Various distributional assumptions are made for u, and the literature shows that the results are contingent of these assumptions.

DFA does not resort to distributional assumptions to separate inefficiency from random error. Instead, DFA presumes that efficiency of each firm is constant over time and that random error tends to cancel out over time. Bauer *et al.* (1998) distinguish three different techniques through which DFA could be implemented in practice. In this study, we chose to apply DFA-P WITHIN, which is a fixed-effects model which estimates inefficiency from the value of a firm-specific dummy variable; each firm's efficiency is then computed as the deviation from the most efficient firm's intercept term. More precisely, we estimate a translog cost function presented in equation (1) for each year (four quarters) where we assume that the random error cancels out over the four quarters and the (in)efficiency term is computed from an estimated bank-specific dummy variable.

4. Data and variables

We use monthly data for all Czech commercial banks[7] during the period 1994-2005 that were reported to the Czech National Bank (CNB) and transformed them into quarterly data. We perform a careful investigation of the data to find and drop outliers. For the failed banks, the observations for the year of failure were dropped as the data for the quarters preceding the failures were mostly chaotic. Furthermore, for each bank and for each year, we tried to have data for all four quarters. We then use an unbalanced panel.

[7] We do not include the mortgage banks since a mortgage bank has a different production function than the one of a commercial bank.

Two approaches are proposed in the banking literature for the definition of inputs and outputs. The intermediation approach assumes that the bank collects deposits to transform them, using labor and capital, into loans as opposed to the production approach, which views the bank as using labor and capital to produce deposits and loans.[8] As our focus is on the loan activity, we adopt the intermediation approach.

Table 1. Descriptive statistics

	Median	Mean	S.D.
Output			
Loans (bn CZK)	14.4	53.9	92.8
Input prices			
Price of labor (thousands CZK)	85.9	116.3	93.7
Price of physical capital	0.09	0.137	0.122
Price of borrowed funds	0.012	0.015	0.011
Other characteristics			
Assets (bn CZK)	20.12	81.09	146.3
Total costs (mil.CZK)	305.4	981.8	1 727.8
Price of loans	0.021	0.023	0.0122

N=1110 observations.

One output, loans, is adopted in the cost function and the cost efficiency frontier. The inputs include labor, physical capital and borrowed funds. The price of labor is measured by the ratio of personnel expenses to the number of employees. The price of physical capital is defined as the ratio of expenses for physical capital to fixed assets. The price of borrowed funds is measured by the ratio of expenses for borrowed funds to borrowed funds. Total costs are the sum of expenses for personnel, physical capital, and borrowed funds. The price of loans is computed by the ratio of interests received on loans to loans. Summary statistics for the period 1994-2005 are reported in table 1.

5. Results

This section presents the empirical results. The first subsection displays the evolution of banking competition. We then look whether the evolution of the Lerner index as resulting from our estimations is influenced by some factors among which we consider macroeconomic variables (GDP growth, inflation and short-term interest rate) and the changes in the structure

[8] Wheelock and Wilson (1995) and Berger *et al*. (1997) have shown that the choice of the approach has an impact on the level of efficiency scores but does not imply strong modifications in their rankings.

of the banking sector (proxied by the Herfindahl index). In the third subsection, we investigate the relationship between competition and efficiency.

5.1 The evolution of banking competition

We present the results regarding the computation of the Lerner index. One cost function is estimated for each year so as to allow coefficients of the cost function to evolve over time. The cost function is estimated introducing fixed effects for the banks.

Our results for each year are displayed in Table 2. One has to keep in mind that the Lerner index is an inverse measure of competition, meaning that a greater Lerner index means lower competition. The statistics of Lerner indices per year are concerning all the Lerner indices of the year for all banks. We focus our comments on the median competition measures for each year.

The most striking finding is the absence of a decreasing trend of the Lerner index, which would have meant an increase in banking competition. Namely, the Lerner index decreased in the first years between 1994 and 1997. Its evolution then became erratic between 1998 and 2001. From 2002 to 2005, the evolution became more regular with a clear increase.

Consequently, two remarks can be made to sum up the evolution of banking competition in the Czech Republic. First, the main trend is in favor of a reduced banking competition over the period. Namely, after the improvement in banking competition in the first years, banking competition considerably fell until 2005, even if this evolution was not straightforward. Second, we do therefore not observe any evolution towards a strong banking competition during the transition period.

