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Efficiency of Commercial Banks in Bulgaria in the Wake of EU Accession

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SUMMARY. The paper examines the efficiency of Bulgarian banks and its determinants over the 1999–2007 period. The levels of technical, allocative, and cost efficiency are first estimated using a non-parametric methodology and then regressed upon a number of bank-specific, institutional, and EU-related factors. The findings indicate that foreign banks were more efficient than domestic private banks, although the gap between them narrowed over time. State-owned banks ranked last on average but their privatization resulted in efficiency gains. Capitalization, liquidity, and enterprise restructuring enhanced bank efficiency, while banking reforms had an adverse effect. The Treaty of Accession and EU membership were associated with significant efficiency improvements.

JEL Classification: C14; G21; P20

Keywords: Transition economies; Banking sector; Efficiency; EU accession

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1. Introduction

The transition to a stable, well-regulated, and competitive banking system in Bulgaria has been a long and tortuous process. The legal framework for commercial banking was established soon after the introduction of market reforms in the early 1990s and led to the rapid increase in the number of private banks, the consolidation of numerous state-owned banks, and the entry of foreign banks into the market. However, the sector continued to be dominated by inefficient state-owned banks burdened with non-performing loans stemming from lending to loss-making state-owned enterprises and relying on financial support from the government. Bad governance, weak regulatory oversight, unsound credit policies, and lack of privatization efforts contributed to the deterioration of the balance sheet of the banking system culminating in a severe banking crisis and a wave of bank failures in 1996–1997. The adoption of a currency board in the aftermath of the crisis signified a fundamental change in the institutional framework of the banking sector introducing new prudential requirements for commercial banks, eliminating the soft budget constraint, and strengthening the regulatory and supervisory powers of the Bulgarian National Bank. In the first half of the 2000s, banking legislation underwent another major revision to comply with European Union (EU) banking directives in the process of EU accession. Moreover, the government initiated the privatization of state-owned banks in 1997 attracting a number of strategic foreign investors. As a result, by the time Bulgaria joined the European Union on 1 January 2007, over 80 per cent of banking assets were controlled by foreign banks and over 98 per cent were privately owned.

The objective of this paper is to estimate the efficiency of Bulgarian banks and its changes over the period between the adoption of the currency board and the membership in the EU, and to examine the impact of ownership, institutional reforms, EU accession, and bank-specific financial factors on efficiency. The issue of bank efficiency in Bulgaria deserves attention for several reasons. As the newest and least developed member state, Bulgaria is in the process of catching up with the rest of the EU. An inefficient banking system which hampers financial development and is detrimental to economic growth would undermine the process of convergence. In addition, Bulgaria is the only EU member along with Estonia and Lithuania operating a currency board that eliminates or, as in the case of Bulgaria, limits the availability of a lender of last resort to situations of systemic risk (defined regulatory trough the payment system problems) and up to the excess of foreign reserves (the so called 'banking department deposit'). This intensifies the danger of bank insolvency and a banking crisis if financial institutions are inefficient and face liquidity problems. Last but not least, the period examined in the paper wit-

nessed numerous institutional reforms of the financial system aimed at dealing with the 1996–1997 banking crisis and attaining legal and regulatory harmonization in the wake of the EU accession. The assessment of bank efficiency changes over this period can provide valuable feedback to regulators and policy-makers about the effectiveness of these reforms.

The empirical analysis is conducted in two stages. First, we employ a non-parametric methodology to estimate technical, allocative, and cost efficiency of Bulgarian banks over the 1999–2007 period. Differences in efficiency levels between state-owned, private, and foreign banks, as well as between large and small banks are explored. In addition, efficiency changes and their contribution to Total Factor Productivity (TFP) are assessed and compared over the periods preceding and following the Treaty of Accession and the EU membership. In the second stage, we use a panel-data Tobin regression model to identify the determinants of the previously estimated technical, allocative, and cost efficiency levels. A set of potential correlates of efficiency are included in the regression accounting for 1) institutional changes, such as banking reforms, privatization, and enterprise restructuring, 2) accession-related events, such as the Treaty of Accession and the EU membership, and 3) bank-specific factors related to profitability, credit risk, liquidity, and capitalization.

The paper contributes to the literature by examining the levels and determinants of bank efficiency under a currency board in a transition economy that has joined the EU. Previous studies described in the next section have included Bulgaria in their efficiency analysis but mostly in a comparative context, whereby the sample of Bulgarian banks was relatively small and separate estimates were often not reported. Our data which were obtained from the Bulgarian National Bank and carefully checked against alternative data sources includes all commercial banks operating in Bulgaria and covers almost the entire period from the introduction of the currency board to the membership in the EU. This allowed us to evaluate the impact of EU accession on bank efficiency, an issue that has not been addressed by previous research. We employed a non-parametric methodology which is only one of several possible approaches to measuring efficiency but has several decisive advantages over the alternatives. It is a data driven approach which creates a benchmark against which relative efficiency can be assessed. Furthermore, the non-parametric methodology relaxes restrictive assumptions common to the parametric analysis of efficiency, allows the decomposition of cost efficiency into technical and allocative components, and enabled us to measure the contribution of efficiency change to TFP.

Our results indicate that bank efficiency in Bulgaria improved over the

sample period, and especially after 2005. In line with the literature, foreign banks were found to be more efficient than domestic private banks, but the gap narrowed significantly in the latter years of the sample period. State-owned banks were the least efficient, but achieved efficiency gains after being privatized. Furthermore, the results show that technical efficiency change became the major driving force behind TFP in the banking sector after 2005. Capitalization, profitability, liquidity, and market share were all found to be positively correlated with efficiency. Enterprise restructuring helped banks become more efficient, whereas banking reforms had the opposite effect. The Treaty of Accession and EU membership might have contributed to efficiency improvements although more research is needed based on observations over longer periods of EU membership.

The remainder of the paper is organized as follows. The next section provides an overview of the literature on bank efficiency in transition economies. The nonparametric methodology is described in Section 3, and the data and variables used in Section 4. Section 5 summarizes the results and the final section draws conclusions.

