WORKING PAPER SERIES 6

2007

Anca Pruteanu-Podpiera, Laurent Weill and Franziska Schobert:
Market Power and Efficiency in the Czech Banking Sector

CNB CZECH NATIONAL BANK

WORKING PAPER SERIES

Market Power and Efficiency in the Czech Banking Sector

Anca Pruteanu-Podpiera
Laurent Weill
Franziska Schobert

6/2007

CNB WORKING PAPER SERIES

The Working Paper Series of the Czech National Bank (CNB) is intended to disseminate the results of the CNB's research projects as well as the other research activities of both the staff of the CNB and collaborating outside contributor, including invited speakers. The Series aims to present original research contributions relevant to central banks. It is refereed internationally. The referee process is managed by the CNB Research Department. The working papers are circulated to stimulate discussion. The views expressed are those of the authors and do not necessarily reflect the official views of the CNB.

Printed and distributed by the Czech National Bank. Available at http://www.cnb.cz.

Reviewed by: Jan Sobotka (Czech National Bank)
Karel Janda (Faculty of Social Sciences, Charles University)
Jonathan Williams (University of Wales, Bangor)

Project Coordinator: Michal Hlaváček

Market Power and Efficiency in the Czech Banking Sector

Anca Pruteanu-Podpiera, Laurent Weill and Franziska Schobert *

Abstract

Banking competition is expected to provide welfare gains by reducing monopoly rents and cost inefficiencies, favoring a 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 to provide evidence on the effects of banking competition in the Czech Republic.

First, we measure the level and evolution of banking competition between 1994 and 2005. Competition is measured by the Lerner index on the loan market, using data on loan prices. The results do not show a clear-cut trend in the evolution of the Lerner index. Second, we investigate the relationship and causality between competition and efficiency. We perform a Granger-causality-type analysis. This supports the 'banking specificities' hypothesis, according to which 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, in this way reducing the cost efficiency of banks. Therefore, our results reject the intuitive 'quiet life' hypothesis and indicate a negative relationship between competition and efficiency in banking.

JEL Codes: G21, L12, P20.

Keywords: Banks, competition, efficiency, transition countries.

* Anca Pruteanu-Podpiera, Czech National Bank (e-mail: anca.podpiera@cnb.cz).
Laurent Weill, Université Robert Schuman, Strasbourg (e-mail:laurent.weill@urs.u-strasbg.fr).
Franziska Schobert, Deutsche Bundesbank, Frankfurt (e-mail:franziska.schobert@bundesbank.de).
This work was supported by Czech National Bank Research Project No. C6/2005.
We would like to thank Michal Hlaváček, Karel Janda, Jan Sobotka, Tomáš Holub for insightful comments.

Nontechnical Summary

Banking competition is expected to provide welfare gains by reducing monopoly rents and cost inefficiencies, in this way favoring investment and growth. On the one hand, a higher degree of banking competition should result in a lower monopoly power of banks, and therefore a decrease in banking prices. On the other hand, 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 the cost inefficiencies averages 50% in transition countries (Fries and Taci, 2005) and 45% in the Czech Republic during the period 1994–2002 (Podpiera and Podpiera, 2005).

The aim of our research is twofold. First, we provide evidence on the level and evolution of banking competition in the Czech Republic between 1994 and 2005. We measure competition with the Lerner index, using data on output prices. We focus exclusively on the loan market, which represents by far the greatest share of assets for Czech banks. Using quarterly data on all Czech commercial banks over the period 1994–2005, we measure the degree of monopoly power for each bank in the loan market and the evolution of competition over the period. The second aim is to investigate the relationship and causality between our measure of competition and estimated cost efficiency. Both the theoretical and empirical literature provide arguments for both signs of this relationship.

The results do not show a clear-cut trend in the evolution of the Lerner index. We see a decrease in competition between the periods 1995–1998 and 1999–2000 followed by an increase lasting until 2002. The period 2003–2004 sees a decrease in competition with a slight revival in 2005. The reduction in competition between the periods 1995–1998 and 1999–2000 might suggest a rather relaxed period for banks after the financial turmoil of 1996–1998. The increase in competition during the period 1999–2002 can be attributed to the entry of foreign banks into the Czech banking industry, which increased considerably from 1999 onwards with the launch of the privatization of major banks. The subsequent (2003–2005) decrease in our measure of competition actually contradicts the common belief of current fierce competition in banking. This might actually have been a temporary situation resulting from the current absence of the threat of a new competitor in the Czech banking market.

Regarding the relationship between the measure of competition and estimated cost efficiency, 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. This result is consistent with the 'banking specificities' hypothesis, according to which 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, in this way reducing the cost efficiency of banks.

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

1. Introduction

As banks play 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 by reducing the prices of financial services and thereby 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 in banking prices. On the other hand, 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 the cost inefficiencies in the banking sectors of 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 by 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 a decrease in loan rates, a reduction of monopoly rents and cost inefficiencies would consequently impact on investment and economic growth.

