Efficiency of European Banking - Inequality and Integration

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This version: July 2005

ABSTRACT

The aim of the paper is to quantify the heterogeneity and convergence of banking efficiency in the old EU member states, the ten new member states and three associated countries during the period 1994-2002 using data envelopment analysis. A two-step approach is followed: First, banking systems are compared in terms of efficiency of banks in attaining two different sets of objectives: those of commercial banks as profit maximizing institutions and the regulatory goals of central banks perceived as enhancement of economic growth through investments and loans. Then, the obtained technical efficiency scores are used to explore hypothesis about the convergence of banking efficiency in Europe using ANOVA tests, sigma and beta convergence tests with fixed effects panel data analysis.

The results show lack of beta convergence and persistently heterogeneous levels of banking efficiency. However, we find a decrease in the variability of efficiency scores and sigma convergence of banking efficiency across Europe, which is biggest in magnitude in 1996 and after the introduction of the EMU.

Keywords: banking efficiency, DEA, European financial integration

JEL Codes: G2, G21, P30, P34, P52

I am grateful and would like to thank without implicating to P. Weil, L. De Souza, M. Lenza and P. Van Roy. The usual disclaimers apply.

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Contents

1. Introduction.

Numerous studies have examined the levels of efficiency of European banking both in terms of time dynamics and cross-sectional differences. Most of the conducted research has been concentrated on the performance of banking sectors in the Western economies but recently, rapidly increases the number of papers analyzing the efficiency of banks in the East. While the banking efficiency research and the lietarure on financial convergence using mean levels of efficiency or aggregate measures are rather extensive, the usefulness of second moments of the distribution of banking performance measures for quantifying cross-sectional differences has received realtively little attention.

The objective of this paper is to add to the existent research by adopting a disaggregated, micro-oriented approach and examining the fisrt and second moments of banking efficiency scores in order to draw conclusions and test hypothesis about the differences in the performance of banks across Europe.

The countries covered are classified in groups according to the stage and timing of their integration into the European Union (EU) and include (i) the fifteen old EU member states (EU 15), (ii) the ten new member states (NMS) and (iii) the three currently accession countries (AC) which are about to join the Union - Bulgaria, Croatia and Romania.

Geographically, we distinguish between the West and East by comparying the performance of banks in the EU old member states to that of banks in Central and Eastern Europe (CEE) which consists of the ten NMS without Cyprus and Malta and the three AC. The study is based on the IBCA BankScope database and covers the period 1994-2002.

The paper is organized as follows: The first part surveys the methods for analysis of banking efficiency and justifies the choice of the adopted approach, data envelopment analysis (DEA), by evaluating the appropriateness of the assumptions needed and the precision of estimation gained by the use of different methodologies. The next part evaluates the efficiency of banks in the

selected countries over the years 1994-2002. In order to differentiate between the various functions performed by banks, two models are analysed using different sets of outputs. First, the performance of banks in achieving the corporate goal of profit maximization is quantified. Second, the technical efficiency of commercial banks is evaluated with respect to their ability to comply with the regulatory objective of central banks to facilitate economic growth preserving in the same time the safety and soundness of the banking system. In the fifth part is investigated the link between banking efficiency and financial convergence in a regional and European dimensions. The last part summarizes.

2. Banking efficiency analysis

2.1. Methodology for analyzing banking efficiency

2.1.1. Analysis of accounting financial ratios

The traditionally most often used approach is the analysis of financial ratios. It has the clear advantage of being easy to perform and straightforward to interpret. However, this approach has several disadvantages. The main reproach is that neither of the coefficients can capture the whole range of services that banks provide. Additionally, bank operating ratios can be severely distorted by differences in the capital structure, accounting practices, level of inflation as well as the range of business and product mix (i.e.Vittas, 1991). While several empirical approaches have been suggested to correct for this influence (i.e., De Young, 1997) or simply the factors suspected to cause distortions can be included in a second stage regression as control variables, this cannot overcome the main deficiency of financial ratios: that they are single factor measures of performance. Consequently, in order to assess in a more complex way the efficiency of financial institutions several ratios have to be taken into consideration.

2.2.2. Frontier methods.

The alternative empirical strategy is to use parametric (i.e. stochastic frontier approach, SFA or distribution-free approach, DFA) or non-parametric (i.e. data envelopment analysis, DEA) frontier techniques to estimate an index of bank operational efficiency. The frontier techniques have the advantage to convey the information of many operational ratios in a single index, thus permitting ranking of decision-making units and summarizing multiple possibly qualitative characteristics in a quantitative way.

Parametric methods.

The SFA has the advantage that it performs well in small and noisy samples. For that reason it is especially often chosen for analysis of transition economies banking systems. The main disadvantage of the approach is that specific functional form for the production frontier has to be assumed. The DFA and some specifications of the SFA require the assumption of constant level of efficiency over time that in the case of transition economies is difficult to be judged as appropriate. Additionally, it makes more difficult the economic explanation and testing of hypothesis related with convergence of efficiency in time.

Nonparametric methods.

One of the most often used non-parametric approach, DEA, has the advantage that the best-practice efficient frontier is derived based on the sample under investigation and there is no need to impose preliminary assumptions about its functional form. This gives to the technique a great potential for identifying the best-practices benchmark and evaluating the performance of banks in comparison to it. The main disadvantage of the approach is that the derived efficiency scores are very sensitive to outliers and shocks as they are treated as a sign of inefficiency.

