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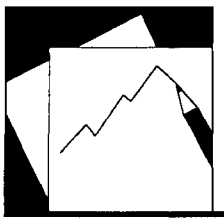

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Determinants of Commercial Bank Performance in Transition: An Application of Data Envelopment Analysis

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Determinants of Commercial Bank Performance in Transition: An Application of Data Envelopment Analysis

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Abstract

Banking sectors in transition economies have experienced major transformations throughout the 1990s. While some countries have been successful in eliminating underlying distortions and restructuring their financial sectors, in some cases financial sectors remain underdeveloped and the rates of financial intermediation continue to be low. We estimate indicators of commercial bank efficiency by applying a version of Data Envelopment Analysis (DEA) to bank-level data from a wide range of transition countries. In addition to stressing the importance of some bank-specific variables, the censored Tobit analysis suggests that (1) foreign ownership with controlling power and enterprise restructuring enhances commercial bank efficiency; (2) the effects of prudential tightening on the efficiency of banks vary across different prudential norms; and (3) consolidation is likely to improve the efficiency of banking operations. Overall, the results confirm the usefulness of DEA for transition-related applications and shed some light on the question of the optimal architecture of a banking system.

JEL Classification Numbers: G21, G28, P23

Keywords: Banking sector development, economies in transition

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I. INTRODUCTION

Banking sectors in transition economies of Eastern Europe and former Soviet Union have experienced major transformations throughout the 1990s. In the pre- and early transition periods, state policies generally distorted resource allocation, as credit (subject to a variety of controls) was directed toward sustaining existing industries and maintaining living standards through explicit and implicit subsidies to enterprises and households. Since the primary role of the banking system was to channel funds to the real sector, efficiency and profitability were not among the top priorities. The banks were not engaged in evaluating the credit conditions of their borrowers, and therefore no risk-management techniques were in use. Outdated statistical standards were designed to serve the objective of easy planning as opposed to disclosure of the true financial state of banks.

While some countries in the region have been successful in eliminating underlying distortions and restructuring their financial sectors, in some cases financial sectors remain underdeveloped and the rates of financial intermediation continue to be quite low. This is especially alarming in light of mounting evidence of the effect of financial sector development on economic growth (see, for instance, Levine and Renelt (1992) and King and Levine (1993)). Although part of the success across countries could be attributed to better initial conditions[2] and achievements of early macroeconomic stabilization programs, structural reforms were the dominant force behind the success in performance (see, for example, Berg and others, 1999). Progress in legal and regulatory reforms, enterprise privatization, and price and external trade liberalization were partially responsible for the changes occurring in some transition countries. These changes manifested themselves in not only the financial soundness of banking institutions but also a wider range and greater sophistication of financial services they provided. A few countries in the region were able to transform their banking sectors from a situation in which dozens of small banks were set up to serve individual enterprises (and/or worse, to con people out of their savings) to one in which banks putting all their eggs in one basket is considered suicidal; establishing correspondent relationships with major Western banks is a matter of life and death; and internet banking is no longer a luxury. Reduced availability of centralized financing encouraged banks in the region to look for alternative sources of financing and undertake measures aimed at deposit mobilization. As economies grew, triggering an increase in savings, so did the number of financial intermediaries (securities market institutions, pension funds, insurance companies, and brokerage firms) claiming a share of the pie and exerting additional pressure on banks to improve service provisions.

In light of these changes, it has become important to assess the relative role of different institutional and policy settings in explaining the difference between outcomes across countries and financial institutions. Yet, the effect and relative importance of various macro and regulatory elements of financial reforms in transition countries have so far not been properly evaluated.[3] Nor is there a consensus on the scope and the scale of effective regulatory regime. Studies on transition economies have yet to look into these issues.

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[2]Yet de Melo and others (1997) and, subsequently, Havrylyshyn and van Rooden (2000) show that although the initial conditions were important in defining the difference in performance across countries, their significance diminished over time.

[3]Exceptions are Claessens (1996) and, more recently, Barth, Caprio, and Levine (2001).

One should note that different policy measures may have different, and often opposite, effects on operational efficiency and technological improvements of banking operations. For instance, although tightening prudential requirements may limit banks' profitability and reduce the operating efficiency in the short run, doing so may encourage banks to look for new and innovative ways to invest, thereby expanding the production-possibilities frontier.[4] It is therefore essential for a policymaker to be able to identify policy instruments that are effective in bringing about changes in productivity and efficiency and come up with the best (often the least-cost) policy response. This is of particular importance for economies in transition, where the choice of instruments for policymakers can be rather limited as well as costly.

This paper aims to fill in the gap. Its purpose is to (1) calculate an appropriate measure of commercial bank efficiency in a multiple-input/output framework and (2) evaluate the effects of the policy framework on the performance of commercial banks as measured by these efficiency indicators. We do so in a wide range of transition countries and across a number of years. We argue that to fully assess the efficiency of commercial bank operations, it is necessary to model various types of functions performed by banks. In the beginning, we skip the discussion on the potential links between various policy measures and bank efficiency, only to discuss them later, along with the final results of estimation. This paper is a product of ongoing research and is not intended to provide answers to all questions it raises. On the contrary, we realize that more questions may have been raised than answered.

The range of questions of concern are as follows: Do banks that are subject to tighter prudential standards do better? Do banks with foreign ownership outperform their domestically owned counterparts? Does competition necessarily improve efficiency? Does enterprise restructuring affect bank performance in any significant way? What is the role of capital market development in strengthening bank performance? Do a country's legal traditions and rule of law affect bank-efficiency indicators?

The paper is structured in the following way: Section II provides an overview of the literature on bank efficiency analysis and describes the methodology used in the study. Section III describes the dataset and discusses the results of Data Envelopment Analysis in cross-country and cross-regional settings. Section IV explains differences in cross-bank efficiency indicators by regressing them on the set of policy instruments and control variables. Finally, Section V concludes.

II. METHODOLOGY

During the past few decades the banking sectors around the world experienced profound regulatory and technological changes. Advanced applications in computer and communications technology together with the introduction of new financial instruments have altered the way banking is conducted. Such changes significantly modified the technology of bank production. In

[4]Regulations might also have the opposite effect of what was originally intended, that is, discouraging banks from taking unjustified risks. To see this, note that allowing banks to collect rents by imposing less stringent regulations may have the potential of deterring them from taking excessive risks.

this regard, a frequently asked question was about the effect of these changes on the efficiency of banks. A large number of studies (see Berger and Humphrey (1997) for a survey) tried to answer this question by proposing new methods to measure the efficiency of the banking sector. The most widely used methods are Data Envelopment Analysis and the Stochastic Frontier Approach. Below we present a short review of the productivity and efficiency literature with a particular focus on the methodology to be used in this paper.

Studies on productivity growth in the banking sector usually base their analysis on cost ratio comparisons. There are several cost ratios to be used and each one of them refers to a particular aspect of bank activity. Since the banking industry uses multiple inputs to produce multiple outputs, a consistent aggregation may be problematic (see Kim, 1986). Some attempts have been made to estimate average practice cost functions. While these approaches were successful in identifying the average practice productivity growth, they failed to take into account the productivity of the best practice banks. These problems associated with the "classical" approach to productivity have led to the emergence of other approaches which incorporate multiple inputs/outputs and take into account the relative performance of banks.