Furthermore, the transition countries underwent 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 offers a relevant illustration of what has happened in transition countries. The Czech Republic was considered a successful country at the beginning of the transition period before facing the same troubles as the other transition countries with bank failures and before opening up its banking sector to foreign investors.

The aim of this research is twofold. First, we provide evidence on the level and evolution of banking competition in this country between 1994 and 2005. A major contribution is the measurement of competition with the Lerner index, using data on output prices. We are therefore able to measure the degree of monopoly power for each bank in the loan market. The second aim is to investigate the relationship and causality between competition and efficiency. Indeed, in spite of the commonly accepted view favoring 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, the theoretical literature provides arguments for both signs of this relationship. Namely, the intuitive ‘quiet life’ hypothesis suggests that competition positively influences 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 cause one to expect that competition negatively influences efficiency, as reduced competition allows banks to benefit from economies of scale in monitoring and from longer customer relationships.

We aim to provide 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 us to investigate 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 the causality between competition and efficiency in banking. This is an issue of considerable interest to the Czech banking industry, and also to the empirical banking literature as a whole. Indeed, to our knowledge this is the first work to investigate the causality between competition and efficiency in banking. We then contribute to the literature on banking in transition countries by providing the first investigation of 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 the normative implications of competition policy in the banking industry. Specifically, a negative relationship between competition and efficiency would mean a trade-off between these two 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 the 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 the economic transition period. The final outcome is fairly similar to that of the banking sectors in the other Central European transition countries, with foreign owners now dominating the banking sector.

In the early 1990s, licenses were granted quite freely to newly created banks and the market was opened up to foreign bank branches in 1992. This led to a rapid 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 with bank regulation did not keep the same pace. The banking sector was formed at a time when banking supervision had been defined and conceived but when no appropriate supervisory activities had yet been developed.

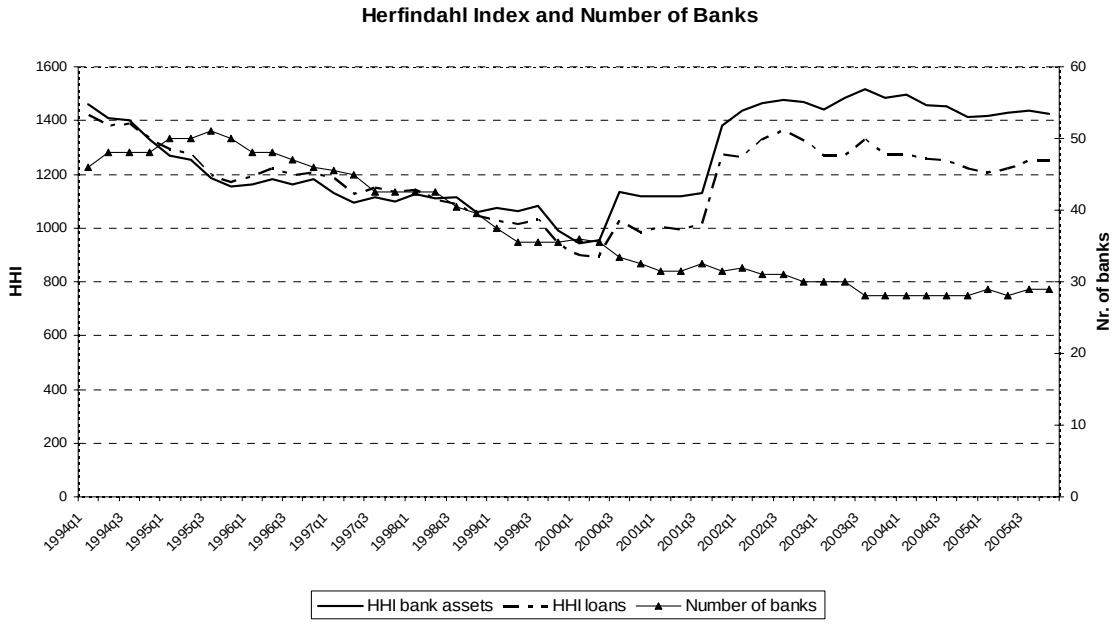
The period from 1994 to 2005 saw two main trends. The first was the failure of numerous banks. Out of the 48 banks operating in 1994 and another 6 licensed later on, 21 banks had failed by 2003. Most of these failures occurred between 1994 and 2000.1 Only 2 failures happened after 2000, both of them in 2003. We can thus distinguish two periods regarding 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 in the Czech market decreased from 48 at the beginning of 1994 to 36 at the end of 2005.

[1] Number of bank failures for each year from 1994 to 2000: 1, 3, 2, 5, 3, 3, 2.

