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BANKING SECTOR EFFICIENCY IN NEW EU MEMBER STATES: A SURVEY

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ABSTRACT

This paper reviews cross-country studies on banking efficiency in new EU member states that apply frontier techniques. We examine the relative rankings in efficiency of individual countries across the studies and the effect of ownership structure on bank performance. Different techniques and efficiency concepts yield different results for efficiency rankings, but some common patterns are discernible. The Czech banking system ranks among the highest intechnical and profit efficiency but lowest in cost efficiency. Banks in Slovenia and Estonia rankamong the most cost efficient. The evidence on the relationship between foreign ownership and cost efficiency is not conclusive.

POVZETEK

Pričujoči prispevek analizira literaturo na temo učinkovitosti bank v novih državah članicah EU. Zaobjema študije, ki analizirajo in primerjajo učinkovitost bank iz različnih držav na podlagi tehnike izračuna meje učinkovitosti. Prispevek primerja razvrstitve držav po učinkovitosti med različnimi študijami in analizira učinek strukture lastništva na uspešnost bank. Ugotavljamo, da razlike v metodologiji in v definiciji koncepta učinkovitosti pripeljejo do razlik v razvrščanju držav, kljub temu pa je možno izpostaviti nekaj skupnih točk. Češki bančni sistem je največkrat razvrščen med najbolj učinkovite po tehnološki in dobičkovni učinkovitosti, med najnižje pa po stroškovni učinkovitosti. Banke v Sloveniji in Estoniji se kažejo kot najbolj stroškovno učinkovite. Analiza relacije med tujim lastništvom in stroškovno učinkovitostjo ne da jasnih zaključkov..

JEL classifications: C30, G21, P20
Keywords: banking, technical efficiency, cost efficiency, profit efficiency, foreign ownership, new EU member states

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I. Introduction

A sound and efficient financial sector is essential for macroeconomic stability and sustainable economic growth. All central and east European countries implemented far-reaching banking sector reform and restructuring programs since the beginning of transition to facilitate their transformation to market economies and for fulfilling the criteria for European Union (EU) accession. Properly functioning banking sectors had to be created from scratch, which meant that the agenda for reforms were broadly similar across these countries. Key common reforms included the establishment of two-tier banking systems, management of bad loans inherited from the past regime, restructuring and privatization of state-owned banks, entry of foreign banks, introduction of international accounting standards, and establishment of a new supervision regulatory framework. Since 1998, attention was directed toward harmonizing banking regulations with those prevailing in the European Union. However, the pace and degree of implementation of reforms differed from country to country and were dependent on a number of exogenous and endogenous factors. Thus the environments in which banks operated varied over time and across countries.

Numerous studies have examined the levels of efficiency of banking systems in transition countries both in terms of cross-sectional differences and time dynamics. They address policy as well as research methodology issues. An important objective is to assess the relative role of differential institutional and policy settings and bank characteristics. The studies also seek to shed light on how well the banking systems were poised to compete and survive in an integrated European financial landscape.

The focus of research on bank performance has shifted from the traditional approach of analyzing financial ratios to estimating efficiency through frontier techniques. Common criticisms of the financial ratios approach are that financial ratios are single factor measures of performance, and that they may be misleading indictors of efficiency because they do not control for product mix or input prices.[1] In contrast, frontier efficiency techniques have the advantage of transforming several input and output dimensions and multiple qualitative characteristics into single index, thus permitting ranking of decision-making units (Berger *et al*, 1993).

The frontier techniques estimate an "efficient frontier" comprising of the best-practice firms and measure inefficiency as deviation from the frontier. The methods are distinguished on the basis of the procedures applied to estimate the frontier and the assumptions made, for example, in relation to the distribution of the inefficiency term. There is no consensus among researchers on the efficiency concept, functional form, and estimation technique that yield the most accurate efficiency measure. The choice of efficiency concept in banking efficiency studies have varied between technical efficiency, cost efficiency, and profit efficiency. In cross-country studies, a common frontier is estimated using a pooled dataset, and the frontier is made up of the best-performing banks from all the countries in the sample. From this, the average (in)efficiency of the banking system of each country is computed and reported.

Policy issues and research issues that rely on cross-country evidence may be more convincingly addressed if the findings are robust across studies and across frontier techniques. It has been argued that efficiency levels estimated in cross-country studies are not comparable because of differences in country samples, estimation method, and measurement of variables (Berger and Humphrey, 1997; Berger, 2007). But, there has been virtually no inquiry into how country

efficiency rankings are affected by these differences. If there is consistency between the empirical studies in the relative efficiency rankings of countries, findings of cross-country studies would be very much applicable in policy making. For transition countries, there has been no systematic comparison of country efficiency rankings across the various studies and between different techniques. Instead, most empirical studies highlight the differences in the estimated efficiency levels from those obtained in other studies. In this paper we review the results of various cross-country frontier efficiency studies involving transition countries and determine if there is consistency in the rankings of individual countries. We particularly focus on the relative rankings of banking systems of the eight countries in central and eastern Europe that joined the European Union in the first wave of accession in May 2004.[2] We do not attempt to provide comprehensive explanations for the variations in findings, as this would require performing controlled experiments applying the various methodologies and variables to a common data set—a task that is beyond the scope of this paper.

This paper also reviews the findings on another aspect of bank efficiency research that has received considerable attention; namely, the effect of ownership on efficiency. In almost all new EU member states, there was a push from the very early stages of transition to privatize banks, including to foreign owners, with the goal of improving efficiency. Lower cost efficiency is often attributed to widespread state ownership in the banking sector (OECD, 2009)

In Section II, we summarize the conceptual, methodological and measurement issues of frontier efficiency studies, mainly to put the survey findings in the proper context. In Section III, we examine the cross-country results on country efficiency rankings. Section IV reviews the findings on the relationship between ownership and bank efficiency, and Section V concludes.

II. Conceptual, methodological and measurement issues in frontier efficiency studies

These issues are well documented in the literature. Still, we sketch them out, drawing heavily on Berger (2007) and Berger and Mester (1997), to put the findings in the literature in the appropriate context.

Two major techniques are frequently used in the literature to generate the efficiency frontier: non-parametric and parametric. The non-parametric techniques typically focus on technological optimization, whereas parametric techniques involve economic optimization.

One of the most often used non-parametric techniques is the Data Envelope Analysis (DEA) approach to measure technical (in)efficiency — i.e., whether banks are using too many inputs or producing too few outputs. This technique uses linear programming methods to construct the efficient frontier from the observed input-output ratios as a piece-wise linear combination of the most efficient units. A major disadvantage of the DEA approach is that it does not allow for random fluctuations, and considers all deviations from the estimated frontier to be inefficiency. The derived efficiency scores are, therefore, very sensitive to outliers and shocks. An additional problem is that, as this approach ignores prices, it cannot account for allocative efficiency or compare firms that tend to specialize in different inputs and outputs.[3]

In parametric techniques, the composite error term is separated into inefficiency and random error components. The estimation methods differ in the way the inefficiency term is disentangled from the composite error term. The two most frequently used parametric techniques are the Stochastic Frontier Approach (SFA) and the Distribution Free Approach (DFA). In the SFA, the random error term is assumed to be two-sided (usually normally distributed), and the inefficiency

term is assumed to be one-sided (usually half-normally distributed). A main shortcoming of the SFA is deemed to be the necessity of prior distributional assumptions regarding the inefficiency component. In contrast, the DFA assumes that random error averages out to zero over time, while core inefficiency is stable over time. Main criticisms of the DFA approach are that the assumption of time invariant efficiency level is likely to become less tenable if the sample time span is long, and that in samples with relatively small time horizons the random error might not average out to zero, thereby causing bias to the inefficiency component. Additionally, the DFA approach does not allow an assessment of the evolution of efficiency over time, which is of interest in the case of transition countries. Parametric techniques are capable of incorporating technical, input allocative, and output efficiencies.

The banking literature typically employs three distinct economic efficiency concepts: cost, standard profit, and alternative profit efficiencies.

- Cost efficiency measures the performance of a banking firm relative to the best-practice banks that produce the same output bundle under the same exogenous conditions. It is derived from a cost function in which total costs depend on a vector of outputs, a vector of input prices, other bank parameters, random error and inefficiency. The inefficiency factor incorporates both allocative inefficiencies and technical inefficiencies.

