Banking Efficiency in Central and Eastern Europe

Stefania P. S. Rossi
Markus S. Schwaiger
Gerhard Winkler[1]

This paper analyzes cost and profit efficiency in Central and Eastern European countries, providing cross-country and time series evidence. A stochastic frontier analysis using a Fourier flexible form produces well-fitting cost and profit functions. Efficiency estimates indicate a generally low level of cost efficiency and an even lower level of profit efficiency. However, we also find some evidence of increasing cost efficiency and, to an even stronger extent, profit efficiency over time. Furthermore, we decompose the inefficiency values obtained from the cost and profit function estimates and thereby gain information about the level of banking efficiency across countries. Finally, we detect differences in efficiency across size and specialization and thereby provide an insight into the reasons for efficiency differences.

Introduction

This paper intends to investigate the state and evolution of banking efficiency in Central and Eastern European countries (CEECs) with a focus on the banking sectors in the countries that have recently acceded or are in the process of accession to the European Union.[2] The swift changes in the financial system following the collapse of the centrally planned economic systems, its catching up with EU levels and the overall transition towards a market economy make the banking systems of these countries a distinct field of research.

The analysis of banks' efficiency levels continues to be important from both a macroeconomic and a microeconomic point of view as is documented by its long tradition in literature.[3] From the micro perspective, the issue of banking efficiency is crucial, given ever increasing competition. From the macro perspective, the efficiency of the banking sector influences the costs of financial intermediation and the overall stability of the financial markets.

In contrast to the huge block of literature on banking efficiency in OECD countries, only relatively few studies have dealt with transition economies in CEE. Most of them focus on cost efficiency and/or use

[1] *The authors would like to thank the Foreign Research Division of the Oesterreichische Nationalbank and in particular Zoltan Walko for the provision of aggregate data for CEE markets as well as the participants of the Economic Studies Division Workshop 2/04, held at the Oesterreichische Nationalbank on July 23, 2004, for helpful comments. Much of the work was undertaken during Stefania Rossi's working visit at the Economic Studies Division of the Oesterreichische Nationalbank. Stefania Rossi is professor of Economics at the Faculty of Economics, University of Cagliari, Italy, and the Department of Economics, University of Vienna; Markus Schwaiger and Gerhard Winkler are members of staff of the Oesterreichische Nationalbank.*

[2] *In order to homogenize our sample, we excluded Malta and Cyprus because of their different levels of financial development as well as Turkey, whose banking sector has undergone very different developments recently. We will henceforth refer to the countries in our sample as Central and Eastern European countries (CEECs), with the Baltic States subsumed in this concept. Our sample therefore includes the following countries: the Czech Republic (CZ), Estonia (EE), Hungary (HU), Latvia (LV), Lithuania (LT), Poland (PL), Romania (RO), Slovakia (SK), Slovenia (SI).*

[3] *For an overview see e.g. Berger and Mester (1997).*

Table 1

The Banking Sector in the CEECs

2003	Total assets	Total assets
	EUR billion	*% of GDP*
CZ	78	107
EE	6	76
HU	54	70
LT	6	33
LV	9	84
PL	111	65
RO	16	12
SI	22	87
SK	21	93

Source: OeNB, own calculations.

data from a single country.[4] The purpose of this analysis therefore is to contribute to the existing literature by analyzing the effect of the consolidation and transition process in the CEECs on the cost *and* profit efficiency of these banking systems. We provide cross-country and time series evidence on cost *and* profit efficiency, employing recent data for banks in the CEECs in order to see whether significant variations in efficiency levels happened during the transition period before EU accession.

Before going into more detail on the data, the methodology employed and the results of our research in chapters 3 and 4, respectively, it is worthwhile putting the CEECs' banking systems as a research field into perspective in terms of its idiosyncrasies.

On the whole, the CEE banking market is relatively small. Its total assets (excluding Russia) are currently well below the total assets encountered in small Western European nations such as e.g. Austria (see table 1).[5]

At the same time, however, the CEE banking market has an enormous potential for growth. This is basically due to, first, the fact that the intermediation depth measured as banking assets over GDP stands at levels well below 100% – far away from the levels achieved in the EU-12 (266% in 2003 – see table 1) for instance[6] – and second, higher GDP growth itself as GDP per capita levels will converge to EU averages in the long run.

A look at table 2 furthermore reveals that the CEE banking market is characterized by a relatively high degree of concentration. Another specific feature of the CEE banking market is the widespread presence of foreign ownership that has emerged over the last years.

These two aspects are the consequence of the intense process of restructuring and growth that has led the CEE banking sector to experience an unprecedented level of consolidation through merger and acquisitions. The acquisition spree by Western

4 *See e.g. Kraft and Tirtiroglu (1998) on Croatia, Opiela (2000) and Nikiel and Opiela (2002) on Poland, or Taci and Zampieri (1998) on the Czech Republic. To our knowledge, few studies provide cross-country comparisons – Bonin et al. (2004), Green et al. (2004) and Weill (2003) analyze the effect of bank privatization on efficiency in selected Eastern European transition countries. Fries and Taci (2003) and Fries et al. (2002) also investigate the efficiency/performance of a sample of banks in transition economies. Zajc (2004) focuses on differences between foreign and domestic banks relying on the methodology of Claessens et al. (2001). Berglöf and Bolton (2002) as well as Fries and Taci (2002) deal with the effect of macroeconomic stabilization and institutional reform on the banking system. Buch (2000) compares interest rate spreads across three CEEs (Hungary, Poland and the Czech Republic). A well-structured overview of recent developments in CEE banking markets can be found in Balling et al. (2004).*