The second trend was an increasing share of foreign investors in the banking industry. After the privatization of one public bank, Živnostenská Banka, sold to foreign investors in 1992, there was a steady rise in foreign branches and subsidiaries specializing in providing investment banking and services to companies and households in the Czech market. The Czech government finally adopted a bank privatization program in 1998, leading to the banking sector being gradually acquired by foreign investors as they were expected to stabilize banks financially, improve their efficiency, and supply expertise in modern banking. Hence, the biggest change occurred between 1999 and 2002 with the privatization and sale of the three largest banks2 to foreign banks. Owing to the failures of Czech-owned banks and sales to foreign investors, foreign investors controlled 96.2% of the assets of the banking sector by the end of 2005 (CNB, 2006).

The entry of foreign banks, especially through the privatization of the largest Czech banks, was expected to provide a substantial increase in competition. The issue of competition in the banking sector was often mentioned both in public discussions and among practitioners, especially given the fact that banks' representatives declared that increased competition in the banking market was one of their goals. A surge in the number of services and products supplied, especially regarding loans, is the main hard fact viewed as signaling an increase in competition in the Czech banking sector (CNB 2004, 2005, 2006). Formally, competition has so far been measured using concentration indices such as the Herfindahl index, with higher concentration signaling lower competition and vice versa. Figure 1 shows the evolution of the Herfindahl index of the Czech banking sector calculated for total bank assets and loans from 1994 to 2005 and the number of banks which were reporting to the central bank. The number of banks decreased continuously over the period 1994–2004, due to bank failures and bank mergers. According to the Herfindahl index, concentration fell continuously from 1994 to 2000 and then strongly increased from 2000 until 2002, followed by a slight decrease between 2003 and 2005.

Figure 1: The Herfindahl Index and the Number of Banks in the Czech Republic 1994–2005



Source: CNB and own calculation.

[2] ČSOB, Česká Spořitelna, and Komerční Banka.

In addition, the Czech Republic's membership of the EU gave licensed European banks the opportunity to set up subsidiaries and branches easily in the Czech Republic. Theoretically, in the long-run perspective, this offers the possibility of some increase in competition in the Czech banking sector and may consequently influence the behavior of the incumbent banks.[3]

2.2 A Brief Survey of the Link between Competition and Efficiency in Banking

Relatively little theoretical literature has examined 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 a relaxing of efforts.[4] 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 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 had the means to control firm performance. But the production function is not known entirely. Therefore, owners cannot check the level of effort exerted by managers. Leibenstein then considers that the main determinant of a reduction in inefficiencies is an increase in competitive pressures, for two reasons. First, competition provides incentives to managers to exert more effort. As they are aware of the increase in competition, managers have to improve their performance or their firm will leave 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. In this way they acquire 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 make changes in the management if necessary. Being informed about the comparative possibilities of competition, managers are inclined to exert more effort. Following Leibenstein's , a few studies have proposed a formalization of his ideas (Hart, 1983; Selten, 1986; Scharfstein, 1988). Leibenstein's X-efficiency theory in fact lies within the scope of the "Structure–Conduct–Performance" (SCP) paradigm proposed by Bain (1951). According to this paradigm, market structure would influence firm behavior in terms of prices and quantities, and therefore firm profits.

[3] However, we have to keep in mind the previous experience of Western European countries vis-à-vis the single European passport. Namely, as stressed in Dermine (2003), the effects of the Second Banking Directive (implementing the single European passport) were far from what was anticipated. Indeed the directive made cross-border expansion through branches easier, but in practice this expansion took place via subsidiaries rather than via branches. Moreover, at the time of the implementation of the single European passport there were already numerous foreign banks in the Czech banking market.

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

An alternative assumption has, however, been proposed by Demsetz (1973). This 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 so far only presented some theoretical references about the link between competition and efficiency which are not necessarily specific to the banking industry. However, banking markets have some specific characteristics as compared 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, the theoretical literature in banking suggests that imperfect competition may result from the information asymmetries between bank and borrower in credit activity. As a consequence, banks have to implement some mechanisms to resolve 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 the 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 economies of scale resulting from their role of delegated monitor.

As a consequence, competition may increase monitoring costs because of the existence of economies of scale and a potential reduction in the length of the customer relationship, further decreasing the 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 text. It can be argued that this assumption should be more valid in transition countries than in developed countries. Indeed, banks are supposed to suffer more from information asymmetries in transition countries, because of uncertainties of accounting information and the relative lack of credit risk analysis know-how of bank employees, owing to the short history of the market economy.

We now turn to the empirical studies on the relationship between competition and efficiency in banking. Only a few studies 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, and Goldberg and Rai (1996) and Punt and Van Rooij (2003) on European banks. In these studies, cost efficiency is measured mostly using the stochastic frontier approach, while market structure is taken into account through market share or concentration indices. These papers tend to support a positive relationship between cost efficiency and concentration/market share. Therefore, they tend to be 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 tends to be 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 study 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 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.