We can point out that the entry of foreign investors in the Czech banking industry, which considerably increased from 1999 with the launching of the privatization of major banks, does not seem to favor a strong increase in banking competition. Or, it lead to an increase in competition until 2002, but then the results show a drastic decrease in competition. This may seem a surprising result, as this entry meant a strong change in the ownership of banks. However, it has to be stressed that the empirical literature on banking sectors in developed economies concludes in favor of imperfect competition. Therefore, the strong foreign ownership in Czech banks may have favored a process of convergence of banking performance towards the normal functioning of a market economy, even if a strong level of banking competition is not observed.

Table 2. Lerner indices per year

	N	Median	Mean	S.D.
1994	87	60.13	59.01	30.97
1995	110	16.94	13.6	49.48
1996	99	14.73	2.46	71.12
1997	106	-14.38	-26.88	83.67
1998	86	8.77	10.94	24.26
1999	99	32.16	30.76	31.73
2000	100	30.37	31.11	23.96
2001	92	24.4	29.12	24.79
2002	92	17.1	17.03	27.7
2003	88	50.95	43.44	30.93
2004	75	55.11	45.74	27.66
2005	76	44.8	42.09	26.67

All indices are in percentage.

Moreover, bank failures provide a limited explanation to the changes in banking competition. Namely, bank failures are expected to decrease competition – and therefore to increase the Lerner index – as they reduce the number of competitors. While the period can clearly be decomposed between one period with many bank failures from 1994 to 2000 and another period with only few bank failures from 2001 to 2005, we do not observe a reduction of competition between these sub-periods. This result is not surprising and in line with non-structural measures of competition from the new empirical IO approaches. Here, the number of competitors does not necessarily constitute a satisfactory measure of competition.

5.2 Factors affecting bank competition

Following Angelini and Cettorelli (2003), we query whether the evolution of our measured competition is affected by the macroeconomic development and the changes in the structure of the banking sector. The theoretical literature claims that the business cycle can have an impact on banks' mark-up. However, there is not an agreement among the results of the theoretical models. Rottemberg and Saloner (1986) find that the mark-up is countercyclical, whereas Green and Porter (1984) find the opposite. Regarding the influence of variations in the monetary policy, Angelini and Cettorelli (2003) claim that, in the periods of monetary tightening, one should notice an expansion of margins and vice-versa as bank liabilities tend to be characterized by greater inertia than those of assets. Hence short-term interest-rates should enter with a positive sign.

The results of our fixed effects panel estimates are presented in table 3.

Table 3. Factors affecting bank competition

	Dependent variable: Lerner index (%)	
	Coefficient	Standard error
Real GDP growth (%)	5.20***	0.88
Inflation (%)	0.23	0.31
Short-term interest rate (%)	-0.84*	0.48
Herfindahl index	-0.004	0.009
R^2	0.17	
Number of observations	872	

*, **, *** denote an estimate significantly different from zero at the 10%, 5% or 1% level.

The results favor the theory of cyclical mark-ups, as the coefficient of real GDP growth is positive and significant. The coefficient of inflation is not significant. The coefficient of short-term interest rate is negative and significant at 10%. Its sign contradicts the theoretical wisdom, signalizing a rather stronger inertia of bank assets than bank liabilities and that short-term market rates directly influence banks' marginal cost. Dinger and von Hagen (2005) finds that the Czech banking sector has characteristics of a two-tier banking system, namely few large liquid banks are net lenders in the interbank market and refinance the loan business of small banks that are thus net borrowers in the interbank market (Dinger and von Hagen, 2005).

The Herfindahl index's coefficient is negative and insignificant showing no relation between the market structure and our proposed measure of bank competition.

5.3 The link between competition and efficiency

Concerning the link between competition and efficiency, theoretical and empirical literature does not provide a clear-cut conclusion in favor of a positive influence of competition on efficiency in banking. Several hypotheses can be advanced on this relationship. While the *'efficient-structure'* hypothesis suggests a negative influence of efficiency on competition, the *'quiet life'* and the *'banking specificities'* hypotheses are both in favor of an impact of competition on efficiency even if they disagree on the sign of this effect.

