Exploring the nexus between banking sector reform and performance: Evidence from newly acceded EU countries

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Abstract
The aim of this study is to examine the relationship between banking-sector reform and bank performance, also accounting for the effects of competition and bank risk-taking. To this end, we draw on recent econometric techniques to develop a new empirical model that is free of some problematic features of previous analyses. This model is applied to bank-level data obtained from newly acceded EU banking systems. The results suggest that both banking-sector reform and competition present a positive effect on bank efficiency, while the effect of reform on total factor productivity growth was significant only towards the end of the reform process. Finally, the effect of capital liquidity or credit risk on performance is mostly negative, which may suggest a strategic role for bank capital in cases of liquidity shortages.

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1. Introduction

Three interrelated determinants of bank performance stand prominently in the contemporary theoretical and empirical debate, namely the financial reform process, the level of competition and the risk-taking behavior of banks (FCR hereafter). At least two families of studies involve these determinants, each following the path to different objectives. The first is nurtured in an important paper by Keeley (1990), who argued that deregulation of the US banking sector in the 1970s and 1980s has increased competition and led to a reduction in monopoly rents, and thus in a worsened equilibrium risk of failure. Keeley's paper triggered a lively discussion on the relationship between bank risk-taking and competition, yielding rather conflicting results. Inasmuch as such a research agenda is seminal to the understanding of the moving factors of competition and risk-taking, there has also been an effort to determine their effect on the performance of the banking institutions, which is naturally banks' ultimate goal. Thus, another strand of literature, mainly empirical in nature, attempts a direct analysis of whether deregulation has an impact on bank performance, yet even the findings of this group of studies are rather contentious. Some conclude that deregulation boosts efficiency through operational and cost savings, thus leading to a surge in productivity (e.g. Kumbhakar et al., 2001; Isik and Hasan, 2003). Others, however, find that deregulation has a negative effect on the performance of banks as it stimulates a decline in productive efficiency and/or total factor productivity (see Grifell-Tatjé and Lovell, 1996; Wheelock and Wilson, 1999).

In the present paper we merge these two strands of literature by focusing on how bank performance is affected by initiatives taken to reform the banking sector and, through these initiatives, by the industry structure and the risk-taking behavior of banks. Differently phrased, we examine the relationship between performance, reform, competition and risk-taking, where given the sequence of the theoretical considerations discussed above, bank performance may be endogenous in the risk-taking behavior of banks. To perform such an analysis, we develop a two-stage empirical model that involves estimation of bank performance in the first stage and assessment of its determinants in the second stage.

Our model draws on the recent econometric frameworks of Simar and Wilson (2007) and Khan and Lewbel (2007). In particular, bank performance, in terms of technical efficiency (TE) and total factor productivity (TFP) growth, is derived via nonparametric techniques and then the scores obtained are linked to reform, competition and bank risk-taking using bootstrapping techniques that account for the possible endogeneity between bank performance and risk. We opt for an application of this model to newly acceded EU countries, since the transition from centrally planned to a market economies involved quite uniform institutional, structural and managerial changes in their banking sectors. As such, it seems that a more appropriate term that encompasses the full set of developments in the banking sector is "banking reform." Rather than merely deregulation, the effect of bank reform is central to the present analysis.

To cast further light on the reform-risk-performance nexus, this study presents a number of auxiliary characteristics. First, additionally to the two nonparametric measures, we employ the net interest margin (NIM) as a measure of bank performance. Second, instead of focusing on concentration indices to measure competition in the banking industry, we construct a yearly index of competition for each country using a non-structural methodology. Third, by utilizing representative bank-level data and the important research output of the European Bank of Reconstruction and Development (EBRD) we are able to derive a direct relationship between the reform process and bank performance. The twelve years of data used (1994-2005) capture almost the entire course of the banking-sector reform process of the countries examined. Finally, to analyze the risk-taking behavior of banks we consider three categories of risk, namely credit, leverage, and liquidity risk.

The rest of this article proceeds as follows. Section 2 briefly reviews the relevant literature. Section 3 describes the first stage of the econometric methodology that corresponds to the derivation of bank performance measures; it also discusses the determinants of bank performance. Section 4 presents the empirical results of the second stage analysis, and finally Section 5 concludes.

2. Brief literature review

In an important contribution, Keeley (1990) provided both a theoretical framework and empirical evidence that deregulation of the US banking sector led to erosion of bank market power and consequently of the market value of their equity capital. In turn, this increased the incentive of banks to take on extra risk, thus also increasing the risk of failure. Keeley's paper triggered a lively discussion about the channels through which bank performance, and hence the stability of the banking system, is affected following deregulation measures. Two different yet complementary strands of literature emerged. The first examines the relationship between deregulation, market power (competition) and bank risk-taking, and the second investigates the direct effect of deregulation on bank performance.

Studies in the first strand have been mainly theoretical. Matutes and Vives (2000) confirmed Keeley's results on the liabilities side of a bank's balance sheet, while Bolt and Tieman (2004) reached similar conclusions by examining the assets side. Hellmann et al. (2000) suggested that bank regulation through capital requirements is not a Pareto optimal policy for controlling banks' risk-taking incentives and proposed that such requirements should be combined with deposit rate controls. In a series of papers, Diamond and Rajan (e.g. 2000, 2001a) pointed out that the optimal bank capital structure trades off liquidity creation and costs of bank distress. Therefore, banks are fragile during episodes of aggregate liquidity shortages, in which case capital has a strategic role to play in preventing failure. However, more recent papers advocate that the relationship between competition and financial stability may in fact be nonnegative. Allen and Gale (2004), studying a variety of models, suggested a complex and multi-faceted link. Boyd et al. (2006) examined two theoretical models, the first pointing to a negative correlation between banks' risk of failure and competition, and the second establishing the opposite result. The fact that the second model was verified empirically on the basis of large US and international samples, implies that increased competition does not lead to unstable banking environments.[1]

The empirical investigation of the above models seems to face considerable difficulty in measuring both deregulation and market power, which may be an important reason for the many differences in the findings. Deregulation is directly measured by Salas and Saurina (2003), who employ dummy variables that correspond to important deregulation laws. On the other hand, most studies, including Boyd et al. (2006), proxy competition by concentration ratios that in many aspects have proved to be poor measures of competition. Other indicators of market power employed include Tobin's q (used by Salas and Saurina, 2003), the Panzar and Rosse H-statistic (used by Claessens and Laeven, 2004, and Yildirim and Philippatos, 2007) and the Lerner index (see e.g. Angelini and Cetorelli, 2003). However, this literature lacks,

[1] For a fuller review of this literature see Boyd and De Nicolo (2005).

with a few exceptions, a measure of market power that shows how competition evolves over time, and thus during the deregulation process.[2]

As regards the second strand of the literature, numerous studies evaluate the direct impact of financial deregulation on bank performance, without accounting for its effect through competition and risk-taking. Most of these studies measure bank performance by parametric or nonparametric estimates of bank efficiency and productivity. However, their empirical results are also rather contentious. For example, Berg et al. (1992) examined the performance of the Norwegian banking sector over the 1980s and found that in the pre-deregulation period productivity declined, whereas a rapid growth was observed in the post-deregulation period.[3] Kumbhakar et al. (2001) concluded that Spanish savings banks experienced efficiency losses during the deregulation period, while in the last few years of that period productivity was growing. Wheelock and Wilson (1999) examined both the efficiency and total factor productivity of US commercial banks in the 1984-1993 period, which corresponds to significant regulatory reforms. On the one hand, they documented diminishing efficiency due to rapid technological change, while on the other hand large banks experienced productivity growth. The discrepancies in the empirical findings may be due to the dissimilar measures of performance and samples used (the latter corresponding to different macroeconomic conditions and deregulation policies). Other parameters like the organizational form and the special features of the institutions considered may also have affected this relationship.