The new empirical IO approach provides non-structural tests to circumvent the problems of measuring competition by the traditional IO approach. 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, it allows us to consider the actual behavior of banks by taking contestability into account. Indeed, as observed by Claessens and Laeven (2004), the actual behavior of a bank is related not only to market structure, but also to barriers to entry, influencing the likelihood of the entry of new competitors and therefore the behavior of incumbents forecasting such entry.

The most commonly applied tool for assessing 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 in favor of monopolistic competition in these three countries and also of the absence of a significant change in banking competition between 1994 and 1999. However, this paper does not use exhaustive information on banks, as it obtains information from the Bankscope database, from which a substantial number of banks are 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. This approach has been applied to banking sectors from Western countries (e.g. Shaffer, 1993) and recently to EU countries (Lhoták, 2004).

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 non-performing loans have been subtracted, because revenues are not likely to come from non-performing loans, so not subtracting non-performing loans would understate the price for banks having significant 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:

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

where *TC* denotes total costs, *y* loans, w_1 the price of labor, w_2 the price of physical capital, and w_3 the price of borrowed funds. The indices for each bank have been dropped from the presentation for the sake of simplicity.

The estimated coefficients of the cost function are then used to compute the marginal cost. Indeed, as the marginal cost is the derivative of the total cost with respect to output (here loans), it can be derived that the derivative of the logarithm of the total cost with respect to the logarithm of output is the ratio of the marginal cost to the total cost multiplied by output. As a consequence, the marginal cost is equal to the product of the derivative of the logarithm of the total cost with respect to output (i.e., the derivative of equation (1) with respect 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 waste 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 (Data Envelopment Analysis), use linear programming techniques, parametric approaches, such as the stochastic frontier approach (SFA) or the distribution-free approach (DFA), apply econometric tools to estimate the efficiency frontier. The cost efficiency estimation techniques are covered in more detail in Podpiera and Podpiera (2005).

In this study, we adopt a distribution- free approach, in this way circumventing the main critique attached to the widely used SFA, namely, its reliance on distributional assumptions. Considering the cost function $TC = f(Y, P) + \varepsilon$, where TC represents total cost, Y is the vector of outputs, P is the vector of input prices and ε is the error term, the SFA would suppose that the 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 on these assumptions.

The DFA does not resort to distributional assumptions to separate inefficiency from random error. Instead, the DFA presumes that the efficiency of each firm is constant over time and that the 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 that 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 the 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.

3.3 Testing the Relationship between Competition and Efficiency

Concerning the link between competition and efficiency, the 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 *'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 equations (2) and (3) as follows:

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

$$x_{it} = \beta_0 + \sum_{l=1}^{m} \alpha_l^{\,x} y_{it-l} + \sum_{l=1}^{m} \delta_l^{\,x} x_{it-l} + f_i^{\,x} + u_{it}^{x} \tag{3}$$

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 the cost efficiency score and the Lerner index, respectively. *i* and *t* represent the 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 the 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 become 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), who also pursue a Granger-causality analysis, we adopt four yearly lags.

Having at our disposal a panel, we do not employ a standard Granger-causality analysis but resort to panel-specific methodology to estimate the dynamic equations (2) and (3). Holtz-Eakin *et al.* (1989) mention the main pitfall of not accounting for panel structure, 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.

To estimate the dynamic equations represented in (2) and (3) we employ the 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 use estimators such 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 $N/T \to \infty$ (*N*- number of observations, *T*- time dimensio), provided that the model is not subject to serial correlation in ε_{it}, (i.e., there 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-year period.

4. Data and Variables

We use monthly data reported to the Czech National Bank (CNB) for all Czech commercial banks[5] during the period 1994–2005, and transform them into quarterly data. We perform a careful investigation of the data to find and drop outliers. For the failed banks, the observations

[5] We do not include mortgage banks, since a mortgage bank has a different production function than a commercial bank.

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.

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.[6] As our focus is on lending activity, we adopt the intermediation approach.

Table 1: Descriptive Statistics

	Median	Mean	S.D.
Output			
Loans (CZK billions)	14.4	53.9	92.8
Input prices			
Price of labor (CZK thousands)	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 (CZK billions)	20.12	81.09	146.3
Total costs (CZK millions)	305.4	981.8	1 727.8
Price of loans	0.021	0.023	0.0122

Source: CNB.
Notes: 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 using the ratio of interest 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 at 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 the short-term interest rate) and changes in the structure of the banking sector (as proxied by the Herfindahl index). In the third subsection, we investigate the relationship between competition and efficiency.

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

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 the coefficients of the cost function to evolve over time. The cost function is estimated introducing fixed effects for 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, 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 banks, where the banks have equal weights. We also compute weighted means and medians of the Lerner indices, where the weights were the banks' market shares in terms of total loans. These results for each year are presented in Table 3. There are no significant differences between the trends in the aggregated Lerner indices as emerging from the two methods of aggregation. We focus our comments on the median competition measures for each year as reported in Table 2.