5 *The Austrian banking sector, as a point of reference, had total assets of EUR 605 billion on an unconsolidated basis as at the end of 2003 (Source:OeNB).*

6 *Along with sharply expanding total assets, our data furthermore document that loan and deposit ratios are increasing as well. This is an indication that the importance of the banking sector's intermediation role is definitely rising, albeit from a low original level.*

Table 2

Banking Sector Characteristics in the CEECs

2003	Market share of the five largest banks %	ROE	CAR[1]
CZ	66	23.2	14.5
EE	98	16.3	12.5
HU	52	17.6	10.7
LT	82	11.9	13.2
LV	63	18.1	11.7
PL	52	6.2	13.7
RO	70[2]	18.3[2]	..
SI	66	3.7[2]	11.5
SK	72	27.9	21.7

Source: OeNB, own calculations.
[1] *CAR: capital adequacy ratio.*
[2] *Data as of 2002.*

financial institutions has created a segmented banking system in the accession economies, with a tier of foreign-owned private financial institutions and a second tier of banks still in government hands losing relative market share (Eichengreen and Ghironi, 2001).

Another characteristic of the CEE banking sector is its relatively high profitability (see table 2). However, our dataset also indicates the onset of a decrease in the comparatively high interest rate margins in the CEECs (see also Walko and Reininger, 2004), which mirrors tightening competition in these markets.[7] Furthermore, table 2 shows that CEE banking systems are well endowed with equity. These high levels of equity[8] together with, as a look at our data suggests, cost income ratios rising in some countries, are a direct consequence of the expansion of the banking sector as a whole outlined above. Any expansion requires "raw materials," which in the banking sector have to be provided in the form of equity and overhead costs for staff and infrastructure.

2 Data

Our dataset is composed of single-bank data for CEE markets – it consists of annual account data derived from the financial statements of banks made available through the BankScope database of Bureau van Dijk and Fitch/Ibca. We use data for the years 1995 to 2002 for the eight CEECs that joined the EU in the first wave of accession (the Czech Republic, Hungary, Poland, Slovakia, Slovenia and the three Baltic countries Estonia, Latvia and Lithuania) as well as for the two CEECs due to join in the second wave (Romania and Bulgaria). As (re-

[7] *Many factors in the CEECs have contributed to increasing competition among financial institutions, such as the institutional upgrading in all economic sectors after the collapse of the socialist regimes, the preparation of the new Member States for joining Economic and Monetary Union, or the privatization and concentration process outlined above.*

[8] *Note that equity ratios are even rising over time.*

liable) data on each bank are not available for every year, we obtained an unbalanced panel dataset.[9] The distribution of banks across countries is given in table 3.

Table 3

Distribution of Banks across Countries

Countries	BG	CZ	EE	HU	LT	LV	PL	RO	SI	SK	Total
Number of banks	0	39	13	30	11	27	72	34	19	27	272

For lack of data we had to drop Bulgaria from our sample. Thus we obtained an unbalanced panel consisting of 1,070 observations, which refers to a sample of 272 banks belonging to nine CEECs (eight new EU Member States plus Romania). Taken together, the banks in our sample on average hold more than 80% of total banking assets in the respective countries. This leads us to the conclusion that our sample can be considered to be highly representative of the CEECs analyzed.

3 Methodology

3.1 Some Remarks on Efficiency Measurement

A production plan is called efficient if it is not possible to produce more with the same input or to reduce these inputs leaving the output unchanged. The duality theory (Beattie and Taylor, 1985, and Shephard, 1970) has shown that under given conditions (exogenous prices and optimal behavior of the producer) the property of the production function can be studied indirectly through cost or profit functions. However, observable production plans and cost/profit levels are not the result of perfectly rational and efficient-decisions: factors such as errors, lags between the choice of plan and its implementation, inertia in human behavior and distorted communication may cause what is called X-inefficiency; this means that real data move away from the optimum production plan. This is why estimation techniques must include some filter device to get rid of the inefficiency component and isolate the theoretical frontier. Two classes of models have been proposed over time. Whereas deterministic models (Aigner and Chu, 1968; Afriat, 1972; Richmond, 1974) use the residuals of the production function as a measurement for inefficiency without controlling random noise, stochastic frontier models (Aigner et al., 1977; Stevenson, 1980; Jondrow et al., 1982; Battese and Coelli, 1988; Kumbhakar and Lovell, 2000) disentangle the error term in two components. The first one, U, accounts for the firm's inefficiency – e.g. factors that affect technical or allocative efficiency, which could be controlled by banks – distributed as a half normal (truncated below zero); the second one, V, corresponds to the random fluctuations distributed as a normal.

[9] *The raw data required substantial editing to obtain a reliable database for the analysis. In a thorough review process we concentrated on choosing the most appropriate accounting standards (we preferred financial statements using IAS over those using national standards and used consolidated balance sheets whenever they were available), on avoiding double counting of institutions and on converting all the values into a single currency (i.e. USD). Furthermore, we conducted several plausibility checks regarding the completeness and consistency of the individual profit and loss accounts and balance sheets.*

According to the stochastic frontier approach, the total costs/profits (*TC* and *TP*) for the *s*-th firm at time *t* assume the following specification:

$$H_{st} = H(Y_{st}, P_{st}) + \varepsilon_{st} = H(Y_{st}, P_{st}) + U_{st} + V_{st} \quad (1)$$

where H is either TC or TP, Y is a vector of outputs of the firm; P is a vector of input prices; ε is the stochastic random noise. Following the Battese and Coelli (1988 and 1992) model, the predictions of individual bank cost/profit efficiency (EFF_H) may then be written as:

$$EFF\_H_{st} = E(H_{st} \mid U_{st}, \varphi_{st}) / E(H_{st} \mid U_{st} = 0, \varphi_{st}) \quad (2)$$

where φ_{st} are the regression parameters.