- Standard profit efficiency measures how close a bank is to producing the maximum possible profit given a particular level of input prices and output prices, and other relevant variables. In addition to inefficiencies on the input side, profit efficiency also accounts for output inefficiencies by incorporating the revenue effects of producing

incorrect levels or mixes of outputs. Hence, the profit efficiency concept is considered superior to cost efficiency for evaluating the overall performance of the bank.

- Alternative profit efficiency, unlike standard profit efficiency, measures how close a bank comes to earning maximum profits given its output levels rather than its output prices. The alternative profit function employs the same dependent variable as the standard profit function and the same exogenous variables as the cost function. The alternative profit function is considered more appropriate under situations where the banking sector is not competitive and banks have some power over prices they charge, if there are unmeasured differences in the quality of banking services, or when output prices are not accurately measured.

Estimation of the efficiency frontier requires making a prior assumption about the functional form of the cost and profit functions. A majority of studies employ the multiproduct translog functional form, which is a local approximation method. However, an increasing number of studies have employed the Fourier-flexible functional form, which augments the translog function by including Fourier trigonometric terms. Advantages of the Fourier-flexible functional form are that it is a global approximation method, and is able to represent the relationship among variables when the true functional form is unknown.

Three competing approaches are used in the literature to define bank inputs and outputs. An important differentiation between them involves the treatment of deposits, which have both input and output characteristics. The intermediation approach views banks as creating output (defined as loans and investments) using their liabilities, labor, and capital. It considers deposits as inputs, and thus treats interest expenses as a component of total costs, together with labor and capital

expenses. The production approach views deposits as output. In the modified production approach, proposed by Berger and Humphrey (1992), deposits are specified as both inputs and outputs of banks in the cost/profit functions.

The ultimate goal of efficiency research is to identify the effects of managements' ability from the effects of the operational environment on banks' operation. The literature has tackled this issue in two alternative ways. Many studies follow a two-stage procedure: (in)efficiency scores of individual banks are estimated in the first stage using one of the frontier techniques, and then the estimated efficiency is regressed in the second step on a set of potential correlates of efficiency such as bank, market, regulatory, and geographic characteristics. The econometrics aspects of this procedure have shortcomings. Bias arises because although the dependent variable in the second stage regression is estimated efficiency, the standard error of this estimate is not accounted for in the regression. To avoid the anomalies of the two-stage procedure, some studies follow a one-step procedure in which environmental factors are incorporated in the estimation of the common stochastic frontier.

Hughes and Mester (1993) and Mester (1996) have emphasized the importance of taking into account differences in managers' risk preference when estimating the efficiency frontier. More risk-averse managers are likely to keep a higher level of equity than the cost-minimizing level. Thus, if equity or a similar variable measuring risk preference is omitted as a variable in the estimation of the efficiency frontier, risk-averse banks who are behaving optimally may appear less efficient than risk-neutral or risk-taking banks.

Of course, the estimated efficiencies in the one-step and two-step procedures are likely to be different. Berger (2007) has argued that despite any controls for environmental differences or

methodological breakthroughs, one cannot eliminate the possibility that measured differences in efficiency levels are due to unmeasured environmental variations rather than actual efficiency differences.

III. Empirical findings on country efficiency rankings by measurement method

We review seventeen studies on frontier efficiency for transition countries that include the first wave of eight new European Union member states. From each of the studies we extracted the mean efficiency scores of the selected eight countries and calculated relative rankings within the selected group, and compared the rankings across studies in two different ways: estimating the rank correlation between the studies, and tallying the frequency distribution of the top and bottom efficiency rankings. The latter method is particularly useful in finding out if particular countries figured consistently in the top or the bottom rankings.

As table 1 shows, the parametric technique dominates the studies. Only four studies followed the data envelope analysis approach, and thirteen studies used the parametric technique. Twelve studies applied the stochastic frontier approach method and four studies reported results of the distribution free approach method, with three overlaps. All the parametric studies estimated cost efficiency and only five of them examined profit efficiency as well.

A. Technical efficiency: Data Envelope Analysis

The country coverage and sample period for the four DEA studies vary. Grigorian and Manole (2006) include 17 transition countries in their sample, while Kenjegalieva *et al* (2009) look at the first wave of 8-NMS. Tomova (2005) and Stavárek (2006) include selected EU countries together with transition countries. Tomova covers almost the entire decade of transition,

Grigorian and Manole focus on the mid-transition period (pre-negotiation period for EU accession), while Stavárek and Kenjegalieva *et al* concentrate on the three to five year period prior to euro adoption.

All four studies apply a output-oriented two-stage model, in which the efficiency results from DEA are regressed on environmental variables in the second stage. All estimate a variant of the intermediation approach,[4] where primary function of banks is transformation of deposits to credits and loans. Still, the measure of the output and input variables differ somewhat. Tomova (2005), Grigorian and Manole (2006), and Kenjegalieva *et al* (2009) try to account for risk and lending quality directly in the assessment of bank efficiency. Kenjegalieva *et al* do this by including loan loss provisions as an input variable, whereas the other two studies do this by measuring loans in the output vector in net terms after deducting problem loans and loan loss provisions.

The DEA studies estimate common frontiers for the countries in the sample for each year and present average efficiency scores by country and over time. To compare the results, we calculate the mean efficiency and efficiency rankings for the overlapping periods. Thus, for Grigorian and Manole and for Tomova we look at the findings for 1995-98. For Stavárek and Kenjegalieva *et al* we look at the findings for 2001-03. We also compare Manova and Kenjegalieva *et al*'s findings for 1999-2002. Thus, we have six sets of results for different common time periods.

As table 2 shows, in all four studies in all periods the Czech banking sector ranks among the most technically efficient. Three of the four studies also rank Lithuania as having the least efficient banks. For the other countries, the results are diverse and time variant. In the final

stages of the transition period prior to euro adoption, Hungary ranks in the top three most efficient banks (in Tomova, Stavárek, and Kenjegalieva *et al*), with Estonia following closely behind. Latvia's efficiency performance appears to have deteriorated between the mid-transition period and the pre-euro-adoption period. Tomova as well as Grigorian and Manole rank Latvian banks among the top three most efficient banking systems during 1995−98, but both Stavárek and Kenjegalieva *et al* rank Latvia among the bottom two during 1999−2002. The slippage in efficiency ranking of Latvia is also corroborated in Tomova's study.

A comparison of the studies by Tomova and by Grigorian and Manole for 1995-98 shows an important contrast. While the relative high ranking for the Czech Republic is common to both studies, the relative ranking of Slovenia is on different ends of the scale. In Grigorian and Manole's study, Slovenia has the highest efficiency, but in Tomova's study it is among the lowest. A relatively low ranking of the Slovene banking system is also observed in the study by Kenjegalieva *et al* (Stavárek did not include Slovenia in his sample). One reason for this difference in finding could be the specification of inputs and outputs. Grigorian and Manole include deposits as an output variable, while Tomova and Kenjegalieva *et al* include deposits as an input variable. Also, we cannot rule out the possibility that differences in sample coverage may have affected the results.

B. Cost efficiency: Stochastic Frontier Approach

The time and country coverage of the twelve studies that have estimated cost efficiency using the stochastic frontier approach differs significantly. The time spans covered vary from five to thirteen years and involve samples from 1993-2007. Most studies examine the mid- and late-transition periods in the second half of the 1990s and early 2000s, while two studies (Bems and

Sorsa, 2008, and Assaf *et al*, 2009) include observations on more recent years since entering the European Union in 2004. Although many of the studies include time effects in the estimation of the cost efficiency frontier, only four (Hollo and Nagy, 2006; Kasman and Yildirim, 2006; Rossi *et al* 2004; and Weill, 2007) report efficiency scores by year. Other studies report average efficiency scores by country for the entire sample period. Thus, cross-country comparisons of efficiency levels cannot be standardized for common time intervals.

As for country coverage, three studies (Kasman and Yildirim, 2006; Košak and Zajc 2006a; and Rossi *et al*, 2004) focus exclusively on the eight central European countries that joined the European Union in the first wave in 2004. The rest additionally include other new EU members, other transition countries, or selective old EU member states. Researchers have included old EU member states in the common efficiency frontier with the aim of estimating the gap in banking efficiency and its convergence between eastern and western European economies.