One string of literature uses frontier analysis to separate the banking units that perform well from those that perform poorly, according to a specified set of criteria. The focus of this literature is on the changes of the efficiency frontier and on how close banks are to operating on the efficiency frontier. In an influential article, Farrell (1957) proposed two ways to estimate the frontier. The first method called for identifying efficient production units and building a piece-wise linear efficiency frontier using these efficient units. This was first implemented by Charnes, Cooper, and Rhodes (1978), who used linear-programming methods to identify the efficient units and coined the term Data Envelopment Analysis (DEA).[5]

Throughout the past two decades, hundreds of articles have used the Data Envelopment Analysis and over a thousand papers have applied the method to different fields ranging from banking to education.[6] This study will estimate the efficiency of banks by using a model which assumes a variable return to scale (VRTS). We start with presenting a model with constant returns to scale (CRTS) and then extend it to allow for variable returns to scale. In the case of CRTS technology, the linear programming method establishes which of the decision-making units (DMUs), in our case banks, determines the envelopment surface. The latter is referred to as the empirical production function or efficient frontier. This benchmark frontier is a linear combination of the efficient banks in the sample. The set of best practice or frontier observations are those for which no other decision making unit or linear combination of units has as much or more of every output (given a fixed amount of inputs—for an output-oriented model) or as little or less of every input (given a fixed amount of outputs—for an input-oriented model). The DEA frontier is formed as the piecewise linear combination that connects the set of these best practice observations,

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[5]Their method is based on the assumption that the production units have constant returns to scale. Banker, Charnes, and Cooper (1984) later relaxed the assumption and proposed a model with units of production with variable returns to scale. Theoretical extensions of these methods and empirical applications are discussed in Seiford (1996) and Cooper, Seiford, and Tone (2000).

[6]For detailed surveys and recent developments in the field see Charnes, Cooper, and Rhodes (1994) and Cooper, Seiford, and Tone (2000).

yielding a convex production possibility set. The DEA provides a computational analysis of relative efficiency for multiple input/output situations by evaluating each decision-making unit and measuring its performance relative to an envelopment surface composed of best practice units. Units that do not lie on the surface are termed inefficient. Thus this method provides a measure of relative efficiency.

Let us provide a brief description of the underlying linear programming model. We assume that there are K inputs and M outputs for every DMU. For the i^{th} DMU the inputs and outputs are represented by vectors x_i and y_i respectively. For each DMU we intend to obtain a measure of the ratio of all outputs over all inputs, such as $u_i' y_i / v_i' x_i$, where u_i and v_i are vectors of weights. To select the optimal weights, the following problem is proposed:

$$\begin{aligned} \max_{u_{ik}, v_{im}} \ & \frac{u_i' y_i}{v_i' x_i} \\ s.t. \ & \frac{u_i' y_j}{v_i' x_j} \le 1 \\ & u_{ik}, v_{im} \ge 0 \\ & i, j = 1,2,...N \\ & k = 1,2,...K \\ & m = 1,2,..M \end{aligned} \qquad (1)$$

A problem with this formulation is that it has an infinite number of solutions. This can be avoided by introducing a constraint $v_i' x_i = 1$, and obtaining the multiplier form of the linear programming problem:

$$\begin{aligned} \max_{\mu_{ik}, \sigma_{im}} \ & \mu_i' y_i \\ s.t. \ & \sigma_i' x_i = 1 \\ & \mu_i' y_j - \sigma_i' x_j \le 0 \\ & \mu_{ik}, \sigma_{im} \ge 0 \\ & i, j = 1,2,...N \\ & k = 1,2,...K \\ & m = 1,2,...M \end{aligned} \qquad (2)$$

where vectors u_i and v_i are replaced with μ_i and σ_i. Using the duality property of this linear programming problem, Charnes, Cooper, and Rhodes (1978) derive an equivalent envelopment form as:

$$\begin{aligned} &\min_{\theta,\lambda} \theta_i \\ &s.t. \; -y_i + Y\lambda_i \geq 0 \\ &\quad \theta_i x_i - X\lambda_i \geq 0 \\ &\quad \lambda_{in} \geq 0 \end{aligned} \tag{3}$$

where λ is an $(N \times 1)$ vector; and θ, a scalar, is the efficiency score for the i^{th} DMU.[7] The combination $(X\lambda_i, Y\lambda_i)$ can be interpreted as the projection of the DMU onto the efficiency frontier, with constraints interpreted accordingly. Note that $\theta_i \leq 1$, with $\theta_i = 1$ implying a DMU, which is located on the efficiency frontier.[8] Due to fewer number of constraints, this formulation is usually used for computations.

However, the above approach is somewhat simplified as it assumes a constant return to scale. The CRTS assumption is only appropriate when all banks are operating at an optimal scale. Factors that may cause banks not to operate at an optimal scale include imperfect competition, leverage concerns, and certain prudential requirements. The fact that banks face nonconstant returns to scale has been documented empirically by, among others, McAllister and McManus (1993), and Wheelock and Wilson (1997). This phenomenon led Banker, Charnes, and Cooper (1984) to suggest an extension of the CRTS DEA model to account for a variable return to scale (VRTS). They added a convexity constraint $N1'\lambda = 1$ to problem 3 above (where $N1$ is a $(N \times 1)$ vector of ones). This condition ensures that an inefficient bank is "benchmarked" against similar sized banks. As a result, VRTS technology envelops the data more closely than CRTS technology, and consequently, VRTS technical efficiency scores are greater than or equal to CRTS technical efficiency scores. The advantages of the VRTS model outweigh the increase in computational power necessary to solve the model, which allowed the VRTS to gain popularity over the CRTS method (Fried, Lovell, and Schmidt (1993), Coelli, Rao, and Battese (1998), Cooper, Seiford, and Tone (2000)).

Data Envelopment Analysis has been used extensively in studies of the banking industry in developed market economies.[9] On U.S. data alone the method was used in more than 30 published articles. The method was also applied for cases in Norway, Spain, the United Kingdom, and several other countries.[10] A vast literature uses DEA for inter-countries

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[7] $X = [x_1, ..., x_N]$ is a $(K \times N)$ input matrix with columns x_i and $Y = [y_1, ..., y_N]$ is an $(M \times N)$ output matrix with columns y_i.

[8] Essentially, θ_i measures the distance between a bank and the efficiency frontier, defined as a linear combination of best practice observations (a convex set thereof), with $\theta_i < 1$ implying that the bank is inside the frontier (i.e., it is an inefficient bank), while $\theta_i = 1$ implying that the bank is on the frontier (i.e., it is an efficient bank).

[9] Various versions of the Data Envelopment Analysis are used for monitoring and/or early warning systems used by bank regulatory agencies (see Barr, Seiford, and Siems (1994), and Brockett and others (1997)).

[10] See Berger and Humphrey (1997) for a detailed survey.

comparisons. For Scandinavian countries, a study by Berg and others (1993) computed a separate frontier for every country and a common frontier for all countries. The study found that Swedish banks were the most efficient, a result sustained by a follow-up paper by Bukh, Berg, and Forsund (1995). Bergendhal (1998) studied the same countries using a slightly modified approach. In a broader context, Pastor, Parez, and Quesada (1994) applied DEA to 427 banks from 8 developed countries. They found a mean efficiency value of 0.86, with the highest efficiency value of 0.95 for France and the lowest efficiency value of 0.55 for the United Kingdom.

III. Data and Measurement Issues

The analysis presented below is based on a data set compiled by BankScope.[11] The set contains comprehensive financial data on a large number of banks from transition economies. The distribution of sample banks by countries for 1995–98 is shown in Table 1. A total of seventeen transition countries are represented. Table 2 contains the shares of assets of sample banks in total assets of the banking system in each particular country. As one can see, the data set is fairly representative: in some cases (e.g., Croatia, Estonia, and Slovenia), it covers over 90 percent of the banking sector at a point in time between 1995 and 1998. Poorly represented banking sectors are those of Bulgaria, Russia, and Ukraine, where the share of sample banks does not exceed 40 percent for any particular year. The financial indicators of individual banks are collected by BankScope using audit reports of banks completed by internationally reputable auditing firms, and are believed to be largely compliant with international accounting standards. As we foresee arguments concerning the reliability of some of the indicators in an environment where serious misreporting and noncompliance takes place, the choice of countries (those with relatively advanced banking sectors compared with the overall population of transition economies[12]), and sample period (mid- as opposed to early transition) for this paper are believed to reduce the extent of these problems. Although there may be some pre-selection bias in the sample (since it could be argued that only better performing banks are likely to have arranged for an audit by international auditing firms) we believe that this would not jeopardize the validity of our (in essence cross-country) arguments. Nevertheless, we acknowledge the presence of data problems specific to the transition environment and discuss them in greater detail in subsequent sections.