3.2 Definition of Input and Output Variables

In modeling banks' cost function, one of the most debated questions is the definition of the *inputs* and *outputs* of multi-product financial firms. The discussion concentrates particularly on the role of deposits, considering that they have both input and output characteristics. Literature suggests a range of different approaches to this issue. In modeling the cost/profit functions of CEE banks, we employ the *modified production approach*.[10] Therefore we shape the functions using loans, deposits and other earning assets as outputs, and price of labor, price of capital and price of deposits as inputs (table 4).

We do not, however, account for their interbank market activities (this mainly refers to the different sorts of deposits from and with banks), since interbank market conditions should be approximately the same for all the banks.

We measure our variables in monetary flows taken from the annual accounts of CEE banks.

Table 4

Variables Used in the Cost Functions for CEE banks

Variables	Name	Description
Exogenous variables		
Output		
y_1	Loans	Loans (performing and nonperforming) with customers
y_2	Deposits	Deposits with customers
y_3	Other earning assets	Banks investments in various types of securities (e.g. government securities, bonds, equity investments, CDS, T-bills, equity investment) not including deposits with banks
Input		
X_1	Labor	Total assets as a proxy for the number of employees due to lack of data
X_2	Capital	Adjusted value of fixed assets net of depreciation
X_3	Deposits	Customer deposits
Input prices		
W	Price of labor	Staff expenses/total assets
K	Price of capital	Cost of capital (operative costs associated with capital expenses/adjusted value of fixed assets net of depreciation)
D*	Price of deposits	Total interest expenses/volume of customer deposits
Endogenous variables		
TC	Total costs	Operating expenses
TP	Total profits	Operating profit minus loan loss provisions

[10] *The modified production approach allows both the input and output characteristics of deposits to be considered. According to this approach the interest paid on deposits has to be accounted as input, while the volume of deposits is considered as output (see Berger and Humphrey, 1991, and Bauer et al., 1993). Note that we also conducted our estimations using the production approach, yielding, to the point of being comparable, similar results.*

3.3 Cost/Profit Function Specifications and Estimation Methodology

In modeling the banks' cost/profit function[11] we use the Fourier flexible form (FF), since the empirically more widely used translog (TL) specification has one main pitfall as pointed out in White (1980) and Mitchell and Onvural (1996): it does not necessarily correspond to the second order Taylor approximation of the underlying function at an expansion point. The Fourier flexible (FF) form combines the standard TL, nested in the FF, with the nonparametric Fourier form, i.e. the trigonometric terms. This theoretical improvement has been proved to give a better fit of the data than the TL (see McAllister and McManus, 1993; Mitchell and Onvural, 1996; Berger and Mester, 1997). It furthermore presents the well-known advantages of being a flexible form and of including, as a particular case, the Cobb-Douglas specification.

The FF representation gives:

$$
\begin{aligned}
ln\ H_{st} = [\alpha_0 + \sum_{i=1}^{3} \alpha_i \cdot ln\ y_{is} + \sum_{k=1}^{3} \beta_k \cdot ln\ p_{ks} + \frac{1}{2}\sum_{i=1}^{3}\sum_{j=1}^{3} \alpha_{ij} \cdot ln\ y_{is} \cdot \\
ln\ y_{js} + \frac{1}{2}\sum_{k=1}^{3}\sum_{h=1}^{3} \beta_{kh} \cdot ln\ p_{ks} \cdot ln\ p_{hs} + \sum_{i=1}^{3}\sum_{k=1}^{3} \delta_{ik} \cdot ln\ y_{is} \cdot ln\ p_{ks}] + \\
\sum_i \alpha_i cos(y_i) + \sum_i b_i\ sin(y_i) + \sum_k c_k\ cos(p_k) + \sum_k d_k\ sin(p_k) + \\
\sum_{ij} e_{ij}[cos(y_i) + cos(y_i)] + \sum_{ij} \int_{ij} [sin(y_i) + sin(y_j)] + \\
\sum_{ij} g_{ij}[cos(y_i) - cos(y_i)] + \sum_{ij} h_{ij}[sin(y_i) - sin(y_j)] + \\
\sum_{kl} i_{kl}[cos(p_k) + cos(p_1)] + \sum_{kl} l_{kl}(sin(p_k) + sin(p_1)] + \\
\sum_{kl} m_{kl}[cos(p_k) - cos(p_1)] + \sum_{kl} n_{kl}[sin(p_k) - sin(p_1)] + \\
V_{st} + U_{st}
\end{aligned}
\tag{3}
$$

where H is again either total cost TC or total profits TP, y_i is the i-th output and p_k is the price of the k-th input. V_{st} is the error term accounting for random noise in the data, and U_{st} refers to technical inefficiency.