While the above literature provides significant evidence on the relationship either between deregulation, market power and bank risk-taking, or between deregulation and bank performance, a study of all the links in the deregulation-bank performance chain is missing. A possible explanation is that such a study of bank performance would require a two-stage approach, where bank performance measures derived via parametric or nonparametric techniques in the first stage, would be regressed on a

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[2] Claessens and Laeven (2004) and Yildirim and Philippatos (2007) derive country-specific H-statistics, which they subsequently regress on a number of explanatory variables using cross-sectional estimation methods. However, some authors suggest that the H-statistic does not map as robustly into a range of oligopoly solution concepts as the Lerner index. Angelini and Cetorelli (2003) recognize this and estimate Lerner indexes for each year in the sample period, which are also regressed on a number of explanatory variables in a second stage of analysis, again using cross-sectional methods. Uchida and Tsutsui (2005) suggest a method that provides yearly estimates of market power for the Japanese banking sector, thus enabling the investigation of short-term changes in the degree of competition.

[3] The positive effect of deregulation on total factor productivity is also corroborated by the recent work of Kumbhakar and Lozano-Vivas (2005) for Spanish banks.

number of determinants reflecting deregulation, market power and risk. Unfortunately, it turns out that conventional two-stage procedures yield inconsistent results, and only very recently Simar and Wilson (2007) suggested a robust procedure for nonparametrically derived measures of performance. This will be used in our empirical analysis that follows.

3. Empirical analysis

Given the theoretical considerations discussed in the previous section, we specify the following empirical model to study the relationship between performance, reform, competition and risk-taking in banking:

$$p_{it} = a_0 + a_1 ref_t + a_2 c_t + a_3 x_{it} + a_4 m_t + u_{it} \qquad (1)$$

where the performance *p* of bank *i* at time *t* is written as a function of a time-dependent banking-sector reform variable, *ref*; an index of banking industry competition, *c*; a vector of bank-level variables representing capital, liquidity and credit risk, *x*; variables that capture the macroeconomic conditions common to all banks, *m*; and the error term *u*.

The above model is estimated on a panel of banks from 10 newly acceded EU countries (listed in Table 1), which corresponds to a relatively long period, covering the banking sector reform process in these countries, namely the 1994-2005 period. We choose to limit the empirical analysis to the unconsolidated statements of commercial, savings and cooperative banks in order to reduce the possibility of introducing aggregation bias in the results. All bank-level data used are obtained from the BankScope database. During the sample period a number of M&As and bank failures took place, which are taken into account in our dataset so as to avoid selectivity bias. Also, the data were reviewed for reporting errors or other inconsistencies (zero or negative values for the variables used). This yielded an unbalanced panel dataset of 4368 observations corresponding to 364 banks. All bank-level data are reported in euros and are expressed in constant 1994 prices (using individual country GDP deflators). Below we discuss the variables used to estimate Eq. (1).

3.1. Measurement of performance

Bank performance is proxied alternatively by productive efficiency, total factor productivity growth, and the net interest margin.

Efficiency: This refers to the distance (in terms of production) of a decision making unit (DMU) from the best practice in the industry. This is given by a scalar measure ranging between zero (the lowest efficiency score) and one (corresponding to the optimum DMU). The literature on the measurement of efficiency follows two major approaches using parametric and nonparametric frontiers, respectively.[4]

In the parametric frontier analysis, the technology of a DMU is specified in the context of a particular functional form for the cost, profit or production relationship that links the DMU's output to inputs and, as the term "parametric" implies, includes a stochastic term. The literature uses various parametric frontier methods depending on the assumptions made about the error term (for more details see Kumbhakar and Lovell, 2000). The nonparametric methods to efficiency measurement include the Data Envelopment Analysis (DEA) and the Free Disposal Hull (FDH). The most widely used is DEA, a programming technique that provides a linear piecewise frontier by enveloping the observed data points and yields a convex production possibilities set. As such, it does not require the explicit specification of the functional form of the underlying production relationship. In the context of the present analysis, the nonparametric efficiency estimates serve better as performance measures compared to their parametric equivalents. Indeed, regressing efficiency estimates obtained from parametric techniques is almost certain to result in problems of statistical consistency, since the covariates of Eq. (1) would be correlated with the fixed or random effects of the initial parametric regression (see Coelli et al., 2005). In contrast, Simar and Wilson (2007) have provided a procedure for robustly regressing efficiency estimates derived from nonparametric techniques on a number of determinants.[5] For this reason we opt here for nonparametric estimates of efficiency, while the specifics of the estimation method of Eq. (1) are provided in the next section.

Total factor productivity: Access to panel data provides the opportunity to exploit also the total factor productivity (TFP) growth of banks, again using nonparametric techniques. Analyzing the productivity of banks is of interest from a policy

[4] For a general introduction to these approaches see Coelli et al. (2005).
[5] For a discussion of the reasons why previous two-stage procedures using nonparametric estimates of efficiency lead to invalid inference see Simar and Wilson (2007).

perspective, since increased productivity may contribute positively to the overall performance of the banking system, to lower prices and improved service quality for consumers. In addition, enhanced productivity may act as a safety net against the various risks associated with the banking industry. To measure TFP change we use standard Malmquist techniques.[6] The most popular has been the DEA-like programming technique suggested by Fare et al. (1994), which is the one we follow here. The Malmquist technique allows decomposition of TFP change into technological change (TC) and technical efficiency change (TEC). An improvement in TC is considered as a shift in the frontier. Also, TEC is the product of scale efficiency change (SEC) and pure technical efficiency change (PTEC). Given this decomposition, the Malmquist index provides a powerful tool of analysis for the sources of TFP growth.[7]

The first problem encountered in evaluating bank efficiency and TFP growth is the definition and measurement of bank output. The two most widely used approaches are the 'production' and the 'intermediation' approaches.[8] While we acknowledge that it would probably be best to employ both approaches to identify whether the results are biased when using a different set of outputs, sufficient data to perform such an analysis on banks from newly acceded EU countries is generally unavailable. Hence, this study uses the 'intermediation approach' for two main reasons: First, this approach is inclusive of interest expenses that usually account for over one-half of total costs, and second the BankScope database lacks the necessary data for implementing the production approach. Accordingly, this study specifies two outputs, namely total loans and total securities; and two inputs, i.e. operating expenses (non-interest and personnel expenses) and total deposits and short-term funding.[9] Both inputs and outputs have risen considerably during the sample period

[6] To save space we do not replicate the mathematical models here, we only provide the Malmquist formula in Appendix I. For a recent review of the literature on productivity change in banking see Casu et al. (2004).

[7] This decomposition has been subject to a number of criticisms (see Casu et al., 2004), mainly in terms of the role of constant returns vs. variable returns to scale frontiers. However, there seems to be consensus that the Malmquist index is correctly measured by the constant returns to scale distance function even when technology exhibits variable returns to scale.

[8] Under the former approach output is measured by the number of transactions or documents processed over a given time period (see Berger and Humphrey, 1997). Under the latter approach output is measured in terms of values of stock variables (such as loans, deposits, etc.) appearing in bank accounts.

[9] The definition of inputs and outputs varies widely across studies of bank efficiency. In this paper, given the limitations of the BankScope database, the further disaggregation of inputs and outputs is not possible (i.e. personnel expenses or fixed assets are not reported for many banks). Clearly it is possible

due to M&As and the quickly growing size of banking institutions (especially of the newly established foreign institutions) of the region (summary statistics are presented in Table 1).