A first glance at the results cannot distinguish a clear-cut trend (leaving aside a decreasing trend) in the evolution of the Lerner index. What we can clearly discern is that during the period 1999–2002 the Lerner index decreased, signaling an increase in competition. This episode was followed by an increase in the Lerner index, hence a decrease in competition, during 2003–2004, followed by a slight decrease in the Lerner index, hence an increase in competition, in 2005. The fact that the results show a negative figure for the Lerner index in 1997[7] make interpretation of the trend difficult for the period 1995–1998. However, a comparison between the Lerner index figures of 1995–1998 and the almost equal ones of 1999 and 2000 suggest a decrease in competition during this time span. To summarize, we see a decrease in competition between the periods 1995–1998 and 1999–2000 followed by an increase lasting until 2002. The period 2003–2004 sees a decrease in competition with a slight revival in 2005.

The reduction in competition between the periods 1995–1998 and 1999–2000 might suggest a rather relaxed period for banks after the financial turmoil of 1996–1998. In the same respect, the drastic increase in the Lerner index from 1998 to 1999 was to some extent triggered by a decrease in banks' marginal costs related to borrowing funds on the interbank market after 1998. The obvious increase in competition during the period 1999–2002 can be attributed to the entry of foreign banks into the Czech banking industry, which considerably increased from 1999 onwards with the launch of the privatization of major banks. The subsequent (2003–2005) decrease in our measure of competition actually contradicts the common belief of current fierce competition in banking. This might actually have been a temporary situation resulting from the current absence of the threat of a new competitor in the Czech banking market. As all the big banks were now sold, and as there were already many subsidiaries of foreign banks, the threat of entry of a new bank seemed low. Consequently, following the contestability theory, the competitive pressures on banks were limited. At the same time, we have to recall that our measures of competition cannot account for riskiness of banks' products. Given that after 2002 banks offered a wider spectrum of products, some of them relatively riskier and consequently pricier, this could have triggered an increase in the Lerner indices to some extent.

[7] The negative figure for the year 1997 comes from the fact that on average the MC was higher than the price of loans. This is likely to have been due to the high interbank rates triggered by the financial turmoil in 1997.

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

Notes: All indices are in percent.

Table 3: Lerner Indices per Year: Weighted Statistics

	N	Median	Mean	S.D.
1994	87	113.94	102.62	19.9
1995	110	90.61	76.59	28.17
1996	99	41.2	37.45	19.2
1997	106	-31.36	-31.6	20.65
1998	86	-0.1	-0.15	10.16
1999	99	31.21	30.08	8.28
2000	100	13.76	9.16	16.83
2001	92	12.19	8.07	16.7
2002	92	-2.51	-2.46	23.82
2003	88	7.37	13.43	30.66
2004	75	61.13	55.1	13.09
2005	76	25.35	25.7	21.47

Notes: All indices are in percent.

In addition, the results potentially signal convergence to the other European banking sectors. It has to be stressed that the empirical literature on banking sectors in developed economies concludes in favor of imperfect competition (De Bandt and David, 2000; Shaffer, 1993; Hempell, 2002). Therefore, the strong foreign ownership in Czech banks might favor a still ongoing process of convergence toward the usual characteristics in the banking industry even if a strong level of banking competition is not observed.

Moreover, bank failures provide a limited explanation for the changes in banking competition. 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 into a period with many bank failures from 1994 to 2000 and another period with only a few bank failures from 2001 to 2005, we do not observe a reduction in competition between these sub-periods. This result is not surprising and is 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 Cetorelli (2003), we query whether the evolution of our measure of competition is affected by macroeconomic developments and 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 no 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 monetary policy, Angelini and Cetorelli (2003) claim that in 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 4.

Table 4: 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	

Notes: *, **, *** denote estimates significantly different from zero at the 10%, 5%, and 1% levels, respectively.

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 the short-term interest rate is negative and significant at 10%. Its sign contradicts the theoretical wisdom, signaling rather stronger inertia of bank assets than bank liabilities and that short-term market rates directly influence banks' marginal costs. Dinger and von Hagen (2005) find that the Czech banking sector has characteristics of a two-tier banking system, i.e., a few large liquid banks are net lenders in the interbank market and refinance the loan business of small banks, which 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 market structure and our proposed measure of bank competition.

5.3 The Link between Competition and Efficiency

The results of the GMM estimation of the dynamic equations represented in (2) and (3) are displayed in Table 5. 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 the lags of the dependent variable as well as the coefficients of the 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 signals 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 for illustrative purposes on the sign of the relationship.

Table 5: 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	

Notes: *, **, *** denote estimates significantly different from zero at the 10%, 5%, and 1% levels, respectively.
AR means auto-regressive lag.

The results show that the Lerner index positively Granger-causes efficiency – hence competition negatively Granger-causes efficiency – but efficiency does not Granger-cause competition. In the equation explaining *Efficiency* the coefficient of the lags of the 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 the *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 the cost efficiency of banks.

In summary, 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 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.