The restrictions in the form of the linear homogeneity conditions and cost exhaustion are obtained by normalizing total costs/profits, the price of labor and the price of deposits by the price of capital. The symmetry conditions state that

$$\alpha_{ij} = \alpha_{ji}\ \forall\ i, j(i, j = 1, ..., n)$$
$$\beta_{ij} = \beta_{ji}\ \forall\ i, j(i, j = 1, ..., m).$$

[11] *A distinction between cost and profit efficiency arises when markets are not perfect. In the case of CEE countries it certainly is a reasonable assumption to say that given our observation period (1995 to 2002) competitive markets did not occur in the banking industry. Therefore a profit efficiency analysis brings additional insights into the workings of the industry.*

The linear homogeneity restrictions demand that:

$$\sum_{k=1}^{3} \beta_k = 1; \quad \sum_{k=1}^{3} \beta_{kh} = 0, \quad \text{for all } h;$$

$$\sum_{k=1}^{3} \delta_{ik} = 0, \quad \text{for all } i.$$

In the FF specification the trigonometric addends have rescaled coherently with our sample size.[12]

Using a three stage maximum likelihood procedure regression (3) is estimated by applying the stochastic frontier approach (Battese and Coelli, 1992).

4 Empirical Findings

Table 5 presents the FF stochastic cost and profit function estimates. The use of a common frontier has the advantage of allowing performance comparisons of banks across countries while having the disadvantage that it does not permit to determine whether divergence in inefficiency is due to environmental conditions or differences in the technology employed. The main results can be summarized as follows.

As for the cost function, all the output and input price coefficients are strongly significant.

The elasticity of production costs to the price of labor ($\beta_{p1} = 0.68$) is larger than the elasticity to the capital price, 0.15 ($1 - \beta_{p1} - \beta_{p2} = 0.17$, due to the linear homogeneity conditions imposed). This means that banks can more easily control capital and deposit expenses than labor expenses when prices rise. For our sample this seems plausible, since at least in the short run, it is/was more difficult to cut labor expenses than capital costs. Looking at the outputs, all the variables present the expected positive sign.

Concerning the profit function, again all the output and input price coefficients have the correct sign and the expected magnitude.

Apart from the variable capturing the volume of deposits raised by the banks, all the coefficients are strongly significant. This, however, can easily be explained by the fact that the influence of deposits on profit is twofold and remains unclear. On the one hand, the more deposits a bank raises, the more costs it has to bear (mostly interest costs but also administrative costs). On the other hand, this effect is (partly) being overlapped and compensated by the fact that in general more deposits means more capital that can be transformed into loans (which raise profits); in particular deposits stemming from customers are usually cheaper than capital borrowed in interbank markets.

[12] *Special attention must be paid to the choice of the rescaling form for the trigonometric terms in order to coherently fix their argument in the 0–2π range. The truncation point here has been chosen according to the rule of thumb expounded in Mitchell and Onvural (1996) that the number of parameters should be set equal to the number of observations raised to the power of two-thirds in order to obtain consistent and asymptotically normal estimates. However, as suggested in Gallant (1981), the effective number of the coefficients is corrected by reducing the number of the regressors to cope with the possible multicollinearity.*

Table 5

Cost and Profit Fourier Functions Estimates – CEE banks

	Cost function		Profit function	
	Ln(TC)		Ln(TP)	
	Coefficient	t-ratio	Coefficient	t-ratio
Ln y_1 (loans)	0.19	3.68*	0.12	2.3**
Ln y_2 (deposits)	0.36	7.41*	0.07	1.53
Ln y_3 (other earning assets)	0.21	6.34*	0.14	4.01*
Ln p_1 (labor price)	0.68	10.95*	0.55	8.93*
Ln p_2 (deposits price)	0.15	2.92*	0.2	4.05*
Ln y_1^2	0.08	4.37*	0.05	2.76*
Ln y_2^2	0.16	14.54*	0.06	3.58*
Ln y_3^2	0.01	10.38*	0.02	2.09**
Ln p_1^2	0.11	4.31*	0.01	0.29
Ln p_2^2	0.14	7.03*	0.01	0.42
Ln y_1y_2	−0.07	−6.58*	−0.06	−4.33*
Ln y_1y_3	0.03	2.82*	0.01	0.84
Ln y_2y_3	−0.06	−6.54*	−0.02	−2.54*
Ln p_1p_2	−0.11	−5.45*	0	−0.21
Ln y_1p_1	0.02	1.58	0.01	0.8
Ln y_2p_1	−0.07	−5.23*	−0.04	−2.45*
Ln y_3p_1	0.01	0.71	0.04	3.57*
Ln y_1p_2	−0.03	−2.26**	0.01	0.43
Ln y_2p_2	0.11	9.09	0.03	2.05**
Ln y_3p_2	−0.03	−2.45*	−0.03	−2.58*
sinq1q2	0.01	1.25	0	0.49
sinq1q3	0.01	1.26	0.01	0.52
cosq1q3	0	-0.12	0	−0.44
difsinq1q2	−0.01	-0.97	0	−0.12
difcosq1q2	0.01	0.47	−0.01	−0.49
difcosq1q3	−0.02	−1.82***	0.01	0.64
sinwkdbk	−0.08	−1.5	−0.04	−0.84
coswkdbk	−0.08	−1.46	−0.03	−0.57
difsinwkdbk	−0.08	−1.92**	0.02	0.53
difcoswkdbk	−0.06	−1.26	0.04	0.94
Constant	2.35	16.24*	10.38	46.36*
μ	−444.24		0.92	5.78*
η	0.05	4.58*	0.02	3.54*
γ	0.99			
	(0.000)		(0.026)	
$\sigma 2$	142.48		0.19	
	(0.48)		(0.017)	
δ_u^2	142.42		0.14	
	(0.48)		(0.017)	
δ_v^2	0.05		0.05	
	(0.002)		(0.002)	
Observations	1,070		1,105	
Number of banks	245		241	

The Table reports magnitude and t-statistics of the Maximum Likelihood estimates (e.q. 3) based on the Davidon-Fletcher-Powell Quasi-Newton algorithm, using the Battese and Coelli (1992) model estimated with Stata 8.1.