Given the above, we estimate TE and TFP change at the bank level for the 10 countries of our sample, to obtain the Stage 1 estimation results (see Appendix I for the technical details of the procedures used). Table 2 reports average estimates, denoted by *te* and *dtfp*, by country and through time. We should bear in mind that the estimations are carried out for each country separately and therefore the mean efficiency scores only reflect the dispersion of efficiency within each sample, they tell as nothing about the efficiency of one sample relative to another.

Almost all countries show a gradual improvement in their TE. This is not surprising, since the banking systems examined have seen fundamental changes in their ownership structure (private vs. public, foreign vs. domestically owned banks), including mergers. In addition, the relatively stable macroeconomic conditions of the period, coupled with a significant improvement in the operating expenses management, may have led to improved TE. The majority of banks comprising the sample seem to cluster around levels of efficiency of approximately 65%, which is a score similar to that found in other recent nonparametric analyses of western European banking systems (see e.g. Casu and Molyneux, 2003).

Table 2 also reports the Malmquist TFP change index (*dtfp*). A value for *dtfp* greater than one indicates positive TFP growth, while a value less than one indicates a TFP decline. All countries present considerable TFP growth over the sample period, which is representative of banking sectors under intense reform. In particular, average TFP growth has been as large as 28.6% and 26.1% in Poland and the Czech Republic, respectively. Even countries like Slovenia and Latvia that present the lowest TFP growth in their banking systems among the countries examined (7.6% and 9.1% respectively), exhibit relatively high TFP growth scores compared with those reported by other studies for developed banking systems (e.g. Casu et al., 2004).

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that the use of expenses rather than physical inputs could result in some bias against those banks that employ high quality and therefore high cost inputs. This potential bias should be mitigated, however, given that banks with high quality inputs should expect to see some benefit in output terms. Hence, if high quality inputs are sufficiently productive, such banks will not be disadvantaged from a relative efficiency perspective (see Berger and Humphrey, 1997; Drake and Hall, 2003). Also, some studies suggest that deposits have both input and output characteristics (e.g. Berger and Humphrey, 1997). However, even this separation of deposits is difficult, given the diversity of the banking systems examined. For the shake of comparison, total deposits are treated here as inputs.

For expositional brevity we do not present all the individual components of TFP growth. However, it seems that the most important element of *dtfp* is TC, especially in the case of *dtfp* increases. Again this is an expected result for banking sectors under rapid transition. To illustrate this latter result, in Figures 1 and 2 we present bivariate kernel regressions of TC and PTEC on *dtfp*, respectively.[10] In both cases, we use the Epanechnikov kernel, which is the most commonly used in the relevant studies, and a small bandwidth (equal to 0.2) that provides detailed information regarding the shape of the examined relationships. Both figures indicate positive relationships between *dtfp* and its two sources; however the *dtfp*-TC locus is steeper especially for higher values of *dtfp*, which is indicative of the greater importance of TC as a source of TFP growth relative to PTEC, particularly for higher values of *dtfp*.

Net interest margin: Along with the nonparametric measures of bank performance discussed so far, we also employ the net interest margin (NIM), i.e. the difference between interest income and interest expenses over total assets, as a measure of bank performance. The chief concern for the bank credit analyst is the quality of earnings, in other words how stable and how reliable income is compared to that of a peer group of banks. Bank earnings provide funds for capital formation, and are needed to attract new investor capital, which is essential for growth. NIM represents the amount by which the interest received from the loan portfolio exceeds the interest paid on deposits or borrowed funds. In the literature NIM has emerged as a key indicator of asset productivity, since a high NIM is indicative of effective use of earning assets and sensible mix of interest-bearing liabilities.[11]

3.2. Determinants of bank performance

3.2.1. Banking sector reform in the CEE region

Banking system restructuring was quite profound over the last decade in most of the countries of our sample. Since the mid 1990s their banking systems were extensively reformed through the abolition of administrative interventions and regulations, which seriously hampered its development. The reforms were adopted gradually and

[10] Here we follow Balaguer-Coll et al. (2007), who suggest using the nonparametric kernel regressions to explain the nonparametric efficiency scores on the basis of various determinants. These are less powerful techniques in terms of prediction, yet they are extremely informative for explanatory purposes.

[11] Recent studies that examine the determinants of NIM include Saunders and Schumacher (2000) and Maudos and de Guevara (2004). A potential weakness of NIM may be that as banks move toward more fee-generating activities, NIM will decline in importance as a measure of asset profitability.

supported the further improvement of the institutional framework and the more competent functioning of banks and financial markets in general. The objective of these countries' participation in the EU initiated efforts towards the further deregulation of their banking systems and macroeconomic convergence. During the past few years, banks tried to strengthen their position in the domestic market and acquire a size, partly through M&As, that would allow them to exploit economies of scale, and have easier access to international financial markets.

Banks operating in the countries examined are gradually reaching the standards of their counterparts in the rest of the EU countries. The institutional reforms briefly described above have been viewed as a means to reduce bank costs, particularly those associated with risk management and the evaluation of credit information. However, for smaller and private domestic banks, risk management techniques need to improve further (see EBRD, 2006). In fact, lending in emerging markets is greatly influenced by how banks perceive the legal environment, and the level of hedging against risks that this environment provides. Institutional improvements, such as effective systems for taking collateral and repossessing assets in cases of default, will play a fundamental role in the further development of the banking sector. However, given the restructuring that took place in the last decade, the newly acceded EU countries provide an excellent case for the study of the relationship between performance, reform, competition and risk-taking.[12]

Data on the banking reform process are obtained from the EBRD. In particular, we use the EBRD index of banking sector reform, either as a structural index (*ebrd*) (see Table 1 for summary statistics) or to generate time dummy variables. This index has been compiled by the EBRD with the primary purpose of assessing the progress of the banking sectors of formerly centrally planned economies. As this indicator quantifies and qualifies the degree of liberalization of the banking industry, it is suitable for an explicit evaluation of the effect of banking sector reform on the performance of banks. Related studies simply measure the impact of deregulation (or specific deregulation policies) on bank performance or competition; they do not focus on the reform process as a whole.[13] The values of *ebrd* range from 1.0 to 4.0+, with

[12] For a detailed review of the reform process in the CEE countries' financial sectors see various issues of the EBRD Transition reports (e.g. Transition report 2006: Finance in transition).

[13] For instance, Salas and Saurina (2003) and Kumbhakar and Lozano-Vivas (2005) employ all the deregulation events that occurred in the period under examination to capture the deregulation process in the Spanish banking industry. Angelini and Cetorelli (2003) measure deregulation via changes in

1.0 indicating a rigid centralized economy and 4.0+ implying the highest level of reform, which corresponds to a fully industrialized market economy. The criteria used for the compilation of the index are common to all countries (see EBRD Transition reports, various issues). When the index is used to formulate dummy variables, we assume that changes in the regulatory regime remain over time, and thus the (country-specific) dummies take a value of one at the year of the change and remain equal to one until the end of the sample period. Obviously, the reform process when treated like this is viewed as an ongoing process that affects banks not only at the year of change in the regulatory regime, but for all the succeeding years of the sample period (see Salas and Saurina, 2003). The upward trend of the index reflects the extensive restructuring that took place in the banking sectors examined during the sample period.