A. Definitions and Measurement Issues

Before analyzing bank-level productivity indicators, we start by defining a bank's objectives and specifying its respective inputs and outputs. There is a long-standing debate over what exactly constitutes banking output. In Fixler and Zieschang's (1992) view, this output consists of "transaction services and portfolio management services that banks provide to depositors while acting as their intermediary." Arguably the range of services, as defined above, could be fairly wide and largely dependent on the degree of the economy's financial development. One should not be surprised to see both the width (variety) and the depth (complexity) of financial services

[11]In addition to making use of data collected by BankScope—which largely contained balance-sheet and income-statement information—with the help of World Bank field staff, we collected data on banks' employment and foreign ownership.

[12]Belarus and Ukraine would be the exceptions.

available to the general public change as the economy develops, so they should be expected to differ across countries.[13] The precise definition of a bank's "mandate" is important inasmuch as the definition of inputs and outputs stems from the functions that banks perform. The latter is essential for building our model.

The most commonly presented approaches to bank production could perhaps be summarized under the following three headings: asset approach, user-cost approach, and value-added approach. Under the *asset approach* banks are considered only as financial intermediaries between liability holders and fund beneficiaries (i.e., debtors). Loans and other assets are considered to be the banks' outputs, while deposits and other liabilities are inputs to the intermediation process (see, for instance, Sealey and Lindley (1977) for a discussion on this issue). While this approach seems to be appropriate for large banks that purchase their funds in big chunks from other banks and large institutional depositors, it may not be so for the majority of banks. For the smaller banks this method fails to account for transaction services delivered by the latter to their depositors, and therefore underestimates the overall value added of banking activities.

Under the *user-cost approach,* the net revenue generated by a particular asset or liability item determines whether that financial product is an input or an output. Hancock (1991) developed a model for bank production and was among the first to apply the user cost approach to banking. Hancock stated that it is not clear *ex ante* whether monetary goods are inputs or outputs in the production process. She goes on to say that if the financial returns on an asset exceed the opportunity cost of funds (or if the financial cost of a liability is less than the opportunity cost), then the instrument is considered to be a financial output. Otherwise, it is considered to be an input. According to Hancock's rule, demand deposits would be classified as outputs while time deposits would be classified as inputs. However, there are problems with this approach. First of all, as interest rates fluctuate, so does the user cost. An item which is considered to be an output in one period can turn into an input in the next period if the sign of its user cost changes. Moreover, it is difficult to measure marginal revenues and costs for each individual liability item. Thus the answer to the question whether an item is an input or output becomes a subject of significant measurement error and is sensitive to changes in data over time.

And finally, the *value-added approach* considers that both liability and asset categories have some output characteristics. Nevertheless, only those categories that have substantial value added are treated as outputs while the others are treated as either inputs or intermediate products depending on the specific attributes of each category. The value-added approach differs from the user cost approach in that it is based on actual operating cost data rather than determining these costs explicitly. This approach has been widely used in studies of the banking industry (Berger, Hanweck, and Hamphrey (1987), and Berger and Humphrey (1997)).

Taking into account the advantages and disadvantages of each method, the value added approach was employed, which enabled the classification of inputs and outputs based on their perceived value added. This method turns out to be quite attractive as it allows one to differentiate between

[13]For simplicity, it is assumed that beyond the difference explained by general macro-, as well as business environment-related indicators, no systemic differences exist between banking sectors in the sample countries.

various functions performed by the banks. What are they and why does one need to account for them? This too turns out to be crucial for the analysis. In analyzing the functions performed by commercial banks, Bergendhal (1998) mentions five fundamental goals of efficient bank management: profit maximization, risk management, service provision, intermediation, and utility provision. To keep things simple, we argue, without the loss of generality, that these five approaches could be pooled into two broadly defined ones: *profit maximization* (combining features of Bergendhal's profit maximization and risk management) and *service provision* (combining elements of service provision, intermediation and utility provision). In reality, any bank operation combines the elements of the two functions, since it is hard to imagine a legitimate bank which is not trying to generate (if not maximize) profits or establish a good rapport with its clients. Bearing this in mind, no weight is added to any of the functions, but instead elements of the two are incorporated into the model. We nevertheless specified two different output sets to incorporate the elements of both functions, each time to have greater emphasis put on one of the two functions performed.

The following three inputs to the banking "production process" are considered *labor, fixed assets* and *interest expenditures*. Doing so accounts for all three essential inputs to commercial bank operations: (1) personnel and management, (2) computer hardware and premises (which also captures the extensiveness of a bank's branch network), and (3) leveraged funds, respectively. Holding output (however specified) and two other inputs constant, the lesser amount of the third input used in the "production" would imply higher efficiency.

Next, we define the two sets of outputs as follows: (1) *revenues*,[14] *net loans*,[15] and *liquid assets*,[16] and (2) *deposits, net loans*, and *liquid assets*. As mentioned above, the efficiency indicator constructed based on the first set of outputs (hereafter denoted as DEA1) places greater emphasis on profit generation.[17] Similarly, an indicator based on the second set of outputs (hereafter denoted as DEA2) would stress service provision as a goal. Both indicators, DEA1 and DEA2, however, recognize the quality of loans (and, therefore, ex post returns) and the provision of liquidity services as objectives of a banks' operations. Since one of the objectives of the paper is to search for potential links between policies and various functions performed by a bank, contrasting these indicators and the ways they are affected by policy instruments will prove interesting.

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[14]Revenues are defined as the sum of interest and non-interest income.

[15]Net loans are defined as loans net of loan loss provisions.

[16]Liquid assets include cash, balances with monetary authorities, and holdings of treasury bills.

[17]The term "*profit maximization*" is intentionally not used here since it is not explicitly modeled in Equations 1–3. However, from the way the model is set up, one could think of the bank's objective as "*conditional* or *constrained* profit maximization": here the banks are assumed to be maximizing their revenues conditional upon (or subject to) a fixed level of costs. For a given level of costs, maximizing revenues would be identical to maximizing profits. Of course, owing to duality property, this problem is identical to minimizing costs subject to a fixed level of revenues.

Prior to turning our attention to the results of the estimation, it is perhaps worth reminding the reader about limitations of transition-specific data which are likely to have implications for the analysis through their impact on output measures. Problems primarily stem from imperfections in accounting standards which generally allowed doubtful treatments of some transactions and financial positions. The most notorious of these was a commonly used practice of rolling over the nonperforming loans by extending fresh credits to delinquent borrowers and immediately crediting the same amount (or a portion thereof) back in, showing it as an interest payment, hence inflating the balance sheet and overstating revenues. However, to the extent that these practices were common in practically all transition countries and all banks, the analysis is unlikely to be significantly affected as a result of these imperfections in our measures of bank revenues and net loans.

Yet in addition to accounting imperfections which defined the playing field for virtually all financial institutions in transition countries, there were country specific differences in the treatments of certain transactions. These primarily refer to differences in loan loss provisioning rules, loan classification requirements, and regulations regarding mandatory investments in liquid assets. For instance, while all principal and interest repayment on a loan had to be current for the loan to qualify as standard in Belarus, Croatia, Kazakhstan, Latvia, Poland, Romania, and Slovenia (at least for a portion of the sample period), "standard" loan classification guidelines in Bulgaria, Czech Republic, Lithuania and Slovakia allowed for up to a 30-day delay in repayments. Even when a loan is qualified as "watch" (the second group after the category of "standard" loans), the regulations provided for different degrees of provisioning, varying from 0 percent in Lithuania to 25 percent in Croatia and Bulgaria.[18, 19]

However, the issue which may have the largest impact on the current analysis is the issue of *enforcement* of prudential regulations, particularly regarding the loan loss provisioning across types of financial institutions. The anecdotal evidence suggests that the strictness with which regulations are being enforced varies not only across countries but also across types of banks (e.g., state- vs. privately-owned, new vs. old, etc.). Although this differentiated approach toward state- and privately-owned banks in the short run may be advocated on grounds of systemic/economic impact of possible bank closures—since old state-owned banks are likely to have a larger share of nonperforming loans and are, therefore, likely to register negative capital if full provisioning is enforced—the existence of the differentiated approach is likely to overstate the net loans of state-owned banks and therefore their performance as measured by the DEA approach. Understandably, these and other data limitations (especially those which are bank-specific and not country- or, more generally, transition-specific) may take a heavy toll on the outcome of our analysis. Yet, by acknowledging the presence of these problems (and, in fact, our inability to deal with some of them within the framework of this paper), we still hope to be able to provide a useful framework for analyzing banking efficiency by, among other things, flagging the potential problems as we unveil our results. With these caveats in mind, let us now proceed to the results of the DEA analysis.