Studies that have estimated the cost efficiency frontier with and without controlling for country-specific macroeconomic and banking environment factors are almost equally divided. Fries and Taci (2005), Hollo and Nagy (2006), and Weill (2007) report efficiency scores generated by both the controlled and uncontrolled models. All these three studies found that when country-specific factors are included in the estimation of the efficiency frontier, the variation in average bank efficiency across countries diminishes and efficiency scores are higher. However, an interesting feature is that relative efficiency rankings of countries do not change much between the controlled and the uncontrolled models.[5] This suggests that a comparison of country efficiency rankings between studies that include country-specific factors and those that do not is not likely to be problematic.

The country efficiency rankings obtained in the various studies are shown in table 3. These rankings are weakly correlated to one another. As table 4 shows, of the 66 possible bilateral comparisons, the rank-order correlations between only nine studies are positive and statistically significant, and in one case it is negative and statistically significant. This weak correlation could be owing to differences in samples (in terms of both size and time span) and definitions of the input and output variables. Though tempting, one should not necessarily conclude from this that the results obtained from different studies do not show any consistent pattern regarding countries with the most or least efficient banking systems. To shed light on this issue, we examine a frequency distribution of how often the efficiency score of a country was ranked among the top three and bottom two.

Two results stand out prominently in the frequency distribution of country rankings on cost efficiency (see Table 5). First, nine out of the twelve studies found the banking system of the Czech Republic to be the least cost efficient. This is in sharp contrast to the findings of DEA studies that the Czech banking sector was one of the most technically efficient. This suggests that Czech banks were particularly deficient in allocative efficiency (that is, they were misresponding to relative prices in choosing inputs and outputs). Rossi *et al* (2004) attribute the weak performance of Czech banks to problems with the quality of banks' portfolios. They note that the Czech banks recorded comparatively high loan loss reserves during much of 1995–2002.

The second consistent finding is that a majority of the studies found banks in Slovenia and Estonia to be among the top three most efficient in the region. The banking systems of Poland and Hungary were also ranked in the top three by one half of the studies. For the other countries in the region, there is no clear consensus. Rossi *et al* (2005), Borovička (2007), and

Mamatzakis *et al* (2008) draw particular attention to the finding on the relative high cost efficiency of Slovene banks despite the dominance of state-owned banks and comparatively low market share of foreign-owned institutions. They explain Slovenia's good performance by the significant institutional reforms in banking regulation and supervision, a relatively high branch density, and relatively restrained credit growth.[6] Rossi *et al* (2005) attribute Poland's performance in part to its relatively low levels of loan loss reserves, while Yildirim and Philippatos (2007) highlight the relatively well-developed nature of the Polish banking industry, in particular to the increased foreign participation with more efficient operating techniques. However, Yildirim and Philippatos do not comment on their finding on Slovenia's high efficiency despite the relatively low share of foreign-owned banks.

Studies that include time effects in the estimation of the cost efficiency frontier generally found a positive and significant increase of efficiency over time for the overall sample of banks. However, the evolution of bank efficiency is not homogenous across countries and the increase in efficiency for the overall sample is mostly driven by a few countries.

Weill (2007) observed large improvements in cost efficiency of Czech banks during 1996–2000. Kasman and Yildirim (2006) and Rossi *et al* (2005) too found significant improvements from 2000 onward. However, Hollo and Nagy (2006) found that the cost efficiency scores of Czech banks had remained stable during 1999-2003. In Rossi *et al*'s study the relative ranking of Czech banking system remains unchanged even though the efficiency gap with other countries narrows, while in Kasman and Yildirim's study there is an improvement in the ranking. Weill ascribes the improvement in cost efficiency of Czech banks to better governance following the privatization of most banks and their acquisition by foreign investors.

Rossi *et al* (2005) and Weill (2007) found that apart from the Czech Republic (as noted above), efficiency improved strongly also in Latvia and Hungary. Kasman and Yildirim (2006), however, observed a downward trend in efficiency in Hungary. Unlike Weill, Mamatzakis *et al* (2008) found evidence of a small but significant convergence in cost efficiency across new EU member states, but they do not provide a country-level breakdown of the trend in efficiency scores. According to Weill, the evolution of interest rates through their impact on financial costs of banks partly explains the evolution of cost efficiency. The three countries in his study that experienced the strongest increase in efficiency were those with the highest decrease of interest rates.

C. Cost efficiency: Distribution Free Approach

Only four studies have used the DFA to estimate a cost efficiency frontier. These confirm the general findings of the SFA studies that Slovenia, Poland, Estonia and Hungary have the highest cost efficiency. Three of the studies (Hollo and Nagy, 2006; Weill, 2007; and Yildirim and Phillippatos, 2007) also employed the SFA, thus allowing us to compare the robustness of the country rankings across methodologies. All three find that cost efficiency scores obtained with DFA are lower than those estimated with SFA. This is a common result in the literature (Weill, 2003). In addition, the rank ordering of countries are identical or near identical to those obtained with SFA, despite the fact that under the SFA there were significant increases in efficiencies for some countries.

D. Profit efficiency

Although the measurement of different efficiency concepts adds some independent information on the workings of the banking industry, especially when the markets are not perfect, studies on profit efficiency are fewer than studies on cost efficiency. According to Weill (2007), comparison of profits across transition countries is problematic because of differences in provisioning rules and behaviors. In addition, Borovička (2007) argues that reported bank profits in transition countries in the 1990s did not provide a reliable picture of the true state of affairs, since the underdeveloped administrative and regulatory systems created loopholes for profit misreporting.

All the five profit efficiency studies on eastern Europe have estimated alternative profit efficiency. As discussed earlier in section II, this is a suitable definition of efficiency to use if output price data are subject to inaccuracies, if output quality has an effect on revenues, and if there is likelihood of possible influence of bank market power on pricing. All these studies have also estimated cost efficiency, which makes for useful comparison between the two concepts.

A common finding across the studies is that profit efficiency levels in all countries are lower than cost efficiency, suggesting that the banks are more efficient in controlling costs than in generating profits. This result shows that a proper evaluation of efficiency should not be restricted to cost efficiency but that profit efficiency should also be examined. The finding for the eastern European countries is similar to that obtained in other studies for western European and United States banking systems (Maudos *et al*, 2002; Berger and Mester, 1997). Mamatzakis *et al* (2008) offer three explanations for profit efficiencies trailing behind cost efficiencies: (i) in an environment of high demand for financial services and low financial intermediation

penetration, banks' efforts have focused on expanding their investment activities which have only partly paid off over the sample period; (ii) given the potential reward of expanding market shares in a rapidly growing market, banks have little incentive to maximize profits by means of full utilization of their discretionary pricing power; and (iii) because of the relatively large interest margins (albeit declining as competition intensifies), banks faced less pressure to further increase profitability and gave priority to restructuring their activities so as to keep costs under control.

Evidence indicates that banks which were high in the rankings according to cost efficiency tended to be ranked lower according to profits or that highly profit efficient banks may not be cost efficient. Rossi *et al* (2004) and Kasman and Yildirim (2006) examined the relationship between cost and profit efficiency at the individual bank level by means of the rank correlation between the two efficiency measures using Spearman correlations test. They found that the correlation between the rankings of banks between cost and profit efficiencies was negative and statistically significant. Berger and Mester (1997) obtained a similar result for the United States banking system. However, for the western European banking systems, Maudos *et al* (2002) found that most cost efficient banks are also the most profit efficient, although the rank correlation is low but statistically significant.

This finding on the rank-order correlation at the individual bank level carries over to the country level evidence as well. Country rankings based on banks' average profit efficiency differs from the one on cost. In particular, banking systems which were found to be most cost efficient are not the most profit efficient. As table 6 shows, in the studies of Rossi *et al* (2004) and Yildirim and Philippatos (2007), the rank-order correlation of country rankings between cost and profit

efficiency is negative and statistically significant. For Kasman and Yildirim (2006) the rank order correlation of country rankings is close to zero, consistent with the pattern that countries that ranked fairly high in cost efficiency fared worse in terms of profit efficiency. For Hallo and Nagy (2006) and Mamatzakis *et al* (2008) the rank correlation between cost and profit efficiency is positive. As such, this suggests that cost efficient countries are also more profit efficient and versa. However, in these two studies also there was slippage in the rankings of the more cost efficient banking systems when it came to profit efficiency performance, though to a lesser degree than in the other studies.