We analyze the link between competition and efficiency in the Czech banking industry in a Granger-causality manner, formally specified in the equations (2) and (3) as follows:

$$y_{it} = \alpha_0 + \sum_{l=1}^{m} \alpha_l^y y_{it-l} + \sum_{l=1}^{m} \delta_l^y x_{it-l} + f_i^y + u_{it}^y \qquad (2)$$

$$x_{it} = \beta_0 + \sum_{l=1}^{m} \alpha_l^x x_{it-l} + \sum_{l=1}^{m} \delta_l^x x_{it-l} + f_i^x + u_{it}^x \quad (3)$$

Where y represents 'Efficiency' and x the 'Lerner index'. f_i represents the bank's 'individual effect'.

Efficiency and *Lerner* are the yearly averages of cost efficiency score and the Lerner index, respectively. i and t represent indices for the bank and the time (year), respectively. Each dependent variable is regressed on its yearly lags and on those of the other variable. We resort to using yearly averages in order to be able to capture a genuine effect, if any, of competition on efficiency and vice-versa. Namely, we believe that it takes time for the effect of competition on efficiency and vice-versa to be apparent, hence such an effect could be revealed by analyzing yearly data rather than quarterly data, which are obviously more volatile. Following Berger and De Young (1997) and Williams (2004), which also pursue a Granger-causality analysis, we adopt 4 yearly lags.

Having at our disposal a panel, we do not employ a standard Granger-causality analysis but we resort to panel specific methodology for estimating the dynamic equations (2) and (3). Holtz-Eakin *et al.* (1989) mention the main pitfall of not accounting for panel structure, but instead estimating a standard Granger-causality by stacking all the time series-cross section observations together. They insist that this procedure would ignore the possibility of accounting for "individual effects" which would summarize the influence of unobserved variables with a persistent effect on the dependent variable.

For estimating the dynamic equations represented in (2) and (3) we employ Generalized Method of Moments as designed by Arellano and Bond (1991). Attanasio *et al.*(2000) mention that most studies seeking Granger-causality type estimation with fixed effects are using estimators as those proposed by Holtz-Eakin, Newey and Rosen (1988) and Arrelano and Bond (1991) (hereinafter "AB"). AB's methodology first differences the autoregressive model in order to eliminate the individual effect and "optimally exploits" the moment conditions using the lagged values dated t-2 and earlier of the dependent variable. This ensures efficiency and consistency under the asymptotic hypothesis of $N/T \to \infty$, and provided that the model is not subject to serial correlation in ε_{it} , (namely, it will be evidence of significant negative first-order serial correlation and no evidence of second-order serial correlation in the differenced residuals) and that the set of instrument variables used is valid (which is tested with the Sargan test). Our panel dimension fulfills the asymptotic condition of large N and small T, as we follow 25 banks over a 12 years period.

The results are displayed in Table 4. The Sargan test and the first- and second-order serial correlations in the differenced residuals are reported at the bottom of the table (AR1 and AR2). The statistics favor a valid set of instrument variables and a significant negative first-order serial correlation and no evidence of second-order serial correlation in the differenced residuals. The table reports the coefficients of lags of dependent variable as well as the coefficients of lags of the independent variable. Of primary interest are the coefficients of the lag of the independent variable. For both equations (2) and (3), we test the joint hypothesis that $\delta_1 = \delta_2 = ... = \delta_m$ are equal to zero which signalizes whether this variable Granger-causes the dependent variable. The sum of these coefficients which gives an overall measure of the effect on the dependent variable is also computed.