Both approaches described suffer from the usual difficulty of having to construct a single index for bank output capturing the whole range of functions that these institutions perform. Additional problems arise if the samples that are combined under a common frontier exhibit too great heterogeneity, which can lead to lower efficiency scores (Mester, 1997). This problem can be exacerbated by cross-sectional or time differences in the quality of data coverage as when the sample is smaller some institutions can be classified as efficient simply because there are not enough banks with similar characteristics against which the comparison can be made (Lovell, 1993).

In this paper is applied a variable returns to scale, output oriented, multi-stage DEA analysis. The DEA approach produces a “fair” comparison only if the decision-making units in the sample have similar functions and operate in identical environmental conditions. One way to take this into account is to control for environmental factors during the DEA estimation (i.e. Hasan et al., 2000). Here, the differences in environmental conditions are controlled for during the second-stage regression analysis. The difference between the two approaches is that in the one-stage model efficiency is measured while controlling for the influence of exogenous variables, whereas in the two-stage model variation in efficiency is attributed to variation in the exogenous, non-discretionary variables (Lovell, 1993). The specific features of the DEA approach as well as the limitations

imposed by the quantity and quality of the data are taken into consideration in the interpretation of the empirical results.

2.2. Studies on banking efficiency for CEE countries

The number of studies of X-efficiency of banks in CEE countries that apply parametric or non-parametric frontier methods is rapidly increasing and filling the gap that existed until recently in the literature.

The prevailing part of these studies analyses the efficiency of banking systems in individual countries. Hasan and Marton, 2003, studied the dynamics of profit and cost efficiency for Hungarian banks and the determinants for their performance. Using SFA they estimated the overall profit and cost inefficiency to be respectively 28.76 and 34.50. Taci (2000) analyzed the cost efficiency of the Czech financial sector in conjunction with the size, ownership structure and performance status of banks using DFA in a cross-sectional estimation and fixed effects approach in panel data estimation. Kraft and Tirtiroglu (1998) studied X-efficiency and scale efficiencies of both new and old, state and private banks in Croatia. Using SFA and data for the period 1994-1995, they found that the new banks are more X-inefficient and more scale-inefficient than either old privatized banks or old state banks. However, according to this study, new, private banks are highly profitable. Consequently, a negative, but only weakly statistically significant relationship between profitability and *X*-efficiency was found to emerge in Croatia.

A growing number of international comparative studies uses banking system efficiency scores for various countries including transition economies to derive policy recommendations and analyse different aspects of financial structures architecture or performance. Yildirim and Philippatos (2002) analyse the cost and profit efficiency of 12 transition economies, excluding Bulgaria and Yugoslavia for the period 1993-2000. Using SFA and DFA they found that the average cost efficiency level for the 12 countries are 72 and 76 percent by the two approaches respectively. The profit efficiency levels were estimated to be significantly lower: almost one-third of banks' profits are lost to inefficiency according to SFA and almost one-half by DFA. Drakos (2002) analysed the effect of reforms on banking efficiency using a dealership model for micro datasets for six CEE countries banks during the period 1993-1999. In a recent study Grigorian and Manole (2002) investigated the determinants of banking efficiency in 16 transition countries, employing DEA and a variation of the value-added approach to the definition of bank output for the period 1995-1998. They differentiate the functions of banks by defining two types of indexes – revenue-based and service-based.

2.3. Specification of input and output variables

The exact definition of input and especially of output variables in banking is still a controversial issue. According to Berger and Humphrey (1992), bank inputs and outputs can be specified using either the assets (intermediation) approach, the user cost approach or the value added (production approach). Recently in the empirical studies more attention has been given to the intermediation approach, which treats deposits as inputs and defines loans and investments as outputs.

In this study, following Leightner and Lovell (1998), a different stance is adopted by defining two specifications of the type of services that banks provide depending on whether they follow their own objectives or the regulatory objectives of the central bank. In the first model, commercial banks are treated as profit maximizing corporate firms and their output is specified as *total operating income* (sum of the *net interest revenues* and *other operating income*). In the second model is examined the behavior of commercial banks in achieving the central bank objectives which can be summarized as an attempt to make the financial system support a faster economic development through loans and investments, while preserving at the same time its stability. In the second model the outputs are the investments made by banks (the *other earning assets*) and the *net total loans* (after deducting problem loans and loan loss provisions). The subtraction of problem loans is aimed at reflecting the risk-taking behavior in lending.

***Table 1*, Input and output variables**		
	Regulatory objectives	**Commercial bank objectives**
Outputs	Loans (Total customer loans) Investments (Other earning assets)	Gross operating income (Net interest income + Other operating income)
Inputs	Physical capital (Total fixed assets) Deposits and other funding (Total customer and short-term funding) Operating costs (Overheads)	

*BankScope definitions of variables in parentheses.

In both models the inputs are *total customers and short-term funding* (total deposits and other funding), *total fixed assets* and *total operating costs*.

3. Convergence of banking efficiency

3.1. Studies on convergence in banking

Financial convergence has been modelled using time-series, cross-section and panel data analysis with respect to various aggregate and firm-level variables. Although there is no universally agreed definition of the term convergence, there are two predominant concepts in the growth literature (Quah 1993) inspiring also the studies of the evolution of banking systems. The first of them, referred to as beta convergence, implies in the case of banking that financial systems with lower bank output, expressed relative to a given steady state level (usually the start of the reforms period in 1993 in the case of transition economies or the start of the Single market program and the Second banking directive for the EU countries) tends to grow faster over time. Additionally, the concept can be explained as a decrease in the differences between average levels of performance measures and this is the definition adopted in this paper. The other concept, known as sigma convergence, concerns cross-sectional dispersion and applies if the variability, measured as a change in the standard deviation of a given price/interest rates indicator, quantity/volume data (i.e. the amount of cross-border activities) or performance measure (i.e. the ratio of Non-interest Income to Gross Income, or as proposed in this paper, X-efficiency multifactor scores), declines over time.