As for the notable swings in the country rankings between cost and profit efficiency, the Czech banking system which was the least cost efficient had among the highest profit efficiency (see table 5). At the other end of the scale, the Hungarian banking system which was ranked among the more cost efficient turned out to be at the low end regarding profit performance. For the other countries, the swings are not as striking and the variations in ranking are smaller. Rossi *et al* (2004) and Yildirim and Philippatos (2007) observed a large swing in the ranking of Slovenia from among the top in cost efficiency to among the bottom in profit efficiency. One explanation for this result may be that these two studies did not include country-specific environmental variables in the estimation of the efficiency frontiers. The other studies, which included environmental variables in the estimation of the efficiency frontiers, did not find any significant swing in Slovenia's ranking.

According to Rossi *et al* (2004), the negative or weak relationship between cost and profit efficiency is an indication that market conditions were not perfectly competitive during the sample period. They don't find the results surprising because although the CEECs banking

systems had benefited by the positive effect of the process of privatization, foreign banking penetration and changes in the institutional and legal requirements, they were still characterized by high concentration of banks.[7] Banks operating in less competitive markets can charge higher prices and feel less market discipline to control costs. An alternative explanation is that banks with relatively high cost inefficiencies supply a better service quality which can generate additional profits at the expense of increasing operating costs.

Berger and Mester (1997) believe that in a situation where profit efficiency is lower than cost efficiency and the correlation between the two efficiency rankings is negative, the market power paradigm dominates any effects of unmeasured differences in product quality on measured inefficiencies. This conclusion is also supported by their finding on correlates of efficiency in the United States. They found that market power (measured by the Herfindahl index) is negatively related to cost efficiency but positively related to alternative profit efficiency. Also, in the context of the western European banking system, Maudos *et al* (2002) found that the degree of concentration has a positive influence on profit efficiency and a negative one on cost efficiency.

The market power explanation for the observed swings in rankings between cost and profit efficiency also receives some support from the regression analyses of correlates of efficiency in the studies on eastern Europe. Kasman and Yildirim (2006) found that banks are more profit efficient in less concentrated markets (measured by the Herfindahl index) and that they have higher costs in highly concentrated markets.[8] Consistent with this finding, Yildirim and Philippatos (2007) observed that the degree of competition (measured by the Panzar and Rosse H-statistic) has a positive influence on cost efficiency and a negative one on profit efficiency. However, in the study by Rossi *et al* (2005), the coefficient on market concentration (measured

by the ratio of the assets of the five largest banks to total assets of the banking system) was not statistically significant for either cost or profit efficiency, contrary to their hypothesis on the influence of market power noted above.[9] Hollo and Nagy (2006) include a market concentration variable similar to Rossi *et al* in estimating the efficiency frontiers but do not present the findings.[10]

The results on the two DFA studies on profit efficiency are not uniform. Yildirim and Philippatos (2007) found that the DFA profit efficiency scores are much lower than the SFA profit efficiency scores, while Hollo and Nagy (2006) found the DFA profit efficiency scores to be somewhat higher. Unlike in the case of cost efficiency, the rankings in profit efficiency are dramatically different depending on whether SFA or DFA technique is use. Yildirim and Philippatos obtain a negative and significant rank correlation (−0.731) between the country rankings of profit efficiency under the SFA and DFA techniques, while Hollo and Nagy obtain a positive and significant relationship (0.667).

IV. Empirical findings on ownership and bank efficiency

The issue of ownership structure and bank efficiency is tackled at two levels: foreign ownership versus domestic ownership, and private ownership versus government ownership. Of the cross-country studies reviewed in this paper, nine focus on the differences in efficiency between foreign-owned and domestic-owned banks (Grigorian and Manole, 2006; Kenjegalieva *et al*, 2009; Yildirim and Philippatos, 2007; Kasman and Yildirim, 2006; Rossi *et al*, 2004; Borovička, 2007; Košak and Zajc, 2006a; Green *et al*, 2004; Matousek, 2008). Five studies divide ownership structure into multiple categories to additionally take into account the influence of privatization (Bonin *et al*, 2005a and 2005b; Fries and Taci, 2005; Mamatzakis *et al*, 2008; Assaf *et al*, 2009).

Thus, this second group of studies distinguish between new foreign banks, foreign ownership arising from privatization, private domestic banks, and state-owned banks.

A priori, the influence of foreign ownership on bank efficiency is not clear cut. On the one hand, foreign banks have the benefits of modern technology and better managerial practices including risk management. Also, they may be less vulnerable to political pressures than domestic banks and less inclined to lend to connected parties. However, foreign banks may suffer from disadvantages, especially in the initial years. It may take time for foreign new entrants to fully grasp the particularities of the domestic market, legal system, and other institutional structures. New entrants also face substantial costs in establishing a branch network, recruiting and training staff, and building up reputation and clientele. These costs are likely to be spread over several years. In the initial years of existence, concentrating on gaining market share may also take priority over cost control. In addition, if the new entrants adapt their approach to operating their business to local market conditions, and the market is subject to low degree of competition, they may not be inclined to pay too much attention to the cost side. In foreign banks acquired through privatized banks, the new foreign owner may incur substantial upfront costs in modernizing the bank so that cost efficiencies may be reaped only several years after acquiring the bank.

Although one expects privatized banks to be more efficient because of a change in objectives, privatization by itself may not be sufficient to insure bank efficiency. Performance improvements are likely only when the new owner(s) take over effective control of the bank. The government could well be in a position to continue running the bank if it retained a large share and private ownership was diffused. Governance problems also could arise if one large owner was played off against the other.

The findings on the relationship between foreign ownership and cost efficiency are mixed. Six studies obtained either a negative or no significant relationship between foreign ownership and cost efficiency (Green *et al*, 2004; Kasman and Yildirim, 2006; Košak and Zajc, 2006a; Rossi *et al*, 2004; Borovička, 2007; and Mamatzakis *et al*, 2008).[11] Mamatzakis *et al* looked at four categories of ownership and, strikingly, found state-owned banks to be the most cost efficient and banks with foreign strategic ownership to be the least efficient. In contrast, another six studies noted strong evidence of a positive effect of foreign ownership on cost efficiency (Matousek, 2008; Yildirim and Philippatos, 2007; Bonin *et al*, 2005a and 2005b; Fries and Taci, 2005; Assaf *et al*, 2009). Notably, Bonin *et al* (2005b) and Fries and Taci found state-owned banks to be the least cost efficient. The relative rankings of the coefficients for new foreign banks and privatized foreign banks differ between these studies. Whereas Fries and Taci determined privatized foreign banks to be the most cost efficient, Bonin *et al* found greenfield foreign banks to have the highest cost efficiency. Two DEA studies also got a positive relationship between foreign ownership and technical efficiency (Grigorian and Manole, 2006; Kenjegalieva *et al*, 2009).

Borovička (2007) argues that there may be an endogeneity bias in the evaluation of the impact of foreign ownership on efficiency, caused by the so-called cream-skimming effect. It is important to investigate whether foreign acquisitions enhance the cost efficiency or if foreign investors had acquired the most efficient domestic banks in the first place without adding too much to their efficiency. Borovička tries to shed light on this issue by employing a two-step instrumental approach. In the first step, he estimates a panel probit model linking the foreign-ownership dummy variable to a set of instruments. The predicted probability of being foreign owned is then used in the estimation of the stochastic frontier in place of the original dummy variable for

foreign ownership. Borovička found that the impact of foreign ownership on cost efficiency changes to a negative significant relationship in the instrumented model from the no significant relationship obtained in the non-instrumented model. He interprets the swing to a negative relationship as confirmation of the cream-skimming hypothesis. Bonin *et al* (2005a) appear to support this conclusion. They remark that "…banks remaining to be privatized in these transition countries are less efficient and provide less service at a higher cost than those already privatized, which is consistent with the hypothesis that the better banks were privatized first in these transition countries"(p. 52).