2. Review of the Literature

The literature on bank efficiency in transition economies can be divided into two categories. One group of studies has focused on bank efficiency within a given transition economy, including Hungary (Hasan and Marton, 2003), the Czech Republic (Weill, 2003; Matousek and Taci, 2004), Croatia (Kraft and Tirtiroglu, 1998; Jemric and Vujcic, 2002), Poland (Nikiel and Opiela, 2002; Havrylchyk, 2006), Ukraine (Mertens and Urga, 2001), and Romania (Asaftei and Kumbhakar, 2008). The sample period of these studies mostly covers the 1990s but none of them includes the years preceding and following the first and second EU expansions in Eastern Europe in 2004 and 2007, respectively. All studies suggest that foreign-owned banks were more efficient than domestic banks although the issue seems to be more nuanced. For instance, foreign greenfield banks scored higher than domestic banks acquired by foreign owners (Havrylchyk, 2006). Moreover, foreign banks servicing foreign and business customers achieved higher cost efficiency relative to foreign banks with domestic customers which were at par with private domestic banks (Nikiel and Opiela, 2002). In contrast to privatization, the tightening of prudential requirements with respect to capital adequacy and required reserved seems to have had a negative effect on efficiency as it imposed higher costs on banks (Asaftei and Kumbhakar, 2008). As for the effect of bank size on efficiency, the evidence from most studies suggests that large banks had an advantage over small banks, although in a few cases this differ-

ence was found not to be statistically significant (Matousek and Taci, 2004; Havrylchyk, 2006).

Nenovsky, Chobanov, Mihaylova, and Koleva (2008) is the only study in this group that focuses on the efficiency of Bulgarian banks. Their results indicate that the average level of technical efficiency between 1999 and 2006 was 0.78 and increased over time. In addition, foreign banks were found to be more efficient than domestic private banks, however state-owned banks surprisingly appeared to be the most efficient group which was probably due to the limited size of the sample.

A second group of studies is comparative in nature and has estimated bank efficiency within a group of transition economies. Fries and Taci (2005) used bank data from 15 transition economies over the 1994–2001 period and found that private banks were more cost efficient than state-owned banks. In particular, privatized banks with majority foreign ownership achieved higher levels of efficiency than those with domestic ownership. Moreover, their study showed that total costs decreased during the initial stages of bank reform but rose at the more advanced stages. The 19 Bulgarian banks included in the sample had an average cost efficiency level of 0.42 which was the lowest in the entire sample. When country-specific factors were included, it rose to 0.62 which was still below the sample average.

Grigorian and Manole (2006) studied 17 transition economies over the 1995–1998 period and reported that consolidation in the banking sector and the privatization to foreign owners had a positive effect on efficiency. In addition, they found that some prudential requirements such as tighter minimum capital adequacy ratios improved efficiency, whereas others such as limits to the exposure to a single borrower did not have a statistically significant effect. Between 10 and 17 Bulgarian banks were included in the sample; however, they represented less than 30 per cent of total assets of the banking system. Nevertheless, the results indicate that their efficiency levels improved from an average of 0.55 during the banking crisis in 1996–1997 to 0.71 in 1998 making them the most efficient in Eastern Europe and the Baltics and at par with the more advanced transition economies in Central Europe.

Bonin, Hasan, and Wachtel (2005) compared profit and cost efficiency of banks in 11 transition economies over the 1996–2000 period. They found that banks controlled by an international institutional investor were the most efficient, followed by foreign banks. However, efficiency of state-owned banks was not statistically significantly different from that of private domestic banks. In addition, bank size was found to be negatively correlated with efficiency. Although the sample included 17 Bulgarian banks, their efficiency was not reported separately from the sample averages.

Yildirim and Philippatos (2007) estimated cost and profit efficiency of banks in 12 transition countries from 1993 to 2000. Their findings suggest that foreign banks were more cost-efficient but less profit-efficient relative to state-owned and private domestic banks. In addition, market concentration was found to be negatively related to efficiency, whereas bank size was associated with higher levels of efficiency. Bulgaria was not included in the sample.

Stavarek (2006) compared the technical efficiency of banks in 9 transition economies with those from Greece and Portugal over the 2001–2003 period and found that even the most efficient banking sectors in Central and Eastern Europe performed worse than the two least developed members of the EU before the expansion of 2004. However, the efficiency levels in transition economies rose significantly over the sample period with Bulgaria achieving the largest improvements in the sample. The 12 Bulgarian banks included were the least efficient in 2001 with a score of 0.32 but managed to climb to a level of 0.72 in 2003.

The analysis by Brissimis, Delis, and Papanikolaou (2008) is the only one from the group of comparative studies that includes the first two years after the 2004 EU accession of 8 transition economies. Their sample consists of 10 transition economies over the 1994–2005 period. The results indicate that bank reforms, foreign ownership, and private ownership all had a positive effect on productive efficiency. Bulgarian banks are included in the sample, although their exact number is not reported. The average productive efficiency of Bulgarian banks over the sample period was estimated at 0.71 and has remained remarkably stable. Surprisingly, productive efficiency appears to have declined in the three years following the banking crisis in 1996–1997 despite reforms and privatization.

3. Methodology

According to Farrell (1957)'s seminal work, the concept of efficiency encompasses two aspects of firm performance. To achieve technical efficiency, firms seek to minimize the quantities of inputs used in producing a given level of output under the assumption of constant elasticity of substitution. In addition, firms also pursue allocative efficiency by evaluating input prices and choosing a combination of inputs that minimizes the cost of production. Combined, technical and allocative efficiency provide an overall efficiency measure, often referred to in the literature as cost efficiency. In practice, the efficiency of a firm is evaluated relative to a reference point on a benchmark production frontier. The efficiency measure is a radial measure of the distance between the firm and the best-practice frontier calculated as the ratio

of actual to potential firm performance. Accordingly, a firm is considered efficient if its performance corresponds to a point on the best-practice frontier. In this case actual and potential performances are identical resulting in an efficiency score of 1. In contrast, a score of less than 1 is associated with inefficient firms located below the frontier due to their poor performance relative to their potential.

The radial measure of efficiency relies on the existence of a benchmark production frontier which is not observed in practice. Two main approaches have been developed in the literature to deal with this issue. Parametric methods, such as the Stochastic Frontier Approach (SFA), use econometric techniques to estimate a frontier and decompose the stochastic term of the regression model into an inefficiency component and random error. Non-parametric methods, such as Data Envelopment Analysis (DEA), use mathematical programming to construct a piecewise linear production frontier that envelopes the observed data points and treats all deviations from the frontier as inefficiency. In the literature on bank efficiency in transition economies, Bonin, Hasan and Wachtel (2005), Fries and Taci (2005), Hasan and Marton (2003), and Yildirim and Philippatos (2007) have used SFA, whereas Grigorian and Manole (2006), Jemric and Vujcic (2002), Stavarek (2006), and Brissimis, Delis, and Papanikolaou (2008) have opted for DEA. In this study we adopt the DEA methodology to estimate the efficiency of Bulgarian banks because the non-parametric approach allows the data to determine the form of the frontier without imposing any restriction that might misspecify the production technology. In other words, this methodology is data driven rather than based on theory. Although SFA has the advantage of taking into account random error, it requires a priori specification of the functional form of the frontier and makes assumptions about the distributional properties of the components of the stochastic term which are often violated (Greene, 1999).