In parenthesis we report the standard deviation. The prefix "Ln" stands for natural logarithm; sum and dif, respectively, represent the sum and difference between trigonometric operators. Total costs, price of labor (p_1), and price of deposits (p_2) are normalized to the price of capital. Mixed products and squares of inputs and outputs represent the second order terms of the flexible form.

$\gamma = \sigma_u^2/\boldsymbol{\sigma}^2$;

$\sigma = \sigma_u^2/\boldsymbol{\sigma}_v^2$;

** Significant at 1% level; **Significant at 5% level; ***Significant at 10% level.*

Overall we can say that firms operate far from the cost/profit efficient frontier, since μ is significantly different from zero. However, the fact that η is positive and significant suggests that both cost and profit efficiency increase over time.[13]

Decomposing the inefficiency values obtained from the cost and profit function estimates on the overall panel according to the methodology outlined in chapter 3 yields information about the level of banking efficiency by country and by time. This analysis provides a first insight into the efficiency of the banking systems.

Tables 6 and 7 provide cost and profit efficiency estimates aggregated by country and by time.[14]

Table 6

Cost Efficiency Levels by Country and by Time Period

Sample	Czech Republic	Estonia	Hungary	Lithuania	Latvia	Poland	Romania	Slovakia	Slovenia
Average	0.58	0.79	0.75	0.78	0.71	0.79	0.75	0.67	0.89
1995 to 2002	(0.19)	(0.10)	(0.17)	(0.09)	(0.15)	(0.16)	(0.14)	(0.19)	(0.07)
1995	0.47	0.78	0.71	0.75	0.64	0.78	0.55	0.63	0.87
	(0.17)	(0.11)	(0.18)	(0.06)	(0.15)	(0.19)	(0.00)[a]	(0.14)	(0.09)
1966	0.55	0.79	0.74	0.74	0.64	0.80	0.57	0.71	0.88
	(0.18)	(0.09)	(0.17)	(0.12)	(0.16)	(0.17)	(0.00)[a]	(0.15)	(0.08)
1997	0.56	0.79	0.75	0.75	0.66	0.79	0.91	0.65	0.89
	(0.22)	(0.10)	(0.16)	(0.1)	(0.16)	(0.16)	(0.00)[a]	(0.14)	(0.08)
1998	0.54	0.78	0.73	0.80	0.70	0.79	0.76	0.70	0.88
	(0.20)	(0.12)	(0.18)	(0.07)	(0.15)	(0.17)	(0.12)	(0.16)	(0.09)
1999	0.56	0.79	0.76	0.79	0.71	0.81	0.73	0.71	0.89
	(0.20)	(0.12)	(0.16)	(0.08)	(0.15)	(0.14)	(0.15	(0.15)	(0.08)
2000	0.58	0.80	0.78	0.80	0.77	0.78	0.74	0.67	0.90
	(0.20)	(0.11)	(0.15)	(0.08)	(0.11)	(0.18)	(0.15)	(0.24)	(0.07)
2001	0.65	0.79	0.76	0.78	0.81	0.79	0.76	0.65	0.90
	(0.18)	(0.10)	(0.21)	(0.09)	(0.09)	(0.16)	(0.14)	(0.24)	(0.07)
2002	0.64	0.80	0.79	0.79	0.77	0.82	0.76	0.66	0.92
	(0.18)	(0.10)	(0.15)	(0.09)	(0.11)	(0.13)	(0.15)	(0.25)	(0.05)

Standard deviations are in parentheses.
[a] *Values due to only one data point.*

[13] *According to the Battese-Coelli (1992) specification, the inefficiency of a bank varies over time according to* $U_{st} = U_s^{(\eta-(t-T))}$*; where* U_s *is the inefficiency term of bank s at time T (which is the last period considered) and* η *is a parameter to be estimated.*
Therefore the U_{st} *decreases over time* t *if* $\eta>0$*, increases if* $\eta<0$ *and stays steady if* $\eta=0$*.*
The Battese-Coelli (1992) specification implies that the disturbances are half normal distributed and μ *is the truncation of a normal density function. Econometrically this means that if* μ *is significantly different from zero we reject the hypothesis that the distribution is half normal truncated and therefore efficiency is not the prevalent behavior of our bank sample.*

[14] *Note that we also conducted mean tests not reported in this paper for the sake of brevity, which indicate that in most of the cases the levels of efficiency by country are statistically different.*