Single-country studies on cost efficiency for sample periods covering the second half of the 1990s also show mixed results on the influence of bank privatization and entry of new domestic and foreign banks. As Fries and Taci (2005, p. 58−59) note, one study on Croatia and another on the Czech Republic found no evidence of greater cost efficiency of foreign-owned banks. However, foreign-owned banks were found to be significantly more cost efficient than domestic banks in studies on Hungary and Poland, and in another study on Croatia. In a recent study on corporate governance in Slovene banks, Štiblar and Ahtik (2010) found that foreign-owned banks performed less efficiently than domestic banks and that the efficiency gap had deteriorated over time.[12]

Only a handful of cross-country studies have examined the relationship between ownership and profit efficiency, but their findings are broadly similar. Rossi *et al* (2005), Kasman and Yildirim (2006), and Mamatzakis *et al* (2008) found that foreign-owned banks were more profit efficient than domestic banks.[13] Mamatzakis *et al*'s results also indicate that among foreign banks those with majority foreign ownership had higher profit efficiency than banks with foreign

strategic ownership. They found state-owned banks to be the least profit efficient. These findings are in sharp contrast to the results that these three studies obtained for cost efficiency; viz. foreign ownership was negatively related or not significantly related to cost efficiency. This swing from a negative or no relationship with ownership for cost efficiency to a positive one for profit efficiency is consistent with the broader finding reported above that banking systems which were found to be most cost efficient are not the most profit efficient.

Bonin *et al* (2005a) too found foreign banks to be more profit efficient than domestic banks and note a slight swing as well in the findings between cost and profit efficiency. The coefficient for strategic foreign ownership is not significant for profit efficiency, unlike the significant positive coefficient obtained for cost efficiency. However, the significant positive impact on efficiency of having majority foreign ownership relative to all domestic banks is robust for both cost and profit efficiency. Unlike Mamatzakis *et al*, Bonin et al also found no discernible evidence that government ownership makes a difference to profit efficiency relative to private domestic ownership.

Only Yildirim and Philippatos (2007) obtained a negative significant relationship between foreign ownership and profit efficiency, opposite to the positive relationship they found for cost efficiency. Bonin *et al* (2005a) point out that Yildirim and Philippatos do not control for country or year effects, and that this may explain the difference between the results obtained by them and Yildirim and Philippatos.

Only three of the fourteen studies reviewed in this section report cross-country bank efficiencies by ownership categories (Kasman and Yildirim, 2006; Matousek, 2008; and Assaf *et al*, 2009). The cost efficiency rankings by country and ownership shown in table 8 indicate weak

correlation between the findings of the three studies. In the bilateral comparisons of the cross-country cost efficiency rankings of foreign banks, none of the Spearman rank-order correlations and the Wilcoxon matched-pairs signed-rank tests is statistically significant. In the bilateral comparisons of cost efficiency rankings of domestic banks, only the rank-order correlation between the studies of Matousek and Assaf *et al* is positive and statistically significant at the 10 percent level.

However, all three studies agree that domestic banks in the Czech Republic are least cost efficient compared to domestic banks in other New Member States. Another common finding of all the three studies is that among foreign banks in New Member States, those in Hungary and Poland rank relatively low in cost efficiency. But there is striking contrast in the ranking of foreign banks in the Czech Republic and Slovenia. In Kasman and Yildirim's (2006) study, foreign banks in the Czech Republic rank in the top three in cost efficiency while foreign banks in Slovenia rank in the bottom three. In contrast, in the studies by Matousek (2008) and Assaf *et al* (2009) foreign banks in the Czech Republic rank in the bottom three while those in Slovenia rank in the top three.

The findings of the three studies are different on the relationship between the cost efficiency rankings of domestic banks and foreign banks. The rank correlation is negative and statistically significant at the 10 percent level in the study by Kasman and Yildirim (2006), positive and statistically significant at the 5 percent level in the study by Assaf *et al* (2009), and positive but not statistically significant in the study by Matousek (2008).

V. Conclusions

In this paper we have reviewed the cross-country studies on banking efficiency in central and eastern Europe that apply different frontier approaches in measuring efficiency. Rather than comparing the efficiency values across the various studies, we examined the relative rankings of individual countries by their efficiency values across the studies. In addition, we looked at the results on the effect of ownership structure on bank performance. The focus of the survey was limited to the findings for the eight transition countries that joined the European Union in the first wave of accession in May 2004.

The literature survey confirms that the different estimation techniques yield different results for efficiency rankings. Also, the rankings vary according to the efficiency concept measured, indicating that each of the efficiency concepts adds some independent informational value. Notwithstanding the considerable differences in the sample periods, country coverage, the measures of input and output variables, and the potential correlates of efficiency, some common patterns emerged from the cross-country comparison.

First, the studies on technical efficiency consistently ranked the Czech banking system as being the most efficient and Lithuania's banking system as being the least efficient. However, the Czech banking system's ranking slipped to the bottom end of the efficiency scale when it came to measuring cost efficiency, suggesting that Czech banks were particularly deficient in responding optimally to relative prices of inputs. A majority of the studies on cost efficiency found banks in Slovenia and Estonia to be among the top three-most efficient in the region. The rank ordering of countries for cost efficiency was robust across measurement methods—the

rankings obtained under the stochastic frontier approach and the distribution free approach were very similar.

Second, banks in all countries were more efficient in controlling costs than in generating profits. The relationship between rankings on cost and profit efficiency was either negative or weak. These two results together suggest that market conditions in the banking sectors in the new EU member states were not perfectly competitive and that banks operating in less competitive markets could charge higher prices and feel less market discipline to control costs. Significantly, the Czech banking system which was the least cost efficient had among the highest profit efficiency. For the other countries, the swings in the rankings between cost and profit efficiency were not as striking and the variations in ranking were smaller. Notably, Slovenia's ranking for profit efficiency was below that for cost efficiency, but not consistently toward the bottom. The findings also suggest that possible defects of the banking intermediation market structure in Slovenia are likely to be less than that commonly perceived.

Third, the findings on the relationship between foreign ownership and cost efficiency were not conclusive. Studies which obtained either a negative or no significant relationship between foreign ownership and cost efficiency were similar in number to studies which found strong evidence of a positive relationship. On the other hand, there was near consensus that foreign-owned banks were more profit efficient than domestic banks.

The cross-country comparisons have important lessons for policy makers and researchers. As such, they seem to suggest that the value and applicability of cross-country studies may be limited because individual studies differ from one another in many different directions. A shortcoming of the literature is that researchers have focused more on methodological

improvements in measuring efficiency and little on explaining the reasons for the variations in findings between the different measures of efficiency. In particular, it would be important for policy makers to know why the rankings or efficiency scores of individual countries vary according to the choice made concerning efficiency measurement. Since each of the efficiency concepts adds some independent informational value, it would be important for future research to apply all the efficiency concepts to a single data set, use a comprehensive set of potential correlates, and systematically explain the differences in findings. To be useful to policy makers, future research should also focus on how the various efficiency measures are evolving over time and the factors influencing them. It would also be important to compare how the findings based on a common international frontier compare with the findings based on a country's own nation-specific frontier.

Notes

[1] It is also argued that bank operating ratios can be severely distorted by differences in capital structure, accounting practices, and level of inflation. However, this can be mitigated by including factors controlling for these distortions in the regression equations.

[2] The countries include Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovenia, and Slovakia.

[3] In a recent paper, Kuosmanen and Johnson (2010) have suggested a formulation that bridges the conceptual gap between mathematical programming-based DEA and the regression-based econometric approaches. They show that the standard DEA model can be formulated as a nonparametric least squares regression subject to shape constraints regarding the frontier and a sign constraint regarding the regression residuals. The DEA studies on banking efficiency reviewed in section III are based on the mathematical programming technique and pre-date Kuosmanen and Johnson.

[4] In addition, Tomova, and Grigorian and Manole estimate a second model which places emphasis on revenue generation or profits. The second model of Kenjegalieva *et al* follows the traditional production approach which views financial institutions as producers of deposits and loans. In each of these three studies, the rank order correlation of efficiencies between the two models are high and statistically significant (0.821 for Tomova, 0.786 for Grigorian and Manole, and 0.952 for Kenjegalieva *et al*). Thus, for comparing the findings we focus on the results of the intermediation approach.