At first, we estimated the technical efficiency of Bulgarian banks by solving the following input-oriented linear programming model developed by Banker, Charnes and Cooper (1984):

$$
\begin{aligned}
&\theta^* = \min_{\theta,\lambda} \theta \\
s.t.\ \ &\theta x_{io} \geq \sum_{j=1}^{n} \lambda_j x_{ij} \quad i = 1,\ldots,\mathrm{m} \\
&y_{ro} \leq \sum_{j=1}^{n} \lambda_j y_{rj} \quad r = 1,\ldots,s \\
&e\lambda = 1 \\
&\lambda_j \geq 0,\ \forall j
\end{aligned}
\tag{1}
$$

where x_{ij} and y_{rj} denote the levels of the ith input and r^{th} output of the jth bank, j = 1, ..., n. The first two constraints require that the performance of a given bank o in terms of its inputs x_{io} and outputs y_{ro} is located within a production possibility set defined by the envelopment of all data points. The last two constraints, where e is a row vector with all elements equal to 1 and $\lambda = (\lambda_1, ..., \lambda_n)$ is a column vector with all elements non-negative, allow for variable returns to scale by imposing a convexity restriction which generates a frontier in the form of a convex hull of intersecting planes. This condition accounts for the fact that the banks in the data set do not necessarily operate at an optimal scale and ensures that an inefficient bank is compared only with banks of a similar size. The scalar Θ^* which is the optimal solution of the minimization problem in Eq. 1 represents the efficiency score of a given bank. If $\Theta^*=1$, the bank is located on the best-practice frontier and is thus efficient, whereas $0 < \Theta^* < 1$ indicates inefficiency.

To examine changes in the efficiency scores of each bank over the sample period we employed the Malmquist Index, a widely-used DEA-based measure of TFP growth. Following Färe, Grosskopf, and Zhang (1994), the Malmquist Index measuring the productivity change between periods t and $t+1$ was defined as:

$$M = \left[\frac{\delta_t(x_{t+1}, y_{t+1})}{\delta_t(x_t, y_t)} \times \frac{\delta_{t+1}(x_{t+1}, y_{t+1})}{\delta_{t+1}(x_t, y_t)} \right]^{1/2} \tag{2}$$

where δ_t and δ_{t+1} are the technical efficiency scores calculated using the DEA model in Eq. 1 and evaluated relative to the frontier in period t and t+1, respectively. The *TFP* growth in Eq. 2 can be decomposed into technical efficiency change (*TEC*) and technological change (*TC*) as follows:

$$TFP = TEC \times TC \tag{3}$$

Technical efficiency change measures the variation in the distance of the firm's performance to the best-practice frontier between two points of time and is given by:

$$TEC = \frac{\delta_{t+1}(x_{t+1}, y_{t+1})}{\delta_t(x_t, y_t)} \tag{4}$$

TEC is thus the ratio of the efficiency score in $t+1$ to its level in t and represents a movement towards or away from the frontier. *TEC*>1 indicates that the technical efficiency of the firm is improving by [(*TEC*-1)x100] per cent as the firm catches up with the best-practice frontier. *TEC*<1 indicates a deterioration in technical efficiency resulting in a growing distance between the firm's performance and the best-practice frontier.

The second component of TFP growth is technological change which measures the shift of the best-practice frontier and can be formulated as:

$$TC = \left[\frac{\delta_t(x_t, y_t)}{\delta_{t+1}(x_t, y_t)} \times \frac{\delta_t(x_{t+1}, y_{t+1})}{\delta_{t+1}(x_{t+1}, y_{t+1})} \right]^{1/2} \tag{5}$$

Technological change thus represents the geometric mean of two ratios. The first ratio involves the efficiency of firm performance in *t* evaluated with respect to the frontiers in *t* and *t+1*. The second ratio focuses on the efficiency of firm performance in *t+1* relative to the frontiers in *t* and *t+1*. TC>1 indicates technological innovation leading to an upward shift of the frontier, whereas *TC*<1 denotes a downward shift due to regress in frontier technology.

Next, we make use of the data on input prices and estimate the cost efficiency by solving the following linear programming model based on Farrell (1957):

$$\begin{aligned} & c_{io} x_{i0}^{*} = \min_{x,\lambda} \sum_{i=1}^{m} c_{io} x_{io} \\ s.t. \quad & x_{io} \geq \sum_{j=1}^{n} \lambda_j x_{ij} \qquad i = 1,\ldots, \mathrm{m} \\ & y_{ro} \leq \sum_{j=1}^{n} \lambda_j y_{rj} \qquad r = 1,\ldots, s \\ & \sum_{j=1}^{n} \lambda_j = 1 \\ & \lambda_j \geq 0 \end{aligned} \tag{6}$$

where the constraints, including variable returns to scale, are identical to the model in Eq. 1 but the goal is to minimize the production cost represented by the product of the input x_{io} and its corresponding price c_{io}. The optimal solution is the input vector x^* which when multiplied with the input-price vector *c* determines the minimal cost. The cost efficiency (*CE*) score for each bank is then obtained by evaluating the minimal cost cx^* relative to the observed cost *cx* as follows:

$$CE = \frac{cx^*}{cx} \tag{7}$$

where $0<CE\leqslant 1$ and the bank is cost efficient only if *CE*=1. Given that cost efficiency can be decomposed into technical (*TE*) and allocative efficiency (*AE*) as follows:

$$CE = TE \times AE \tag{8}$$

we are able to estimate the *AE* by dividing the estimate from Eq. 7 by the estimate from Eq. 1. Whereas *TE* is concerned with the distance between the bank performance and the best-practice frontier, AE measures the distance between the reference point on the frontier and the cost line. Full allocative efficiency defined as *AE*=1 is achieved if a bank has an optimal combination of inputs and costs which corresponds to a location on the cost line. Consequently, full cost efficiency is attained only if a bank has perfect scores in both technical and allocative efficiency and is thus located on both the best-practice frontier and the cost line.