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[18]The treatments also differed by countries according to the way the collateral entered the formula for determining the required provisioning, ranging from full exclusion to full inclusion.

[19]More details on these and other prudential standards are available from authors upon request.

B. Results of Efficiency Analysis

The results of DEA analysis by countries using the model described in Equation 3 is presented in Tables 3 and 4. Countries that produced the best outcome in terms of a revenue-based index (i.e., DEA1) are the Czech Republic (1995 and again in 1998), the Slovak Republic (1996), and Croatia (1997). The list of those achieving the best service-based index (i.e., DEA2) were the Czech Republic (1995), Slovenia (1996 and again in 1998), and Latvia (1997). Conversely, countries that yielded the lowest revenue-based index in any one of the four years are Lithuania (1995), Belarus (1996 and 1997) and Moldova (1998). The worst performers in terms of the service-based index were Belarus (1995 and 1996), Romania (1997) and Ukraine (1998). To further check the consistency of the analysis, the countries were grouped together in three relatively homogenous clusters (subregions).[20] Figures 1 and 2 summarize the findings across subregions. A number of interesting points are worth stressing here.

First of all, if looked at through the prism of medium term development, results vary across functions that banks perform. It is interesting to note that while the catch-up rate[21] of a revenue-based index of the entire sample was less than 1 percent every year between 1995 and 1998, the average catch-up rate of a service-based index reached a level of 16.5 percent per annum. This suggests that even though an average bank in the region might have reached a satiation point in terms of its ability to improve upon revenue performance (either because it knew a lot at the outset or further improvements were outside of their control, or both), it had a lot to learn in terms of reaching out and delivering transaction services to its clients.

Second, although experiencing less of a lag compared to banks in the Central European (CE) and the Southeastern European (SEE) regions in terms of revenue generating capacity, banks in the Commonwealth of Independent States (CIS) countries are clearly in a more disadvantageous position if judged by the service-based index. However, it turns out there are dramatic differences between the rate of catch-up in a service-based index across subregions: the DEA2 index for CIS countries grew on average 30 percent per annum, followed by almost 16 percent in SEE countries, and only 11 percent in CE countries.

Third, with the exception of 1997, banks in Central Europe are more efficient in terms of both revenue generating capacity as well as the ability to provide services to their clients. A skeptical reader should note that the presence of the sample bias—resulting because countries with more advanced banking systems may have a larger share of their banks (i.e., both strong and weak banks) presented in the sample—does not run in favor of CE banks. On the contrary, eliminating

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[20]The first cluster, Central Europe (CE), includes the Czech Republic, Hungary, Poland, the Slovak Republic and Slovenia. The second cluster, Southern and Eastern Europe and the Baltic Republics (SEE), consists of Bulgaria, Croatia, Romania, Estonia, Latvia, and Lithuania. Finally, the third cluster, the Commonwealth of Independent States (CIS), includes Armenia, Belarus, Kazakhstan, Moldova, the Russian Federation, and Ukraine.

[21]Since the DEA index is a relative measure of efficiency vis-à-vis the most efficient bank, the term *catch-up rate* (symbolizing the reduction of distance between the bank in question and the most efficient bank) is a more appropriate one to use than the term *growth rate*.

the bias (by ensuring equal representation from all countries) is likely to make the difference between CE and CIS look larger.

Overall, we conclude that the trends described above are largely consistent with one's expectations about banking sectors in various transition countries, thereby indicating that the DEA analysis could be successfully applied in studies of banking in transition economies. Despite concerns about the quality of data, the analysis provides a somewhat plausible outcome in terms of the relative ranking of countries and subregions. Thus confident in the quality of the indicators, we proceed to the next chapter where we evaluate the effects of various institutional and policy settings on these indicators.

IV. Second-Stage Regression Results

The purpose of this section is to take a step further in analyzing banking sector productivity indicators by looking at their potential determinants. In doing so let us assume that the provision of banking services could be presented, in a simplified setting, by the following function:

$$y_{ij} = f_i(B_{ij}, M_j R_j, E_j) \qquad (5)$$

where y_{ij} measures output or efficiency of i^{th} commercial bank operating in country j, B_{ij} denotes bank specific variables, M_j describes the macroeconomic environment in country j, and R_j and E_j define the regulatory and general business environment respectively. Assuming that the above factors affect the bank efficiency and productivity in additive fashion, the coefficients of interest could be estimated using the following specification:

$$DEA_{ij} = \alpha + \sum_p \beta_p B_{ij,p} + \sum_k \gamma_k M_{j,k} + \sum_m \eta_m R_{j,m} + \sum_n \lambda_n E_{j.n} + \varepsilon_{ij} \qquad (6)$$

The dependent variable is the efficiency index, DEA, calculated earlier in Chapter 4.

To control for bank-specific features, we included (1) equity as a share of total assets, (2) a bank's assets as a share of total assets of the banking system of its country of origin (i.e., market concentration), (3) a dummy variable for foreign controlled banks,[22] and (4) a dummy variable to account for new versus old banks.[23] The following are indicators describing the underlying macroeconomic environment: GDP per capita, annual average rate of inflation, and monetary depth and size of the financial sector (measured by the ratio of broad money to GDP).[24] It should

[22]This variable takes the value of 1 if a bank is more than 30 percent foreign owned, and 0 otherwise.

[23]This variable takes the value of 1 if a bank is newly established, and 0 if it was established before 1990.

[24]Controlling for crisis in the region proved to be quite a challenging task, which we were unable to complete. The primary reason for abandoning the idea of controlling for crisis is the mere definition of it. Although, it is true that some events that affected transition countries in the course of the 1990s had little or no cross-border repercussions (e.g., those in Estonia and Latvia in 1995, Bulgaria in 1996, and the Czech Republic and Romania in 1997), at least one event in

be noted that including inflation in Equation 6 is intended to capture the potential inefficiencies, which could take the form of both price (e.g., high interest margins) and nonprice (e.g., excessive branching) behavior, common for high inflationary environments.[25]

Because of difficulties with obtaining a consistent series on a broad range of prudential requirements, the choice of indicators describing the regulatory environment was the most difficult one to make. We, nevertheless, were able to construct a data series on (1) capital adequacy, (2) maximum exposure to a single borrower, and (3) a limit on the foreign exchange open position for four consecutive years, 1995–98.

Differences relating to the institutional and general business environment are captured in the regressions by including the EBRD indexes of legal/institutional quality and enterprise restructuring. Developments in capital markets and nonbank financial institutions and their effect on commercial bank performance are captured by (1) stock market capitalization, and (2) EBRD index of securities markets and nonbank financial institutions development.

Finally, subregional dummy variables are used (distinguishing between Central European, South-East European/Baltic and CIS countries) to capture any differences in efficiency indicators not accounted for by the above measures.

A. Regression Outcome

Due to the limited nature of the dependent variable (note that the DEA index ranges between 0 and 1), a censored Tobit regression model was used to estimate Equation 6. Unlike a conventional Ordinary Least Squares estimation, in cases with limited dependent variables, Tobit models are known to generate consistent estimates of regression coefficients. The results of estimation based on pulled annual cross-section data are presented in Table 5. Overall, regressions provide a reasonably good fit and are robust with respect to the inclusion of new variables. The outcome is definitely worth some consideration.