[5] If we compare the efficiency rankings for the controlled and uncontrolled models, the rank correlation is 0.933 in the study by Fries and Taci, 0.943 in the study by Weill, and 0.786 in the study by Hollo and Nagy. All the rank correlations are significant at the 5 percent level or better.

[6] The emphasis on high branch density is surprising. It is difficult to see how this factor could have helped to increase cost efficiency. Maudos *et al* (2002) for western Europe found that banks operating with a high network density are less cost efficient as a consequence of the high structural overheads that they bear.

[7] See also European Central Bank (2006).

[8] Kasman and Yildirim regress cost and profit *inefficiency* on various correlates. They obtain a negative significant coefficient on the Herfindahl concentration index for profit *inefficiency* and a positive significant coefficient for cost *inefficiency*.

[9] It is possible that the different way of measuring the concentration index is affecting the results. The ordering of the Herfindahl index may not necessarily match that of the share of the largest five banks in total banking assets. The Herfindahl index is calculated as the sum of the squares of all the banks' asset market shares.

[10] Among the studies that have examined only cost efficiency, Košak and Zajc (2006a) obtained a negative and significant coefficient for the Herfindahl index, suggesting that higher market concentration is associated with lower cost efficiency. However, Fries and Taci (2005) found that banking market concentration (measured by the share of five largest banks in the total banking system assets) is not significantly associated with cost efficiency.

[11] Although Kasman and Yildirim observed no significant difference between the mean cost efficiency levels of foreign-owned and domestic banks for the overall sample, this pattern held only for Slovakia and Slovenia. Foreign banks operating in the Czech Republic, Estonia, Hungary, Latvia, Lithuania, and Poland had significantly higher cost efficiency levels than domestic banks.

[12] However, Štiblar and Ahtik do not use frontier techniques, but carry out regression analysis of various performance indicators.

[13] However, Kasman and Yildirim found that there was no significant difference in the profit efficiency scores of foreign and domestic banks in Czech Republic, Estonia, and Slovenia.

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Table 1. List of studies on banking efficiency and their modelling and estimation details

Author	Efficiency concept	Methodology	Sample countries	Sample period	Number of banks	Number of observations	Functional form	Outputs	Inputs	Equity as variable	Environmental / control variables
Grigorian and Manole (2006)	Technical	DEA	ARM, BYR, BGR, HRV, CZE, EST, HUN, KAZ, LAT, LIT, MDV, POL, ROM, RUS, SVK, SVN, UKR	1995-1998	209-334	1,074		Deposits, net loans, liquid assets	Labor, fixed assets, interest expenditures	No	Yes, second stage
Tomova (2005)	Technical	DEA	BGR, CZE, HRV, EST, HUN, LAT, POL, ROM, SVK, SVN, FRA, PRT, ESP	1993-2002	51-523	3,825		Net loans, investment	Deposits, fixed assets, total operating costs	No	Yes, second stage
Stavárek (2006)	Technical	DEA	BGR, CZE,EST, HUN, LAT, LIT, POL, ROM, SVK, GRC, PRT	2001-2003	122-125	373		Loans, net interest income	Labor, physcial capital, deposits	No	No
Kenjegalieva, Simper and Weyman-Jones (2009)	Technical	DEA	CZE, EST, HUN, LAT, LIT, POL, SVN, SVK	1999-2003	115-128	115-128		Loans, other earning assets, net commission, net fee and other trading income, other income	Deposits, labor, capital, loan loss provisions	No	Yes, second stage
Yildirim and Philippatos (2007)	Cost, Profit	SFA, DFA	ALB, BGR, CZE, EST, HRV, HUN, LAT, LIT, MKD, POL, ROM, RUS, SVN, SVK, YUG	1993-2000	325	2,042	Translog	Deposits, loans, investments	Labor, physical capita, funds	Yes, in frontier equation	Yes, second stage
Fries and Taci (2005)	Cost	SFA	BGR, CZE, HRV, EST, HUN, KAZ, LAT, LIT, MKD, POL, ROM, RUS, SVN, SVK, UKR	1994-2001	289	1,615	Translog	Deposits, Loans	Labor, physical capital	Yes, in frontier equation	Yes, in frontier equation
Kasman and Yildirim (2006)	Cost, Profit	SFA	CZE, EST, HUN, LAT, LIT, POL, SVN, SVK	1995-2002	190	277	Fourier flexible	Deposits, loans, other earning assets	Labor, physical capital, funds	Yes, in frontier equation	Yes, in frontier equation
Rossi, Schwaiger and Winkler (2004, 2005)	Cost, Profit	SFA	CZE, EST, HUN, LAT, LIT, POL, ROM, SVN, SVK	1995-2002	245	1,070	Fourier flexible	Deposits, loans, other earning assets	Labor, physical capital, deposits	No	Yes, second stage
Borovička (2007)	Cost	SFA	ALB, ARM, AZB, BGR, BYR, HRV, CZE, EST, GEG, HUN,KAZ, LAT, LIT, MDV, POL, ROM, SVK, SVN, UKR	1995-2004	282	1,780	Translog	Deposits, Loans	Labor, physical capital	Yes, in frontier equation	Yes, in frontier equation
Košak and Zajc 1 (2006a)	Cost	SFA	CZE, EST, HUN, LAT, LIT, POL, SVN, SVK	1996-2003	98-101	800	Translog	Deposits, loans, other earning assets	Labor, physical capital, funds	Yes, in frontier equation	Yes, second stage
Košak and Zajc 2 (2006b)	Cost	SFA	CYP, CZE, EST, HUN, LAT, LIT, MLT, POL, SVN, SVK, AUT, BEL, GER, ITA	1996-2003	267-661	3,204	Translog	Deposits, loans, other earning assets	Labor, physical capital, funds	Yes, in frontier equation	No
Weill (2007)	Cost	SFA, DFA	CZE, HUN, LAT, POL, SVN, SVK, AUT, BEL, DMK, FRA, GER, GRC, ITA, NLD, PRT, ESP, UK	1996-2000	955	na	Fourier flexible	Loans, other earning assets	Labor, physical capital, funds	Yes, in frontier equation	Yes, in frontier equation
Hollo and Nagy (2006)	Cost, Profit	SFA, DFA	EU-25	1999-2003	2459	na	Fourier flexible	Loans, other earning assets, noninterest revenues	Labor, physical capital, funds	No	Yes, in frontier equation
Bems and Sorsa (2008)	Cost	SFA	AUT, BEL, CZE, ESP, EST, FIN, GRC, HUN, IRL, LAT, LIT, NLD, POL, PRT, SVN, SVK	1995-2007	594	3,452	Translog	Deposits, loans, other earning assets	Labor, physical capital, funds	No	No
Mamatzakis, Staikouras and Koutsomanoli-Filippaki (2008)	Cost, Profit	SFA	CYP, CZE, EST, HUN, LAT, LIT, MLT, POL, SVN, SVK	1998-2003	97-150	766	Translog	Loans, other earning assets	Labor, borrowed funds	Yes, in frontier equation	Yes, in frontier equation
Assaf, Barros and Matousek (2009)	Cost	SFA	BGR, CZE, EST, HUN, LAT, LIT, POL, ROM, SVN, SVK	2001-2007	158	1,085	Bayesian	Deposits, loans	Labor, capital	No	Yes, in frontier equation
Matousek (2008)	Cost	DFA	CZE, EST, HUN, LAT, LIT, POL, SVN, SVK	1995-2002	147	1,020	Translog	Deposits, loans, liquid assets	Labor, physical capital, funds	No	Partial, in frontier equation

ALB = Albania; ARM = Armenia; AUT = Austria; AZB = Azerbaijan, BEL = Belgium; BYR= Belarus; BGR = Bulgaria; HRV = Croatia; CZE = Czech Republic; CYP = Cyprus; DMK = Denmark; ESP = Spain; EST = Estonia; FIN = Finland; FRA = France; GER = Germany; GEG = Georgia; GRC = Greece; HUN = Hungary; ITA = Italy; IRL = Ireland; KAZ = Kazakhstan; LAT = Latvia; LIT = Lithuania ; MKD = Macedonia; MLT = Malta; MDV = Moldova; NLD = Netherlands; POL = Poland; PRT = Portugal; ROM = Romania; RUS = Russia; ESP = Spain; SVK = Slovak Republic; SVN = Slovenia; UKR = Ukraine; YUG = Yugoslavia

Table 2. Country ranking of Technical Efficiency under Data Envelope Analysis

	Griogrian and Manole[1]	Tomova[2]		Kenjegalieva *et al*[3]		Stavárek[3]
Period covered	1995-1998	1995-1998	1999-2002	1999-2002	2001-2003	2001-2003
Czech Republic	2	2	1	1	1	1
Estonia	5	3	2	4	4	3
Hungary	6	5	3	3	2	2
Latvia	3	1	4	7	7	7
Lithuania	7	…	…	8	8	6
Poland	8	6	5	2	3	4
Slovenia	1	7	7	6	6	…
Slovakia	4	4	6	5	5	5

Source: Author's calculations.

