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Article

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Banking Sector in the Process of European Integration: How did EU Accession and Euro Adoption affect Cost Efficiency of Slovak Banking Sector?[1]

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Abstract

The aim of this paper is to examine the influence of the accession of Slovakia to the European Union and the Euro zone (Euro area) on the efficiency of Slovak banks. We use data envelopment analysis to estimate bank efficiency, and ordinary least squares and tobit regression to estimate influence of possible bank efficiency determinants. Our analysis shows that the bank efficiency increases both after the accession of Slovakia to the European Union and the Euro zone. We find that the adoption of the Euro has positive impact on bank efficiency in the longer run, although it can have short term negative impact. Our results suggest that efficiency of Slovak banks was not affected by macroeconomic conditions and banking reforms, which is in line with the argument that Slovak banking sector is in the advanced stage of development when influence of these factors is of less importance. We also find that large banks are more efficient than small banks, and foreign banks are more efficient than domestic banks.

Keywords: *Slovak banking sector, cost efficiency, accession to the EU, adoption of the Euro, banking reforms*

JEL Classification: G21, F33, C14

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Introduction

Banking sectors of the Central and East European (CEE) economies went through substantial reforms starting from the early 1990s, which aimed at establishing efficient banks able to support development, transition and accession of the CEE economies to the European Union (EU). The transition of Slovak economy from planned to market-oriented was initiated in 1989, and the legal framework for development of the market oriented two-tier banking sector and commercial banking was established soon after. However, major banking sector restructuring, through the privatization of state-owned banks and liquidation of insolvent banks, took place between 1998 and 2001. After the accession of Slovakia to the EU on 1 May 2004 and the adoption of the Euro on 1 January 2009, Slovak banks were forced to decrease their costs and operate more efficiently due to the strong competition in a highly integrated EU financial market, narrower interest rate spreads, and lower income from foreign exchange operations.

The aim of this paper is to examine the influence of the accession of Slovakia to the EU and the adoption of the Euro on the efficiency of Slovak banks. Our sample includes only 148 observations, but covers almost 77% of the Slovak banking sector assets. It spans a period of 14 years – from 2000 to 2013, and allows the investigation of the impact of major structural and legislative changes on Slovak banks' efficiency. We conduct the analysis in two stages. In the first stage, we use data envelopment analysis (DEA) to estimate five measures of bank efficiency – cost, allocative, technical, pure technical and scale efficiency. In the second stage, we use ordinary least squares (OLS) and tobit regression to investigate possible bank efficiency determinants. Besides the accession to the EU and adoption of the Euro, we identify indicators of banking sector reform and structure, various bank specific variables (ownership, size, activity and capitalization) and macroeconomic indicators (real GDP growth rate and key monetary interest rate) as possible bank efficiency determinants.

Our paper contributes to the relevant literature in three ways. There are no prior studies on the possible influence of the Euro adoption on the cost efficiency of banks in the new EU member states from CEE region. Our study, therefore, aims to shed some light on this issue, focusing on the Slovak banking sector. Secondly, results of the previous studies focusing on efficiency of the Slovak banking sector are rather inconclusive and focused on overall efficiency measures. We estimate four disaggregated efficiency measures, besides one overall cost efficiency measure, which allows us to search for possible sources of cost inefficiencies, like market distortions and managerial inefficiencies. Last but not least, as studies on the possible determinants of various bank efficiency measures in Slovakia are practically non-existent, we fill this gap in the empirical literature.

Our study also has implications for policy makers who are supposed to facilitate financial sector development through the design of the legal and institutional framework, and for investors who are supposed to exercise their influence on bank management.

The structure of this paper is as follows. In section 1 we present a survey of the previous literature on the possible determinants of bank efficiency in the transition economies. Section 2 presents our sample and methodology. In sec tion 3 we report results of efficiency measures estimation and regressions of the efficiency measures on their possible determinants. Last section presents our conclusions.

1. Literature Review

Bank efficiency and its possible determinants in CEE transition economies were subject to many empirical studies in the last twenty years. Regardless of the chosen efficiency estimation approach, these studies usually show that bank efficiency is lower in transition than in developed economies. For example, based on a review of 188 cost and production efficiency estimates presented in 50 studies, Berger and Humphrey (1997) found that the average efficiency of US banks is 0.79, with a range of 0.31 to 0.97. Pastor, Perez and Quesada (1997) estimated that the average bank efficiency in 8 developed economies was 0.865, with a range of 0.548 in UK to 0.951 in France. Average cost efficiency of banks in transition economies, estimated in the cross-country empirical studies, is 0.622 in Staikouras, Mamatzakis and Koutsomanoli-Filippaki (2008), 0.405 to 0.777 (depending on model specification) in Bonin, Hasan and Wachtel (2005), and 0.729 in Chronopoulos, Girardone and Nankervis (2011).

CEE transition economies implemented banking sector reforms to facilitate their market transition, economic development and the accession to EU. Reforms involved adoption of prudent macroeconomic stabilization policies, and the radical liberalization of financial markets (Mamatzakis, Staikouras and Koutsomanoli-Filippaki, 2008). Banking sectors were liberalized by allowing entry of foreign banks and letting interest rates float, and decentralized through restructuring, privatization and relocation of banking activities from central to commercial banks (Fries and Taci, 2005). The reforms have helped banks reduce costs, diversify and increase the quality of their services, and prepare for competition on the EU market. It is, therefore, no surprise that the empirical studies usually report positive influence of banking sector reforms on bank efficiency (Grigorian and Manole, 2006; Brissimis, Delis and Papanikolaou, 2008; Kosak, Zajc and Zoric, 2009; Fang, Hasan and Marton, 2011).

Peculiar characteristic of the banking sectors in transition economies is high proportion of assets owned by foreign banks. Transition economies opened their banking sectors to foreign banks to facilitate privatization, help bank restructuring, and attract necessary capital. Positive effects of this process are confirmed in empirical studies showing that state-owned domestic banks are the least efficient, while foreign banks are more efficient than private domestic banks in terms of costs efficiency (Matousek and Taci, 2004; Jemric and Vujcic, 2002; Yildirim and Philippatos, 2007; Tochkov and Nenovsky, 2011) and profit efficiency (Fang, Hasan and Marton, 2011). However, unlike the majority of previous studies, Siranova and Cupic (2015) found no significant differences in cost efficiency of foreign and domestic banks in Slovakia.

Substantial reforms and establishment of new banking legislation and tighter supervision was significant aspect of CEE transition economies accession to the EU. Prudential banking laws of transition economies have been changed to gradually bring them in line with EU banking directives and the Bank for International Settlements guidelines, and to enhance banking intermediation and banking sector attractiveness for foreign investors (Mamatzakis, Staikouras and Koutsomanoli-Filippaki, 2008). Accordingly, empirical studies often find higher or growing average efficiency of banks in transition economies after the accession to the EU (e.g. Kosak, Zajc and Zoric, 2009; Brissimis, Delis and Papanikolaou, 2008; Tochkov and Nenovsky, 2011). However, results of studies on Slovak banks are not conclusive. While Stavarek and Sulganova (2009) and Siranova and Cupic (2015) report increase, Repkova and Migletti (2013) report decrease in efficiency of Slovak banks after Slovakia accession to the EU. Boda and Zimkova (2014) find that the average efficiency of Slovak banks increased after the Slovakia's accession, but argue that this result was mostly due to the high economic growth rate and introduction of new banking products.