Additionally, the sigma convergence of banking efficiency measured by a decrease in the variability of the efficiency scores can be interpreted as a qualitative indicator for integration in banking as it can show to what extent the way of doing business is becoming similar across countries or profit/arbitrage opportunities are becoming easier to exploit. The two most often used traditional indicators for banking integration are criticized on several grounds. The price-based indicators are based on the assumption that financial services have to be equally prices in different countries. However, due to the fact that banking is a heavily regulated industry as well as to the presence of language and cultural differences, the law of one price should not necessarily hold in banking. The quantity-based indicators measure the volume of cross-border flows or the amount of assets held by a foreign company. Their absence, though, cannot be interpreted as incompatible with a high degree of integration as long as the competitive pressures keep the price differences equal to the arbitrage costs. In addition, since there is no volume equivalent to the law of one price, several statistical indicators of cross-border activity may needed to be applied together (Manna, 2004).

Theoretically, the usefulness of the dispersion of the distances from a best-practice frontier as measure for integration in banking can be sought in the fact that this micro-oriented indicator should not be affected by the endogeneity bias which is typical for most of the traditional indicators. Presumably, there should be no reason why the changes in the efficiency of managers have to be

influenced by the growth rate of GDP. However, recently some studies have challenged this view and showed that even those measures of banking performance are strongly interrelated with macroeconomic variability (i.e. Lozano-Vivas and J.Pastor, 2004). For Europe it is even more difficult to distinguish between the influence of the procyclicality of banking efficiency and financial integration because of the short time period and the coincidence between cyclical turning points and major stages of integration.

Numerous papers investigate the existence and implications of financial convergence in Europe, especially in relation with, and after the introduction of the EMU. Convergence in banking is analysed most often by testing the time trends of number of aggregate and micro level indicators. Calcagnini et al. (2000), use a statistical cost accounting approach to investigate whether there is convergence of marginal rates of return on costs and liabilities in Europe. Other approach is to estimate and test a model of growth of output in banking, using different measuers of bank outputs like loans to government sectors, loans to public enterprises or bank loans to the private sectors (Murinde, et al, 2000). De Guevara and Maudos (2002) and Altunbas and Chakravarty (1998) analyze the importance of productive specialization and the country effects in the explanation of the differences in the efficiency of banking sectors in the EU, using Theil indexes decomposition.

Almost all authors in the extensive literature on scale and scope economies in banking have looked at the convergence of efficiency scores although to our knowledge, there are no studies expliciely testing hypothesis for convergence in banking based on second moments of parametric or non-parametric frontier efficiency measures.

3.2. Methodology for analyzing convergence in banking

In this paper convergence in banking is investigated by cross-sectional and time-series comparisons using three types of tests. Sigma convergence tests are used to examine the conjectured decrease in the dispersion of banking efficiency scores, ANOVA F-tests are applied to question the appropriateness of the construction of a common European frontier and fixed effects panel data analysis is employed to analyze the presence of beta convergence.

3.2.1. Sigma convergence tests.

The first type of tests is based on the hypothesis that convergence in banking can be detected via a decrease in time of the variability of efficiency across countries as the way of doing business is becoming more similar even though heterogeneity in the mean levels of efficiency may be preserved.

The estimated regression model is:

$$\sigma_t = \alpha + \beta\, T + u_t \qquad (1)$$

where σ_t is the standard deviation of banking efficiency scores in year t when the efficiency estimation is done under a common frontier, T is the time trend with respect to year 1994 and u_t, is the disturbance term.

3.2.2. ANOVA tests.

The second type of tests is built upon the hypothesis that, although there might be differences in the average levels of banking efficiency across countries and regions, the two samples including banks from different parts of Europe are drawn from the same population and consequently the construction of a common frontier is justified.

3.2.3. Beta convergence tests – fixed effects panel data analysis.

Further, the micro-level differences in banking performance across countries are explored using panel data analysis with time and country fixed effects controlling for bank and country specific non-discretionary environmental variables.

To examine whether productive efficiency varies systematically across countries and over time and what part of its changes can be explained by country and time differences, the following regression model is estimated:

$$Eff_{jit} = \alpha X_{it} + \beta Y_{jt} + \gamma D_j + \delta T_t + u_{jit} \qquad (2)$$

where Eff_{jit} is the efficiency of bank i from country j in year t; X_{it} is a vector of bank specific control variables; Y_{jt} is a vector of country specific control variables; D_j, is a vector of country specific dummy variables; T_t, is a vector of time specific dummy variables; α, β, γ and δ are the vectors of regression coefficients and u_{jit}, is the disturbance term.

4. Data

The information used is annual firm-level data from bank balance sheets and income statements for the fifteen old EU member states, the ten new member states and three accession

countries between 1994 and 2002 from BankScope, OECD financial accounts and central banks statistics.