3.2.2. Bank competition

To measure the evolution of competitive conditions over time in the banking systems of the 10 newly acceded EU countries, we use the methodology suggested by Uchida and Tsutsui (2005). In particular, we jointly estimate the following system of three equations that correspond to a translog cost function, to a revenue equation obtained from the profit maximization problem of banks, and to an inverse loan demand function:

$$\begin{aligned}
\ln C_{it} &= b_0 + b_1 \overline{\ln q_{it}} + \frac{1}{2} b_2 (\overline{\ln q_{it}})^2 + b_3 \overline{\ln d_{it}} + \frac{1}{2} b_4 (\overline{\ln d_{it}})^2 + b_5 \overline{\ln w_{it}} + \frac{1}{2} b_6 (\overline{\ln w_{it}})^2 + \\
&\quad b_7 (\overline{\ln q_{it}})(\overline{\ln w_{it}}) + b_8 (\overline{\ln q_{it}})(\overline{\ln d_{it}}) + b_9 (\overline{\ln d_{it}})(\overline{\ln w_{it}}) + e_{it}^C \\
R_{it} &= \frac{\theta_t}{\eta_t} R_{it} + r_{it} q_{it} + c_{it}(b_1 + b_2 \overline{\ln q_{it}} + b_7 \overline{\ln w_{it}} + b_8 \overline{\ln d_{it}}) + \\
&\quad C_{it} \frac{q_{it}}{d_{it}} (b_3 + b_4 \overline{\ln d_{it}} + b_8 \overline{\ln q_{it}} + b_9 \overline{\ln w_{it}}) + e_{it}^s \qquad (2) \\
\ln p_{it} &= g_0 - (1/\eta_t) \ln q_{it} + g_1 \ln gdpg + g_2 \ln ir + e_{it}^D
\end{aligned}$$

where C is the total cost of bank i at time t, q is bank output, d are deposits, w are bank inputs, R is bank revenue, r is the interest rate on deposits, p is the price of bank output, and e are the error terms. Variables with bars are defined as deviations from

minimum capital requirements, or through the abrogation of the interest rate ceilings policy. Similarly, Yildirim and Philippatos (2007) choose foreign bank penetration to capture deregulation. Other studies also use abolition of entry restrictions as deregulatory proxies (e.g. Demirguc-Kunt et al., 2004).

their cross sectional means at each time period, so as to remove their trend. The variables *gdpg* and *ir* are exogenous variables that affect demand. The degree of competition in each year is given by θ, which represents the well-known conjectural variations elasticity of total industry output with respect to the output of the i*th* bank.

The range of possible values of θ is given by [0, 1]. In the special case of Cournot competition, θ_{it} is simply the market share of the *i*th bank. In the case of perfect competition, $\theta_{it} = 0$; under pure monopoly, $\theta_{it} = 1$; and, finally, $\theta_{it} < 0$, implies pricing below marginal cost and could result, for example, from a non-optimizing behavior of banks. Note that in system (2) we dropped the subscript *i* on θ in order to capture the industry average degree of competition (on this point see also Bresnahan, 1989). Both θ and η, which represents the market demand elasticity for bank output, are parameters to be estimated. To estimate θ we use year dummy variables, while to estimate η we use dummy variables for every two years.[14] A merit of this estimation method is that it provides an index of industry market power to be used in subsequent analysis.

Data for the bank-level variables are taken from BankScope, and data for the control variables are taken from the EBRD's Transition reports and the World Bank's World Development Indicators (WDI). Specifically, C is measured by total expenses, *q* by total earning assets, *d* by total deposits and short-term funding, *w* by the ratio of total operating expenses (overheads) to total assets, *R* by total revenue, *r* by the ratio of interest expenses to total deposits and short-term funding, *p* by the ratio of total revenue to total earning assets, *gdpg* by the annual % GDP growth rate, and *ir* by a short-term interest rate.[15]

Estimation is carried out for each country separately using multivariate regression. For expositional brevity only the average results for each country are presented in Table 3.[16] The country- and year-specific estimates derived correspond to c_t in Eq. (1). The picture presented by the estimates is mixed, with some countries

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[14] To estimate η we cannot use year dummy variables because they are linearly dependent with the time-specific control variables *m*.

[15] The short-term interest rates used vary between countries (e.g. in some countries we use the interbank rate, in others the central bank rate etc.). Since estimation is carried out for each country separately this is not a potential problem.

[16] The full set of θ_t results are available upon request. Several robustness checks were performed (e.g. estimation using three-stage least squares), however the results remained unchanged at the 10% level of significance. Also, we used some risk variables (i.e. capitalization and/or credit risk) as inputs in the cost and revenue equations, yet again the results remained unchanged with the exception of Romania (15% rise in θ) and Slovenia (10% fall).

reflecting fairly competitive practices (e.g. Bulgaria and Romania), other reflecting anticompetitive behavior (Lithuania and Slovenia), and most lying in between. Changes over time are also different on a country by country basis, yet there seems to be a convergence towards middle values for θ.

3.2.3. Bank risk-taking

To capture the effect of risk in the second-stage regressions, we differentiate between three different types of risk, namely capital (*cap*), liquidity (*lq*) and credit risk (*cr*). Poor asset quality and low levels of liquidity are the two major causes of bank failures. During periods of increased uncertainty, financial institutions may decide to diversify their portfolios and/or raise their liquid holdings in order to reduce their risk. Banks would therefore improve their performance by improving screening and monitoring of both liquidity and credit risk, and such policies involve the forecasting of future levels of risk.[17] Following the empirical literature, we use the ratio of liquid to total assets to proxy liquidity risk, the ratio of loan loss provisions to total loans to measure credit risk, and the ratio of total equity to total assets to proxy capital. Table 1 reports all the bank-level risk variables used, along with some descriptive statistics, which show gradual convergence with European practice. In particular, all three ratios gradually decline, even though they are still far-off the quality levels proposed by CAMEL analysis (5-8% for *cap*, 2-30% for *lq* and below 1% for *cr*).[18]

3.2.4. Control variables

Finally, following the literature the second-stage analysis includes some macroeconomic country-specific variables (*m*), namely the GDP growth rate or alternatively the ratio of total investment to GDP as a proxy for fluctuations in economic activity, and a short-term interest rate, which captures variability of market interest rates. These variables are taken from the EBRD and the WDI. In addition to the macroeconomic variables, we also use foreign (for) and public (pub) ownership as potential determinants of bank performance.

[17] Most studies find a negative relationship between liquidity or credit risk and performance measures (e.g. Athanasoglou et al., forthcoming). As regards the capital-performance relationship, Berger (1995) suggests a positive correlation, which is mainly due to market imperfections.

[18] CAMEL analysis provides a framework for the evaluation of banks through the complete coverage of the factors affecting bank creditworthiness. It has emerged as the industry standard. The factors covered in this framework are capital adequacy, asset quality, management, earnings and liquidity. In a nutshell, the acronym to remember is CAMEL.

4. Results and sensitivity analysis

4.1. Econometric procedure

The previous sections inclined towards the estimation methodology of Eq. (1). As Simar and Wilson (2007) point out, DEA efficiency estimates are serially correlated, and consequently standard approaches to inference (such as censored regressions) are invalid. In fact, Simar and Wilson propose bootstrap procedures to be used in the second-stage regressions that permit for valid inference.[19] Yet, the theoretical considerations of Keeley (1990) and the debate that followed imply that performance and risk-taking in banking may be endogenous variables. To this end, we follow the methodology put forth by Khan and Lewbel (2007) who for the first time suggested a two stage least squares estimation of truncated regression models. Their simulation results show that their new estimator performs well, while they specifically state that their method is applicable in general contexts involving two-stage analyses with a nonparametric first step, such as ours. In what follows, we discuss the results obtained from estimating Eq. (1) using this advanced procedure that merges the implications of Simar and Wilson (2007) and Khan and Lewbel (2007). The technical details of the estimation procedure are presented in the Appendix.