Summaries of the Euro adoption benefits and costs for individual commercial banks, along with discussions on their relevance in different CEE economies can be found in Suster et al. (2006), Hufner and Koske (2008), Dzuida and Mastrobuoni (2009), Ehrmann (2006), and Ganev (2009). Banks usually suffer losses due to the short-term operations costs of the change in payment system (e.g. costs of currency conversion) and lower real interest rates in the monetary union. If significant portion of bank revenues come from operations in foreign currency, bank can incur additional losses. On the other hand, banking sector competitiveness and cost management are expected to improve and lead to a long-term improvement in the overall bank efficiency.

Fidrmuc and Worgotter (2013) argue that the adoption of the Euro in Slovakia brought about borrowing costs decrease, the exchange rate risk disappearance,

and reduction in barriers for borrowers. They believe that the global financial crisis neutralized the expected credit boom resulting from the Euro adoption before it could cause serious economic problems. Arguing in a slightly different way, Sikulova and Okali (2009) suggest that Euro adoption had stabilizing effect on banking sector and whole economy after the global financial crisis spilled over to the Slovakia financial system in 2009. Prior to the Euro adoption, Slovak banks had high share of income from foreign exchange transactions (NBS, 2009), and a short-term decrease in banking sector efficiency was possible. However, due to the increase in domestic competition, Euro adoption is expected to bring long-term increase in cost efficiency of Slovak banks.

2. Sample and Methodology

2.1. Sample

We collect our data from the financial statements published by the commercial banks in our study. Some of the banks went through a merger/acquisition process (CSOB and Istrobanka, Unibanka and HVB banka), some changed its business form from branch to banking institution and vice versa (Citibank, Komercni banka, UniCredit Bank) and most of them needed to comply with international accounting principles, which made a collection of the dataset a difficult job.

Therefore, we firstly collected data only for the commercial banks (not branches) on the consolidated basis according to the International Financial Reporting Standards (IFRS). The rest of the data was collected from non-consolidated financial statements prepared according to the domestic accounting principles. Gaps in data for 4 banks (HVB Bank Slovakia, Istrobanka, Ludova banka and Privatbanka) over 2000 – 2004 were filled using Trend Analysis database.

Our dataset includes the majority of banking institutions operating in the Slovak banking sector, with all the important banking institutions included. It includes 148 bank-year observations from a total of 13 banks, representing about 43% of the total population of banks and branch offices of foreign banks (64% of banks), about 77% of banking assets, about 77% of loans, and about 87% of deposits in Slovak banking sector. The coverage of our dataset in terms of share in total number of banks and branch offices of foreign banks approaches 31% in 2013, mostly because of the large number of branches of foreign banks operating in the Slovak market. Also, as we collect data on consolidated basis, data for some of the banks (Slovenska sporitelna and CSOB) refer to two separate banking institutions.[2]

Table 1

Selected Indicators for Slovakia Banking Sector and Banking Institutions in Dataset

	Banking sector reform	Number of banks			Total assets	FBS	BC3	Key interest rate (%)	Number of banks			Assets		Deposits		Loans	
		with foreign ownership	without foreign ownership	branches					Sample	%	%*	Sample	%	Sample	%	Sample	%
2000	3.0	14	7	2	19,278	28.1	49.99	8.80	6	26.09	28.57	9,844	51.06	7,717	71.25	2,665	51.58
2001	3.3	13	6	2	21,673	60.5	52.05	8.80	6	28.57	31.58	10,875	50.18	8,820	61.97	2,340	36.09
2002	3.3	15	3	2	24,432	90.2	56.16	7.92	11	55.00	61.11	14,702	60.18	11,185	74.39	4,433	58.22
2003	3.3	16	2	3	23,936	93.0	54.47	6.44	12	57.14	66.67	18,418	76.95	14,205	90.59	6,839	76.96
2004	3.7	16	2	3	30,042	92.1	53.61	5.00	13	61.90	72.22	24,084	80.17	17,288	98.06	8,751	81.33
2005	3.7	16	2	5	37,094	92.2	47.76	3.17	12	52.17	66.67	25,618	69.06	17,406	89.55	10,912	77.54
2006	3.7	15	2	7	41,435	91.1	53.13	3.98	13	54.17	76.47	32,512	78.46	22,874	93.30	15,018	80.26
2007	3.7	15	1	10	50,135	94.6	50.38	4.40	12	46.15	75.00	41,975	83.72	28,044	98.53	20,979	87.24
2008	3.7	15	2	9	62,838	93.3	54.65	4.02	12	46.15	70.59	55,830	88.85	35,842	97.97	27,086	88.02
2009	3.7	13	2	11	53,008	91.2	57.26	1.27	11	42.31	73.33	47,394	89.41	31,716	89.04	27,578	90.03
2010	3.7	13	2	13	54,739	91.2	55.81	1.00	11	39.29	73.33	49,042	89.59	34,937	92.29	29,189	90.53
2011	3.7	12	2	17	55,774	91.5	56.73	1.25	10	32.26	71.43	49,737	89.18	35,226	89.09	31,489	89.70
2012	3.7	12	2	16	57,894	92.2	55.39	0.88	10	33.33	71.43	51,217	88.47	37,027	88.45	32,605	90.69
2013	3.7	12	2	15	59,222	91.6	55.26	0.54	9	31.03	64.29	48,817	82.43	36,002	82.50	31,107	81.83
Average	3.56	14.07	2.64	8.21	42,250	85.2	53.76	4.11		43.25	64.48		76.98		86.93		77.14

Notes: Table presents selected indicators for Slovakia banking sector from 2000 to 2013. Banking sector reform is European Bank for Reconstruction and Development (EBRD) index of banking sector reform which can range from 1 to 4+, where 1 denotes little progress beyond establishment of two-tier system, and 4+ means that banking sector has achieved standards and performance norms of advanced industrial economies. Total assets is expressed in EUR millions. Number of banks and the share of foreign banks in the total capital of the banking sector of Slovakia is from NBS (2015). FBS is the share of foreign banks in total capital of the banking sector according to National Bank of Slovakia. BC3 is an indicator of bank concentration measured as a share of three largest banks in the total banking assets. Key interest rate represents yearly average of monthly data for basic interest rate of the National Bank of Slovakia up to 2008 and key interest rate of the European Central Bank since 2009. Total assets, deposits and loans are taken from the National Bank of Slovakia database on balance sheet data of the banking sector at the end of the year, and expressed in € millions. % represents percentage coverage of the total population in our sample. Number of banks includes banks and branch offices of foreign banks as reported by National Bank of Slovakia. %* represents percentage coverage of the number of banks (without branch offices) in our sample.

Source: EBRD; NBS; ECB; individual banks.

As apparent from Table 1, our sample covers all important banking institutions involved in the basic intermediation business – accepting deposits and providing loans. Wustenrot and Slovenska zarucna a rozvojova banka are excluded from the dataset as these banks are focused on specialized operations, such as providing housing loans and guarantees. Postova banka is considered to be private domestic commercial bank even though the headquarters of its owner are registered abroad.