The finding of a negative link between banking competition and banking efficiency suggests that policies favoring banking competition should take into 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 increased risk-taking by 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 previous papers on this issue in two major aspects. On the one hand, all the previous 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 studies.

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 an absence of increased competition in the Czech banking market between 1994 and 2005. This may seem a surprising finding, as one may have expected that the massive entry of foreign investors into the Czech banking industry would have contributed to enhancing the degree of banking competition. However, one has to keep in mind the imperfect competition observed in banking markets in developed economies.

An analysis relating the estimated panel of the Lerner index to several macroeconomic factors (GDP growth, inflation, and the short-term interest rate) and to a measure of banking concentration (the Herfindahl index) finds that the business cycle can have an impact on banks' mark-ups (cyclical mark-ups), with no inflationary pressure on mark-ups but a positive relationship to the short-term interest rate, meaning 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 the previous literature, which supports the existence of a negative link between competition and efficiency in banking. No increase in competition observed in the Czech banking industry does not necessarily reflect a bad trend. Furthermore, it can be explained by the fact that increased competition leads to greater monitoring costs for banks, owing to economies of scale and a reduction of the length of the customer relationship between the bank and the borrower.

The finding of a negative link between banking competition and banking efficiency suggests that policies favoring banking competition should take into consideration its possible effects on banking efficiency and therefore on financial stability. Our work supports the literature regarding the trade-off between banking competition and financial stability (Allen and Gale, 2004; Carletti and Hartmann, 2002).

References

ALLEN, F. AND D. GALE (2004): "Competition and Financial Stability." *Journal of Money, Credit and Banking* 36, 3, 453–480.

ANGELINI, P. AND N. CETORELLI (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 S. BOND (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., L. PICCI, AND A. SCORCU (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., A. BERGER, G. FERRIER, AND D. HUMPHREY (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 R. DEYOUNG (1997): "Problem Loans and Cost Efficiency in Commercial Banks." *Journal of Banking and Finance* 21, 849–870.

BERGER, A. AND T. HANNAN (1997): "Using Efficiency Measures to Distinguish among Alternative Explanations of the Structure-Performance Relationship in Banking." *Managerial Finance* 1, 23, 6–31.

BERGER, A., J. LEUSNER, AND J. MINGO (1997): "The Efficiency of Bank Branches." *Journal of Monetary Economics* 40, 1, 141–162.

BIKKER, J. AND K. HAAF (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 and R. Willig), Elsevier, 1011–1057.

CARLETTI, E. AND P. HARTMANN (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., G. KRAUSE, AND C. THIMANN (2002): "Key Features of the Financial Sectors in EU Accession Countries." In C. Thimann, Ed., *Financial Sectors in Transition Countries.* European Central Bank, Frankfurt.

CLAESSENS, S. AND L. LAEVEN (2004): "What Drives Bank Competition? Some International Evidence." *Journal of Money, Credit and Banking* 36, 3, 563–583.

CNB (2004): *Financial Stability Report 2003.*Czech National Bank, Prague.

CNB (2005): *Financial Stability Report 2004.*Czech National Bank, Prague.

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

DE BANDT, O. AND P. DAVIS (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.

DERMINE, J. (2003): "Banking in Europe: Past, Present and Future." In V. Gaspar, P. Hartmann, O. Sleijpen, Eds., *The Transformation of the European Financial System.* European Central Bank, Frankfurt.

DIAMOND, D. (1984): "Financial Intermediation and Delegated Monitoring." *Review of Economic Studies* 51, 393–414.

FERNANDEZ DE GUEVARA, J., J. MAUDOS, AND F. PEREZ (2005): "Market Power in European Banking Sectors." *Journal of Financial Services Research* 27, 2, 109–137.

FRIES, S. AND A. TACI (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 J. ROLDOS (2004): "Consolidation and Market Structure in Emerging Market Banking Systems." *Emerging Markets Review* 5, 1, 39–59.

GOLDBERG, L. AND A. RAI (1996): "The Structure-Performance Relationship in European Banking." *Journal of Banking and Finance* 20, 745–771.

GREEN, E. AND R. PORTER (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 K. MARTON (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., W. NEWEY, AND H. ROSEN (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, 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.

LHOTÁK, T. (2004): "Testing the Competition in the Banking Sectors of EU25 Countries." (Testování konkurence v bankovních sektorech zemí EU25), dissertation, Vysoká škola ekonomická v Praze, Fakulta finance a účetnictví.

MAUDOS, J. AND J. FERNANDEZ DE GUEVARA (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 J. PODPIERA (2005): "Deteriorating Cost Efficiency in Commercial Banks Signals an Increasing Risk of Failure." Working Paper No. 6, Czech National Bank.

PUNT, L. AND M. VAN ROOIJ (2003): "The Profit-Structure Relationship and Mergers in the European Banking Industry: An Empirical Assessment." *Kredit und Kapital* 36, 1, 1–29.