4. Data

The data set included all commercial banks in Bulgaria over the 1999–2007 period. The number of banks in each year varied between 29 and 35. Since the DEA measures the efficiency of producing multiple outputs using a set of inputs, the choice of input and output variables is of great significance for the resulting estimates. We based our selection of variables on the intermediation approach (Sealey and Lindley, 1977) which focuses on the traditional role of banks as financial intermediaries that collect deposits and convert them, using labor and capital, into loans and other earnings assets.[1] Accordingly, we defined three inputs and two outputs. The inputs included labor, capital, and borrowed funds. Labor was measured as the number of bank employees, and capital as the value of fixed assets. Borrowed funds were the sum of total deposits and short- and long-term borrowings. The two outputs were total loans and investment assets.

Data on the number of employees were provided by the Bulgarian National Bank (BNB). All other variables were collected from end-year balance sheets and income statements published by BNB in the *Commercial Banks in Bulgaria* bulletin. Nominal variables expressed in Bulgarian levs (BGN) were deflated by the consumer price index with 2005 as base year. Given that DEA efficiency estimates are sensitive to measurement errors, it was important to address the data quality issues stemming from poor accounting standards and weak regulatory supervision common to all transition economies. To reduce the possible impact of these problems we used data published by BNB, verified it against an alternative database, and focused on the later years of transition when financial reporting standards improved significantly.

[1] The alternative production approach (**Sherman and Gold**, 1985) argues that banks use labor and capital to produce loans and deposits. It justifies treating deposits as output rather than input by pointing out that transaction services provided by banks to depositors create value added as well. In the literature on bank efficiency in transition economies, the production approach has been adopted by **Grigorian and Manole** (2002) and **Fries and Taci** (2004).

The introduction of a currency board in the aftermath of the 1997 banking crisis was accompanied by the adoption of a new institutional framework which strengthened bank regulation and supervision and led to a more strict enforcement of the rules. Moreover, the rapidly increasing market share of foreign banks from member states of the EU since the late 1990s improved compliancy with international accounting principles. This process was further enhanced by the implementation of EU banking directives in the period leading up to the Treaty of Accession. Banks began adhering to the International Accounting Standards in their financial reporting in 1999 which was chosen as the first year of the sample period. In addition, we also checked the data against financial information reported in the reputable *BankScope* database that has been widely used in previous studies on banking efficiency but has a less comprehensive coverage of Bulgarian banks than the BNB data. The fact that only a few insignificant differences were found was further evidence for the high quality of the data used.

Besides input and output variables, cost efficiency analysis required also data on input prices for each bank. In line with the literature, we defined the price of borrowed funds as the ratio of interest expenses to borrowed funds, the price of labor as the ratio of personnel expenses to the number of employees, and the price of capital as the ratio of operating expenses (net of interest and personnel expenses) to fixed assets.[2] While interest expenses and operating expenses are available from the BNB bulletin, personnel expenses are not reported separately for each bank. Instead, since 2003 the BNB has been providing aggregate annual data on personnel expenses for three groups of banks arranged according to asset size and ownership. We calculated the personnel expenses as a percentage of non-interest operating expenses for each of the three groups and used these ratios to estimate the annual personnel expenses for each bank over the 2003–2007 period. Although *BankScope* reports personnel expenses by bank, they were not used because of incomplete data for some banks and years in our sample. Nevertheless, the correlation between our estimates and the actual personnel expenses available from *BankScope* for each year varied between 0.95 and 0.98.

The descriptive statistics of the input, output, and price variables are summarized in Table 1. The mean value of loans adjusted for inflation increased from BGN 215 million in 1999 to BGN 1.4 billion in 2007. The mean value of investment assets was very small in comparison (BGN 26 million in 1999) but increased rapidly over the sample period reflecting the development of capi-

[2] For the price of capital we used alternatively the ratio of operating expenses (net of interest and personnel expenses) to total assets, however this did not result in any significant changes in the cost efficiency estimates.

tal markets and investment opportunities for Bulgarian banks. The number of employees *per* bank remained relatively stable at around 630 until it rose rapidly to over 1000 in the last three years of the sample period mainly as a result of a few large-scale mergers and takeovers. The mean value of borrowed funds mirrored the magnitude and increases of loans, reaching a level of BGN 1.5 billion in 2007 from a level of BGN 271 million in 1999. The average prices of labor and capital experienced initial increases but then remained relatively stable, whereas the price of borrowed funds exhibited gradual but steady increases.

Table 1

DESCRIPTIVE STATISTICS OF THE INPUT, OUTPUT, AND PRICE VARIABLES

Year		1999	2000	2001	2002	2003	2004	2005	2006	2007
Number of banks		34	34	35	34	35	35	33	32	29
Outputs										
Loans	Mean	215	266	285	324	375	523	714	894	1369
	SD	354	470	427	415	450	624	826	1025	1645
Investment	Mean	26	17	18	38	55	54	82	91	80
assets	SD	98	64	72	138	180	159	182	179	146
Inputs										
Employees	Mean	641	638	636	638	612	642	737	826	1054
	SD	1158	1105	1068	975	802	766	782	831	1145
Fixed assets	Mean	14	16	16	21	19	20	24	27	33
	SD	23	22	23	36	31	31	33	38	49
Borrowed	Mean	271	292	334	397	463	572	848	1051	1502
funds	SD	456	471	528	550	601	677	977	1192	1774
Input prices										
Labor	Mean					17.2	18.5	19.0	18.8	18.7
	SD					9.6	10.0	11.8	11.1	11.0
Capital	Mean					2.4	2.7	2.3	3.5	3.5
	SD					3.2	3.7	3.3	6.9	7.7
Borrowed	Mean					2.1	2.2	2.3	2.4	2.6
funds	SD					1.1	1.3	1.1	0.9	0.6

Notes: 1. All input and output variables are measured in millions of constant 2005 BGN with the exception of the number of bank employees.