Table 4. Granger-causality tests

	Dependent variable: Efficiency$_t$		**Dependent variable: Lerner$_t$**	
	Coefficient	Std err.	Coefficient	Std err.
Intercept	-0.06***	0.011	0.06***	0.02
Efficiency$_{t-1}$	-0.6***	0.12	0.11	0.15
Efficiency$_{t-2}$	0.05	0.12	0.28*	0.17
Efficiency$_{t-3}$	-0.18**	0.09	-0.11	0.14
Efficiency$_{t-4}$	0.05	0.09	-0.05	0.14
Efficiency$_{t-1}$= Efficiency$_{t-2}$= = Efficiency$_{t-3}$= Efficiency$_{t-4}$=0	chi2(4) = 32.94 Prob > chi2 = 0.0000		**chi2(4) = 4.33** **Prob > chi2 = 0.3629**	
$\sum AR$ Efficiency coefficients	-0.69***	0.24	**0.24**	**0.32**
Lerner$_{t-1}$	0.2***	0.07	-0.33***	0.11
Lerner$_{t-2}$	0.29***	0.08	-0.17	0.12
Lerner$_{t-3}$	0.29***	0.08	-0.15	0.11
Lerner$_{t-4}$	0.12**	0.06	-0.12	0.10
Lerner$_{t-1}$= Lerner$_{t-2}$= Lerner$_{t-3}$= = Lerner$_{t-4}$=0	**chi2(4) = 32.69** **Prob > chi2 = 0.0000**		chi2(4) = 11.99 Prob > chi2 = 0.0175	
$\sum AR$ Lerner coefficients	**0.898*** **	**0.16**	-0.77***	0.24
p-value AR1/AR2	0.05 / 0.13		0.000 / 0.24	
p-value Sargan	0.003		0.04	
Number of observations	1085		1085	

*, **, *** denote an estimate significantly different from zero at the 10%, 5% or 1% level.

The results show that the Lerner index positively Granger-causes the efficiency – hence, competition negatively Granger-causes efficiency – but efficiency does not Granger-causes competition. In the equation explaining *Efficiency* the coefficient of the lags Lerner index are jointly different from zero (Prob > chi2 = 0.0000) and they sum up to 0.9, significant at 1%.

In the equation explaining *Lerner index*, the lags of Efficiency are not jointly different from zero (Prob > chi2 = 0.3629) and their sum is 0.24, not significant at 10%.

This means that competition negatively Granger-causes efficiency. This result is consistent with the *'banking specificities'* hypothesis, according to which greater competition should reduce cost efficiency of banks.

In sum, our findings endorse only a negative causality running from competition to efficiency in the Czech banking sector during its transition period from 1994 to 2005, meaning that an exacerbated competition can lead to an increase in monitoring costs through the reduction in the length of the customer relationship and due to the presence of scale economies in the banking sector.

The finding of a negative link between banking competition and banking efficiency suggests that policies favoring banking competition should take into the consideration its possible effects on banking efficiency and therefore on financial stability. It is worth mentioning that our findings can be considered as a contribution to the literature regarding the trade-off between banking competition and financial stability (Allen and Gale, 2004). Namely, several papers have underlined the possible negative effects of banking competition on financial stability, notably through the increase of risk-taking of banks. We provide another channel of transmission for the negative effects of banking competition through hampered cost efficiency of banks.

The finding of a negative relationship between competition and efficiency in the Czech banking industry is in accordance with most studies providing results on the link between competition and efficiency in banking (Berger, 1995; Goldberg and Rai, 1996; Weill, 2004). However our study differs from former works on this issue in two major aspects. On the one hand, all former papers adopted concentration or market share indices, if we except Weill (2004) using the Rosse-Panzar model. On the other hand, unlike other papers concentrating on Western countries, we provide evidence on the link between competition and efficiency in banking in the framework of a transition country. As a consequence, this result brings some robustness to the counterintuitive negative relationship between competition and efficiency in banking generally observed in empirical works.

6. Conclusion

This research provides new evidence on the link between competition and efficiency in the banking sector, by focusing on the economic transition period of the Czech Republic. Our first results show the absence of increased competition on the Czech banking market between 1994 and 2005. This may appear as a surprising finding as one may have expected that the massive entry of foreign investors in the Czech banking industry would have contributed to enhance the degree of banking competition. However, one has to keep in mind the imperfect competition observed on banking markets in developed economies.

An analysis relating the estimated panel of the Lerner index to several macroeconomic factors (GDP growth, inflation and short-term interest rate) and to a measure of banking concentration (Herfindahl index) finds that business cycle can have an impact on banks' mark-up (cyclical mark-ups), no inflationary pressure on mark-ups but a positive relationship with the short-term interest rate, meaning a stronger inertia of bank assets than bank liabilities.