[1] Service-based index.

[2] Regulatory objective. Lithuania is not included in Tomova's study.

[3] Intermediation approach. Slovenia is not included in Stavárek's study.

Table 3. Country rankings of Cost Efficiency under Stochastic Frontier Approach (SFA) and Distribution Free Approach (DFA)

SFA	Yildirim and Philippatos	Fries and Taci		Kasman and Yildirim	Rossi et al	Borovička	Bems and Sorsa	Weill[1]		Košak and Zajc 1	Košak and Zajc 2	Mamatzakis et al	Hollo & Nagy		Assaf et al
		Uncontrolled	Controlled					Uncontrolled	Controlled				Uncontrolled	Controlled	
Czech Republic	5	8	8	8	8	8	7	2	2	8	8	8	4	4	8
Estonia	6	1	1	1	3	1	1	…	…	7	5	5	1	1	3
Hungary	3	7	5	5	5	5	3	1	1	4	3	2	3	3	6
Latvia	7	4	5	5	6	4	2	4	5	5	6	7	5	5	2
Lithuania	8	2	2	4	4	2	4	…	…	6	7	4	8	8	1
Poland	1	6	7	2	2	6	5	5	4	2	1	6	2	2	7
Slovenia	2	4	3	3	1	3	8	3	3	3	2	1	6	6	5
Slovakia	4	3	3	7	7	7	6	6	6	1	4	3	7	7	4

DFA	Yildirim and Philippatos	Weill[1] (Controlled model)	Hollo & Nagy (Controlled model)	Matousek
Czech Republic	4	2	4	7
Estonia	6	…	1	3
Hungary	3	1	3	5
Latvia	7	5	5	1
Lithuania	8	…	8	6
Poland	1	4	2	8
Slovenia	2	3	6	2
Slovakia	5	6	7	4

[1] Estonia and Lithuania are not included in Weill's study.

Table 4. Spearman rank-order correlation between various studies on cost efficiency

Sample period	Yildirim and Philippatos 1993-2000	Fries and Taci 1994-2001	Kasman and Yildirim 1995-2002	Rossi et al 1995-2002	Borovička 1995-2004	Bems and Sorsa 1995-2007	Weill 1996-2000	Košak and Zajc 1 1996-2003	Košak and Zajc 2 1996-2003	Mamatzakis et al 1998-2003	Hollo & Nagy 1999-2003	Assaf et al 2001-2007
Yildirim and Philippatos	1											
Fries and Taci	-0.410	1										
Kasman and Yildirim	0.168	0.497	1									
Rossi et al	0.405	0.374	0.898***	1								
Borovička	-0.405	0.807**	0.731**	0.619	1							
Bems and Sorsa	-0.500	0.349	0.347	0.000	0.524	1						
Weill	0.200	-0.412	-0.029	0.143	0.029	-0.143	1					
Košak and Zajc 1	0.643*	-0.036	0.060	0.262	-0.262	-0.310	-0.543	1				
Košak and Zajc 2	0.857***	-0.036	0.491	0.667***	0.000	-0.167	0.029	0.786**	1			
Mamatazakis et al	0.357	0.494	0.204	0.452	0.310	-0.214	0.143	0.524	0.548	1		
Hollo and Nagy	0.333	-0.229	0.431	0.214	0.024	0.429	0.543	-0.214	0.286	-0.310	1	
Assaf et al	-0.738**	0.759**	0.239	0.095	0.714*	0.524	-0.657	-0.095	-0.310	0.143	-0.452	1

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Siginificant at the 10 percent level.

Correlation coefficients not marked with asteriks were not statistically significant.

Table 5. Frequency distribution of Top and Bottom Rankings of Cost, Technical and Profit Efficiency[1]

	Cost efficiency, SFA			Cost efficiency, DFA			Profit efficiency, SFA		
	Top two	Top three[2]	Bottom two[3]	Top two	Top three	Bottom two	Top two	Top three	Bottom two
Czech Republic	1	1	9	1	1	1	2	3	0
Estonia	5	7	1	1	2	0	2	2	1
Hungary	2	6	0	1	3	0	1	1	3
Latvia	2	2	2	1	1	1	1	2	1
Lithuania	3	3	3	0	0	2	1	1	0
Poland	6	6	2	2	2	1	1	1	2
Slovenia	4	9	1	2	3	0	0	2	2
Slovakia	1	3	4	0	0	1	2	3	1
Number of studies	12			4			5		

[1] In studies which have specifications with and without country-specific environmental factors, ranking of the controlled model has been used.

[2] In one study, Slovenia and Slovakia were ranked equal third.

[3] In one study only 6 of the 8 New Member States were covered. Hence no ranking of bottom two were assigned.

Table 6. Country Rankings of Profit and Cost Efficiency.

	Yildirim and Philippatos (2007)		Yildirim and Philippatos (2007)		Kasman and Yildirim (2006)		Rossi, Schwaiger and Winkler (2004)		Hollo and Nagy (2006)		Hollo and Nagy (2006)		Mamatzakis, Staikouras and Koutsomanoli-Filippaki (2008)	
	Profit, SFA	Cost, SFA	Profit, DFA	Cost, DFA	Profit, SFA	Cost, SFA	Profit, SFA	Cost, SFA	Profit, SFA	Cost, SFA	Profit, DFA	Cost, DFA	Profit, SFA	Cost, SFA
Czech Republic	3	5	8	4	1	8	1	8	5	4	2	4	6	8
Estonia	2	6	7	6	4	1	4	3	1	1	1	1	8	5
Hungary	8	3	1	3	7	5	8	5	4	3	4	3	1	2
Latvia	1	7	4	7	5	5	3	6	8	5	7	5	4	7
Lithuania	5	8	5	8	2	4	5	4	6	8	8	8	5	4
Poland	7	1	2	1	6	2	5	2	2	2	3	2	7	6
Slovenia	6	2	3	2	3	3	7	1	7	6	5	6	3	1
Slovakia	4	4	5	5	8	7	2	7	3	7	6	7	2	3
Spearman's correlation between profit and cost efficiency rankings		−0.691*		0.539		0.024		−0.719**		0.619		0.857***		0.643*

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at 10 percent level.

Table 7. Cross-country evidence on bank ownership structure and efficiency

Author	Sample details	Sample period	Measurement of ownership	Findings
Technical efficiency, DEA				
Grigorian and Manole (2006), DEA	17 transition countries	1993-2000	A dummy variable equal to 1 if more than 30% foreign owned; equal to 0 otherwise.	Banks with foreign ownership are likely to be *more* efficient than their domestically owned counterparts . (Result holds for both revenue-based index model and service-based index model.)
Kenjegalieva, Simper and Weyman-Jones (2009), DEA	8 New EU member states	1999-2003	A dummy variable equal to 1 if more than 50% foreign owned; equal to 0 otherwise.	Performance of banks with foreign ownership tends to be *better* than their domestic counterparts. (Result holds for both intermediation approach and production approach, for three of the five sample years. Not statistically significant in 1999 and 2001).
Cost efficiency, DFA				
Matousek (2008)	8 New EU member states	1995-2002	A dummy variable equal to 1 for de novo foreign banks; 0 otherwise.	De novo foreign banks have *higher* cost efficiency than banks in other ownership categories. However, in Lithuania foreign banks are *less* cost efficient than other banks.
Cost efficiency, SFA				
Yildirim and Philippatos (2007), SFA	12 Central and East European transition countries	1993-2000	A dummy variable equal to 1 if more than 50% of the bank assets are foreign owned; equal to 0 otherwise.	Foreign banks are *more* cost efficient relative to domestic banks.
Kasman and Yildirim (2006)	8 New EU member states	1995-2002	Not included in regression equation, but mean efficiency scores presented separately for foreign banks and domestic banks for the overall sample and for each country in the sample	*No statistically significant difference* in the mean cost efficiency levels between foreign banks and domestic banks for the overall sample. Foreign banks in Czech Republic, Estonia, Latvia, and Lithuania have significantly *higher* cost efficiency than domestic banks. In Hungary and Poland, foreign banks have significantly *lower* cost efficiency than domestic banks. In Slovakia and Slovenia no statistically significant difference in cost efficiency between foreign and domestic banks.
Rossi, Schwaiger and Winkler (2005)	8 New EU member states	1995-2002	Percent of bank assest foreign owned	*Negative* and significant correlation between foreign owned bank assets and cost efficiency