2. The price of labor is expressed in thousands of constant 2005 BGN.

3. The price of capital and of borrowed funds is measured in percentage.

The sample of banks was subdivided by ownership (state-owned, private domestic and foreign) and by size (large, medium, small). The reason for selecting these two factors was the fact that a handful of large banks have a relatively large market share and that bank privatization is a major determi-

nant of bank performance as evidenced by previous studies on transition economies.[3] The last state-owned bank of any significance was privatized in 2002 making this category obsolete in subsequent years of the sample period.[4] Banks with foreign ownership of at least 50 per cent were treated as foreign. With regard to bank size, the categories of large and small banks were defined as the upper and lower quartiles of the asset distribution in each year.[5]

Table 2

MEAN ANNUAL VALUES OF THE VARIABLES BY OWNERSHIP AND SIZE, 1999–2007

Bank type	State-owned[a]	Private domestic	Foreign	Large	Medium	Small
Number of banks	3-7	6-10	19-23	6-9	15-20	7-9
Total assets	784	494	880	2316	441	77
Outputs						
Loans	446	334	648	1633	324	53
Investment assets	66	43	54	192	16	5
Inputs						
Employees	1954	693	836	1959	456	89
Fixed assets	39	16	23	64	12	3
Borrowed funds	652	418	721	1886	378	50
Input prices[b]						
Labor (thousands BGN)	-	13.4	21.1	17.1	19.9	17.2
Capital (%)	-	2.6	2.2	2.0	2.3	2.8
Borrowed funds (%)	-	3.0	2.1	2.1	2.5	2.2

All variables are expressed in millions of constant 2005 BGN except as noted.

[a] State-owned banks averages are for the 1999–2002 period.

[b] Input price averages are for the 2003–2007 period.

[3] Cluster analysis would have provided a more rigorous approach to the creation of subsamples, however we chose to follow the literature and use only size and ownership so as to make our results directly comparable to previous studies on transition economies, none of which employs cluster analysis. Furthermore, the factors that would have been used in a cluster analysis are included as possible determinants of efficiency in the second-stage regression in Section 5.2.

[4] Two state-owned banks continued to operate after 2002 and were included in the sample but the small number and their relatively small size were not sufficient to justify a separate category.

[5] Interestingly, despite mergers and takeovers the composition of these two groups remained extremely stable over the sample period resulting in a remarkably consistent categorization of banks by size across years.

Descriptive statistics for the six subsamples are displayed in Table 2. The dominant position of foreign banks in Bulgaria is evident from the fact that they represented two-thirds of all banks and had the highest mean annual value of assets, loans, and borrowed funds. Despite their small number, state-owned banks were close second in terms of assets over the 1999–2002 period and had the highest average values of investment assets and fixed capital. In addition, the mean number of employees was two to three times higher than that of private banks. Foreign banks had higher labor costs and lower costs for fixed capital and borrowed funds than private domestic banks. Large banks enjoyed the lowest prices for all three inputs but small banks also paid lower prices for labor and borrowed funds than medium-sized banks.

5. Results

5.1. Efficiency Estimates

The DEA estimates are reported in Table 3 and indicate that the mean efficiency score of Bulgarian banks was 0.83 over the 1999–2007 period. From the annual estimates it is evident that there is a significant difference between the 1999–2004 and 2005–2007 periods. Whereas in the first six years of the sample period efficiency fluctuated between 0.69 and 0.84 without a clear pattern, it soared above 0.90 in 2005 and remained at this relatively high level despite minor decreases in the following years. The reason for the lower efficiency in the late 1990s and early 2000s is that most banks were reluctant to lend as they were still haunted by the aftermath of the 1996 crisis. This changed in 2004 when foreign banks were attracted by higher rates of return and the prospect of Bulgaria's EU accession, poured resources into the financial system through their Bulgarian subsidiaries creating a credit boom reflected in the jump in efficiency scores. BNB reacted by raising the reserve requirements and imposing restrictions on lending which were most likely responsible for the moderate decline in efficiency after 2005.

Foreign banks were more efficient than private domestic banks, and their score mirrored the overall pattern of change of the sample average. By contrast, private domestic banks exhibited consistent improvements in technical efficiency since 2005 thereby surpassing foreign banks in 2007. State-owned banks which were evaluated over the first four years of the sample before being privatized recorded the lowest level of technical efficiency. Moreover, their efficiency worsened over the years as the best banks were privatized first. Foreign banks were the main beneficiaries of privatization and the analysis of the four takeovers in the years 1999–2002 showed that the efficiency

of the state-owned banks involved increased on average from 0.82 to 0.90 following privatization.

Table 3

TECHNICAL EFFICIENCY BY OWNERSHIP AND SIZE, 1999–2007

Year		1999	2000	2001	2002	2003	2004	2005	2006	2007	Mean
Sample	N	34	34	35	34	35	35	33	32	29	
	Mean	0.81	0.84	0.80	0.69	0.82	0.75	0.93	0.91	0.90	0.83
	SD	0.20	0.18	0.20	0.30	0.19	0.21	0.10	0.13	0.14	0.18
	Min	0.06	0.50	0.41	0.11	0.41	0.41	0.70	0.56	0.45	0.40
State	N	7	4	4	3						
	Mean	0.87	0.65	0.74	0.48						0.69
Private	N	8	9	10	10	10	10	9	7	6	
	Mean	0.72	0.77	0.65	0.52	0.70	0.59	0.89	0.90	0.92	0.74
Foreign	N	19	21	21	21	23	23	22	23	21	
	Mean	0.82	0.90	0.89	0.79	0.89	0.84	0.95	0.93	0.91	0.88
Large	N	8	9	9	8	7	7	6	7	7	
	Mean	0.88	0.83	0.90	0.95	1.00	0.92	1.00	1.00	1.00	0.94
Medium	N	19	16	17	19	20	20	19	18	15	
	Mean	0.77	0.77	0.73	0.76	0.76	0.68	0.88	0.88	0.90	0.79
Small	N	7	9	9	7	8	8	8	7	7	
	Mean	0.80	0.98	0.83	0.46	0.83	0.77	0.98	0.92	0.82	0.82

Large banks were found to be the most efficient subsample with an average score of 0.94. They achieved maximum efficiency in every year since 2005 and thus determined the best-practice frontier. Small banks were less efficient and experienced a decline in efficiency after reaching a peak in 2005.

The estimates of the Malmquist Index measuring changes in TFP and its components are shown in Table 4.[6] The average TFP growth rate over the 2000–2007 period was 3.7 per cent. Although technical efficiency improved by 1.4 per cent, the contribution of technological change to TFP growth was larger. A comparison between the periods before and after the Treaty of Accession revealed the same pattern found in Table 3. During the 2000–2004

[6] This type of analysis requires a balanced panel which limited the size of the sample to 25 banks. Institutions founded during the sample period or those that merged together to form a new bank were excluded.

period, technological change was the only driving force behind TFP as efficiency remained largely unchanged. This pattern was reversed after 2005 as technical efficiency increased by 4.3 per cent and was responsible for TFP growth. In the first year of EU membership TFP grew by 6 per cent but technical efficiency deteriorated.[7]

Foreign banks exhibited the largest improvement in technical efficiency and the highest growth rate of TFP over the sample period. However, private domestic banks surpassed them in both aspects in 2005–2007 by achieving technical efficiency change of over 10 per cent. State-owned banks experienced a severe decline in TFP and deterioration in technical efficiency before being privatized. Furthermore, the results suggest that TFP growth for large banks relied mostly on technical efficiency change, whereas for small banks it was almost exclusively driven by technological change due to lack of any efficiency improvements. Small banks recorded significantly higher rates of efficiency change for the 2005–2007 period but in 2007 they also experienced a steeper efficiency decline than large banks.