Furthermore, we analyze the relationship and causality between our proposed measure of competition and estimated efficiency and provide evidence in favor of a negative causality running only from competition to efficiency in the Czech banking sector. This finding may appear counterintuitive. It is however in accordance with former literature in banking, which supports the existence of a negative link between competition and efficiency in banking. No increase of competition as observed in the Czech banking industry, does not necessarily reflect a bad development. Furthermore, it can be explained by the fact that increased competition leads to greater monitoring costs for banks owing to economies of scale and the reduction of the length of the customer relationship between the bank and the borrower.

This finding has major implications, as it casts uncertainty on the view of favoring banking competition in the perspective of reducing prices of financial services. Indeed, greater banking competition may hamper cost efficiency of banks, which could result in higher loan rates.

References

Allen, F., and Gale, D. (2004). 'Competition and Financial Stability', *Journal of Money, Credit and Banking* 36, 3, 453-480.

Angelini, P. and Cetorelli, N. (2003). 'Bank Competition and Regulatory Reform: The Case of the Italian Banking Industry', *Journal of Money, Credit and Banking,* 35, 663-684.

Arrelano, M., and Bond, S. (1991). 'Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations", *Review of Economic Studies*, 58, 277–297.

Attanasio, O., Picci L. and Scorcu A. (2000). 'Saving, Growth and Investment: A Macroeconomic Analysis Using a Panel of Countries', *The Review of Economics and Statistics,* 82(2), 182-211.

Bain, J. (1951). 'Relation of Profit Rate to Industry Concentration.' *Quarterly Journal of Economics* 65, 293-324.

Bauer, P., Berger, A., Ferrier, G. and Humphrey, D. (1998). 'Consistency Conditions for Regulatory Analysis of Financial Institutions: A Comparison of Frontier Efficiency Methods', *Journal of Economics and Business* 50, 2, 85-114.

Berger A. (1995). 'The Profit-Structure Relationship in Banking – Tests of Market-Power and Efficient-Structure Hypotheses.' *Journal of Money, Credit, and Banking* 27, 404-431.

Berger, A., and DeYoung, R. (1997). 'Problem Loans and Cost Efficiency in Commercial Banks.' *Journal of Banking and Finance* 21, 849-870.

Berger, A. and Hannan, T. (1997). 'Using Efficiency Measures to Distinguish among Alternative Explanations of the Structure-Performance Relationship in Banking.' *Managerial Finance* 1, 23, 6-31.

Berger, A., Leusner, J. and Mingo, J. (1997). 'The Efficiency of Bank Branches.' *Journal of Monetary Economics* 40, 1, 141-162.

Bikker, J., and Haaf, K., (2002). 'Competition, Concentration and their Relationship: An Empirical Analysis of the Banking Industry.' *Journal of Banking and Finance* 26, 2191-2214.

Bresnahan, T. (1982). 'The Oligopoly Solution Concept is Identified.' *Economics Letters* 10, 87-92.

Bresnahan, T. (1989). 'Empirical Studies of Industries with Market Power.' in *Handbook of Industrial Organization* (Editors: R. Schmalensee et R. Willig), Elsevier, 1011-1057.

Carletti, E. and Hartmann, P. (2002). 'Competition and Stability: What's Special about Banking?'*ECB Working Paper* 146.

Caves, R. (1980). 'Industrial Organization, Corporate Strategy and Structure.' *Journal of Economic Literature* 18, 64-92.

Caviglia, G., Krause, G. and Thimann, C. (2002). 'Key Features of the Financial Sectors in EU Accession Countries.' In C. Thimann, Ed., *Financial Sectors in Transition Countries*, European Central Bank, Francfort.

Claessens, S. and Laeven, L. (2004). 'What Drives Bank Competition? Some International Evidence.' *Journal of Money, Credit and Banking,* 36, 3, 563-583.

CNB (1998). *Banking Supervision in the Czech Republic*, Czech National Bank, Prague.

CNB (2006). *Financial Stability Report 2005*, Czech National Bank, Prague.

De Bandt, O. and Davis, P. (2000). 'Competition, Contestability and Market Structure in European Banking Sectors on the Eve of EMU.' *Journal of Banking and Finance* 24, 1045-1066.