The owner of the bank since 2013 has been J&T Finance Group, originally Slovak investment group with headquarters now registered in Prague, Czech Republic. From 2004 to 2012 the dominant owner of this bank was Istrokapital SE, an originally Slovak investment group with headquarters registered in Cyprus. Prima banka and Privat banka, currently owned by international investment group Penta Investments, Ltd., with headquarters registered in Cyprus, are also considered to be private domestic commercial banks given that Penta Investments, Ltd. initially operated in Slovakia and subsequently spread its operation mainly to Czech Republic and Poland.

2.2. Methodology

We perform a two-stage efficiency analysis. In the first stage, we use Data Envelopment Analysis (DEA) on the set of inputs and outputs to estimate efficiency measures. In the second stage, we use ordinary least squares (OLS) and tobit regression to regress efficiency measures against a number of explanatory variables.

2.2.1. Bank Efficiency Estimation Methodology

Following empirical studies by Grigorian and Manole (2006), Havrylchyk (2006), and Tochkov and Nenovsky (2011) we use DEA to estimate cost efficiency of banks in our study. Grigorian and Manole (2006) argue that DEA can be successfully applied to banking sectors of transition economies, while Havrylchyk (2006) and Ariff and Can (2008) choose DEA because of its good performance

[2] We opt for the collection of data on consolidated basis for the following reason. For majority of banking institutions in Slovakia core business (accepting deposits and granting loans) is operated by the core banking institution in the holding structure. However, many of the supportive business activities (asset management including mutual and pension funds, factoring and forfeiting services, leasing services) are operated by entities owned by core banking institution. Since our analysis aims to also take into account efficiency of the non-core business (i.e. other earning assets, off-balance sheet items), omission of these important activities in the dataset would unnecessary limit the scope of our analysis. On top of that, by focusing on broader set of activities, including core and non-traditional banking business, we take into account decisions of banking institutions to diversify their core business as a response to changing business environment, including EU accession and Euro adoption.

with small number of observations. DEA measures how efficiently bank chooses its input and/or output levels to optimize an economic goal, usually cost minimization or profit maximization. Bauer et al. (1998) proposes the choice of cost minimization over profit maximization because it is usually specified efficiency concept in the literature.

We use two most frequently used DEA models, i.e. Constant Returns to Scale (CRS) proposed by Charnes, Cooper and Rhodes (1978) and Variable Returns to Scale (VRS) proposed by Banker, Charnes and Cooper (1984). CRS model is suitable when all banks are operating at an optimal scale. It allows estimation of the overall cost efficiency (CE) and its decomposition into technical efficiency (TE) and allocative efficiency (AE).

Bank is cost efficient if it minimizes the cost of producing observed outputs given the best-practice technology and input prices. Bank is technically efficient if it either minimizes its inputs given outputs or maximizes its outputs given inputs. AE is related to the ability of a bank to choose the optimum mix of inputs given their prices. Allocative inefficiency is usually caused by market distortions, whereas technical inefficiency (also called managerial inefficiency) is caused by poor management.

VRS model reflects the fact that production technology may exhibit increasing, constant, or decreasing return to scale because of factors such as imperfect competition, prudential requirements and financial constraints. It allows decomposition of TE into pure technical efficiency (PTE) and scale efficiency (SE). PTE measures a proportional reduction in input usage if inputs are not wasted, and reflects pure managerial performance to organize the inputs in the production process. SE measures proportional reduction in input usage if the bank can arrive at the optimum production level, and reflects the ability of the manager to decide on the bank size or scale of production.

Consistent with most recent studies on bank efficiency (Bonin, Hasan and Wachtel, 2005; Brissimis, Delis and Papanikolaou, 2008; Chronopoulos, Girardone and Nankervis, 2011), we use the intermediation approach for the choice of bank inputs and outputs. Such an approach focuses on the role of banks as financial intermediaries that collect deposits and convert them, using capital and labour, into loans and other earning assets. In addition to traditional on-balance sheet items, we include non-traditional fee-earning off-balance sheet items which represent on average 16.82% of total assets of the banks in our study. Isik and Hasan (2003) argue that off-balance sheet items often require similar information, monitoring, and costs, produce similar revenues, and have nearly the same perceived credit risk as loans.

Table 2

Average Values of Outputs, Inputs and Input Prices

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Average
Number of banks	6	6	11	12	13	12	13	12	12	11	11	10	10	9	
Outputs															
Loans	610.19	518.52	508.81	664.27	714.64	909.34	1,082.68	1,469.14	1,707.39	1,848.86	1,948.28	2,273.57	2,325.63	2,543.07	1,368.75
Other earning assets	1,120.97	1,729.89	1,090.29	1,031.00	1,145.54	1,160.46	1,193.12	1,394.53	1,727.87	1,245.07	1,240.20	1,194.95	1,219.25	1,293.16	1,259.36
Off-balance sheet items	66.69	85.43	117.53	222.87	378.43	436.92	479.12	777.23	721.02	675.28	702.70	739.79	717.99	748.78	511.65
Inputs															
Labour	2,468.67	2,286.50	1,304.09	1,422.50	1,367.69	1,432.83	1,353.15	1,542.17	1,606.08	1,645.00	1,616.00	1,832.00	1,840.10	1,925.22	1,623.03
Fixed assets	93.53	90.18	57.24	52.37	49.11	44.17	42.85	47.04	47.11	48.14	43.91	49.65	46.13	44.04	51.23
Borrowed funds	2,012.01	2,135.32	1,514.85	1,599.31	1,760.66	1,907.76	2,101.61	2,673.42	3,184.30	2,825.93	2,916.36	3,172.88	3,154.25	3,371.01	2,438.58
Input Prices															
Price of labour	0.0117	0.0130	0.0161	0.0159	0.0172	0.0192	0.0215	0.0213	0.0229	0.0213	0.0207	0.0206	0.0205	0.0209	0.0192
Foreign banks	0.0121	0.0130	0.0172	0.0161	0.0176	0.0195	0.0216	0.0212	0.0290	0.0208	0.0198	0.0193	0.0197	0.0205	0.0192
Domestic banks	0.0113	0.0131	0.0110	0.0135	0.0115	0.0165	0.0201	0.0219	0.0228	0.0232	0.0249	0.0235	0.0223	0.0216	0.0192
Price of capital	0.7817	0.9998	1.7240	1.9946	2.0024	2.1821	2.5270	2.7422	3.3929	2.5569	3.1966	2.5517	2.7855	3.1549	2.4144
Foreign banks	0.8814	1.0995	1.9665	2.0944	2.0350	2.2086	2.5593	2.4462	3.1669	2.3190	2.8881	1.8857	2.2143	2.2112	2.2584
Domestic banks	0.6819	0.5012	0.6326	0.8971	1.6120	1.8901	2.1389	4.2222	4.5234	3.6278	4.5850	4.1059	4.1184	5.0425	3.1136
Price of borrowed funds	0.0744	0.0535	0.0471	0.0327	0.0244	0.0179	0.0233	0.0255	0.0287	0.0174	0.0132	0.0161	0.0160	0.0138	0.0267
Foreign banks	0.0742	0.0513	0.0477	0.0331	0.0246	0.0187	0.0246	0.0271	0.0307	0.0184	0.0127	0.0133	0.0144	0.0109	0.0263
Domestic banks	0.0746	0.0649	0.0445	0.0281	0.0226	0.0088	0.0080	0.0174	0.0186	0.0129	0.0153	0.0227	0.0200	0.0196	0.0282

Notes: Table presents average annual values of outputs, inputs and input prices used in the DEA analysis. Loans, Off-balance sheet items, Other earning assets, Fixed assets and Borrowed funds are in EUR millions expressed in real 2005 terms. For input prices, average annual values are presented for all banks, foreign banks and domestic banks.