REININGER, T., F. SCHARDAX, AND M. SUMMER (2002): "Financial System Transition in Central Europe: The First Decade." SUERF Studies No. 16.

ROTTEMBERG, J. AND G. SALONER (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 and 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 P. WILSON (1995): "Evaluating the Efficiency of Commercial Banks: Does Our View of What Banks Do Matter?" *Federal Reserve Bank of Saint-Louis Review* 77, 4, 39–52.

WILLIAMS, J. (2004): "Determining Management Behaviour in European Banking." *Journal of Banking and Finance* 28, 2427–2460.

CNB WORKING PAPER SERIES

6/2007	Anca Pruteanu-Podpiera Laurent Weill Franziska Schobert	*Market power and efficiency in the Czech banking sector*
5/2007	Jiří Podpiera Laurent Weill	*Bad luck or bad management? Emerging banking market experience*
4/2007	Roman Horváth	*The time-varying policy neutral rate in real time: A predictor for future inflation?*
3/2007	Jan Brůha Jiří Podpiera Stanislav Polák	*The convergence of a transition economy:* *The case of the Czech Republic*
2/2007	Ian Babetskii Nauro F. Campos	*Does reform work?* *An econometric examination of the reform-growth puzzle*
1/2007	Ian Babetskii Fabrizio Coricelli Roman Horváth	*Measuring and explaining inflation persistence:* *Disaggregate evidence on the Czech Republic*
13/2006	Frederic S. Mishkin Klaus Schmidt-Hebbel	*Does inflation targeting make a difference?*
12/2006	Richard Disney Sarah Bridges John Gathergood	*Housing wealth and household indebtedness: Is there a household 'financial accelerator'?*
11/2006	Michel Juillard Ondřej Kameník Michael Kumhof Douglas Laxton	*Measures of potential output from an estimated* *DSGE model of the United States*
10/2006	Jiří Podpiera Marie Raková	*Degree of competition and export-production relative prices when the exchange rate changes: Evidence from a panel of Czech exporting companies*
9/2006	Alexis Derviz Jiří Podpiera	*Cross-border lending contagion in multinational banks*
8/2006	Aleš Bulíř Jaromír Hurník	*The Maastricht inflation criterion: "Saints" and "Sinners"*
7/2006	Alena Bičáková Jiří Slačálek Michal Slavík	*Fiscal implications of personal tax adjustments in the Czech Republic*
6/2006	Martin Fukač Adrian Pagan	*Issues in adopting DSGE models for use in the policy process*
5/2006	Martin Fukač	*New Keynesian model dynamics under heterogeneous expectations and adaptive learning*
4/2006	Kamil Dybczak Vladislav Flek Dana Hájková Jaromír Hurník	*Supply-side performance and structure in the Czech Republic (1995–2005)*
3/2006	Aleš Krejdl	*Fiscal sustainability – definition, indicators and assessment of Czech public finance sustainability*

2/2006	Kamil Dybczak	*Generational accounts in the Czech Republic*
1/2006	Ian Babetskii	*Aggregate wage flexibility in selected new EU member states*
14/2005	Stephen G. Cecchetti	*The brave new world of central banking: The policy challenges posed by asset price booms and busts*
13/2005	Robert F. Engle Jose Gonzalo Rangel	*The spline GARCH model for unconditional volatility and its global macroeconomic causes*
12/2005	Jaromír Beneš Tibor Hlédik Michael Kumhof David Vávra	*An economy in transition and DSGE: What the Czech national bank's new projection model needs*
11/2005	Marek Hlaváček Michael Koňák Josef Čada	*The application of structured feedforward neural networks to the modelling of daily series of currency in circulation*
10/2005	Ondřej Kameník	*Solving SDGE models: A new algorithm for the sylvester equation*
9/2005	Roman Šustek	*Plant-level nonconvexities and the monetary transmission mechanism*
8/2005	Roman Horváth	*Exchange rate variability, pressures and optimum currency area criteria: Implications for the central and eastern european countries*
7/2005	Balázs Égert Luboš Komárek	*Foreign exchange interventions and interest rate policy in the Czech Republic: Hand in glove?*
6/2005	Anca Podpiera Jiří Podpiera	*Deteriorating cost efficiency in commercial banks signals an increasing risk of failure*
5/2005	Luboš Komárek Martin Melecký	*The behavioural equilibrium exchange rate of the Czech koruna*
4/2005	Kateřina Arnoštová Jaromír Hurník	*The monetary transmission mechanism in the Czech Republic (evidence from VAR analysis)*
3/2005	Vladimír Benáček Jiří Podpiera Ladislav Prokop	*Determining factors of Czech foreign trade: A cross-section time series perspective*
2/2005	Kamil Galuščák Daniel Münich	*Structural and cyclical unemployment: What can we derive from the matching function?*
1/2005	Ivan Babouček Martin Jančar	*Effects of macroeconomic shocks to the quality of the aggregate loan portfolio*
10/2004	Aleš Bulíř Kateřina Šmídková	*Exchange rates in the new EU accession countries: What have we learned from the forerunners*
9/2004	Martin Cincibuch Jiří Podpiera	*Beyond Balassa-Samuelson: Real appreciation in tradables in transition countries*
8/2004	Jaromír Beneš David Vávra	*Eigenvalue decomposition of time series with application to the Czech business cycle*
7/2004	Vladislav Flek, ed.	*Anatomy of the Czech labour market: From over-employment to under-employment in ten years?*
6/2004	Narcisa Kadlčáková Joerg Keplinger	*Credit risk and bank lending in the Czech Republic*
5/2004	Petr Král	*Identification and measurement of relationships concerning inflow of FDI: The case of the Czech Republic*