First, the results suggest that well-capitalized banks are ranked higher in terms of their ability to collect deposits than their poorly capitalized counterparts. This is in line with the conventional

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the history of the region had major subregional, if not regional, implications. It is the Russian crisis of August 1998. While this was clearly a major adverse shock to the banking sector and the economy of Russia as a whole (which one ideally would like to be able to control), it also had adverse effects on economies of the entire region (the countries of former Soviet Union in particular). It is a well documented fact that a number of countries in the region (Armenia, Hungary, Kyrgyz Republic, and Ukraine, to name but a few), were perhaps hit almost as hard as Russia itself in terms of the effect on quality of bank assets, the stock markets, purchasing power of economic agents, etc. Now, the question is, do these countries qualify to get a value of 1 as far as the dummy variable for crises is concerned? Where does one draw the line? Yet, this said, we assume that the regression will still capture the events of the crisis since relevant information is likely to be contained in the rate of inflation, stock market capitalization, and per capita income.

[25]Examples where high inflationary environment led banks to build excessive branch networks include Argentina, Brazil, Turkey, to name but a few.

wisdom of capital playing a role of implicit deposit insurance, which in turn encourages more deposits. The reasoning behind the observed positive link between capitalization and revenues is, however, less obvious. Although the causality might run both ways, most studies found that well-capitalized banks are more efficient (see, for example, Berger and Mester (1997)). A possible explanation for this could be based on the theory of moral hazard: the managers of banks that are closer to bankruptcy will be more inclined to pursue their own goals (knowing the bank closure is in sight), which are not necessarily in line with the owners' objectives.

Second, it appears that banks with a larger share of a given country's market are likely to be more efficient than those with a smaller share. This might be the case if banks were to take advantage of economies of scale (or at least a wider array of borrowers), or play the role of a market maker on the loanable funds market. As far as the deposit-based performance is concerned (DEA2), larger banks are likely to be viewed as too-big-to-fail, and therefore enjoy higher credibility than their smaller counterparts. This phenomenon could subsequently emerge in lower premiums depositors charge banks for their willingness to deposit their savings with them, hence lowering the banks' interest expenditures. In any case, this outcome is consistent with Demirguc-Kunt and Detragiache (1998), who find that financial liberalization (defined as removal of barriers to competition) makes a financial system weaker and a crisis more likely. The authors also show that the impact of liberalization on banking sector fragility is weaker in countries with a more developed institutional environment. Therefore, we conjecture that given a level of institutional development—especially in a fragile transition environment—lower concentration, and therefore, more competition is likely to be associated with lower efficiency. As the economic environment becomes stable (and hopefully so does the institutional framework surrounding the banking system), the banks should be able to handle more competitive pressures by responding in the usual efficiency-enhancing manner. The presence of this nonlinearity in the behavior of competition-performance link becomes compelling if one compares banking systems in countries that undertook the path to consolidation (e.g., Estonia) with those where banking sectors remained relatively dispersed (e.g., Latvia and Lithuania). Getting off to a somewhat similar start with neighboring Latvia and Lithuania, the banking system in Estonia was able to consolidate sooner and weather most of the shocks which hit the banking system in the 1990s and became one of the success stories among transition economies.[26]

Third, banks with controlling share of foreign ownership are likely to be more efficient than their domestically owned counterparts (including state-owned and private domestic). This should come as no surprise because of the ability of foreign owned banks to capitalize on their access to better risk management and operational techniques, which is usually made available through their parent banks abroad. In addition, as foreign ownership is likely to be concentrated, foreign owned banks are less prone to typical corporate governance conflict between (dispersed) owners and the management. The anecdotal evidence also shows that foreign owned banks are more likely to cherry-pick the best borrowers available on the market (especially those from their own countries of origin), thereby improving the quality of their portfolio and increasing *ex post*

[26] The crisis of 1992 was caused by freezing by Russian authorities of accounts of the two largest Estonian banks in Moscow, partly coupled with severe liquidity crunch imposed by the Bank of Estonia (see Fleming, Chu, and Bakker (1996)). The total fiscal cost of banking crisis in Estonia was estimated to be 1.9 percent of GDP, compared with 2.7 and 3.1 percent in Latvia and Lithuania respectively (see Tang, Zoli, and Klytchnikova (2000), p. 35).

returns. On the deposit side, owing to a popular perception that, if necessary, a foreign owned bank will be bailed out by its more powerful parent institutions abroad, foreign ownership plays a role of implicit deposit insurance. Therefore, foreign owned banks would be likely to attract deposits by paying lower rates than their domestically owned counterparts.[27]

Fourth, on another bank specific variable included in the regressions (i.e., dummy variable for new vs. old banks) the outcome is just as intriguing. It turns out that after controlling for ownership, newly established banks are not necessarily more efficient than those that existed prior to 1990. Note that if viewed as a proxy for overall private ownership[28] (since banks that were established after 1990 are likely to have a larger share of private ownership—both domestic and foreign—than banks that existed prior to 1990), the results shed some light on the effect of domestic private ownership on efficiency. It appears that although positive, its effect is not statistically significant. However, if viewed together with the point made in the previous paragraph (i.e., banks with controlling share of foreign ownership are more efficient), this suggests that unless privatization leads to a controlling foreign ownership, privatization of banks does not lead to statistically significant improvements in efficiency. This finding reiterates the importance of factors that are usually associated with foreign ownership for banking operations in a transition environment: transfer of technology, better management, and favorable (transition country) public opinion.

Fifth, although there seems to be some indication that prudential regulations have an impact on the efficiency of banks, the effects are not uniform across different prudential norms. Tighter minimum capital adequacy ratios seem to be associated with improved revenue generating capacity (DEA1) and more aggressive deposit taking behavior (DEA2).[29] On the other hand, the impact of a single borrower limit on efficiency is insignificant.[30] This is perhaps explained by banks' own increasing interest in diversifying away from large credit exposures, which is in turn facilitated by the availability of more advanced market instruments (including wider use of Treasury securities). This suggests that diversification objectives of regulatory authorities are generally in line with those of the banks, and that further tightening of single borrower exposure limits should come at no cost to banks. This is consistent with Barth, Caprio, and Levine (2001)

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[27]A notable example of this taking place in a transition environment is Yerevan-based HSBC-Armenia bank (originally set up as Midland-Armenia bank). For years being the only foreign owned bank in Armenia and having offered deposit rates, which are three to four times lower than those offered by its domestic counterparts, the bank has managed to increase its share of deposits over time.

[28]It should be noted that the dataset did not contain information on state ownership of the banks, and therefore it was impossible for us to explicitly control for domestic private ownership.

[29]This result runs contrary to Barth, Caprio, and Levine (2001) who find that there is no relationship between stringency of capital requirements and bank performance.

[30]Note that, unlike capital adequacy ratio, higher values of single borrower and foreign exchange exposure limits imply less stringent control.

who find no link between diversification guidelines and banking development and efficiency.[31] Finally, banks in countries with relatively lax foreign exchange exposure regulations seem to be doing better than those in countries with tighter policies. This could be explained by the fact that in some countries in transition, foreign exchange earnings constitute a big share of noninterest income, and tightening limits on foreign exposure effectively limits banks' ability to make extra income on foreign exchange transactions. Tighter standards on foreign exchange positions seem to affect banks' intermediation function as well (DEA2). This could be explained by the fact that most depositors in the region, perhaps rationally so, still prefer foreign currency denominated instruments to those denominated in domestic currency. Of course, should this be the case, depending on their asset position, banks will be restricted in their ability to borrow in foreign currency. Overall, this indicates that further limiting foreign exchange related exposure is likely to come at a cost.

Sixth, the coefficient on GDP per capita indicates that banks in higher per capita income countries are more efficient in terms of attracting more deposits and generating stronger cash flows than banks in low income countries. This should not be surprising as countries with higher per capita income (i.e., more developed countries) tend to generate more savings, and hence more deposits.[32] Concerning other elements of the macro environment, our findings on the effect (or precisely lack thereof) of macro financial structure are consistent with those of Demirguc-Kunt and Huizinga (2000) who report no effect of macro financial structure on commercial bank performance. An interesting point to note in this regard is that unlike the experience of some countries (notably in Latin America), high inflation is not necessarily associated with large-scale inefficiencies, which could take the form of price- and nonprice behavior, as hypothesized earlier.