4.2. Estimation results

Table 4 presents the stage 2 results, using *te*, *dtfp* and *nim* as the dependent variables. Note that for the regressions on *te* and *dtfp* (columns 1-4) we use the algorithm in the Appendix, as well as for the regressions on *nim* when nonparametric estimates are employed as covariates (columns 6-7). The regression of column 5 corresponds to a simple panel two-stage least squares estimation (to account for the endogeneity of the risk variables). For *te* and *dtfp* we report estimates based on the use of the EBRD index as an ordinal index (*ebrd*), as well as on the basis of the reform dummies (*ref94*-*ref05*). In the *dtfp* equations we use the change in each explanatory variable (denoted with a *d* in front of each variable), since *dtfp* also reflects change. In the *nim* equations we use only *ebrd* and not the reform dummies to save space. The rest of the covariates used are common in all regressions: market power (*mp*), the three risk

[19] In another paper, Balaguer-Coll et al. (2007) acknowledge this drawback and suggest bivariate kernel regressions in the second stage. To our knowledge, no other studies use either the Simar and Wilson (2007) or the Balaguer-Coll et al. (2007) methodology.

variables (*cap*, *lq*, *cr*), the two control variables (*ir*, *invgdp*), and two dummy variables that capture foreign (*for*) and public (*pub*) ownership. The model seems to fit the data reasonably well, having fairly stable coefficients against slight changes in the specified variables.

The results in column 1 show that TE has substantively gained ground following the reforms, as most of the coefficients on the reform dummies are positive and statistically significant. The largest and most significant change is reported in 2005. Reform measures undertaken in 1995, 1999, 2002 and 2004 had no significant effect on efficiency, while a significantly negative impact is documented in 1998, and 2001. In spite of these non-significant and/or negative changes, the positive impact that reform has on bank efficiency does not alter in the aggregate. In fact, not all transformations in the regulatory regime of banks can be significant or necessarily lead to an improvement in efficiency.[20] Besides, the positive relationship is confirmed by the coefficient on *ebrd* (see column 2).

Column 3 shows that the relationship between *dtfp* and the reform dummies are mostly insignificant except from the last two years, when they turned into positive and significant, reflecting that the productivity of banks gained momentum in 2004 and 2005. These results are similar to those of Isik and Hassan (2003), who find that Turkish banks have experienced a positive growth in productivity only in the last years of the financial deregulation process.[21] This phenomenon may be attributed to the long-term nature of technology investments. When *ebrd* is employed in the regression (column 4), a positive link between reform and *dtfp* is documented, possibly driven by the last years of our panel, when countries reached higher levels of reform. In addition, the liberalization of banking sectors and the subsequent loosening of regulatory conditions held resulted in lower interest margins, as evident from the negative relationship between *nim* and *ebrd*. A number of theoretical and empirical works has reached the same conclusion (see e.g. Keeley, 1990; Demirguc-Kunt et al., 2004).

Whereas the above results clearly indicate that the reform process resulted in upgraded efficiency, and later in improved TFP growth, they only provide us with a

[20] The empirical results of Salas and Saurina (2003) provide great support to this argument. By regressing market power on a series of different liberalization measures, they reached similar conclusions.

[21] Findings also corroborate with those of Berg et al. (1992) who report a noticeable productivity growth for Norwegian banks only in the post-deregulation period.

hint concerning how these advances have been channeled. An important element in this transmission process is market power. Even though competition was not significantly enhanced (see Table 3), its relationship with *te* and *nim* is negative and positive, correspondingly. This suggests that banks strive for efficiency, even though market power remains stable, in light of falling net interest margins.[22] The fact that competition presents no significant effect on productivity change may reflect that the negative effect of *mp* on *te* is outbalanced by a positive relationship between *mp* and TC. This would imply that banks with market power are leaders in technology innovation.[23]

According to the traditional view, which can be traced back in Keeley's (1990) paper, deregulation in banking leads to intensified competition. Competition, in turn, erodes interest and profit margins and hence the charter value of banks; having less to lose, banks are entangled into riskier activities. As a result, the quality of loans deteriorates enhancing banks' failure risk.[24] Boyd and de Nicolo (2006) challenged the dominance of this view by showing that banks' probability of failure as well as bank profits are positively related to concentration.[25] Here we differentiate between different measures of risk to provide a clear picture of how risk management affects bank performance. The results regarding capital and liquidity are uniform across all estimated equations, indicating a positive and negative relationship, correspondingly. This result is new in the literature and requires some additional comments. Traditionally, banks have been solving the liquidity problem by holding cash together with a considerable amount of government securities that they could sell for cash. Normally, a higher leverage ratio would thus imply a lower insolvency risk. Financial reform, however, led to the development of new bank products and gave rise to alternative sources of funds for banks, which have increased the ease with which banks generate liquidity. This implies that banks of the newly acceded EU countries should reallocate their assets by raising their capital base and reducing their holdings

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[22] For a recent study of the determinants of NIM with similar results with these presented here, see Maudos and de Guevara (2004).

[23] We have additionally included a 3-bank concentration ratio among the regressors to capture the effect of industry concentration. However, the results showed that concentration is always an insignificant determinant of bank berformance, regardless of the measure of performance employed and even if *mp* is not included in the estimated equation (nevertheless the correlation between mp and concentration is as low as 0.1). These results are available upon request.

[24] Consistent with this view, Bolt and Tieman (2004) shows that competition leads banks to ease their loan acceptance criteria in order to attract more assets.

[25] By the same token, Chen (2007) provides evidence for increased screening activity due to intensified competition that leads to higher loan quality and hence to a reduction in the risk of failure.

of liquid assets.[26] Furthermore this may suggest a strategic role for bank capital even in cases of liquidity shortages (see Diamond and Rajan, 2001a; 2001b).

Concerning credit risk, the regression results reveal a significantly negative relation with efficiency and TFP change. This shows that the banks of the countries examined should focus more on credit risk management, which has been proved problematic in the recent past. Serious banking problems have arisen from the failure of banks to recognize impaired assets and create reserves for writing-off these assets. An immense help towards smoothing these anomalies would be provided by improving the transparency of the financial systems, which in turn will assist banks to evaluate credit risk more effectively and avoid problems associated with hazardous exposure. Finally, as columns 5-7 report *cr* is not a significant determinant of *nim*. This may reflect the weakness of NIM to capture the increasing importance of fee-generating activities.

Regarding the ownership variables the results are as expected. In particular, we find that banks with public ownership are less efficient, while they fall behind in their TFP growth rates. Also, foreign entry reduces *nim*, while public banks do not seem to present higher margins.[27] Finally, as regards the effect of the macroeconomic control variables on bank performance, we find a positive and significant relationship between *te* and *ir*, and a marginally significant relation with *invgdp*. Furthermore, the short-term interest rate has a negative significant effect on productivity growth, while no such effect is found for *invgdp*. Regarding the link between *nim* and the control variables, no significant relation is documented.

The methodology followed in the present paper leads to different implications than if standard two-stage procedures were used. In fact, if we proceeded with a simple panel data tobit regression in the second stage (that is we do not account for the serial correlation of the DEA estimates and for the endogeneity between performance and risk) the results for equations (2) and (6) would be as follows:

$$\begin{aligned} te = {} & \underset{(4.96)}{0.49} + \underset{(5.40)}{0.13}ebrd - \underset{(-4.45)}{0.18}mp + \underset{(1.67)}{0.08}cap - \\ & \underset{(-2.18)}{0.15}lq - \underset{(-1.61)}{0.01}cr + \underset{(4.15)}{0.005}ir + \underset{(0.53)}{0.000}invgdp + \underset{(4.91)}{0.002}for - \underset{(-2.82)}{0.002}pub \end{aligned} \tag{3}$$

[26] Such a result may have similar implications to those of Hellman et al. (2000) who find that capital requirements on their own do not lead to Pareto optimality.