4/2004	Jiří Podpiera	*Consumers, consumer prices and the Czech business cycle identification*
3/2004	Anca Pruteanu	*The role of banks in the Czech monetary policy transmission mechanism*
2/2004	Ian Babetskii	*EU enlargement and endogeneity of some OCA criteria: Evidence from the CEECs*
1/2004	Alexis Derviz Jiří Podpiera	*Predicting bank CAMELS and S&P ratings: The case of the Czech Republic*
12/2003	Tibor Hlédik	*Modelling the second-round effects of supply-side shocks on inflation*
11/2003	Luboš Komárek Zdeněk Čech Roman Horváth	*ERM II membership – the view of the accession countries*
10/2003	Luboš Komárek Zdeněk Čech Roman Horváth	*Optimum currency area indices – how close is the Czech Republic to the eurozone?*
9/2003	Alexis Derviz Narcisa Kadlčáková Lucie Kobzová	*Credit risk, systemic uncertainties and economic capital requirements for an artificial bank loan portfolio*
8/2003	Tomáš Holub Martin Čihák	*Price convergence: What can the Balassa–Samuelson model tell us?*
7/2003	Vladimír Bezděk Kamil Dybczak Aleš Krejdl	*Czech fiscal policy: Introductory analysis*
6/2003	Alexis Derviz	*FOREX microstructure, invisible price determinants, and the central bank's understanding of exchange rate formation*
5/2003	Aleš Bulíř	*Some exchange rates are more stable than others: Short-run evidence from transition countries*
4/2003	Alexis Derviz	*Components of the Czech koruna risk premium in a multiple-dealer FX market*
3/2003	Vladimír Benáček Ladislav Prokop Jan Á. Víšek	*Determining factors of the Czech foreign trade balance: Structural issues in trade creation*
2/2003	Martin Čihák Tomáš Holub	*Price convergence to the EU: What do the 1999 ICP data tell us?*
1/2003	Kamil Galuščák Daniel Münich	*Microfoundations of the wage inflation in the Czech Republic*

CNB RESEARCH AND POLICY NOTES		
2/2006	Garry J. Schinasi	*Private finance and public policy*
1/2006	Ondřej Schneider	*The EU budget dispute – A blessing in disguise?*
5/2005	Jan Stráský	*Optimal forward-looking policy rules in the quarterly projection model of the Czech National Bank*
4/2005	Vít Bárta	*Fulfilment of the Maastricht inflation criterion by the Czech Republic: Potential costs and policy options*
3/2005	Helena Sůvová Eva Kozelková David Zeman Jaroslava Bauerová	*Eligibility of external credit assessment institutions*
2/2005	Martin Čihák Jaroslav Heřmánek	*Stress testing the Czech banking system: Where are we? Where are we going?*
1/2005	David Navrátil Viktor Kotlán	*The CNB's policy decisions – Are they priced in by the markets?*
4/2004	Aleš Bulíř	*External and fiscal sustainability of the Czech economy: A quick look through the IMF's night-vision goggles*
3/2004	Martin Čihák	*Designing stress tests for the Czech banking system*
2/2004	Martin Čihák	*Stress testing: A review of key concepts*
1/2004	Tomáš Holub	*Foreign exchange interventions under inflation targeting: The Czech experience*
2/2003	Kateřina Šmídková	*Targeting inflation under uncertainty: Policy makers' perspective*
1/2003	Michal Skořepa Viktor Kotlán	*Inflation targeting: To forecast or to simulate?*

CNB ECONOMIC RESEARCH BULLETIN	
December 2007	*Fiscal policy and its sustainability*
August 2007	*Financial stability in a transforming economy*
November 2006	*ERM II and euro adoption*
August 2006	*Research priorities and central banks*
November 2005	*Financial stability*
May 2005	*Potential output*
October 2004	*Fiscal issues*
May 2004	*Inflation targeting*
December 2003	*Equilibrium exchange rate*

Czech National Bank
Economic Research Department
Na Příkopě 28, 115 03 Praha 1
Czech Republic
phone: +420 2 244 12 321
fax: +420 2 244 14 278
http://www.cnb.cz
e-mail: research@cnb.cz