Table 4

TFP GROWTH, TECHNICAL EFFICIENCY CHANGE, AND TECHNOLOGICAL CHANGE (IN PERCENTAGE)

Period		2000–2007			2000–2004		2005–2007		2007	
Variable	*N*	*TFP*	*TEC*	*TC*	*TFP*	*TEC*	*TFP*	*TEC*	*TFP*	*TEC*
Sample	25	3.7	1.4	2.3	5.0	-0.7	2.0	4.3	6.0	-7.7
State*	4	-9.5	-1.1	-8.5						
Private	8	0.4	1.3	-0.9	-2.4	-4.8	4.4	10.2	8.0	-9.1
Foreign	13	5.5	1.6	3.8	7.6	1.7	2.7	1.4	4.8	-5.5
Large	5	4.9	3.3	1.5	10.6	4.1	-2.4	2.2	8.7	-3.1
Medium	14	1.7	1.3	0.4	0.0	-1.2	4.3	4.7	13.1	-0.3
Small	6	7.4	0.1	7.3	13.0	-3.6	0.4	5.3	-10.7	-22.7

All growth rates are geometric means over the respective period and are expressed in percentage (e.g., [TFP-1]x100).

* The values for state-owned firms are geometric means over the 2000–2002 period.

[7] Although this decline in efficiency was already observed in Table 3, its magnitude might have been overestimated due to the fact that there were two large mergers in 2007 and the five involved banks were excluded from the sample for the estimation of the Malmquist Index.

Table 5 displays the estimates of cost efficiency which represents a measure of overall efficiency taking into account technical as well as allocative aspects. It is evident that when input prices were included in the analysis the average cost and allocative efficiency scores of Bulgarian banks over the 2003–2007 period became 0.63 and 0.72, respectively. Cost efficiency improved consistently over the years witnessing a larger increase in 2006 and reaching a peak of 0.78 in 2007. Foreign banks were again more cost and allocative efficient than domestic banks, however the gap between the two groups narrowed significantly, especially after domestic banks experienced a dramatic boost in efficiency in 2005. Large banks had again the highest average scores and achieved perfect efficiency in 2007. In contrast, small banks were extremely inefficient and despite some minor improvements in 2006–2007 they remained below the average efficiency level for the entire sample.

Table 5

COST AND ALLOCATIVE EFFICIENCY BY OWNERSHIP AND SIZE, 2003–2007

Year		2003	2004	2005	2006	2007	Mean
Sample	Mean (CE)	0.53	0.55	0.59	0.72	0.78	0.63
	SD (CE)	0.28	0.29	0.37	0.25	0.26	0.29
	Mean (AE)	0.62	0.70	0.64	0.77	0.85	0.72
	SD (AE)	0.24	0.23	0.39	0.22	0.20	0.26
Private domestic	CE	0.34	0.34	0.65	0.65	0.72	0.54
	AE	0.49	0.61	0.75	0.72	0.76	0.67
Foreign	CE	0.62	0.66	0.56	0.76	0.81	0.68
	AE	0.68	0.76	0.59	0.80	0.87	0.74
Large	CE	0.88	0.85	0.96	0.97	1.00	0.93
	AE	0.88	0.92	0.96	0.97	1.00	0.95
Medium	CE	0.43	0.48	0.55	0.67	0.76	0.58
	AE	0.56	0.67	0.63	0.75	0.83	0.69
Small	CE	0.46	0.45	0.42	0.57	0.61	0.50
	AE	0.54	0.56	0.42	0.61	0.73	0.57

5.2. Determinants of Efficiency

To identify the determinants of bank efficiency, the DEA estimates were regressed on a number of bank-specific and institutional variables using the following specification:

$$EFF_{it} = \alpha + \sum_{k} \beta_k OWN_{it,k} + \sum_{m} \beta_m CAMEL_{it,m} + \sum_{q} \beta_q INST_{t,q} + \sum_{z} \beta_z EU_{t,z} + \varepsilon_{it} \quad (9)$$

Three separate regressions were estimated with technical, cost, and allocative efficiency as the dependent variable. As DEA efficiency scores are limited to values between 0 and 1, estimation via OLS would result in inconsistent estimates. Therefore, we employed a Tobit specification for panel data which captures the lower and upper censoring of the dependent variable and produces consistent Maximum Likelihood estimates.

The potential correlates of efficiency were broadly grouped into four categories. The first addressed issues of ownership and size (*OWN*) and included dummy variables for state-owned and foreign banks as well as a variable for bank size defined as the ratio of a bank's assets to the total assets of the banking system. The second group of variables consisted of bank-specific financial indicators which are part of the *CAMEL* (Capital adequacy, Asset quality, Management, Earning, Liquidity) Rating System used by supervisory bodies, including BNB, to assess bank performance. From the numerous CAMEL indicators we selected the four most frequently used in the literature for which data were available in the *BankScope* database and the *Commercial Banks in Bulgaria* bulletin. The ratio of equity to total assets was used as a measure of bank capitalization. Asset quality was proxied by loan loss provisions as a fraction of total loans. The return on assets (ROA) was a proxy for profitability, and liquidity was measured as the share of liquid assets in total assets.
The third group of correlates (*INT*) controlled for changes in the institutional environment in which commercial banks operated. In particular, we included three variables representing progress in banking reform, large-scale privatization, and enterprise restructuring in Bulgaria. Each of the variables was measured by a composite index computed by the European Bank of Reconstruction and Development and reported in its annual *Transition Report*. The indices measure institutional development in Bulgaria relative to the standards of industrialized market economies and range from 1 (little or no change from a rigid centrally-planned economy) to 4+ (standards of an industrialized market economy). The banking reform variable assessed progress in establishing an effective framework of prudential supervision and regulation, convergence of banking laws and regulations with international standards, banking competition, lending to private enterprises, and the share of private banks. The large-scale privatization variable accounted for changes in the

share of state-owned enterprises and the effectiveness of corporate governance. Lastly, the restructuring variable focused on the transition from a soft to a hard budget constraint, the enforcement of bankruptcy legislation, new investment in enterprises, and the effectiveness of corporate control.