Source: Own compilation.

We define three outputs and three inputs. The outputs are loans, other earning assets, and off-balance sheet items. Loans include short-term and long-term loans to non-financial firms and individuals; off-balance sheet items include guarantees and warranties, commitments, foreign exchange and interest rate transactions, as well as other off-balance sheet activities; other earning assets include loans to special sectors, inter-bank funds sold, financial assets and investment securities, and other investments in associates. The inputs are labour, capital, and borrowed funds. Labour is the number of bank employees; capital is the book value of fixed assets; borrowed funds is the amount of deposit and non-deposit interest bearing funds (including inter-bank loans borrowed). We also define input prices. Price of labour is measured as the total expenditures on employees divided by the average number of employees; price of capital is measured as the total expenditure on fixed assets (i.e., overhead expenses less personnel expenses) divided by the book value of fixed assets; price of borrowed funds is measured as the total interest expenses divided by total borrowed funds.

Table 2 presents average values of outputs, inputs, and input prices for the banks in our sample. It should be noted that loans are more important bank output than other earning assets only since 2007. Also, average ratio between off--balance sheet items and total assets was 2.96% in 2000, and 19.45% in 2013, which indicates the change in the nature of banking business in Slovakia. On average, capital is the most expensive, and labour the least expensive bank input. Labour was the least expensive bank input until 2009 when, partly due to a decrease in key interest rate, borrowed funds became the least expensive. Isik and Hasan (2003) suggest that the capital is typically the most expensive and labour the least expensive bank input in developing countries. They find that foreign banks in Turkey pay higher prices of labour and capital, but lower price of borrowed funds than domestic banks. On the contrary, we find that foreign banks pay almost the same price of labour as domestic banks, but pay lower prices of capital (since 2007) and borrowed funds (since 2010) than domestic banks. This implies that the quality of human capital in domestic and foreign banks is similar, while foreign banks use better technology and spend less on non-productive fixed assets (e.g. buildings). However, this finding should be considered with caution because the sample is biased toward foreign banks, and includes only 27 observations for domestic banks.

2.2.2. Bank Efficiency Determinants

Potential determinants of bank efficiency are grouped into four categories. The first group examines the impact of the accession of Slovakia to the EU and the Euro zone on bank efficiency. It includes time dummy variable EUA which

takes the value of 1 for 2005 – 2013 and 0 otherwise, and accounts for the effects of the accession of Slovakia to the EU. We do not include 2004 in our after the accession subsample because Slovakia acceded to EU on 1 May 2004 and the efficiency measures were still considerably influenced by the bank performance in the first half of 2004. Time dummy variable EUR takes value of 1 for 2009 – 2013 and 0 otherwise, and accounts for the effects of the accession of Slovakia to the Euro zone. We assume that the effects of the accession of Slovakia to the EU and the Euro zone remain over time, and thus EUA and EUR take a value of 0 up to the year of the accession, and a value of 1 until the end of the sample period.

The second group of variables examines the impact of banking sector reforms on bank efficiency. Like Brissimis, Delis and Papanikolaou (2008) and Tochkov and Nenovsky (2011) we use variable BSR representing index of banking sector reform compiled by the European Bank for Reconstruction and Development. Index can range from 1 to 4+, where 1 denotes little progress beyond establishment of two-tier system, and 4+ means that banking sector has achieved standards and performance norms of advanced industrial economies. As an additional measure of banking sector reform and privatization, similar to Pasiouras, Tanna and Zopounidis (2009), and Delis and Papanikolaou (2009) we use variable FBS representing share of foreign banks in total equity of Slovak banking sector.

The third group of variables is included in the analysis to control for the potential impact of bank specific characteristics on bank efficiency. The natural logarithm of total assets (SIZE) is used to measure bank size, and the equity to total assets ratio (EAR) is used as a proxy for bank capital structure. To account for the differences in the banking business and market power we follow Isik and Hasan (2003) and Havrylchyk (2006) and use variable LAR calculated as the ratio between loans (approved to non-financial firms and individuals) and total assets. To take into account differences in ownership type, we follow Grigorian and Manole (2006) and Brissimis, Delis and Papanikolaou (2008) and include dummy variable OWN, which takes value of 1 if bank has at least 50% of foreign ownership, and 0 otherwise.

The fourth group of variables is included in the analysis to control for the potential impact of the changes in the macroeconomic environment, especially 2009 financial crisis which occurred simultaneously with the adoption of the Euro. These are Slovakia real GDP growth rate (GGR) and key interest rate (KIR).[3] KIR decreased from 2008 to 2013 and could have affected, through the impact on the input prices, some efficiency measures (primarily AE) and regression coefficients for EUR. Therefore, it is possible that regression coefficient for

[3] Key interest rate was managed by the National Bank of Slovakia until 2009, and has been managed by European Central Bank since.

EUR does not capture the impact of Euro adoption, but the impact of KIR decrease. By controlling for GGR and KIR we attempt to minimize the impact of confounding variables, especially on the regression coefficients for EUR.

In order to test the influence of explanatory variables on bank efficiency we use the following regression model:

$$\begin{aligned} Efficiency\,Measure_{it} &= \beta_0 + \beta_1 EUA_t + \beta_2 EUR_t + \beta_3 BSR_t + \beta_4 FBS_t + \\ &+ \beta_5 SIZE_{it} + \beta_6 EAR_{it} + \beta_7 LAR_{it} + \beta_8 OWN_{it} + \beta_9 GGR_t + \beta_{10} KIR_t + \varepsilon_{it} \end{aligned} \quad (1)$$

Efficiency measures are usually regressed against the explanatory variables by using the tobit regression, which is suitable when the dependent variables are either censored or corner solution outcomes, where efficiency measures belong to the second category. Given that the efficiency measures are continuous and limited to values between 0 and 1, the two-limit tobit regression with limits at 0 and 1 is often used. However, Hoff (2007) argues that the two-limit tobit regression is in essence mis-specified when applied to efficiency measures, given that these only take on the value 1 with positive probability, and not the opposite limiting value 0. He, nevertheless, concludes that tobit and OLS regressions may be sufficient for modelling efficiency measures against explanatory variables even though neither of these are well-defined. Unlike Hoff (2007), McDonald (2009) shows that tobit is an inappropriate estimation procedure in the second stage of efficiency analysis, and argues that the best that can be said is that tobit estimates are often similar to OLS estimates. He further argues that OLS is a consistent estimator, and, if White's heteroskedastic-consistent standard errors are calculated, analysis can be valid for a range of disturbance distribution assumptions.