4.1. Data transformations

From the initial sample were excluded bank holding companies and banks with missing observation or negative values on a model variable, due to the efficiency estimation specification. Only commercial banks were considered for the old EU member states. For the new member states and the accession countries the sample includes also saving banks and in some cases banks with consolidated statements due to the more limited data coverage in those countries. To preserve the number of observations, the efficiency estimations were done separately on cross-sectional data for each year. Even though the model for banking efficiency in the generation of revenues has one output variable, i.e. the *gross operating income*, from the sample were excluded banks with negative values on either of its components, i.e. the *net interest revenues* or *other operating income*. In that way was obtained a relatively balanced sample of banks in terms of specialization and profitability, including predominantly financial institutions with universal type of specialization. All data are reported in thousands US dollars and are corrected for inflation using the IMF's International Financial Statistics GDP deflators.

4.2. Data coverage.

Table 2 A lists the number of banks in the sample by region and year. A more detailed description of the number of included banks per country and year is given in Table 2 B in the appendix.

***Table 2 A*, Number of banks per region, 1994-2002.**

	1994	1995	1996	1997	1998	1999	2000	2001	2002
EU 15	412	806	871	859	835	792	783	722	571
NMS	76	155	168	177	151	160	168	141	105
AC	25	42	49	63	77	88	93	92	37
CEE	97	186	205	227	214	235	249	221	131
***Total*: EU 25 and the 3 AC**	610	1189	1293	1326	1277	1275	1293	1176	844

Source: Author's calculations based on BankScope and Central bank statistics.

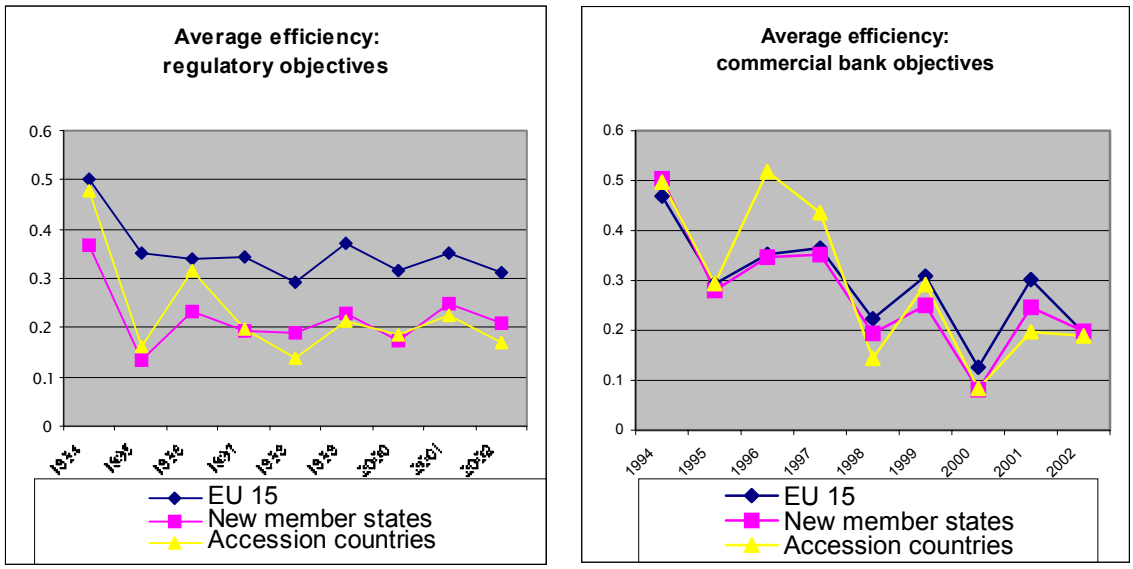
The coverage of BankScope in terms of number of financial institutions per country is relatively good especially for the EU old member states. However, the data limitations have to be taken into consideration when interpreting the empirical results obtained later. The quality of the

coverage of banks is varying both in time and cross-sectionally. The number of included banks is greatest for the years 1997 to 2000, smaller after the year 2001 and very limited before 1995. Cross-sectionally, the percentage of banks included in the database is bigger for the old EU member states and smaller for the CEE countries. Qualitatively, the coverage per country is likely to create a sample bias that does not run in favour of the countries with more developed banking systems as they may have reporting a larger share of their banks, including both, good and bad banks.

5. Empirical results: banking efficiency

The two panels of Figure 1 present the results of the application of DEA on the pooled sample of old and new EU member states as well as the three accession countries – Bulgaria, Romania and Croatia. The regional averages are calculated from the efficiency scores obtained from the pooled under a common European frontier sample.

Figure 1, Average banking efficiency per region



Source: Author's calculations based on BankScope

The dynamics of efficiency across Europe is very different between the two models used for the definition of banking efficiency. The differences in the efficiency of banks in the East and in the West are bigger with respect to efficiency in achieving the regulatory objectives and decreasing or even inexistent at the end of the period for efficiency in revenue generation.

5.1. Efficiency in achieving regulatory objectives

The model for determination of efficiency with respect to the regulatory objectives is having as outputs the loans granted and the investments made Consequently it is close to the measures of financial development and financial deepening based on aggregate data and using most often loans to the private sector in the nominator. Several studies confirm the lower level of financial intermediation in the CEE even though it is improving especially in the years after 2000. Still, studies based on aggregate measures of financial development show that banking intermediation is lower both in the new member states and in the accession countries. This is confirmed using our microeconomic disaggregated approach in the first panel of Figure 1.