The fourth group of variables (EU) examined the impact of EU accession on bank efficiency. In particular, dummy variables for the years 2005 and 2007 accounted for the effects of the signing of the Treaty of Accession and EU membership, respectively.

Table 6

RESULTS OF THE TOBIT REGRESSION ANALYSIS OF EFFICIENCY DETERMINANTS

Dependent variable	TE	CE	AE
Constant	0.299	-0.319	-0.708
	(0.81)	(-0.37)	(-0.88)
Ownership and size			
State-owned	-0.042		
	(-0.77)		
Foreign	0.220***	0.116**	0.065
	(6.43)	(2.06)	(1.22)
Market share	0.028***	0.066***	0.056***
	(5.42)	(6.83)	(6.18)
CAMEL			
Equity/Total assets	0.005***	0.005**	0.002
	(4.64)	(2.10)	(0.85)
Loan loss provisions/Loans	-0.001	0.015	0.020
	(-1.23)	(0.80)	(0.18)
ROA	0.020***	0.021***	0.020**
	(3.36)	(2.35)	(2.37)
Liquid assets/Total assets	-0.001	0.003**	0.004***
	(-1.36)	(1.95)	(2.94)
Institutional reforms			
Privatization	0.198		
	(1.50)		
Banking reform	-0.457***	0.114	0.278
	(-2.95)	(0.47)	(1.22)
Restructuring	0.401**		
	(2.22)		
EU Accession			
Treaty of Accession	0.248***	0.096	-0.018
	(5.12)	(1.34)	(-0.26)
EU Accession	-0.009	0.195***	0.218***
	(-0.15)	(2.59)	(3.09)
Period	1999–2007	2003–2007	2003–2007
Observations	234	145	145

t-values in parenthesis. ** 5% significance level. *** 1% significance level.

The results of the Tobit regression are presented in Table 6. The estimated coefficients of the ownership dummy variables indicate that foreign banks were significantly more cost efficient and more technically efficient than domestic banks which is consistent with the findings of previous studies on transition economies. The majority of foreign banks in Bulgaria are owned by large and established banks from Germany, France, Italy, and Austria giving them access to advanced technology and expertise, better risk management and corporate governance, and capital from their parent banks. Moreover, foreign banks have the advantage of counting foreign firms and the most creditworthy Bulgarian companies as their customers (Koford and Tscheogl, 2003). Greek and Turkish banks, for instance, followed corporate customers from their home countries on the Bulgarian market where they continued servicing their needs. Foreign corporate customers have been shown to improve cost efficiency of banks in other transition economies (Nikiel and Opiela, 2002).

State-owned banks were found to be less technically efficient than private domestic and foreign banks, which is also in line with previous research. The coefficient for state ownership reported in Table 6 is negative but not statistically significant because two major state-owned banks had to be dropped from the sample for the sake of a balanced panel dataset over the 1999–2007 period. When the model was estimated for the 1999–2003 period with all state-owned banks included, this coefficient turned significant. With respect to size, it appears that technical, cost, and allocative efficiency were higher for banks with a larger market share as they were able to benefit from lower costs and economies of scale.

The regression results reveal further that capitalization was positively related to technical and cost efficiency.[8] A possible explanation is that well-capitalized banks attract more deposits as they offer implicit deposit insurance which is reflected in lower interest expenses and thus lower total costs. Moreover, higher returns on assets were positively associated with all three types of efficiency. The coefficient for the ratio of loan loss provisions to total loans was not statistically significant for any aspect of efficiency.[9] This contradicts Yildirim and Philippatos (2007), Havrylchiyk (2006), and Brissimis et al. (2008) who reported a significantly negative relationship between the share of impaired assets and efficiency. A look at the data suggests that the subsidiaries of foreign banks in Bulgaria had an average provisions-to-loans ratio of

[8] A number of studies have reported similar results, including **Fries and Taci** (2005), **Grigorian and Manole** (2006), and **Yildirim and Philippatos** (2007).

[9] **Matousek and Taci** (2004) found an overall positive correlation between ROA and cost efficiency for the Czech Republic. They further showed that while this was also true for big and foreign banks, the correlation was negative for small banks.

only 1 per cent over the 2003–2007 period. However, the average ratio of 3.01 per cent for large foreign banks was only slightly lower than the 3.3 per cent for the rest of the banking sector. In addition, the coefficient of variation decreased over the years as the quality of the credit portfolio of less efficient banks improved.

Liquidity had a positive effect on cost and allocative efficiency.[10] Given the limited role of BNB as a lender of last resort under the currency board, commercial banks need to either maintain high liquidity or rely on short-term money markets in the case of a liquidity crisis. Keeping a larger share of liquid assets seems to be more efficient as it minimizes the costs of borrowing.

Enterprise restructuring contributed to higher levels of technical efficiency of banks. This reflects improvements in the credit portfolio of banks and an increase in their willingness to lend as a result of the hardening of the budget constraint, the risk of bankruptcy, and better corporate governance of firms. Large-scale privatization of state-owned enterprises did not significantly affect technical efficiency of banks.[11] Banking reform was negatively associated with technical efficiency but was not significantly correlated with cost and allocative efficiency. This result reflects the difference in the periods for which the regressions were estimated. Technical efficiency was analyzed over the entire sample period and thus included the 1999–2004 period when banking reforms were most intense in the aftermath of the banking crisis and in the wake of the Treaty of Accession. The regressions of cost and allocative efficiency covered the 2003–2007 period when banking reforms slowed down which explains the lack of significance of the corresponding coefficients. Our results therefore suggest that fundamental reforms of the banking system in Bulgaria involving for instance tighter reserve and liquidity requirements affected adversely bank operations and imposed costs which had a negative effect on efficiency. This finding is consistent with Fries and Taci (2005) and Asaftei and Kumbhakar (2008) but contradicts the positive relationship reported by Brissimis et al. (2008).[12]

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[10] **Hasan and Marton** (2003) also showed that a higher share of liquid assets was linked to less cost inefficiencies in the case of Hungary.

[11] The indices for large-scale privatization and enterprise restructuring did nor change over the 2003–2007 period and were therefore excluded from the regressions of cost and allocative efficiency.

[12] It should be noted again that EBRD's banking reform variable measures the convergence of institutional standards in the Bulgarian banking system to those of mature market economies. A more detailed analysis of the various reform measures as conducted by **Grigorian and Manole** (2006) for a number of transition economies suggests that prudential requirements can have differing effects on efficiency.