Seventh, the insignificance of the coefficient on the quality of institutions is surprising, but by no means unexplainable. The effect of a developed legal and regulatory system is likely to be captured by other factors, such as foreign ownership or per capita GDP. It could be argued that a developed legal and regulatory regime is conducive to foreign entry, since it is likely to reduce the transaction costs (associated with entry) and the likelihood of expropriation (of foreign assets by the state). In addition, it has been demonstrated that a developed legal framework and the rule of law are positively correlated with economic growth (see, for instance, Knack and Keefer, 1995). Should this be the case, of course, foreign ownership and per capita GDP indicators would be stealing some explanatory power away from the indicators of institutional quality, possibly making their effect on banking efficiency insignificant. Finally, since countries grouped in the same subregion are likely to be similar at least in terms of the *enforcement* of laws (i.e., a *de facto* indicator of rule of law), if not in terms of the development of the legal system (i.e., a *de jure* measure), the effect of institutional quality indicators on banking efficiency are likely to be captured also by subregional dummies.

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[31]The diversification index (an aggregate of diversification guidelines and foreign lending related limits) was, however, found by Barth, Caprio, and Levine (2001) to have explanatory power in terms of predicting major banking crises in small countries.

[32]The link between the level of a country's development and revenue-based efficiency is less clear, since higher risks of investment projects may end up being outweighed by higher marginal returns on investments.

Eighth, as one should have expected, the EBRD indicators of enterprise restructuring have strong explanatory power in determining bank efficiency across countries. The presence of this link carries a strong message that privatization of state-owned enterprises, enterprise competition, and corporate governance-related improvements (i.e., to name but a few criteria covered by the EBRD enterprise restructuring index) are important in boosting commercial bank efficiency. This could obviously work through (i) improved efficiency of enterprises themselves (which then results in improved portfolio quality and revenue generation ability of banks), but also through (ii) intensified corporate governance pressures exerted by the newly emerging and stronger private sector on commercial banks.

Finally, there is some evidence that securities market and nonbank financial institutions development hinders the efficiency of banks. The results indicate that higher securities market capitalization reduces revenue-based efficiency, while more developed nonbank financial institutions hinder deposit taking. As unusual as these links may sound at first, they are not counterintuitive. On the one hand, it is relatively straightforward to see that an opportunity to raise funds on the stock market would reduce the demand for bank loans by the best borrowers on the market. Less credits extended to the *crème de la crème* would then manifest itself into lower *ex post* returns and result in lower efficiency of banking operations. In that sense, this outcome supports the one on the competition-performance link made above. On the other hand, more developed nonbank financial institutions (i.e., pension funds, insurance companies, brokerage firms, etc.) would in all likelihood produce a greater demand for household savings, thereby reducing the amount of bank deposits available to the banks and eventually transaction services rendered by the banks.

V. Conclusions

This paper argues that to fully assess the efficiency of commercial bank operations it is necessary to model various types of functions performed by banks and control for the inputs necessary to provide a certain level of utility to owners (that is, profits) and depositors (that is, services) while performing those functions. In presenting this argument, we have used Data Envelopment Analysis (DEA) to measure bank efficiency by stressing profit maximization and provision of transaction services as banks' primary objectives.

One of the contributions of this paper to the empirical literature is that it demonstrates that DEA could be successfully applied to banking systems in transition countries. Despite certain concerns about the quality of data in less advanced transition countries and its incompatibility with that of more advanced reformers, the analysis provides a plausible outcome in terms of the relative ranking of countries and subregions.

This analysis is the first attempt to consider differences in commercial bank efficiency across transition countries and a number of years against a wide array of variables describing macro environment, regulatory regime, institutional quality, enterprise restructuring, and nonbank financial sector development. The paper is, therefore, able to provide some answers to a range of fundamental questions of financial sector policymaking in transition.

First, it sheds some light on the question of the optimal architecture of a banking system. If combined, the positive effects of capitalization and market concentration on DEA indicators

suggest that banking sectors with a few large, well-capitalized banks are likely to generate better efficiency and higher rates of intermediation.

Second, our findings on the effects of prudential tightening on the efficiency of banks vary across different prudential norms. Although policy actions in this regard may require deeper case-by-case analyses, we conclude that, contrary to conventional wisdom, not all prudential requirements are detrimental to efficiency. Specifically, we found that (1) tighter minimum capital-adequacy ratios are associated with stronger revenue-generating capacity and more aggressive deposit-taking behavior; (2) banks in countries with relatively lax foreign exchange exposure limits are doing better than those in countries with tighter policies; and (3) the single borrower-related limits do not affect bank performance in a statistically significant manner.

Finally, the results provide a useful lesson about the effect of private share ownership on bank efficiency. They suggest that privatization of banks, beyond those involving a transfer of controlling share to foreign owners, does not necessarily lead to statistically significant improvements in efficiency. It would, however, be interesting to see whether the efficiency gains introduced by foreign ownership are due to better managerial control or to the transfer of technology from the banks' foreign owners.

The paper is not without shortcomings. First, as indicated above, the analysis may suffer from a sample-selection bias resulting from the fact that some countries (especially those in the CIS) are poorly represented in the dataset. Since it is more likely that only better-performing CIS banks are in the sample, the bias is likely to underestimate the gap in average bank efficiency between CIS and other subregions. Second, the paper fails to account for any potential complementarity between a regulatory environment, on the one hand, and country- and individual bank-specific indicators, on the other hand. Doing so might have shed some light on differences between the effect of regulatory measures on efficiency across countries with different levels of institutional and/or economic development. Nevertheless, we acknowledge these shortcomings and leave it for further research to properly address them.

Summary of Indicators Used

Dependent variables—efficiency indicators

DEA1 Individual bank DEA indicator with revenues, net loans, and liquid assets used as outputs
DEA2 Individual bank DEA indicator with deposits, net loans, and liquid assets used as outputs

Individual bank-specific variables

Number of employees
Value of fixed assets
Interest expenditures
Value of outstanding loans, net of accumulated provisions
Cash, balances with monetary authorities, and treasury bills
Interest and non-interest income
Total value of deposits
Equity of the bank over total assets
Dummy for foreign ownership (1 if more than 30 percent owned, 0 otherwise)
Whether the bank was established before or after 1990 (1 if new, 0 if old)
Ratio of bank's total assets to the total assets of the banking system

Macroeconomic indicators

GDP per capita, PPP adjusted
Annual average rate of inflation
Ratio of M2 to GDP

Institutional quality and "rule of law" indicators

Overall score for extensiveness and effectiveness of law [European Bank for Reconstruction and Development (EBRD)]

Transition/restructuring indicators

Enterprise restructuring (EBRD)

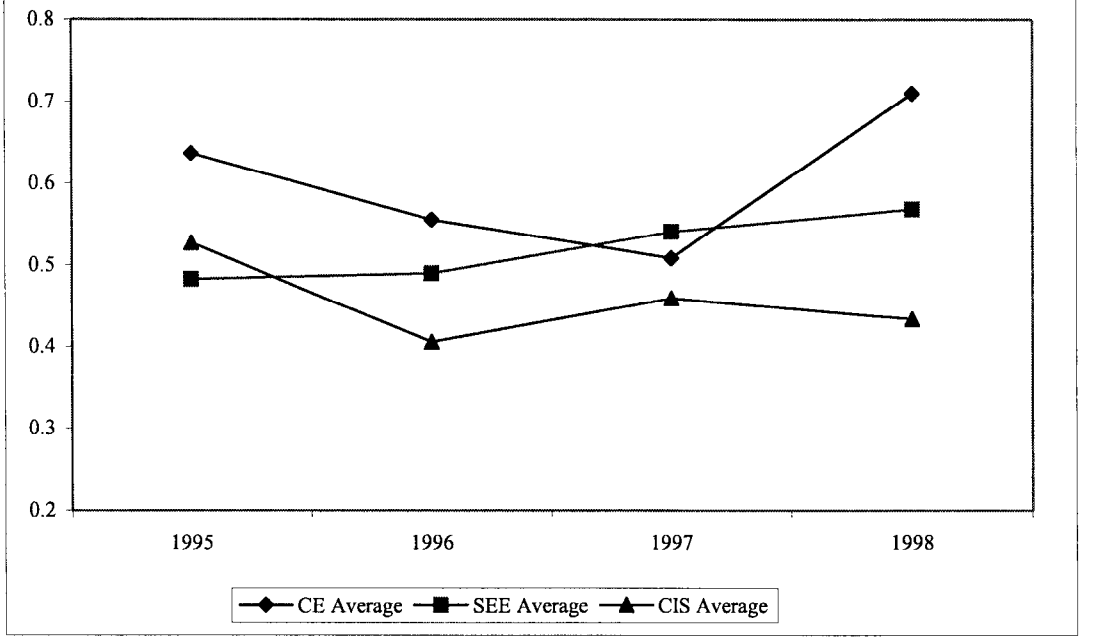
Prudential standards

Capital-adequacy ratio
Maximum exposure to single borrower
Limit on foreign exchange open position