In the same time, efficiency of banks in the accession countries is not significantly lower than that in the new member states. Banks in both sets of countries have similar levels of efficiency with respect to achieving regulatory objectives and the most significant difference is between them and the old member states.

Measuring financial development and efficiency based on the amount of loans made by banks is to some extent controversial. On one side it is considered as beneficial for the countries in CEE to achieve similar levels of financial intermediation as those in the old member states. On another side it is difficult to incorporate into this type of indicators concerns about financial and economic stability. For the disaggregated microeconomic measures of efficiency there are some possibilities to incorporate proxies for the quality of loans i.e. by including problem loans as an input variable or measures for the risk undertaken by managers by including equity as an input variable. In this study, we do not include measures for the risk or quality of loans (i) because of data limitations, (ii) in order to treat in an equal way banks in the two set of countries and (iii) because including such proxies in general would not significantly influence the empirical results. Instead, we choose to interpret the obtained efficiency scores having in mind those considerations. We can observe an increase in the efficiency of banks with respect to regulatory objectives in the countries in the new member states and particularly in the accession countries exactly in the years when banking crises occurred, i.e. 1996-1997 for Bulgaria and Romania. Part of this result should be also due to the sample selection bias: data from BankScope for the

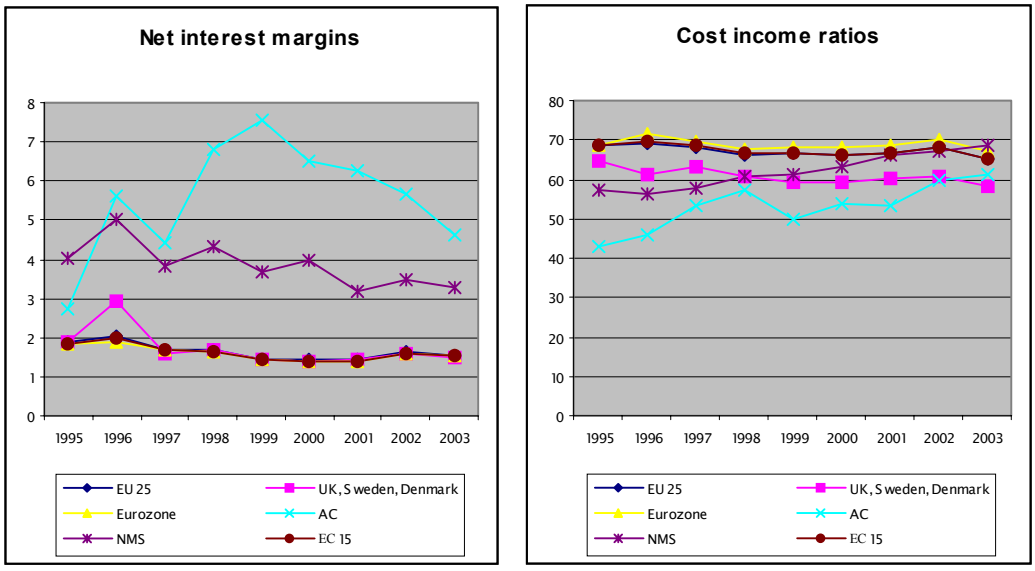
years before 1997 is having more limited coverage especially for the countries in Eastern Europe and actually those banks that are in the sample are the biggest institutions that survived the crises and were successful both in terms of loan and investment activities as well as in terms of profitability (see the second panel of Figure 1).

5.2. Efficiency in achieving commercial bank objectives (revenue generation)

The second panel of Figure 1 shows the differences in the cross-regional patterns and the dynamics of bank profit efficiency according to our behavioural model for defining the optimum. The overall dynamics of profit efficiency is declining and it can be interpreted as a result of macroeconomic and financial integration or depleting of cross-sectional arbitrage opportunities in the banking industries.

Some studies using financial ratios report significantly lower banking profitability in the countries in CEE despite the higher net interest margins (i.e. Riess, Wagenvoort and Zajc, 2002). Some of the explanations are the relatively higher operational costs (i.e. Buch, 1996), the specific time period or the methodology used. Figure 2 shows two of the main microeconomic financial ratios for efficiency measurement calculated for different regions of Europe. While the net interest margins are significantly higher in CEE, operating costs as a percentage of the gross operating income are also lower in those countries.

Figure 2, Efficiency ratios



Source: Author's calculations based on BankScope.

Additionally, in the studies of bank profitability in CEE using financial ratios usually is applied inflation correction directly to the ratios, which significantly reduces them. In our multifactor, non-parametric model of banking profit efficiency, all variables are corrected symmetrically for inflation before the application of DEA and the operational costs are included as one of the input variables.

The results confirm that profit efficiency of banks is lower in CEE in comparison to the old EU member states, although the difference might not be as significant as previous studies have suggested. Moreover, it is rapidly decreasing over time.