Simar and Wilson (2007) argue that the DEA efficiency estimates are serially correlated and follow truncated distribution, so the standard approaches to inference, like tobit and OLS regression, are invalid. They provide evidence from Monte Carlo experiments that their seven-stage double-bootstrap procedure permits valid inference and improves statistical efficiency in the second-stage regression. However, Banker and Natarajan (2008) and McDonald (2009) argue that the Simar and Wilson bootstrap procedure is robust only under very restrictive assumptions, i.e. only if efficiency measures in the second-stage regression are unit-specific, truncated and normal random variables. Banker and Natarajan (2008) provide Monte Carlo simulation evidence supporting two-stage procedure with DEA in the first stage. They show that OLS and maximum likelihood estimation (MLE) in the second stage perform as good as the best alternative parametric methods in the estimation of the explanatory variables impact. Given the theoretical reasoning and empirical evidence giving support to OLS, and popularity of tobit regression, we will use these procedures to estimate model (1).

3. Results of the Analysis

3.1. Results of the Efficiency Estimation

We use a panel data of 148 bank-year observations to estimate efficiency measures, i.e. we conduct intertemporal analysis. Cullinane, Ji and Wang (2005) argue that each unit (bank) under study should be observed at more than a single point of time, because random shocks could contribute to variations in efficiency measures estimated on cross-sectional data. In addition, we apply intertemporal analysis to avoid possible self-identifier problem, which most often arises when there is a small number of observations relative to the number of inputs, outputs, and other constraints (Bauer et al., 1998).

Intertemporal analysis was applied in some previous studies on small samples (e.g. Ariff and Can, 2008; Wang et al., 2014); nevertheless, it should be noted that this approach assumes no technological change over the time, which can be problematic for industries undergoing significant technological changes (Hughes and Yaisawarng, 2004).

T a b l e 3

Average Values of Efficiency Measures

	Obs.	Cost efficiency	Allocative efficiency	Technical efficiency	Pure technical efficiency	Scale efficiency
2000	6	0.4775	0.5895	0.8042	0.8135	0.9882
2001	6	0.4887	0.5217	0.9373	0.9397	0.9975
2002	11	0.4292	0.4684	0.9085	0.9195	0.9886
2003	12	0.3822	0.4108	0.9278	0.9444	0.9828
2004	13	0.4269	0.4555	0.9218	0.9429	0.9778
2005	12	0.4233	0.4467	0.9380	0.9538	0.9837
2006	13	0.5022	0.5299	0.9377	0.9515	0.9858
2007	12	0.6202	0.6542	0.9408	0.9516	0.9888
2008	12	0.6429	0.6697	0.9497	0.9672	0.9822
2009	11	0.5875	0.6176	0.9491	0.9665	0.9819
2010	11	0.6356	0.6594	0.9628	0.9755	0.9869
2011	10	0.7384	0.7716	0.9533	0.9616	0.9910
2012	10	0.7666	0.7889	0.9691	0.9787	0.9904
2013	9	0.7813	0.8014	0.9700	0.9771	0.9928
2000 – 2013	148	0.5605	0.5924	0.9370	0.9502	0.9863

Source: Own compilation.

Table 3 reports the average values of the bank efficiency measures by year and for the whole period of study (2000 – 2013). After a decline in 2002 and 2003, CE recovers in 2004 and increases from 2005 to 2008. CE growth should be viewed in the context of the accession of Slovakia to the EU and key interest rate decrease, which resulted in reduced regulatory expenses, release of additional liquidity, increased banks' credit potential and reduced banks' interest rates. This is consistent with prior studies that find the progress of a country toward EU

membership, transition to a market economy, banking industry reforms, and more responsible bank risk-taking behaviour have a positive influence on bank efficiency and performance (Brissimis, Delis and Papanikolaou, 2008; Siranova and Cupic, 2015; Tochkov and Nenovsky, 2011). After initial negative shock to scale efficiency in 2002 lasting till 2004, banks became more scale efficient, meaning that the size of their operations became more optimal after the accession of Slovakia to the EU.

CE decline in 2009 is consistent with the trends in the global banking industry and macroeconomic environment characterized by low or negative economic growth, but could also be a result of higher operational and other costs after the adoption of the Euro. CE continues to grow from 2010 to 2013. This increase in efficiency may be attributed to decreasing input prices since 2009 as presented in Table 2.

Unprecedented drop in the key interest rate after 2007 (Table 1) has been transmitted into historically low price of borrowed funds. On top of that, trend of the price of labour increase was stopped in 2009 as the financial crisis has brought about stabilization of this input price around 0.021.

It should be noted that CE decline in 2002, 2003 and 2009 was mostly due to a decline in AE. Efficiency measures are higher in 2013 than in 2000, and the percentage increase is greatest for CE (63.62%) and AE (35.95%). Cost inefficiencies of Slovak banks are mostly result of high allocative inefficiencies approaching 0.5892 in 2003. TE and PTE are surprisingly high, but similar values were reported for banks operating in Bulgaria (Tochkov and Nenovsky, 2011), Turkey (Isik and Hasan, 2003) and Greece (Pasiouras, 2008).

3.2. Results of the Regression Analysis

Table 4 reports the results of five OLS and five tobit regressions based on model (1), where efficiency measures are the dependent variables. To eliminate possible problems regarding the standard errors, which affect inference and the significance of the regression results, we undertake a heteroskedasticity robust estimation using the White heteroskedasticity consistent standard errors method. OLS regression models are statistically significant ($p < 0.01$), and the amount of explained variance of efficiency measures ranges from 17.3% in case of SE to 36.4% in case of AE. The likelihood ratio (LR) test statistics are statistically significant ($p < 0.01$) and reject the null hypothesis that the parameters in the tobit regressions are jointly equal to zero. Disregarding some differences in the level of regression coefficients statistical significance, OLS and tobit regressions offer very similar results. We continue our discussions based on the results from the tobit regressions.