Despite the negative relationship between efficiency and banking reforms aimed at legal and regulatory convergence with developed market economies, the EU accession appears to have boosted efficiency, although this result should be treated with caution due to the relatively short period of evaluation. The Treaty of Accession in 2005 marked a significant improvement in technical efficiency, whereas the first year of EU membership was associated with pronounced gains in cost and allocative efficiency. It is also possible that these variations in efficiency during accession and EU membership were magnified by other factors such as institutional reforms and financial indicators, as evidenced by the regression results.

6. Conclusions

In this paper we measured the efficiency of commercial banks in Bulgaria and examined its determinants over the 1999–2007 period. Our findings indicate that estimates for the different types of efficiency varied between 0.63 and 0.83, and improved over time, exhibiting particularly large gains in 2005. As a result, technical efficiency change replaced technological innovation as the major driving force behind TFP growth in the banking sector after 2005. Foreign banks were found to be more efficient than private domestic banks, which is consistent with previous research. However, the efficiency gains attained by private domestic banks in the 2005–2007 period helped them catch up with their foreign competitors. State-owned banks were the worst performers but their efficiency recovered following their privatization and restructuring.

Furthermore, our analysis identified a number of financial, institutional, and EU-related variables that determined efficiency levels of Bulgarian banks over the sample period. Profitability, liquidity, and capitalization were shown to have a positive effect on efficiency. A larger market share and foreign ownership were also associated with higher efficiency levels. Enterprise restructuring boosted bank efficiency as it improved the governance and creditworthiness of corporate customers. Bank reforms, on the other hand, were inversely related to technical efficiency and had no significant effect on cost and allocative efficiency. As previous studies on transition economies have shown, the tightening of prudential requirements imposes costs on financial intermediation and may adversely affect efficiency; however, more research is needed to reveal the reform components responsible for efficiency losses. Our findings also indicate that the accession to, and the membership, in the EU might have contributed to marked improvements in bank performance. The signing of the Treaty of Accession in 2005 coincided with the largest gains in technical efficiency over the sample period, whereas the first year of

EU membership was associated with advances in cost and allocative efficiency, although more research is needed to confirm these findings over longer periods of EU membership.

The successful privatization of state-owned banks, the dominance of well-managed foreign banks, the improving efficiency of the banking sector, and the benefits of EU accession revealed in this paper reflect the transition of Bulgaria from a slow reformer to a thriving emerging economy over the past decade.

References

Asaftei, G., S. C. Kumbhakar (2008) Regulation and efficiency in transition: The case of Romanian banks. *Journal of Regulatory Economics* 33, pp. 253–282.

Banker, R. D., A. Charnes, W. W. Cooper (1984) Some models for estimating technical and scale inefficiencies in Data Envelopment Analysis. *Management Science* 30, pp. 1078–1092.

Bonin, J. P., I. Hasan, P. Wachtel (2005) Bank performance, efficiency, and ownership in transition countries. *Journal of Banking and Finance* 29, pp. 31–53.

Brissimis, S. N., M. D. Delis, N. I. Papanikolaou (2008) Exploring the nexus between banking sector reform and performance: Evidence from newly acceded EU countries. *Bank of Greece Working Paper* No. 73.

Färe, R. S., M. N. Grosskopf, Z. Zhang (1994) Productivity growth, technical progress, and efficiency change in industrialized countries. *American Economic Review* 84, 66–83.

Farrell, M. J. (1957) The measurement of productive efficiency. *Journal of the Royal Statistical Society* A120, pp. 253–290.

Fries, S., A. Taci (2004) Cost efficiency of banks in transition: Evidence from 289 banks in 15 post–communist countries. *Journal of Banking and Finance* 29, pp. 55–81.

Greene, W. H. (1999) Frontier Production Function. In: Pesaran, M. H., Schmidt, P. (Eds.), Handbook of Applied Econometrics, Vol. 2: Microeconomics. Blackwell, Oxford, pp. 81–166.

Grigorian, D. A., V. Manole (2002) Determinants of commercial bank performance in transition: An application of Data Envelopment Analysis. *Comparative Economic Studies* 48, pp. 497–522.

Hasan, I., K. Marton (2003) Development and efficiency of the banking sector in a transition economy: Hungarian experience. *Journal of Banking and Finance* 27, pp. 2249–2271.

Havrylchyk, O. (2006) Efficiency of the Polish banking industry: Foreign versus domestic banks. *Journal of Banking and Finance* 30, 1975–1996.

Jemric, I., B. Vujcic (2002) Efficiency of banks in Croatia: A DEA approach. *Comparative economic studies* 44, pp. 169–193.

Koford, K., A. Tschoegl (2003) Foreign Banks in Bulgaria, 1875–2002. *William Davidson Institute Working Paper* No. 537.

Kraft, E., D. Tirtiroglu (1998) Bank efficiency in Croatia: A stochastic–frontier analysis. *Journal of Comparative Economics* 26, pp. 282–300.

Matousek, R., A. Taci (2004) Efficiency in banking: Empirical evidence from the Czech Republic. *Economics of Planning* 37, pp. 225–244.

Mertens, A., G. Urga (2001) Efficiency, scale and scope economies in the Ukrainian banking sector in 1998. *Emerging Markets Review* 2, pp. 292–298.

Nenovsky, N., P. Chobanov, G. Mihaylova, D. Koleva (2008) Efficiency of the Bulgarian banking system: Traditional approach and Data Envelopment Analysis. *Agency for Economic Analysis and Forecasting Working Paper* No. 1.

Nikiel, E. M., T. P. Opiela (2002) Customer type and bank efficiency in Poland: Implications for emerging banking market. *Contemporary Economic Policy* 20, pp. 255–271.

Sherman, H.D., F. Gold (1985) Bank Branch Operating Efficiency: Evaluation with Data Envelopment Analysis, *Journal of Banking and Finance*, 9 (2), pp. 297–315.

Stavarek, D. (2006) Bank efficiency in the context of European integration. *Eastern European Economics* 44, pp. 5–31.

Sealey, C.W., Lindley, J. T. (1977) Inputs, outputs, and a theory of production and cost and depositary financial institutions. *Journal of Finance* 32, pp. 1251–1265.

Weill, L. (2003) Banking efficiency in transition economies: The role of foreign ownership. *Economics of Transition* 11, pp. 569–592.

Yildirim, H. S., G. S. Philippatos (2007) Efficiency of banks: Recent evidence from the transition economies, 1993–2000. *The European Journal of Finance* 13, pp. 123–143.

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