Capital markets/nonbank financial institutions

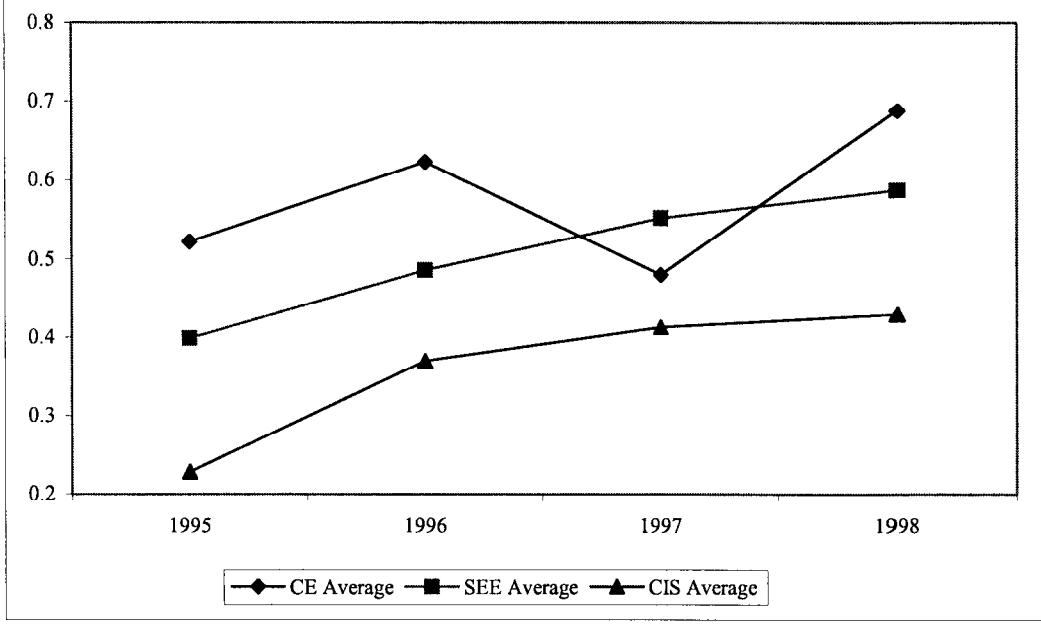
Stock market capitalization in percent of GDP
Securities markets and nonbank financial institutions (EBRD)

Figure 1. DEA Indicators by Subregions, 1995–98
(outputs: revenues, net loans, and liquid assets)



Notes: CE denotes Central Europe, SEE Southeastern Europe, and CIS the Commonwealth of Independent States.

Figure 2. DEA Indicators by Subregions, 1995–98
(outputs: deposits, net loans, and liquid assets)



Notes: CE denotes Central Europe, SEE Southeastern Europe, and CIS the Commonwealth of Independent States.

Table 1. Sample Banks, by Country, 1995–98

	1995	1996	1997	1998	Total number of observations
Armenia	...	4	7	6	17
Belarus	6	9	10	8	33
Bulgaria	10	13	17	17	57
Croatia	19	25	32	31	107
Czech Republic	10	20	23	15	68
Estonia	5	6	6	3	20
Hungary	20	22	22	19	83
Kazakhstan	1	4	12	11	28
Latvia	13	13	12	12	50
Lithuania	5	6	7	7	25
Moldova	1	1	7	5	14
Poland	24	31	33	30	118
Romania	9	9	18	17	53
Russian Federation	53	58	66	40	217
Slovak Republic	10	16	17	13	56
Slovenia	14	16	27	17	74
Ukraine	9	12	18	15	54
Total	209	265	334	266	1,074

Table 2. Assets of Sample Banks as a Percentage of Total Banking System Assets, 1995–98

	1995	1996	1997	1998
Armenia	...	50	66	47
Belarus	...	...	48	82
Bulgaria	5	5	24	28
Croatia	80	92	93	92
Czech Republic	25	54	62	44
Estonia	50	59	70	93
Hungary	41	42	47	45
Kazakhstan	2	9	44	52
Latvia	...	66	68	67
Lithuania	38	42	50	54
Moldova	...	...	61	63
Poland	25	39	45	45
Romania	22	60	64	44
Russian Federation	4	37	34	22
Slovak Republic	48	50	50	39
Slovenia	73	79	92	89
Ukraine	...	...	25	20

Table 3. DEA1 Average, by Country and Subregion, 1995–98

	1995	1996	1997	1998
Central Europe (CE)				
Czech Republic	0.769	0.547	0.552	0.799
Hungary	0.632	0.496	0.542	0.683
Poland	0.440	0.456	0.473	0.687
Slovak Republic	0.640	0.647	0.457	0.611
Slovenia	0.705	0.630	0.516	0.771
CE Average	0.637	0.555	0.508	0.710
Southeastern Europe (SEE) and Baltics				
Bulgaria	0.529	0.566	0.542	0.711
Croatia	0.597	0.568	0.598	0.627
Estonia	0.460	0.472	0.564	0.641
Latvia	0.563	0.488	0.544	0.522
Lithuania	0.264	0.466	0.521	0.541
Romania	0.532	0.455	0.472	0.511
SEE Average	0.491	0.503	0.540	0.592
Commonwealth of Independent States(CIS)				
Armenia		0.328	0.408	0.338
Belarus	0.491	0.237	0.316	0.516
Kazakhstan	-	0.572	0.612	0.594
Moldova	-	-	0.412	0.272
Russian Federation	0.603	0.47	0.515	0.493
Ukraine	0.488	0.346	0.445	0.293
CIS Average	0.527	0.391	0.451	0.418

Table 4. DEA2 Average, by Country and Subregion, 1995–98

	1995	1996	1997	1998
Central Europe (CE)				
Czech Republic	0.721	0.671	0.569	0.788
Hungary	0.413	0.524	0.458	0.597
Poland	0.245	0.471	0.383	0.617
Slovak Republic	0.604	0.720	0.426	0.594
Slovenia	0.627	0.726	0.565	0.843
CE Average	0.522	0.622	0.480	0.688
Southeastern Europe (SEE) and Baltics				
Bulgaria	0.361	0.362	0.401	0.768
Croatia	0.501	0.586	0.601	0.631
Estonia	0.452	0.509	0.571	0.715
Latvia	0.586	0.545	0.784	0.664
Lithuania	0.211	0.495	0.568	0.588
Romania	0.243	0.296	0.238	0.335
SEE Average	0.399	0.486	0.552	0.587
Commonwealth of Independent States (CIS)				
Armenia	-	0.373	0.344	0.380
Belarus	0.155	0.248	0.316	0.554
Kazakhstan	-	0.576	0.524	0.574
Moldova	-	-	0.382	0.279
Russian Federation	0.332	0.396	0.453	0.483
Ukraine	0.196	0.260	0.388	0.260
CIS Average	0.228	0.371	0.401	0.422