[27] Foreign banks improve efficiency by about 0.3% relative to domestic private banks. Analogous is the deterioration of NIM. The presence of public banks reduces efficiency by 0.2% and productivity by 1.2% the highest compared to domestic private banks.

$$nim = 14.75 - 1.92 ebrd - 0.53 te + 0.20 mp + 8.19 cap$$
$$\quad (7.80) \quad (-4.16) \quad (-0.92) \quad (1.33) \quad (9.34)$$
$$- 1.13 lq + 0.15 cr - 0.06 ir - 0.03 invgdp - 0.01 for + 0.02 pub \qquad (4)$$
$$\quad (-1.50) \quad (1.36) \quad (-3.13) \quad (-0.74) \quad (-1.81) \quad (2.18)$$

Qualitatively similar results are found for the rest of the equations of Table 4, and the results presented in Eqs. (3) and (4) suggest clear differentiations from their equivalents contained in this Table. In particular, endogeneity between the risk variables seems to be a significant problem in Eq. (3), while efficiency and market power appear to be insignificant determinants of *nim* in Eq. (4). These would suggest that the transmission of reform to efficiency works only through liquidity, whereas higher (lower) margins are the result of enhanced (worse) capitalization ratios. Naturally, these later results completely sweep up the implications discussed above, and as they are biased and inconsistent they may lead to flawed interpretations and economic policies.

5. Conclusions

This paper introduced a new empirical model into the study of bank performance. It merged a theoretical strand of literature that studies the relationship between financial deregulation, banking industry competition and risk-taking of banks with an empirical strand that studies the evolution of bank performance during periods of financial deregulation. The rapid and quite uniform transition of newly acceded EU countries from centrally planned to market economies provides an obvious case study of the nexus between banking sector reform and performance. Given the two strands of literature, a special role in this nexus is played by banking industry competition and bank risk-taking behavior.

In a first set of results we provided a wide range of estimates of bank efficiency, TFP growth and banking industry competition by country and through time. These results indicate that on average efficiency and TFP are improving, while the competitive conditions in the banking systems examined were subject only to small changes. Subsequently we used these results to analyze the nexus between banking sector reform and performance. By drawing on the two recent econometric models of Simar and Wilson (2007) and Khan and Lewbel (2007) we have been able to show that banking sector reform presents a positive effect on bank efficiency, which is channeled through the effect of competition. Also, TFP growth has gained ground towards the end of the reform process, indicating the long-term effect of technological improvements. Finally, the effect of capitalization on bank performance (irrespective of the measure used) is positive, while liquidity and credit risk usually bear a negative sign. This latter finding implies that bank capital may have a strategic role in cases of liquidity shortages and increases in credit risk.

The approach followed in this paper may have considerable potential as a tool for further exploring various determinants of bank performance, with the purpose of suggesting optimal policies to bank management. A possible area for future research could be to provide a more detailed analysis of the different country-specific institutional characteristics that may affect bank performance and more broadly the financial stability of emerging markets.

Appendix

Here we describe the methodology of estimation and inference in two-stage semi-parametric models of production processes, building on Simar and Wilson (2007). In the first stage, we employ input-oriented DEA[28] to measure variable returns to scale TE, as well as the Malmquist index to measure TFP change. In the second stage we describe a double bootstrap procedure that accounts for the endogeneity between bank performance and risk-taking.

Stage 1

To introduce some notation, let us assume that for *N* observations there exist *M* inputs producing *S* outputs. Hence, each observation *n* uses a nonnegative vector of inputs denoted $x^n = (x_1^n, x_2^n, ..., x_m^n) \in R_+^M$ to produce a nonnegative vector of outputs, denoted $y^n = (y_1^n, y_2^n, ..., y_S^n) \in R_+^S$. Production technology, $F = \{(y,x): x \text{ can produce y}\}$, describes the set of feasible input-output vectors, and the input sets of production technology, $L(y) = \{x: (y,x) \in F\}$ describe

[28] DEA may be computed either as input or output oriented. Input-oriented DEA shows by how much input quantities can be reduced without varying the output quantities produced. Output-oriented DEA assesses by how much output quantities can be proportionally increased without changing the input quantities used. The two measures provide the same results under constant returns to scale but give slightly different values under variable returns to scale. Nevertheless, both output- and input-oriented models will identify the same set of efficient/inefficient DMUs. The variable vs. constant returns to scale option has no influence on the results since both are used to calculate the various distances used to construct the Malmquist indexes. For a more detailed discussion of the above see Coelli et al. (2005).

the sets of input vectors that are feasible for each output vector (Kumbhakar and Lovell, 2000).

To measure variable returns to scale TE we use the following input-oriented DEA model, where the inputs are minimized and the outputs are held at their current levels:

$$\theta^* = \min\theta, \text{ s.t.}$$
$$\sum_{j=1}^{n}\lambda_j x_{ji} \le \theta x_{i0} \quad i = 1,2,...,m;$$
$$\sum_{j=1}^{n}\lambda_j y_{rj} \ge y_{r0} \quad r = 1,2,...,s; \tag{1a}$$
$$\sum_{j=1}^{n}\lambda_j = 1$$
$$\lambda_j \ge 0 \qquad j = 1,2,...,n;$$

where $bank_0$ represents one of the N banks under evaluation, and x_{i0} and y_{r0} are the ith input and rth output for $bank_0$, respectively. If $\theta^* = 1$, then the current input levels cannot be proportionally improved, indicating that $bank_0$ is on the frontier. Otherwise, if $\theta^* < 1$, then $bank_0$ represents an inefficient bank and θ^* represents its input-oriented efficiency score. Finally, λ is the activity vector denoting the intensity levels at which the S observations are conducted. Note that this approach, through the convexity constraint $\vec{1}\lambda = 1$ (which accounts for variable returns to scale) forms a convex hull of intersecting planes, since the frontier production plane is defined by combining some actual production planes.

As regards estimation of TFP change, we follow Fare et al. (1994) who defined the Malmquist index as

$$M_0(y_s, x_s, y_t, x_t) = \left[\frac{d_0^s(y_t, x_t)}{d_0^s(y_s, x_s)} \text{ x } \frac{d_0^t(y_t, x_t)}{d_0^t(y_s, x_s)}\right]^{1/2} \tag{2a}$$

where M_0 measures the productivity change between periods s (base period) and t, and $d_0^s(y_t, x_t)$ represents the distance from the period t observation to the period s technology. $M_0>1$ indicates positive TFP growth from period s to period t, $M_0<1$ indicates a decline and $M_0=1$ indicates constant TFP growth.

Stage 2

In this stage we present the algorithm used to obtain estimates on a number of endogenous explanatory factors of TE and TFP change. This is performed by merging the algorithm suggested by Simar and Wilson (2007) with the two-stage least squares truncated regression model put forth by (Khan and Lewbel, 2007), so as to account for the endogeneity of the risk variables. We consider all observations as cross sections and therefore we drop subscript *t* in Eq. (1).