Table 4

Results of the OLS and Tobit Regression Analysis of Potential Efficiency Determinants in Slovak Banking Sector

	Cost efficiency		Allocative efficiency		Technical efficiency		Pure technical efficiency		Scale efficiency	
Regression method	OLS	Tobit	OLS	Tobit	OLS	Tobit	OLS	Tobit	OLS	Tobit
Intercept	–0.530	–0.548	–0.227	–0.244	0.429	0.258	0.513*	0.383	0.908***	0.859***
	(–0.685)	(–0.716)	(–0.296)	(–0.323)	(1.508)	(0.787)	(1.885)	(1.119)	(12.301)	(9.348)
Integration into EU										
EUA	0.111	0.108	0.101	0.098	0.034*	0.047**	0.033**	0.053**	0.001	0.005
	(1.390)	(1.339)	(1.261)	(1.216)	(1.875)	(2.154)	(2.000)	(2.128)	(0.171)	(0.535)
EUR	0.281***	0.289***	0.253***	0.261***	0.075**	0.110**	0.068*	0.099**	0.008	0.019
	(3.064)	(3.153)	(2.789)	(2.885)	(2.048)	(2.503)	(1.926)	(2.128)	(0.894)	(1.624)
Banking sector reforms										
BSR	0.113	0.122	0.069	0.078	0.064	0.091	0.059	0.086	0.005	0.012
	(0.587)	(0.628)	(0.359)	(0.401)	(1.047)	(1.294)	(1.044)	(1.161)	(0.224)	(0.522)
FBS	0.001	0.001	0.0001	0.0001	0.001	0.001	0.001	0.001	–0.0001	–0.0001
	(0.468)	(0.450)	(0.063)	(0.044)	(1.213)	(1.151)	(1.320)	(1.259)	(–0.446)	(–0.730)
Bank-specific variables										
SIZE	0.069***	0.069***	0.070***	0.070***	0.009	0.013*	0.005	0.008	0.004***	0.005***
	(4.098)	(4.095)	(4.071)	(4.075)	(1.540)	(1.938)	(0.916)	(1.044)	(2.773)	(2.925)
EAR	–1.224**	–1.227**	–1.589**	–1.593**	0.343*	0.484**	0.409**	0.639***	–0.068	–0.027
	(–1.991)	(–2.022)	(–2.476)	(–2.521)	(1.908)	(2.297)	(2.314)	(2.755)	(–1.250)	(–0.396)
LAR	–0.124	–0.131	–0.074	–0.079	–0.104***	–0.124***	–0.164***	–0.271***	0.061***	0.059***
	(–0.981)	(–1.038)	(–0.579)	(–0.640)	(–3.008)	(–2.853)	(–5.474)	(–5.124)	(4.746)	(3.760)
OWN	–0.045	–0.050	–0.074	–0.078	0.043**	0.051**	0.050***	0.072***	–0.007*	–0.006
	(–0.835)	(–0.898)	(–1.385)	(–1.447)	(2.281)	(2.473)	(2.770)	(3.036)	(–1.740)	(–1.209)
Control variable										
GGR	0.009	0.009	0.008	0.009	0.001	0.002	0.001	0.001	0.001	0.001
	(1.042)	(1.142)	(0.994)	(1.096)	(0.926)	(0.931)	(0.660)	(0.476)	(0.784)	(0.993)
KIR	0.026	0.026	0.021	0.021	0.011	0.017	0.007	0.011	0.003	0.005*
	(1.077)	(1.094)	(0.891)	(0.907)	(1.004)	(1.379)	(0.734)	(0.884)	(1.452)	(1.709)
F-statistic	8.838***		0.364***		6.487***		7.978***		4.071***	
Adjusted R^2	0.348		0.364		0.272		0.322		0.173	
LR-statistic		69.708***		73.210***		52.807***		59.881***		30.980***

Notes: Table presents results of the OLS and tobit regression analysis of potential efficiency determinants in Slovak banking sector over 2000 to 2013. Number of observations in each model is 148. Potential efficiency determinants are: EUA (time dummy variable which takes the value of 1 for the 2005 – 2013 period and 0 otherwise), EUR (time dummy variable which takes value of 1 for the 2009 – 2013 period and 0 otherwise), BSR (index of banking sector reform compiled by EBRD), FBS (share of foreign banks in total equity of Slovak banking sector), SIZE (natural logarithm of total assets), EAR (equity to total assets ratio), LAR (ratio between loans and total assets), OWN (dummy variable which takes value of 1 if bank has at least 50% of foreign ownership, and 0 otherwise), GGR (Slovakia real GDP growth rate) and KIR (key interest rate). In parentheses are t-statistics. Regression coefficients are statistically significant at 1% (***), 5% (**) and 10% (*). LR-statistic is likelihood ratio for ten degrees of freedom (regressors).

Source: Own compilation.

EUA is positively related to all efficiency measures but significantly only to TE and PTE ($p < 0.05$). These results differ from Tochkov and Nenovsky (2011) who find significant positive impact of EU accession on CE and AE, but not on TE. Our results reflect the fact that Slovak banks improved managerial practice after privatization by foreign investors and changes in banking legislation between 2002 and 2004. Slovakia also experienced expansion of the domestic credit to the private sector and strengthening of banking sector prudential supervision after the accession to the EU (EBRD, 2004). Specifically, domestic credit to private sector rose from 30.4% of GDP in 2004 to 35.1% in 2005 and to 44.7% in 2008 and, at the same time, domestic credit to households also rose from 8.6% of GDP in 2004 to 11.2% in 2005 and to 18.5% in 2008 (EBRD, 2009). Table 2 shows that the average value of loans in our sample increased by almost 140% from 2004 to 2008, while the total value of bank output increased by more than 85% in the same period. At the same time, usage of capital decreased, while the usage of labour and borrowed funds increased to a lesser degree – by 17% and 81%, respectively. These differences in the dynamics of output production and input usage can explain significantly greater TE and PTE of Slovak banks after the accession to the EU.

Although it could be expected that this result is partly due to the high real GDP growth rate and banking reforms, GGR, BSR and FBS have insignificant influence on all efficiency measures. Although empirical studies often find that indicators based on GDP has significant influence on cost efficiency (e.g. Grigorian and Manole, 2006; Yildirim and Philippatos, 2007), insignificant GDP coefficient was recorded in some previous studies (e.g. Fries and Taci, 2005). Insignificant influence of both banking sector reforms indicators (BSR and FBS) is unexpected, but was observed in some previous studies (e.g. Kosak, Zajc and Zoric, 2009). It was already noted that the major reforms and legislative changes that shaped the Slovak banking sector took place in relatively short period between 2000 and 2002, before the accession to the EU. After 2003, the structure and legislation of the banking sector did not undergo significant changes and share of foreign banks in the total banking sector equity remained relatively stable (between 91.1% and 94.6%). Therefore, it can be argued that Slovakia banking sector is in the advanced stage of development when the influence of macroeconomic factors and legislative changes is less important. Our results and argument are consistent with Fries and Taci (2005) who argue that only the initial stages of the banking sector reform lead to significant increase in cost efficiency.

The adoption of the Euro had positive and significant influence on all efficiency measures except SE. While the accession to the EU contributed mainly to improvement in managerial practices, Euro adoption has also led to a change in overall

market conditions and movement toward more optimal product mix of Slovak banks. Slovak banking sector was affected by the financial crisis and economic slowdown, as well as by a decrease in income and profit from foreign exchange transactions. However, banks not only succeeded in keeping their CE and AE on pre-crisis levels but significantly improved their efficiency. Table 3 shows that CE and AE declined in 2009, but increased in 2010 and reached maximum values in 2013. Given that KIR was found to have no significant influence on efficiency measures, except in the case of SE, it can be argued that efficiency decline in 2009 was not under strong influence of financial crisis and key interest rate decrease, but of the adoption of the Euro. Results from Table 4 further imply that the adoption of the Euro generally has positive impact on bank efficiency; nevertheless, it can have negative impact in the first years after the adoption. Table 2 shows that foreign banks were better prepared for Euro adoption and were able to use less expensive inputs. We may confirm our initial hypothesis that some negative effects of the adoption of the Euro (e.g. decrease in profits from foreign exchange transactions) have been compensated by the increase in cost efficiency.