Table 7

Profit Efficiency Levels by Country and by Time Period

Sample	Czech Republic	Estonia	Hungary	Lithuania	Latvia	Poland	Romania	Slovakia	Slovenia
Average	0.57	0.41	0.33	0.38	0.45	0.38	0.29	0.47	0.37
1995 to 2002	(0.17)	(0.08)	(0.08)	(0.08)	(0.13)	(0.08)	(0.13)	(0.12)	(0.12)
1995	0.55	0.41	0.31	0.33	0.40	0.34	0.24	0.47	0.34
	(0.15)	(0.03)	(0.08)	(0.07)	(0.13)	(0.07)	(0.11)	(0.16)	(0.05)
1966	0.53	0.43	0.32	0.35	0.44	0.36	0.25	0.47	0.34
	(0.17)	(0.10)	(0.08)	(0.08)	(0.14)	(0.07)	(0.11)	(0.14)	(0.05)
1997	0.56	0.41	0.33	0.38	0.46	0.38	0.32	0.49	0.34
	(0.18)	(0.11)	(0.08)	(0.08)	(0.14)	(0.08)	(0.17)	(0.12)	(0.05)
1998	0.55	0.38	0.33	0.39	0.47	0.39	0.27	0.47	0.35
	(0.15)	(0.06)	(0.08)	(0.08)	(0.14)	(0.09)	(0.13)	(0.09)	(0.05)
1999	0.57	0.38	0.33	0.39	0.48	0.37	0.27	0.45	0.38
	(0.17)	(0.06)	(0.08)	(0.08)	(0.14)	(0.07)	(0.13)	(0.10)	(0.10)
2000	0.57	0.40	0.32	0.40	0.45	0.39	0.27	0.47	0.39
	(0.19)	(0.06)	(0.09)	(0.08)	(0.11)	(0.08)	(0.12)	(0.12)	(0.09)
2001	0.59	0.40	0.34	0.40	0.43	0.41	0.30	0.48	0.40
	(0.21)	(0.06)	(0.08)	(0.08)	(0.09)	(0.09)	(0.12)	(0.12)	(0.09)
2002	0.61	0.40	0.35	0.41	0.49	0.41	0.33	0.47	0.38
	(0.21)	(0.06)	(0.07)	(0.08)	(0.14)	(0.08)	(0.13)	(0.11)	(0.04)

Standard deviations are in parentheses.

As expected, the overall results highlight the presence of inefficiency in the banking system of these countries: in general the efficiency values obtained for cost efficiency as well as for profit efficiency are fairly low, indicating that banks operate far from the efficient frontier.[15] Furthermore nearly all the banking systems display a (slight) tendency to increase in efficiency (cost and profit) over time.[16] We can further see that firms' expertise in exploiting their competitive advantages and thereby generating high profits is not as homogeneously developed as their ability to supply their services in a cost-saving way. This fact leads to profit efficiency scores well below cost efficiency scores. There are several reasons for this. As intermediation depth is still fairly low and demand for financial services of all kinds very high in CEE countries, one explanation lies in banks' expansion efforts, which have absorbed enormous resources but have only partly paid off up to now, leaving profit efficiencies behind cost efficiencies. Furthermore, given the potential reward of maintaining/expanding market shares in a rapidly growing market, banks have little incentive to maximize profits by means of full utilization of their discretionary pricing power. As margins, although declining recently, are still comparatively high and profits therefore sufficient, they rather have incentives to keep their costs under control.

Inspecting the average efficiency scores by country enables comparisons among the performances achieved by the various banking systems examined and reveals that efficiency levels vary considerably across countries.

As far as cost efficiency is concerned, values range from 0.58

[15] *In our analysis we additionally took into account the efficiency levels when we truncate the distribution of the efficiency values at both tails at the 95% and 99% quantile, respectively, in order to eliminate the influence of the outliers. Results remained quite robust.*

[16] *A clear indication of this tendency shows the value of η which is positive and significant in the estimate of the stochastic cost and profit functions (table 5).*

(Czech Republic) to 0.89 (Slovenia). For its part, Slovenia has the most efficient banking system of all the countries selected. Its good performance despite the dominance of state-owned banks and the comparatively low market share of foreign-owned institutions may be due to the fact that the country itself has a relatively high branch density and credit growth has been weak over the last years. This would suggest that the costs to be incurred to finance future growth in this market are comparatively low. As for Estonia and Lithuania, part of the reasoning behind the good performance of the banking sector in terms of cost efficiency may be due to the fact that these two banking sectors are highly concentrated and virtually entirely in foreign hands. Considering this, it could be argued that foreign ownership pays in terms of efficiency. Alternatively, a simpler reasoning would suggest that some of the costs of the Estonian or the Lithuanian banking sector appear in the accounts of the parent enterprises. Concerning Poland, central bank data show that the country has fared relatively well in terms of loan loss reserves.[17] As loan loss provisions are not part of the total costs (TC) this thought would imply that banks that manage their loan portfolios well also manage operating costs efficiently.

By contrast, Sovakia and the Czech Republic posted the worst cost efficiency performances (0.67 and 0.58, respectively). In both cases, the results again can be explained by the comparatively high loan loss reserves recorded over much of the observation period.[18]

In interpreting country differences, it should however be noted that these differences outlined above only show the cost side of the economics underlying the banking business. It could very well be the case that banks with relatively high cost "inefficiencies" supply a better service quality and are thus able to generate higher profits. If certain products are differently equipped with value-added services across banks/countries for example, their production will be more or less cost intensive but the potential yield they offer will differ, meaning that higher returns could very well offset higher costs. A comparison of cost efficiency scores with corresponding profit efficiency scores supports this argument. Regarding cost efficiency, Czech and Slovak banks obtained the worst results. At the same time and to some extent for the same reasons, Czech banks were the most efficient ones as regards their ability to maximize profits.

Conversely, the position of Slovenia, which turned out to be very cost efficient, changed completely when examining profit efficiency, where its performance is at the lower end. This may very well be due to the dominance of state-owned banks. Romania recorded the worst performance in terms of profit efficiency. The stage of economic development of Romania in comparison to the other countries in the sample may be one reason behind this.

To sum up, the results of the panel estimation yield evidence of wide differences among cost and profit inefficiency levels by country, with overall efficiency levels increasing over time.

[17] *For an overview of loan loss reserves in CEECs, see Boss et al. (2004).*

[18] *See also chapter 1 in Boss et al. (2004).*

In a final step we also study efficiencies across specialization and size.