1. Obtain maximum likelihood estimates $\hat{\alpha}_k$ of α_k and $\hat{\sigma}_u$ of σ_u in the endogenous truncated regression of $\hat{p}_i$ on its *k* determinants (z_i) in Eq. (1), where $\hat{p}_i$<1.
2. Loop over the next three steps *L*=2000 times to obtain a set of bootstrap estimates $\mathrm{B}_i = \left[(\hat{\alpha}^*, \hat{\sigma}_u^*)_b\right]_{b=1}^{L}$:

   2.1 For each *i*=1,…,*m*, draw u_i from the $N(0, \hat{\sigma}_u^2)$ distribution with left-truncation at $(1 - z_i\hat{a})$. For details on how to draw from a left-truncated normal distribution see the Appendix of Simar and Wilson (2007).

   2.2 Again for each *i*=1,…,*m*, compute $p_i^* = z_i\hat{\alpha} + u_i$.

   2.3 Use the maximum likelihood method to estimate the endogenous truncated regression of p_i^* on z_i, yielding estimates μ_μ^*, ν_ν^*.

3. Use the bootstrap values in B and the original estimates α, σ_u to construct estimated confidence intervals for each element of α and for σ_u. This is done by using the *j*th element of each bootstrap value $\hat{\alpha}^*$ to find values μ_π^*, ν_π^* such that $\Pr\left[-\nu_\pi \le (\hat{\alpha}_j^* - \hat{\alpha}_j) \le \mu_\pi^*\right] \approx 1 - \pi$, for some small conventional value of π, $\pi = 0.05$ in the present analysis. The approximation improves as $L \to \infty$. Substituting μ_π^*, ν_π^* for μ_π, ν_π in $\Pr\left[-\nu_\pi \le (\hat{\alpha}_j - \alpha_j) \le \mu_\pi\right] = 1 - \pi$ leads to an estimated confidence interval $(\hat{\alpha}_j + \mu_\pi^*, \hat{\alpha}_j + \nu_\pi^*)$.

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Table 1
Descriptive statistics

Country	Deposits	Operating expenses	Loans	Securities	nim	cap	lq	cr	ebrd
Bulgaria	369543	40119	173574	52388	6.996	0.172	0.345	0.090	2.834
	1153297	114744	508450	194806	6.737	0.157	0.207	0.147	
Czech Republic	826647	64813	245522	471046	5.984	0.149	0.415	0.071	3.362
	2333851	188499	615576	2242569	1.195	0.148	0.225	0.100	
Estonia	148847	15193	83598	14177	6.727	0.201	0.470	0.066	3.501
	249862	34126	184138	39222	8.790	0.162	0.200	0.193	
Hungary	261343	20341	150198	41739	5.137	0.134	0.397	0.022	3.667
	687891	40828	448350	199562	4.086	0.123	0.233	0.134	
Latvia	221715	19882	143328	54074	5.592	0.201	0.413	0.023	3.223
	648897	44016	466209	165898	4.579	0.193	0.235	0.038	
Lithuania	119094	9898	74679	49512	5.731	0.159	0.467	0.037	3.028
	317985	17398	252820	184244	6.682	0.129	0.228	0.100	
Poland	133195	18825	81301	32103	5.286	0.172	0.373	0.054	3.248
	696864	46525	368764	273076	6.155	0.177	0.216	0.098	
Romania	365849	19960	183360	90259	5.320	0.161	0.389	0.071	2.696
	967780	41214	542599	375642	4.493	0.126	0.212	0.082	
Slovakia	316425	23273	103444	118123	5.695	0.157	0.345	0.067	3.029
	1027710	55965	316492	835073	5.934	0.247	0.235	0.078	
Slovenia	389928	31450	352859	71019	5.313	0.151	0.383	0.038	3.193
	1190925	69622	1473242	273222	4.760	0.117	0.219	0.066	
Average	322426	28353	161132	101472	5.739	0.164	0.392	0.054	3.178
	1130051	88261	621520	813899	6.808	0.162	0.223	0.094	

Year	Deposits	Operating expenses	Loans	Securities	nim	cap	lq	cr	ebrd
1994	159630	18876	110596	36672	8.738	0.165	0.425	0.078	2.714
1995	204555	21161	107384	54715	7.065	0.168	0.413	0.079	2.865
1996	219199	23762	103162	57156	6.592	0.156	0.408	0.072	2.865
1997	226427	19248	123344	55002	6.047	0.168	0.400	0.060	2.920
1998	264755	26558	133510	77402	6.841	0.180	0.397	0.051	3.045
1999	291622	23321	142632	129917	6.273	0.170	0.405	0.040	3.197
2000	337431	33006	150228	103316	5.555	0.165	0.395	0.045	3.260
2001	396119	34002	166735	124261	5.033	0.172	0.411	0.026	3.356
2002	416086	30805	192840	142874	4.886	0.173	0.374	0.031	3.423
2003	426105	27036	215785	152103	4.857	0.165	0.345	0.028	3.437
2004	487973	39157	222555	170847	4.683	0.146	0.364	0.019	3.557
2005	439210	38217	264817	113394	4.150	0.127	0.389	0.019	3.666

Table 2
Technical efficiency and total factor productivity change (annual means)

Country	Year	te	dtfp	Country	Year	te	dtfp
Bulgaria	1994	0.652		Lithuania	1994	0.751	
	1995	0.701	1.362		1995	0.675	1.010
	1996	0.754	1.255		1996	0.655	0.914
	1997	0.726	1.210		1997	0.382	0.944
	1998	0.686	1.117		1998	0.394	1.013
	1999	0.621	0.882		1999	0.377	1.767
	2000	0.767	1.740		2000	0.565	1.021
	2001	0.727	0.960		2001	0.767	1.186
	2002	0.753	1.224		2002	0.744	1.090
	2003	0.703	1.070		2003	0.853	0.925
	2004	0.681	1.025		2004	0.865	1.126
	2005	0.763	1.548		2005	0.841	1.149
Average		0.711	1.218			0.656	1.104
Czech Republic	1994	0.376		Poland	1994	0.682	
	1995	0.490	1.255		1995	0.663	0.975
	1996	0.726	1.244		1996	0.566	0.870
	1997	0.784	1.287		1997	0.575	1.176
	1998	0.663	1.627		1998	0.680	1.493
	1999	0.606	1.271		1999	0.696	0.963
	2000	0.568	1.251		2000	0.588	1.825
	2001	0.451	1.411		2001	0.487	1.484
	2002	0.410	1.081		2002	0.416	1.547
	2003	0.327	1.050		2003	0.456	1.210
	2004	0.340	1.210		2004	0.489	1.249
	2005	0.449	1.184		2005	0.592	1.357
Average		0.516	1.261			0.574	1.286
Estonia	1994	0.691		Romania	1994	0.761	
	1995	0.716	1.167		1995	0.747	0.961
	1996	0.786	1.028		1996	0.766	1.283
	1997	0.781	1.182		1997	0.732	1.305
	1998	0.707	1.010		1998	0.732	1.796
	1999	0.768	1.086		1999	0.757	1.009
	2000	0.697	0.975		2000	0.716	0.996
	2001	0.789	1.362		2001	0.724	1.113
	2002	0.853	1.096		2002	0.796	1.207
	2003	0.765	1.147		2003	0.793	1.367
	2004	0.830	0.821		2004	0.744	1.276
	2005	0.898	1.165		2005	0.825	0.874
Average		0.773	1.094			0.758	1.199

Table 2 (continued)