SIZE is positively and significantly correlated with each efficiency measure, except PTE, which is in line with most prior studies on bank efficiency in transition economies (e.g. Yildrim and Philippatos, 2007; Chronopoulos, Girardone and Nankervis, 2011). Large banks are usually considered to have more professional management and to be more cost conscious (e.g. Isik and Hassan 2003). Their size allows them to exploit economies of scale and they have easier access to international financial markets (Brissimis, Delis and Papanikolaou, 2008). Positive impact of SIZE on SE implies that larger banks are on average closer to the optimal production scale. More than a third (36.49%) of large banks (banks with total assets larger than the total assets of median bank) operates at constant return to scale, i.e. have no scale inefficiencies. Only 25.68% of small banks and 55.41% of large banks operate at decreasing return to scale, while 56.76% of small banks and 8.11% of large banks operate at increasing return to scale. This result is consistent with previous studies reporting that scale inefficiencies among larger banks often appear due to decreasing return to scale, and among smaller banks due to increasing return to scale (Seiford and Zhu, 1999; Luo, 2003). It implies that majority of small banks should increase (e.g., through mergers), while majority of large banks should decrease their production capacity to increase their scale efficiency.

EAR is significantly and negatively correlated with CE and AE, implying that stricter capital adequacy norms introduced under the Basel III accord to promote financial systems stability and decrease banking risks, negatively influence general market conditions, leading to a change in optimal bank product mix. At the same time, EAR is significantly and positively correlated with TE and PTE plausibly

due to lower bankruptcy and agency costs. According to Grigorian and Manole (2006), managers of banks with limited capital tend to make riskier decisions and pursue their personal goals instead of those of the shareholders. Moreover, owners of banks with limited capital have less incentive to monitor bank efficiency.

Our analysis shows that LAR has significantly negative influence on TE and PTE. This finding implies that banks with higher LAR are less risk averse and have higher operational costs than banks that concentrate more on investment securities (government bonds, mortgage backed securities) or interbank lending. It is also possible that less efficient banks tend to grant more risky loans in order to increase their profitability. Significant and positive relationship between LAR and SE implies that banks with higher LAR have more potential for reduction in input usage.

Consistent with most prior empirical studies (e.g., Isik and Hasan, 2003; Jemric and Vujcic, 2002; Tochkov and Nenovsky, 2011), our results indicate that foreign banks are more TE than domestic banks, suggesting that foreign banks have more efficient management structure. The superior efficiency of foreign banks in transition economies depends on their ability to exploit better risk management and operational techniques. It also depends on their ability to choose the optimum mix of inputs given their prices. However, foreign banks were not very successful in this regard given the negative, though insignificant, regression coefficients for AE.

To conclude, our study suggests that the accession to the EU have overall positive impact on Slovak banking sector efficiency, which confirms findings of Stavarek and Sulganova (2009), and Siranova and Cupic (2015); as argued in Boda and Zimkova (2014), this finding is statistically significant even after controlling for overall changes in macroeconomic conditions. As reported in Vincova (2006) and Kocisova (2008), decrease in the average efficiency during the pre-accession period might partially explain the improvement in the banking sector efficiency after the accession to the EU. The adoption of the Euro led to a general improvement in cost efficiency in the longer horizon, mostly because this structural change forced Slovak banks to operate at higher efficiency levels in order to compensate for decrease in profit from some banking activities, higher regulatory costs and increased international competition.

3.3. Tests of Results for Robustness

Following Bauer et al. (1998) we calculate the Spearman rank correlation between the efficiency measures and the following traditional measures: the ratio of earnings before taxes and total assets (ROA), the ratio of total assets to number of employees (TAL), the ratio of total cost (sum of interest expenses and administrative expenses) to total assets (TCTA), and the ratio of total costs to interest income (TCII). The correlation coefficients are expected to be positive

for the first two, and negative for the latter two traditional measures. The correlation coefficients should not be expected to be close to 1, because traditional measures are not affected only by efficiency measures, but also by other exogenous variables. Statistically significant and relatively high Spearman rank correlations presented in Table 5 imply that the efficiency measures are generally consistent with the traditional bank performance measures. Insignificant correlations are reported only in the case of SE.

T a b l e 5

Spearman Rank Correlation Coefficients between Efficiency Measures and Traditional Bank Performance Measures

	Cost efficiency	Allocative efficiency	Technical efficiency	Pure technical efficiency	Scale efficiency
ROA	0.181**	0.147*	0.390***	0.390***	0.118
TAL	0.480***	0.454***	0.313***	0.323***	0.096
TCTA	–0.512***	–0.471***	–0.426***	–0.422***	–0.102
TCII	–0.395***	–0.393***	–0.233***	–0.163**	–0.456***

Notes: Table presents results of the Spearman rank correlations between efficiency measures calculated in the paper and traditional bank performance measures. Traditional bank performance measures are: ROA (ratio of earnings before taxes and total assets), TAL (ratio of total assets to number of employees), TCTA (ratio of total cost to total assets) and TCII (ratio of total costs to interest income). Number of observations is 148. Statistically significant at 1% (***), 5% (**) and 10% (*).

Source: Own compilation.

Following Cullinane, Ji and Wang (2005), we calculate the Spearman rank correlation between efficiency measures estimated over 2000 – 2013 (148 observations) and efficiency measures estimated for the following three time periods: before the accession of Slovakia to the EU (2000 – 2004, 48 observations), after the accession of Slovakia to the EU (2005 – 2008, 49 observations), and after the adoption of the Euro (2009 – 2013, 51 observations). The later efficiency measures are used to reduce possible impact of technological progress on efficiency measures; it is reasonable to assume that different banks are more likely to use the same or similar technology within shorter time periods. The rank correlations between each pair of efficiency measures are significant at 1% and are approaching 0.794 for CE and TE. The lowest rank correlation is for SE (0.578). Significant and high positive value of rank correlations indicates that the efficiency rank of a bank in the sample is independent of the DEA model specification.

As a further robustness check, we re-estimate model (1) using the Papke and Wooldridge (1996) quasi-likelihood estimation method which involves maximizing a Bernoulli log-likelihood function and generating a robust variance matrix of coefficient estimates. Hoff (2007) and McDonald (2009) argue that Papke and Wooldridge method and OLS perform well and produce similar inferences, though the former is more complex. The results of the quasi-likelihood estimation are in almost every aspect consistent with the results of the OLS regression (Table 6).