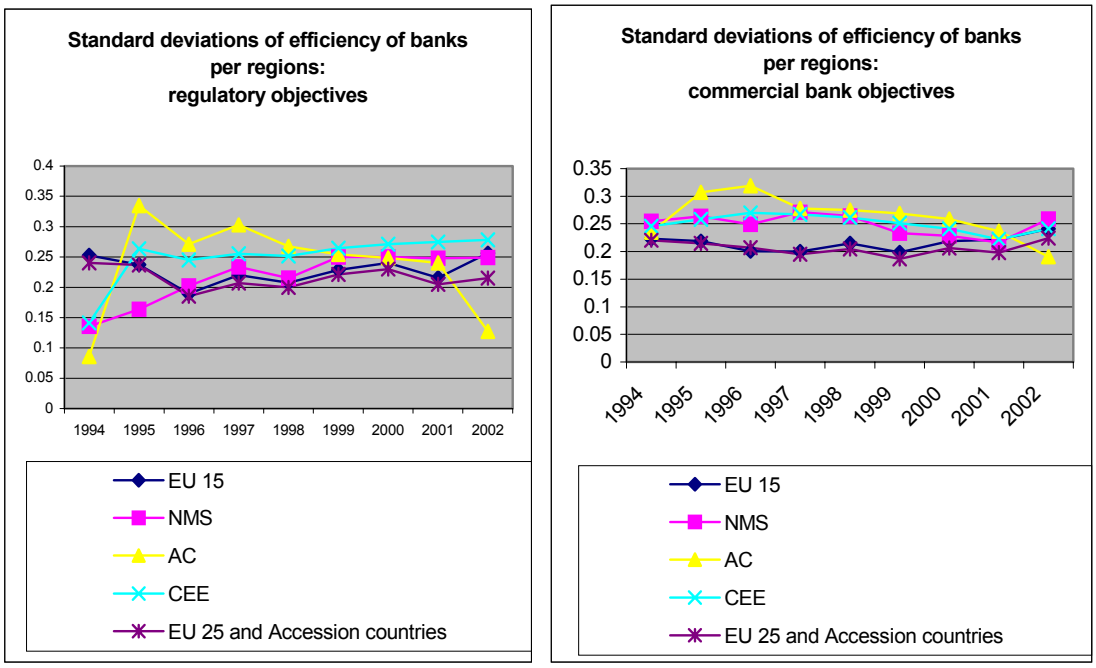
During the crisis period for some of the present accession countries 1996-1997, the banks that "survived" in addition to being very efficient in investing prove also to be very efficient with respect to profitability. However the limited cross-sectionally sample again does not permit to extend this result to the majority of not as successful banks that eventually failed in that period in Bulgaria and Romania.

The fast decrease in profit efficiency after 1999 can be interpreted as a result of the integration in banking eliminating the unused profit opportunities and the immediate effect of the introduction of the EMU. After 2000 the profit efficiency of banks is increasing again and in 2002 the differences between the old member states, the new member states and the three accession countries are completely eliminated.

5.3. Dispersion of efficiency scores

Figure 3 shows the standard deviations of efficiency scores for the two types of definition of efficiency. To compare the dynamics of the variability of the distances from the frontier and to get a first insight on the appropriateness of the hypothesis of sigma convergence, DEA was performed separately on the banks from different groups of countries.

Figure 3, Differences in efficiency variability across regions



Source: Author's calculations based on BankScope.

The decrease in variability is greater for the accession countries, followed by the new member states both with respect to regulatory and profit efficiency. For the old EU member states, the dispersion of efficiency levels is decreasing in the two important for the EU financial integration years: 1996 and 1999. The decrease of variability of efficiency with respect to profit efficiency is occurring before the official start of the EMU in 1999.

For both models, when in the sample are included the banks from the CEE countries, the dispersion of efficiency for banks in the enlarged Union is lower.

6. Convergence of banking efficiency?

In this part of the paper are applied formal econometric tests of the hypothesis that as the European integration proceeds there is an ongoing process of convergence in banking efficiency and decrease of heterogeneity in the pooled sample of banks from CEE and the old EU member states.

6.1. Sigma convergence tests.

Table 3 as well as Figures 3 and 4 present the results of regressions on time trends of cross-sectional standard deviations of average technical efficiency scores for different groups of countries. Almost all coefficients for the time trends have negative signs and those for the efficiency of achieving commercial bank objectives are higher in magnitude. The results imply that there is convergence in profit efficiency both in regional and European dimension and the decrease of divergences is faster when the NMS are included in the sample.

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***Table 3*, Sigma Convergence tests – Regressions of Standard Deviations of Efficiency Scores on Time, 1994-2001**				
	Constant	**Trend**	**R-squared**	**St. error of regression**
Regulatory objectives				
EU old member states	0.2313***	-0.0016	0.040	0.0212
New member states	0.1403***	0.0159***	0.830	0.0193
Accession countries	0.2205**	0.0067	0.050	0.0770
EU old member states, the new member states and the 3 accession countries	0.2252***	-0.0021	0.072	0.0203
Commercial banks objectives				
EU old member states	0.2119***	-0.0011	0.020	0.1135
New member states	0.2743***	**-0.0059*** **	0.551	0.0141
Accession countries	0.2930***	-0.0046	0.142	0.0299
EU old member states, the new member states and the 3 accession countries	0.2176***	**-0.0030** **	0.462	0.0086

*** significant at 1 % level , ** significant at 5 % level, * significant at 10 % level.

6.2. ANOVA convergence tests.

In order to perform the ANOVA tests, DEA was applied separately on the different regional subsamples (*CEE countries* including the new member states without Cyprus and Malta and the accession countries, *EU 15* and the *new member states*) for the years 1999, 2000, 2001 and 2002. Evaluating efficiency separately for each group of countries permits to avoid the problem of inherent dependency of the relative efficiency scores and comply with the sample independence assumption of the ANOVA tests. The tests were done for the two types of banking efficiency: in obtaining central banks goals and commercial banks objectives. The results of testing the null hypothesis that the two samples are drawn from the same population are presented on Table 4.