As for specialization, we distinguish the following types of banks, thereby accounting for different fields of businesses, different legal structures and different normative goals of banks (bank holding companies; commercial banks; cooperative banks; investment banks; medium- and long-term credit banks; real estate and mortgage banks; savings banks; government credit institutions).

Additionally, we divide our data sample into three subgroups according to the size of banks, using the upper and lower quartile of distribution of total assets to create the following subsamples: large (total assets above USD 1,144.1 million), medium (total assets between USD 123.2 million and USD 1,144.1 million) and small (total assets below USD 123.2 million).

Tables 8 and 9 show the results.

Table 8

Cost and Profit Efficiency Levels by Bank Specialization

Sample	Bank holding companies	Commercial banks	Cooperative banks	Investment banks	Medium- and long-term credit banks	Real estate/ mortgage banks	Savings banks	Governmental credit institutions
	Cost efficiency							
Average 1995 to 2002	0.83 (0.15)	0.75 (0.17)	0.73 (0.23)	0.82 (0.02)	0.87 (0.01)	0.78 (0.18)	0.79 (0.06)	0.36 (0.08)
	Profit efficiency							
Average 1995 to 2002	0.35 (0.08)	0.41 (0.13)	0.47 (0.15)	0.45 (0.01)	0.42 (0.01)	0.71 (0.16)	0.33 (0.16)	0.32 (0.05)

Table 9

Cost and Profit Efficiency Levels by Size

Sample	Small	Medium	Large
	Cost efficiency		
Average 1995 to 2002	0.74 (0.17)	0.72 (0.19)	0.78 (0.12)
	Profit efficiency		
Average 1995 to 2002	0.41 (0.13)	0.42 (0.14)	0.38 (0.11)

The typology of banks seems to have an impact on inefficiency – all sorts of private-sector banks post better performances in terms of both cost and profit efficiency than governmental credit institutions. This result is not surprising and reflects the well-known fact that generally speaking state-owned banks fulfilling special tasks in a protected environment often do not work as efficiently as institutions exposed to market forces and that privatization was used as a means of sorting out the problems that beset state-owned banks.

The results show that in terms of cost efficiency, it pays to be either small or large. Medium-sized banks tend to display lower cost efficiencies. A look at table 9 shows that this picture changes for profit efficiencies. These results indicate the need for further research in this direction.

Although our analysis can therefore give a first impression of the different efficiency levels in CEE markets, some important caveats should be considered in order to set all our results into perspective.

1. As we based our results on single cost and profit function frontiers to be able to study differences across countries, we must implicitly presuppose that in general, banks are comparable across countries, though legal regulations, the range of products, service levels, etc. may differ.
2. Although our estimations show a very high goodness of fit, which to some extent justifies the assumptions we made in chapter 1, we are aware that our investigation, as successful as it may be in giving important first insights, could fail to capture all relevant variables which should be included in the cost and profit functions and therefore also determine bank efficiency.

5 Conclusions

This paper attempts to investigate the cost and profit efficiency of banks in the CEECs over the period from 1995 to 2002. These years witnessed a large process of consolidation in the banking systems of these then EU accession economies.

Not surprisingly, our findings, based on the stochastic cost and profit functions, show a generally low level of cost and profit efficiency for banks in the CEECs. Conversely, the results also reveal a tendency of efficiency (both cost and profit) to increase over time. Comparing the efficiency scores obtained from the cost and profit estimates, banks in the former accession countries seem to be more efficient in controlling costs than in generating profits; this is reflected by the profit efficiency scores, which are far well below cost efficiency levels. Decomposing cost efficiency scores by country, we encountered large differences across countries. High concentration and foreign ownership seem to pay in terms of efficiency.

When the profit efficiency scores are taken into account, the order of the country ranking looks rather different: low cost efficiencies are often offset by high profit efficiencies and vice versa.

Finally, the size and typology of banks seem to have an impact on inefficiency. Our results suggest that in terms of cost efficiency it pays to be either small or large. Evidence also supports the view that governmental credit institutions show a poorer performance than more market-oriented banks, both in terms of cost and profit efficiency.

References

Afriat, S. N. 1972. Efficiency Estimation of Production Functions. In: International Economic Review 13(3). 568–598.

Aigner, D. J., C. A. K. Lovell and P. Schmidt. 1977. Formulation and Estimation of Stochastic Frontier Production Function Models. In: Journal of Econometrics 6. 21–37.

Aigner, D. J. and S. F. Chu. 1968. On Estimating the Industry Production Function. In: American Economic Review 58(4). 826–839.

Balling, M., F. Lierman and A. Mullineux. 2004. Financial Markets in Central and Eastern Europe. Stability and Efficiency Perspectives. Routledge.

Battese, G. E. and T. Coelli. 1988. Prediction of Firm-Level Technical Efficiencies with a Generalized Frontier Production Function and Panel Data. In: Journal of Econometrics 38. 387–399.

Battese, G. E. and T. Coelli. 1992. Frontier Production Functions, Technical Efficiency and Panel Data: With Application to Paddy Farmers in India. In: Journal of Productivity Analysis 3. 153–169.

Battese, G. E. and T. Coelli. 1995. A Model for Technical Inefficiency Effects in a Stochastic Frontier Production Function for Panel Data. In: Empirical Economics 20. 325–332.

Bauer, P., A. N. Berger and D. B. Humphrey. 1993. Efficiency and Productivity Growth in US Banking. In: Fried, H. O., C. A. K. Lovell and S. S. Schmidt (eds.). The Measurement of Productive Efficiency: Techniques and Applications. Oxford University Press. 386–413.