Table 6

Results of the PW Quasi-likelihood and Fixed Effect Estimation of Potential Efficiency Determinants in Slovak Banking Sector

	Cost efficiency		Allocative efficiency		Technical efficiency		Pure technical efficiency		Scale efficiency	
Regression method	PW	FE	PW	FE	PW	FE	PW	FE	PW	FE
Intercept	–4.555	–2.464***	–3.259	–2.274***	–4.102	0.551***	–3.892	0.725***	–0.007	0.925***
	(–1.360)	(–8.982)	(–0.972)	(–7.352)	(–1.318)	(3.269)	(–1.076)	(3.284)	(–0.001)	(19.906)
Integration into EU										
EUA	0.459	0.044	0.415	0.041	0.484*	0.019**	0.570*	0.015	0.058	0.009***
	(1.329)	(0.953)	(1.193)	(1.271)	(1.698)	(2.319)	(1.648)	(1.641)	(0.114)	(3.511)
EUR	1.227***	0.196***	1.140***	0.151***	1.247**	0.045**	1.330**	0.026	0.567	0.012**
	(3.000)	(4.109)	(2.735)	(3.909)	(2.397)	(2.366)	(2.168)	(1.295)	(0.844)	(2.357)
Banking sector reforms										
BSR	0.520	0.066	0.327	0.006	0.808	0.093***	0.963	0.066	0.414	0.012*
	(0.627)	(0.883)	(0.391)	(0.090)	(1.134)	(3.076)	(1.156)	(1.619)	(0.325)	(1.739)
FBS	0.003	–0.001	0.0002	–0.002**	0.009	0.000	0.011	0.000	–0.009	0.000
	(0.425)	(–1.088)	(0.040)	(–2.007)	(0.895)	(0.585)	(0.898)	(1.055)	(–0.739)	(1.059)
Bank-specific variables										
SIZE	0.301***	0.342***	0.308***	0.365***	0.197**	–0.011	0.175	–0.012	0.181**	–0.005
	(3.932)	(9.696)	(3.829)	(10.928)	(2.011)	(–0.623)	(1.399)	(–0.900)	(2.077)	(–1.299)
EAR	–5.378*	–0.827***	–6.982**	–0.899***	5.968**	–0.068	8.045**	–0.040	–3.927	0.081*
	(–1.902)	(–3.321)	(–2.277)	(–3.521)	(2.023)	(–0.686)	(2.182)	(–0.445)	(–0.997)	(–1.929)
LAR	–0.502	0.284**	–0.296	0.321***	–1.378**	0.087**	–2.772***	–0.010	3.651***	0.036***
	(–0.896)	(2.120)	(–0.524)	(2.862)	(–2.542)	(2.184)	(–3.805)	(–0.273)	(5.481)	(4.260)
OWN	–0.204	0.021	–0.038	–0.011	0.615***	0.004	0.811***	0.015	–0.402	–0.008*
	(–0.846)	(0.737)	(–1.364)	(–0.564)	(2.815)	(0.285)	(3.099)	(1.452)	(–1.499)	(–1.831)
Control variable										
GGR	0.038	0.005*	0.038	0.004	0.031	0.001**	0.019	0.000	0.042	0.000
	(1.022)	(1.661)	(0.977)	(1.523)	(0.857)	(2.099)	(0.656)	(0.106)	(0.809)	(1.507)
KIR	0.113	0.028***	0.093	0.022***	0.141	0.010**	0.115	0.005	0.209	0.005***
	(0.277)	(2.811)	(0.895)	(2.731)	(1.048)	(2.029)	(0.721)	(0.820)	(1.136)	(3.525)
F-statistic		30.641***		37.009***		17.669***		14.075***		3.940***
Adjusted R^2		0.829		0.855		0.731		0.681		0.324
Quasi-LR statistic	82.893***		87.777***		62.581***		68.734***		36.942***	

Notes: Table presents results of the Papke and Wooldridge (PW) quasi-likelihood and fixed effect (FE) estimation of potential efficiency determinants in Slovak banking sector over 2000 to 2013. Number of observations in each model is 148. Potential efficiency determinants are: EUA (time dummy variable which takes the value of 1 for the 2005 – 2013 period and 0 otherwise), EUR (time dummy variable which takes value of 1 for the 2009 – 2013 period and 0 otherwise), BSR (index of banking sector reform compiled by EBRD), FBS (share of foreign banks in total equity of Slovak banking sector), SIZE (natural logarithm of total assets), EAR (equity to total assets ratio), LAR (ratio between loans and total assets), OWN (dummy variable which takes value of 1 if bank has at least 50% of foreign ownership, and 0 otherwise), GGR (Slovakia real GDP growth rate) and KIR (key interest rate). In parentheses are t-statistics. Regression coefficients are statistically significant at 1% (***), 5% (**) and 10% (*).

Source: Own compilation.

We also estimate cross-section fixed effect panel model with robust standard errors using GLS weights with cross-section effects. The results of the model are similar to the results in Table 4 when it comes to CE, AE and TE. Some differences are present for PTE and SE given that the accession of Slovakia to the EU and the adoption of the Euro do not have significant influence on the PTE, but have significant influence on the SE. We conclude that our results are generally robust to the estimation procedure.

Conclusion

We investigate the possible influence of the accession of Slovakia to the EU and the Euro zone on the efficiency of Slovak banks. To estimate efficiency measures we use data envelopment analysis and to investigate possible efficiency determinants, we use ordinary least squares and tobit regression models. We conduct the analysis on a sample of 148 observations, covering almost 77% of the Slovak banking sector assets, over a period of 14 years – from 2000 to 2013. Cost efficiency of Slovak banks increases in the major part of this period, except between 2002 and 2004, possibly due to the efforts to complete banking sector reforms and align banking legislation with that of EU, and in 2009, because of the trends in the global banking industry and macroeconomic environment. The average cost efficiency of Slovak banks during the period is relatively low – around 0.56, but with a significant upward trend.

Our results indicate that the accession of Slovakia to the EU positively affected technical efficiency, implying that Slovak banks improved managerial practice after privatization by foreign investors and changes in banking legislation between 2002 and 2004. This result could have been due to the fact that Slovakia experienced expansion of the domestic credit to the private sector and strengthening of banking sector prudential supervision after the accession to EU. The adoption of the Euro had positive influence on all efficiency measures except scale efficiency, which means that the Euro adoption led to a change in managerial practice of Slovak banks, but also to a change in the overall market conditions and movement toward more optimal product mix of Slovak banks. Our analysis did not find factors reflecting macroeconomic environment and banking reforms to have significant influence on the efficiency measures. Therefore, we argue that Slovakia banking sector is in the advanced stage of development when the influence of macroeconomic factors and legislative changes are of less importance. With the overall cost efficiency score approaching 0.78 in 2013, Slovak banking sector became comparable to the average efficiency of US banks (Berger and Humphrey, 1997) and slightly below score for 8 most advanced world economies (Pastor, Perez and Quesada, 1997).

We also find that large banks are more efficient than small banks, which is in line with the results of many previous studies and argument that large banks have more professional management, easier access to international financial markets, and size which allows them to exploit economies of scale. We find that majority of small banks should increase (e.g., through mergers), while majority of large banks should decrease production capacity to increase their scale efficiency. Bank capitalization has negative impact on the cost and allocative efficiency, which implies that stricter capital adequacy norms introduced under the Basel III accord negatively influence general market conditions and input prices. At the same time, we find that well capitalized banks are more technically efficient, possibly because they offer more implicit deposit insurance allowing them to attract more deposits with lower interest rate. Our results show that banks with higher loan to asset ratio are less technically, but more scale efficient, implying that they have higher operational costs, but are closer to the optimal production scale. Finally, we find that foreign banks are more technically efficient than domestic banks suggesting that foreign banks have better management structure.

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