The tests for equality of means show that there are still strong disparities between the average levels of banking efficiency in the different parts of Europe. The null hypothesis that the mean efficiency scores of banks are equal is rejected for almost all combinations of set of countries, time periods or type of efficiency. This result is further confirmed in what follows by the panel data analysis of beta convergence. An exception, is the model for efficiency with respect to regulatory objectives for which there are no statistically significant differences in the mean levels of efficiency of banks in the old EU member states and the CEE countries for year 2001. There are no differences in the mean level of efficiency of banks also between the *new member states* and the *accession countries* for the years 2000 and 2001 with respect to regulatory objectives and for the years 1999 and 2000 with respect to commercial bank objectives.

***Table 4*, ANOVA tests**
for equality of means and variances of banking efficiency across Europe

Regulatory objectives								
	Equality of means (ANOVA F-test)				***Equality of variance*** (t-test)			
	1999	2000	2001	2002	1999	2000	2001	2002
EU 15 / new member states	269.6***	783.4***	285.4***	218.7***	1.384**	**1.087**	**1.046**	1.147
EU 15 / accession countries	89.3***	490.7***	193.8***	224.7***	1.844***	1.394**	**1.138**	1.602**
EU 15 / CEE	146.9***	190.3***	**2.4**	160.4***	1.353**	1.283**	**1.081**	**1.176**
New member states / accession countries	5.002**	**0.33**	**0.0005**	23.2***	**1.338**	**1.281**	**1.192**	1.838**
Commercial bank objectives								
EU 15 / new member states	193.2***	245.7***	209.9***	224.9***	**1.200**	**1.081**	1.327**	**1.056**
EU 15 / accession countries	85.7***	121.1***	98.3***	219.4***	**1.261**	**1.069**	**1.245**	4.053***
EU 15 / CEE	153.5***	932.4***	281***	274.8***	1.636***	1.187*	**1.007**	**1.045**
New member states / accession countries	**1.4**	**0.96**	2.9*	26.9***	**1.050**	**1.011**	**1.066**	3.835***

*** significant at 1 % level , ** significant at 5 % level, * significant at 10 % level.

The results of the tests for equality of variances are more promising and in favor of the hypothesis of financial convergence especially with respect to profit efficiency for almost all years and combinations of countries. The results from the equality of variances tests imply that in terms

of profit efficiency for years 2000 and to a lesser extent for year 2001 and 2002, the null hypothesis of having no significant differences between the efficiency of banks in the two groups of countries cannot be rejected.

6.3. Panel data analysis and beta convergence tests.

In order to test for convergence in levels of banking performance was conducted panel data analysis at disaggregated level. Individual bank efficiency scores were regressed on time and country dummies as well as on non-discretionary bank and country specific variables.

For identification purposes, the country dummies for the EU old member states are omitted so that the estimated coefficients measure the relative performance of banks in the new member states and the three accession countries with respect to that of banks in the EU 15 economies. The results are presented in Table 5.

All country dummies are statistically significant and the null hypothesis of equality of the levels of efficiency of banks in the two groups of countries is rejected for both models of determination of banking efficiency. Moreover, the regression coefficients of the country dummies have negative signs for all new member states and accession countries, which indicates that the efficiency of their banks is lower than that of banks in the old EU member states.

With respect to the regulatory objectives, the biggest difference between the East and the West is observed for Estonia, Lithuania and Romania. Closer to that in the old EU member states is the performance of banks in the Czech Republic as well as Malta, Croatia and Poland. The magnitude of the estimated coefficients for the country dummies is significantly smaller for profit efficiency of banks, although still all the coefficients have negative signs. After controlling for the differences in the macroeconomic environment, risk preferences of managers and market share, banks in the new member states and the three accession countries are less efficient in generating profit (before tax) than those in the EU 15. The difference is smaller for banks in Poland, Hungary and the Czech Republic and biggest for Estonia, Lithuania, Malta and Cyprus. There are no significant differences between the performance of banks in the current accession countries and those that already joined the EU and in some cases they even outperform them.

The market share is the most significant determinant of banking efficiency with respect to both sets of objectives. Its relative importance is bigger for profit efficiency indicating that some of the difference between banking performance in the East versus West may be due to lack of competition. GDP growth is also significantly positively related to efficiency of banks again with respect to both sets of bank objectives influencing more the ability of banks to generate profit.