Country	Year	te	dtfp	Country	Year	te	dtfp
Hungary	1994	0.526		Slovakia	1994	0.732	
	1995	0.541	1.097		1995	0.773	1.514
	1996	0.483	1.004		1996	0.719	1.622
	1997	0.470	1.014		1997	0.734	1.125
	1998	0.623	1.235		1998	0.751	1.011
	1999	0.792	1.107		1999	0.765	0.876
	2000	0.753	0.981		2000	0.578	1.136
	2001	0.692	1.301		2001	0.534	1.299
	2002	0.661	1.161		2002	0.656	1.237
	2003	0.653	1.315		2003	0.696	1.296
	2004	0.658	1.215		2004	0.718	1.150
	2005	0.701	1.182		2005	0.785	0.924
Average		0.629	1.147			0.703	1.199
Latvia	1994	0.737		Slovenia	1994	0.580	
	1995	0.836	1.077		1995	0.676	0.985
	1996	0.821	1.039		1996	0.670	1.107
	1997	0.667	1.079		1997	0.605	1.030
	1998	0.578	1.179		1998	0.617	1.007
	1999	0.424	1.183		1999	0.619	1.184
	2000	0.528	1.128		2000	0.731	0.972
	2001	0.570	0.899		2001	0.638	1.160
	2002	0.623	1.170		2002	0.664	1.155
	2003	0.637	1.172		2003	0.596	1.093
	2004	0.707	1.133		2004	0.748	1.009
	2005	0.557	0.945		2005	0.823	1.136
		0.640	1.091			0.664	1.076

Table 3
Yearly estimates of banking industry competition

Year	Bulgaria	Czech Republic	Estonia	Hungary	Latvia	Lithuania	Poland	Romania	Slovakia	Slovenia
1994	0.181	0.591	0.731	0.224	0.413	1.158	0.762	-0.044	0.534	1.097
1995	0.245	0.601	0.589	0.382	0.416	0.900	0.775	-0.031	0.498	1.005
1996	0.169	0.500	0.670	0.317	0.713	1.147	0.888	0.153	0.445	0.901
1997	0.187	0.366	0.703	0.328	0.846	1.114	0.742	0.236	0.396	0.970
1998	0.183	0.437	0.684	0.449	0.683	1.134	0.754	0.279	0.412	0.977
1999	0.259	0.414	0.801	0.366	0.756	1.138	0.723	0.381	0.419	1.077
2000	0.293	0.577	0.861	0.419	0.671	1.098	0.742	0.328	0.373	1.067
2001	0.349	0.369	0.887	0.377	0.629	1.134	0.742	0.236	0.321	1.008
2002	0.210	0.651	0.936	0.473	0.832	1.163	0.771	0.293	0.284	1.012
2003	0.347	0.653	0.853	0.481	0.773	1.101	0.800	0.382	0.322	0.996
2004	0.378	0.676	0.700	0.563	0.839	1.161	0.675	0.322	0.356	1.083
2005	0.340	0.617	0.646	0.549	0.830	1.107	0.636	0.293	0.287	0.991

Table 4

Performance, deregulation market power and risk

	(1) te		(2) te		(3) dtfp		(4) dtfp		(5) nim		(6) nim		(7) nim	
	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic
ebrd			0.233	8.02			0.184	3.36	-1.170	-2.28	-1.103	-2.18	-1.292	-3.46
ref94	0.157	2.82			0.046	0.17								
ref95	-0.134	-1.09			-0.317	-1.01								
ref97	0.235	5.67			0.238	0.81								
ref98	-0.111	-2.36			0.163	0.50								
ref99	-0.020	-0.81			-0.010	-0.05								
ref00	0.076	2.07			0.341	1.16								
ref01	-0.050	-1.93			0.055	0.18								
ref02	-0.022	-0.68			-0.111	-0.34								
ref03	0.210	2.79			0.670	0.75								
ref04	0.052	1.72			1.171	2.48								
ref05	0.287	7.86			1.514	2.94								
te											-0.935	-2.07		
ldtfp													-0.011	-2.26
mp	-0.379	-4.95	-0.463	-6.32					2.103	3.11	2.539	3.57	2.428	3.58
cap	0.201	3.57	0.189	3.32					9.209	8.79	9.492	9.25	9.946	10.11
lq	-0.408	-10.26	-0.375	-9.36					-1.967	-2.71	-2.346	-3.21	-1.660	-2.88
cr	-0.018	-3.59	-0.019	-3.73					0.139	1.35	0.122	1.21	-0.061	-0.62
dmp					0.510	0.61	0.119	0.15						
dcap					1.096	2.54	1.168	1.63						
dlq					-2.254	-4.31	-2.491	-4.78						
dcr					-1.722	-28.66	-1.732	-28.62						
ir	0.003	2.33	0.004	2.87	-0.026	-2.12	-0.025	-2.62	-0.038	-1.59	-0.033	-1.41	0.004	0.21
invgdp	0.004	1.81	0.002	1.05	0.010	0.40	0.001	0.07	-0.040	-0.98	-0.040	-1.01	0.002	0.05
for	0.002	3.68	0.003	5.99	0.001	0.17	0.005	1.21	-0.025	-2.47	-0.025	-2.49	-0.021	-2.9
pub	-0.002	-3.28	-0.002	-2.92	-0.006	-1.02	-0.012	-2.01	0.017	1.39	0.013	1.14	0.031	0.35
cons	0.986	10.75	0.495	4.36	0.679	0.92	0.675	0.71	11.137	5.31	11.849	5.75	9.947	6.52

Figure 1. Relationship between TFP growth and TC

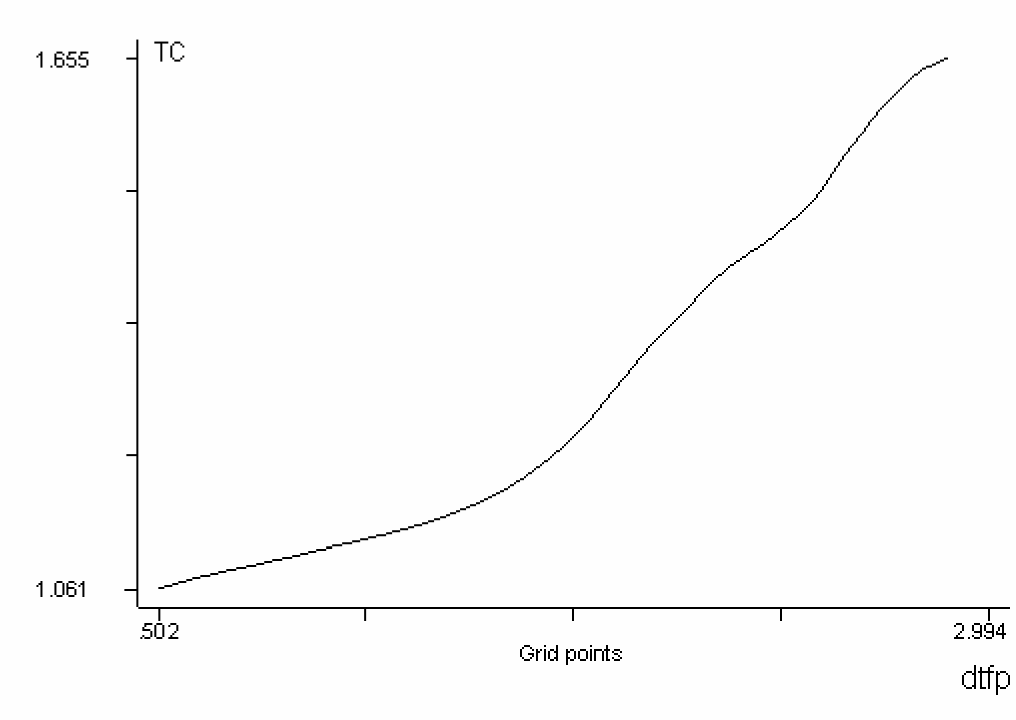

Figure 2. Relationship between TFP growth and PTEC