Borovička (2007)	19 transition countries	1995-2004	Two alternative measures. In benchmark model, a dummy variable equal to 1 if bank is foreign owned. In instrumented model, predicted probability of being foreign-owned.	*No significant relationship* between foreign ownership and cost efficiency in bench mark non-instrumented model. *Negative significant* relationship between foreign ownership and cost efficiency in instrumented model.
Košak and Zajc (2006a)	8 New EU member states	1996-2003	Dummy variable equal to 1 if more than 50% of equity is foreign owned; 0 otherwise	Banks in foreign ownership achieved *lower* cost efficiency scores than banks with different ownership structures.
Fries and Taci (2005)	15 transition countries	1994-2001	Five ownership categories, represented by four dummy variables:newly-established foreign banks, privatised bank--foreign, privatised bank--domestic, state-owned banks, and newly-established private domestic banks.	Private banks are more cost efficient than state-owned banks. But significant differences among private banks. Privatised banks with majority foreign ownership are the most cost efficient, followed by newly established private banks, both domestic and foreign owned. Privatised banks with majority domestic ownership are the least efficient private banks, though they are still more efficient than state-owned banks.
Bonin, Hasan, Wachtel (2005a)	11 transition countries	1996-2000	Four categories: strategic foreign ownership, other foreign majority ownership, majority government ownership	Foreign ownership (both strategic foreign ownership and other majority ownership) have significant positive effect on cost efficiency relative to domestic private banks. Government ownership has no statistically significant effect on cost efficiency relative to domestic private banks.
Bonin, Hasan, Wachtel (2005b)	6 transition countries	1994-2002	Four ownership categories, represented by three dummy variables: foreign greenfield banks, privatized banks, state-owned banks, and domestic de novo private banks. A separate dummy variable to measure the incremental imapct of strategic foreing ownership	Foreign greenfield banks are most cost efficient and government owned banks are the least cost efficient. No significant difference between privatized banks and domestic private de novo banks regarding cost efficiency. Strategic foreign ownership has no incremental impact.
Mamatzakis, Staikouros, and Koutsomanoli-Filippaki (2008)	10 New EU member states	1998-2003	Four ownership categories: foreign strategic, other foreign, state-owned, and domestic private	Banks with foreign strategic ownership are *least* cost efficient, and state-owned banks are *most* cost efficient. Majority foreign-owned banks are *more* cost efficient than domestic private banks.

Assaf, Barros and Matousek (2009)	10 New EU member states	2001-2007	Three ownership categories: greenfield foreign banks with 100% ownership, privatized state-owned banks, other domestic banks	For the overall sample, greenfield foreign banks are *less* cost efficient than privatized state-owned banks. Greenfield foreign banks and privatized state-owned banks are *more* cost efficient than de novo domestic banks. In Latvia and Slovakia, greenfield foreign banks have *lower* cost efficiency than the other ownership categories. In Estonia, Hungary, Lithuania,and Slovenia greenfield foreign banks had *higher* cost efficiency than other ownership categories.
Green, Murinde and Nikolov (2004)	9 New EU member states	1995-99	A dummy variable equal to 1 if more than 50% of the bank assets are foreign owned; equal to 0 otherwise.	*No statistically significant relationship* between foreign ownership and costs, except in Lithuania. In Lithuania, foreign ownership has a significant *negative relationship* with costs.
Profit efficiency, SFA				
Yildirim and Philippatos (2007), SFA	12 Central and East European transition countries	1993-2000	A dummy variable equal to 1 if more than 50% of the bank assets are foreign owned; equal to 0 otherwise.	Foreign banks are *less* profit efficient than domestic banks.
Kasman and Yildirim (2006)	8 New EU member states	1995-2002	Not included in regression equation, but mean efficiency scores presented separately for foreign banks and domestic banks for the overall sample and for each country in the sample	For overall sample, foreign banks are *more* profit efficient than domestic banks. Foreign banks in Hungary, Latvia, and Lithuania are significantly *more* profit efficient han domestic banks. In Czech Republic, Estonia, Poland, and Slovenia *no statistically significant difference* in profit efficiency between foreign and domestic banks.
Rossi, Schwaiger and Winkler (2005)	8 New EU member states	1995-2002	Percent of bank assest foreign owned	*Positive* and significant correlation between foreign owned bank assets and profit efficiency
Bonin, Hasan, Wachtel (2005a)	11 transition countries	1996-2000	Four categories: strategic foreign ownership, other foreign majority ownership, majority government ownership	Coefficient for strategic foreign ownership is not significant for profit efficiency. Majority foreign ownership without a strategic investor has a robust significant positive effect on profit efficiency. Government ownership has no significant impact on profit efficiency.

Bonin, Hasan, Wachtel (2005b)		6 transition countries	1994-2002	Four ownership categories, represented by three dummy variables: foreign greenfield banks, privatized banks, state-owned banks, and domestic de novo private banks. A separate dummy variable to measure the incremental imapct of strategic foreing ownership	Foreign greenfield banks are significantly more profit efficient and state-owned banks are significantly less profit efficient than domestic private de novo banks. Ptivatized banks are signficantly less profit efficient than domestic private banks, but the presence of foreign owner improves the profit efficiency of a bank significantly. Privatized banks and privatized banks having a strategic foreign owner are significantly more cost efficient than state-owned banks.
Mamatzakis, Staikouros, and Filippaki (2008)	Koutsomanoli-	10 New EU member states	1998-2003	Four ownership categories: foreign strategic, other foreign, state-owned, and domestic private	Majority foreign-owned banks are *most* profit efficient followed by banks with strategic foreign ownership. State-owned banks have the *lowest* profit efficiency.

Table 8. Country rankings of cost efficiency by ownership, and Spearman rank-order correlation

	Country rankings of cost efficiency						
	Kasman and Yildirim (2006)		Matousek (2008)		Assaf *et al* (2009)		
	Foreign	Domestic	Foreign	Domestic	Greenfield foreign	Domestic privatized	De novo domestic
Czech Republic	3	7	6	7	8	2	8
Estonia	1	4	4	2	2	4	5
Hungary	8	2	5	4	6	7	6
Latvia	4	6	3	1	4	1	2
Lithuania	2	8	8	4	1	3	1
Poland	5	1	7	8	7	6	7
Slovak Republic	7	3	2	3	5	5	3
Slovenia	6	4	1	4	3	8	4

	Rank-order correlation between studies: domestic banks			Rank-order correlation between studies: foreign banks		
	Kasman and Yildirim	Matousek	Assaf *et al*	Kasman and Yildirim	Matousek	Assaf *et al*
Kasman and Yildirim	1			1		
Matousek	-0.209	1		-0.405	1	
Assaf *et al*	-0.419	0.634*	1	0.429	0.143	1

	Rank-order correlation within studies: foreign vis-à-vis domestic banks
Kasman and Yildirim	-0.659*
Matousek	0.561
Assaf *et al*	0.786**

** Statistically significant at the 5 percent level.

* Statistically significant at the 10 percent level.

Correlation coefficients not marked with asteriks were not statistically significant.

Wilcoxon matched-pairs signed-rank tests were also calculated for the rankings between studies for domestic banks and foreign banks and for rankings within studies between domestic and foreign banks, but none of the tests was statistically significant.