***Table 5*: Panel data analysis of banking efficiency, 1994-2002** (White heteroscedasticity-consistent standard errors in parentheses.)		
	Regulatory objectives	**Commercial bank objectives**
Market share	**0.7965***** (0.0036)	**1.0166***** (0.0251)
GDP growth	**0.0912***** (0.0167)	**0.4388***** (0.0275)
Inflation	**-0.0227***** (0.0017)	**-0.0076***** (0.0021)
Equity/Total assets	**0.0008***** (0.0000)	**0.0003***** (0.0001)
Bulgaria	**-0.1410***** (0.0049)	**-0.0673***** (0.0054)
Croatia	**-0.1290***** (0.0012)	**-0.0788***** (0.0016)
Romania	**-0.2078***** (0.0023)	**-0.0880***** (0.0055)
Cyprus	**-0.1357***** 0.0007)	**-0.1767***** (0.0100)
Czech Republic	**-0.0953***** 0.0018)	**-0.0597***** (0.0100)
Estonia	**-0.2531***** (0.0099)	**-0.2247***** (0.0155)
Hungary	**-0.1304***** (0.0010)	**-0.0298***** (0.0030)
Latvia	**-0.1749***** (0.0008)	**-0.1258***** (0.0026)
Lithuania	**-0.2580***** (0.0032)	**-0.1977***** (0.0052)
Malta	**-0.1297***** (0.0022)	**-0.1690***** (0.0061)
Poland	**-0.1226***** (0.0011)	**-0.0260***** (0.0035)
Slovenia	**-0.1548***** (0.0010)	**-0.1096***** (0.0018)
Slovak Republic	**-0.1447***** (0.0008)	**-0.0960***** (0.0013)
1994	**0.4518***** (0.0036)	**0.4153***** (0.0041)
1995	**0.2742***** (0.0024)	**0.2536***** (0.0034)
1996	**0.3078***** (0.0020)	**0.3187***** (0.0030)
1997	**0.2953***** (0.0020)	**0.3249***** (0.0027)
1998	**0.2664***** (0.0019)	**0.1740***** (0.0026)
1999	**0.3204***** (0.0019)	**0.2503***** (0.0025)
2000	**0.2746***** (0.0019)	**0.0845***** (0.0024)
2001	**0.3412***** (0.0018)	**0.2345***** (0.0026)
2002	**0.2922***** (0.0018)	**0.1474***** (0.0028)
Adjusted R^2	0.9945	0.7987

*** significant at 1 % level , ** significant at 5 % level, * significant at 10 % level.

Inflation has a negative effect on bank efficiency even after correcting symmetrically all variables with respect to it before obtaining the efficiency scores. The coefficient of the share of equity in total assets is significant and positive which indicates that better capitalization is linked with higher efficiency.

All the time dummies are statistically significant and positive. Consequently, efficiency of banks with respect to both regulatory and corporate objectives is increasing over time for the period 1994-2002. While efficiency in obtaining the regulatory objectives is relatively constant and more gradually improving, efficiency in following commercial banks own objectives is more volatile, especially in the years 1998 and 2000.

7. Summary

The paper compares efficiency of banks in different parts of the EU and the accession countries in obtaining the objectives of revenue generation and financial intermediation by pooling them under a common frontier and applying DEA.

In levels, banks in the East tend to have lower efficiency scores with respect to both sets of objectives when controlling for a number of country and bank specific variables. The differences in efficiency levels are significant and the null hypothesis of equality of performance between banks in CEE countries and the old EU member states is rejected for all countries and time periods both by the ANOVA equality of means tests and the panel data analysis.

However, the second moments of the efficiency scores are decreasing and indicative of sigma convergence as the null hypothesis that the variances are statistically indistinguishable in the East and West cannot be rejected. The observed significant trend of decrease in the dispersion of average performance measures across countries is confirming the ongoing financial convergence in banking (profit) efficiency not only for the EU countries but also for the three accession economies. The equality of variances tests suggest that after the start of the European Monetary Union, for the years 2000, 2001 and 2002 the variability of the efficiency scores obtained in performing DEA analysis separately on the two groups of CEE and EU member states do not permit to reject the null hypothesis that the two samples of countries are the same with respect to revenue generation.

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Appendix

Table 2 B, Number of banks per country, 1994-2002.									
	1994	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Austria	18	42	44	38	41	35	37	33	40
Belgium	26	32	35	37	24	22	23	19	9
Germany	94	193	192	196	190	178	171	147	158
Denmark	3	13	54	51	53	49	53	48	46
Finland	3	6	6	6	6	6	6	5	5
Greece	11	17	18	18	16	12	11	10	12
Italy	35	77	84	97	101	100	98	104	7
Luxembourg	50	107	107	107	101	106	98	79	81
The Netherlands	8	11	14	13	10	10	10	13	9
Portugal	12	16	19	21	22	18	13	13	14
France	120	187	175	160	150	142	140	130	90
Portugal	21	27	29	30	32	32	35	27	14
Spain	17	61	71	68	67	64	67	65	50
Sweden	5	8	9	5	6	7	7	6	17
UK	12	32	39	38	40	36	37	36	24
EU 15	**412**	**806**	**871**	**859**	**835**	**792**	**783**	**722**	**571**
Cyprus	4	4	4	6	6	6	6	5	5
The Czech Republic	16	23	22	21	20	19	17	14	20
Estonia	3	7	8	9	2	4	5	5	4
Hungary	15	27	27	27	22	26	30	26	26
Latvia	11	13	15	19	19	21	19	19	18
Lithuania	4	7	8	9	8	9	10	8	5
Malta	2	7	7	7	8	7	6	6	6
Poland	35	38	46	48	45	42	43	31	14
The Slovak Republic	2	13	16	20	20	17	20	17	13
Slovenia	5	15	16	21	16	17	17	13	10
NMS	**76**	**155**	**168**	**177**	**151**	**160**	**168**	**141**	**105**
Bulgaria	2	7	14	13	17	24	30	28	20
Croatia	24	26	29	42	36	34	37	37	20
Romania	2	6	5	12	23	30	29	27	17
Accession countries	**25**	**42**	**49**	**63**	**77**	**88**	**93**	**92**	**37**
CEE *	**97**	**186**	**205**	**227**	**214**	**235**	**249**	**221**	**131**
***Total*: EU 25 and the 3 AC**	**610**	**1189**	**1293**	**1326**	**277**	**1275**	**1293**	**1176**	**844**

Source: Author's calculations based on BankScope and Central bank statistics.

*CEE includes the new member states without Cyprus and Malta and the three accession countries.