Beattie, B. R. and C. R. Taylor. 1985. The Economics of Production. New York: Wiley.

Berger, A. N. and L. J. Mester. 1997. Inside the Black Box: What Explains Differences in the Efficiency of Financial Institutions. In: Journal of Banking and Finance 21. 895–947.

Berger, A. N. and D. B. Humphrey. 1991. The Dominance of Inefficiencies over Scale and Product Mix Economies in Banking. In: Journal of Monetary Economics 28. 117–148.

Berglöf, E. and P. Bolton. 2002. The Great Divide and Beyond – Financial Architecture in Transition. In: Journal of Economic Perspective 16. 77–100.

Bonin, J. P., I. Hasan and P. Wachtel. 2004. Privatization Matters: Bank Efficiency in Transition Countries. William Davidson Institute Working Paper 679. April.

Boss, M., G. Krenn, M. S. Schwaiger and W. Wegschaider. 2004. Stress Testing the Austrian Banking System. Working Paper. OeNB. (Forthcoming).

Buch, C. 2000. Is Foreign Control a Panacea? On Governance and Restructuring of Commercial Banks in Transition Economies. Kiel Institute of World Economics. April.

Claessens, S., A. Demirguc-Kunt and H. Huizinga. 2001. How Does Foreign Entry Affect Domestic Banking Markets? In: Journal of Banking and Finance 25. 891–911.

Coelli, T. 1996. A Guide to FRONTIER Version 4.1: A Computer Program for Stochastic Frontier Production and Cost Function Estimation. CEPA Working Paper 96/7. Armidale NSW Australia: University of New England, Centre for Efficiency and Productivity Analysis.

Coelli, T., D. S. P. Rao, G. E. Battese. 1998. An Introduction to Efficiency and Productivity Analysis. Boston: Kluwer Academic Publishers.

Eichengreen, B. and F. Ghironi. 2001. EMU and Enlargement. Mimeo.

Fries, S. and A. Taci. 2002. Banking Reform and Development in Transition Economies. EBRD Working Paper 71.

Fries, S. and A. Taci. 2003. Cost Efficiency of Banks in Transition: Evidence from 15 Transition Economies. Paper presented at the Ninth Dubrovnik Economic Conference, sponsored by Bank of Croatia, June 26–28.

Fries, S., D. Neven and P. Seabright. 2002. Bank Performance in Transition Economies. EBRD. June.

Gallant, R. 1981. On the Bias of Flexible Functional Forms and an Essentially Unbiased Form. In: Journal of Econometrics 15. 211–245.

Green, C., V. Murinde and I. Nikolov. 2004. Are Foreign Banks in Central and Eastern Europe More Efficient than Domestic Banks? In: Balling et al. (eds.). Financial Markets in Central and Eastern Europe. Routledge. 225–250.

Jondrow, J., C. A. K. Lovell, I. S. Materov and P. Schmidt. 1982. On the Estimation of Technical Inefficiency in the Stochastic Frontier Production Function Model. In: Journal of Econometrics 19. 233–238.

Kraft, E. and D. Tirtiroglu. 1998. Bank Efficiency in Croatia: A Stochastic Frontier Analysis. In: Journal of Comparative Economics 26. 282–300.

Kumbhakar, S. C. and C. A. K. Lovell. 2000. Stochastic Frontier Analysis. Cambridge: Cambridge University Press.

La Porta, R., F. Lopez-de-Silanes and A. Schleifer. 2002. Government Ownership of Banks. In: Journal of Finance 57(1). 265–301.

McAllister, P. H. and D. McManus. 1993. Resolving the Scale Efficiency Puzzle in Banking. In: Journal of Banking and Finance 17. 389–405.

Mitchell, K. and N. M. Onvural. 1996. Economies of Scale and Scope at Large Commercial Banks: Evidence from the Fourier Flexible Functional Form. In: Journal of Money, Credit and Banking 28. 178–199.

Nikiel, E. M. and T. P. Opiela. 2002. Customer Type and Bank Efficiency in Poland: Implication for Emerging Market Banking. In: Contemporary Economic Policy 20. 55–71.

Opiela, T. P. 2000. Assessing the Evaluation of Polish Commercial Banks. National Bank of Poland Working Paper 18.

Papi, L. and D. Revoltella. 2000. Foreign Direct Investment in the Banking Sector: Experiences and Lesson from CEECs. Mimeo.

Richmond, J. 1974. Estimating the Efficiency of Production. In: International Economic Review 15(2). 515–521.

Shephard, R. W. 1970. Theory of Cost and Production Functions. Princeton: Princeton University Press.

Stevenson, R. F. 1980. Likelihood Functions for Generalised Stochastic Frontier Estimation. In: Journal of Econometrics 13. 57–66.

Taci, A. and E. Zampieri. 1998. Efficiency in the Czech Banking Sector. Charles University CERGE-EI Discussion Paper 4.

Walko, Z. and T. Reininger. 2004. Credit and Deposit Interest Rate Margins in Four New EU Member States. In: Financial Stability Report 8. Oesterreichische Nationalbank. 60–76.

Weill, L. 2003. Banking Efficiency in Transition Economies: The Role of Foreign Ownership. In: Economics of Transition 11. September. 569–592.

White, A. 1980. Using Least Squares to Approximate Unknown Regression Functions. In: International Economic Review 21. 149–170.

Zajc, P. 2004. The Effect of Foreign Bank Entry on Domestic Banks in Central and Eastern Europe. In: Balling et al. (eds.). Financial Markets in Central and Eastern Europe. Routledge. 189–205.