Demsetz, H. (1973). 'Industry Structure, Market Rivalry and Public Policy.', *Journal of Law and Economics* 16, 1-9.

Diamond, D. (1984). 'Financial Intermediation and Delegated Monitoring.' *Review of Economic Studies* 51, 393-414.

Fernandez de Guevara, J., Maudos, J., Perez, F. (2005). 'Market Power in European Banking Sectors.' *Journal of Financial Services Research* 27, 2, 109-137.

Fries, S., and Taci, A. (2005). 'Cost Efficiency of Banks in Transition: Evidence from 289 Banks in 15 Post-Communist Countries.' *Journal of Banking and Finance* 29, 55-81.

Gelos, R., and Roldos, J. (2004). 'Consolidation and Market Structure in Emerging Market Banking Systems.' *Emerging Markets Review* 5, 1, 39-59.

Goldberg, L., and Rai, A. (1996). 'The Structure-Performance Relationship in European Banking." *Journal of Banking and Finance* 20, 745-771.

Green, E. and Porter, R. (1984). 'Non-cooperative Collusion under Imperfect Price Information', *Econometrica* 52, 87-100.

Hart, O. (1983). 'The Market Mechanism as an Incentive Scheme.' *Bell Journal of Economics* l4, 366-382.

Hasan, I., and Merton, K. (2003). 'Development and Efficiency of the Banking Sector in a Transitional Economy.' *Journal of Banking and Finance* 27, 12, 2249-2271.

Hempell, H. (2002). 'Testing for Competition among German Banks', Discussion Paper 04/02, Economic Research Centre of the Deutsche Bundesbank.

Hicks, J. (1935). 'The Theory of Monopoly', *Econometrica* 3, 1-20.

Holtz-Eakin, D., Newey W. and Rosen H. (1989). 'The Revenues-Expenditures Nexus: Evidence from Local Government Data', *International Economic Review* 30, 415-429.

Lang, G. (1996). 'Efficiency, Profitability and Competition.' *IFO Studien* 4, pp. 537-561.

Lau, L. (1982). 'On Identifying the Degree of Competitiveness from Industry Price and Output Data.' *Economics Letters* 10, 93-99.

Leibenstein, H. (1966). 'Allocative Efficiency versus X-Efficiency', *American Economic Review* 56, 392-415.

Maudos, J., and Fernandez de Guevara, J. (2004). 'Factors Explaining the Interest Margin in the Banking Sectors of the European Union.' *Journal of Banking and Finance* 28, 2259-2281.

Podpiera, A., and Podpiera, J. (2005) 'Deteriorating Cost Efficiency in Commercial Banks Signals an Increasing Risk of Failure.' Working Paper n°6, Czech National Bank.

Punt, L., and Van Rooij, M. (2003). 'The Profit-Structure Relationship and Mergers in the European Banking Industry: An Empirical Assessment'. *Kredit und Kapital* 36, 1, 1-29.

Reininger, T., Schardax, F. and Summer M. (2002): "Financial System Transition in Central Europe: The First Decade", SUERF Studies No.16.

Rottemberg, J. and Saloner G. (1986). 'A Super-Game Model of Price Wars during Booms', *American Economic Review* 76, 390-407.

Scharfstein, D. (1988). 'Product-Market Competition and Managerial Slack.' *Rand Journal of Economics* 19, 147-155.

Selten, R. (1986). 'Elementary Theory of Slack-Ridden Imperfect Competition.' in *New Developments in the Analysis of Market Structure* (Editors: J.E.Stiglitz et G.F. Mathewson), Macmillan, 126-146.

Shaffer, S. (1993). 'A Test of Competition in Canadian Banking.' *Journal of Money, Credit, and Banking* 25, 1, 49-61.

Weill, L. (2004). 'On the Relationship between Competition and Efficiency in the EU Banking Sectors', *Kredit und Kapital* 37, 3, 329-352.

Wheelock, D. and Wilson, P. (1995). 'Evaluating the Efficiency of Commercial Banks: Does Our View of What Banks Do Matter ?' *Review of Federal Reserve Bank of Saint-Louis* 77, 4, 39-52.

Williams, J. (2004). 'Determining Management Behaviour in European Banking.' *Journal of Banking and Finance* 28, 2427-2460.