Table 5. Second-Stage Regression Results: Censored Tobit Analysis

Dependent Variable	DEA1	DEA2	DEA1	DEA2	DEA1	DEA2	DEA1	DEA2	DEA1	DEA2
GDP per capita	4.36E-05**	7.74E-05**	4.56E-05**	8.91E-05**	4.77E-05**	8.47E-05**	5.48E-05**	8.33E-05**	4.53E-05**	9.57E-05**
	(4.261)	(4.698)	(4.374)	(5.118)	(4.549)	(4.940)	(4.869)	(4.670)	(4.204)	(5.403)
Inflation	4.15E-05	-5E-05	5.71E-05	-7.5E-05	7.82E-05	3.14E-06	7.0E-05	7.82E-06	8.9E-05	-4.8E-05
	(0.513)	(-0.597)	(0.673)	(-0.861)	(0.911)	(0.036)	(0.796)	(0.088)	(1.029)	(-0.535)
M2/GDP	0.118	0.126	0.126	-0.01015	0.072	0.028	0.117	0.028	0.085	-0.089
	(0.825)	(0.672)	(0.811)	(-0.052)	(0.454)	(0.147)	(0.727)	(0.148)	(0.533)	(-0.453)
Equity/assets	0.444**	0.226**	0.414**	0.156	0.4079**	0.145	0.402**	0.146	0.415**	0.140
	(4.964)	(2.376)	(4.426)	(1.531)	(4.368)	(1.446)	(4.315)	(1.451)	(4.433)	(1.398)
Market concentration	2.031**	1.450**	1.974**	1.483**	1.980**	1.512**	2.015**	1.504**	1.996**	1.472**
	(8.018)	(5.849)	(7.577)	(5.713)	(7.621)	(5.907)	(7.723)	(5.847)	(7.679)	(5.755)
New vs. old	0.026	0.034	0.025	0.029	0.025	0.037	0.0202	0.038	0.026	0.032
	(0.914)	(1.157)	(0.833)	(0.919)	(0.842)	(1.210)	(0.680)	(1.228)	(0.863)	(1.026)
Foreign ownership	0.229**	0.242**	0.237**	0.251**	0.239**	0.252**	0.247**	0.250**	0.241**	0.252**
	(9.376)	(9.072)	(9.407)	(9.118)	(9.475)	(9.296)	(9.644)	(9.145)	(9.527)	(9.344)
Capital adequacy	0.017	0.064**	0.022**	0.069**	0.025**	0.068**	0.021*	0.069**	0.026**	0.074**
	(1.612)	(5.004)	(1.968)	(4.665)	(2.159)	(4.683)	(1.789)	(4.519)	(2.248)	(5.073)
Single borrower limit	8.95E-05	0.002	0.0001	0.001	0.0001	-0.0003	0.0002	-0.00026	0.00014	0.004
	(0.814)	(0.975)	(1.142)	(0.364)	(1.130)	(-0.172)	(1.259)	(-0.148)	(1.097)	(1.601)
Forex exposure limit	0.003**	0.004**	0.004**	0.004**	0.002	0.002	0.0028	0.002	0.0014	0.003**
	(2.285)	(3.063)	(2.454)	(2.680)	(1.270)	(1.549)	(1.593)	(1.531)	(0.730)	(2.207)
Legal/institutional quality			0.013	-0.006	0.003	0.005	0.0138	0.005	-0.006	-0.00028
			(0.483)	(-0.181)	(0.095)	(0.146)	(0.504)	(0.153)	(-0.216)	(-0.009)
Enterprise restructuring					0.087	0.241**	0.114**	0.234**	0.087	0.221**
					(1.540)	(4.075)	(1.957)	(3.639)	(1.551)	(3.703)
Market capitalization							-0.005*	0.001		
							(-1.723)	(0.296)		
Securities market									0.037	-0.142**
									(0.959)	(-2.395)
Subregional dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-0.190	-0.781**	-0.277	-0.765**	-0.398**	-1.174**	-0.494**	-1.168**	-0.445**	-1.042**
	(-1.303)	(-4.303)	(-1.490)	(-3.496)	(-1.973)	(-4.935)	(-2.365)	(-4.892)	(-2.146)	(-4.286)
No. of observations	700	630	661	589	661	589	661	589	661	589
R-squared	0.31	0.31	0.31	0.32	0.32	0.35	0.32	0.35	0.32	0.37

Notes: *t*-statistics are in parentheses. ** and * indicate significance at 5 percent and 10 percent confidence levels, respectively.

References

Banker, R.D., A. Charnes, and W.W. Cooper, 1984, "Some Models for Estimating Technical and Scale Inefficiencies in Data Envelopment Analysis," *Management Science*, Vol. 30, pp. 1078–92.

Barr, R. S., L.M. Seiford, and T.F. Siems, 1994, "Forecasting Bank Failure: A Non-Parametric Frontier Estimation Approach," *Recherches Economiques de Louvain*, Vol. 60, No. 4, pp. 417–29.

Barth, J., G. Caprio, and R. Levine, 2001, "Bank Regulation and Supervision: What Works Best?" unpublished; Washington: World Bank.

Berg, A., E. R. Borensztein, R. Sahay, and J. Zettelmeyer, 1999, "The Evolution of Output in Transition Economies—Explaining the Differences," IMF Working Paper No. 99/73 (Washington: International Monetary Fund).

Berg, S.A., F.R. Forsund, L. Hjalmarsson, and M. Suominen, 1993, "Banking Efficiency in the Nordic Countries," *Journal of Banking and Finance*, Vol. 17, No. 2–3, pp. 371–88.

Bergendahl, G., 1998, "DEA and Benchmarks – An Application to Nordic Banks," *Annals of Operations Research*, Vol. 82, pp. 233–49.

Berger, A.N., G.A. Hanweck, and D.B. Humphrey, 1987, "Competitive Viability in Banking: Scale, Scope and Product Mix Economies," *Journal of Monetary Economics*, Vol. 20, pp. 501–20.

Berger, A.N., and D.B. Humphrey, 1997, "Efficiency of Financial Institutions: International Survey and Directions for Future Research," *European Journal of Operational Research*, Vol. 98, No. 2, pp. 175–212.

Berger, A.N., and L.J. Mester, 1997, "Efficiency and Productivity Change in the U.S. Commercial Banking Industry: A Comparison of the 1980s and 1990s," Federal Reserve Bank of Philadelphia Working Paper No. 97-5 (Philadelphia).

Brockett, P.L., A. Charnes, W.W. Cooper, Z.M. Huang, and D.B. Sun, 1997, "Data Transformations in DEA Cone Ratio Envelopment Approaches for Monitoring Bank Performances," *European Journal of Operational Research*, Vol. 98, No. 2, pp. 250–68.

Bukh, P.N.D., S.A. Berg, and F.R. Forsund, 1995, "Banking Efficiency in the Nordic Countries: A Four-Country Malmquist Index Analysis," University of Aarhus Working Paper (Aarhus, Denmark).

Charnes A., W.W. Cooper, A.Y. Lewin, and L.M. Seiford, 1994, "Data Envelopment Analysis: Theory, Methodology and Applications" (Dordrecht and Boston: Kluwer Academic Publishers).

Charnes, A., W.W. Cooper, and E. Rhodes, 1978, "Measuring the Efficiency of Decision Making Units," *European Journal of Operations Research*, No. 2, pp. 429–44.

Claessens, S., 1996, "Banking Reform in Transition Countries," World Development Report (Washington: World Bank).

Coelli, T., D.S.P. Rao, and G.E. Battese,1998, "An Introduction to Efficiency and Productivity Analysis" (Norwell, MA: Kluwer Academic Publishers).

Cooper, W.W., L.M. Seiford, and K. Tone, 2000, "Data Envelopment Analysis" (Norwell, MA: Kluwer Academic Publishers).

de Melo, M., C. Denizer, A. Gelb, and S. Tenev, 1997, "Circumstance and Choice: The Role of Initial Conditions and Policies in Transition Economies," *The World Bank Policy Research Working Paper No. 1866* (Washington: World Bank).

Demirgüç-Kunt, A., and E. Detragiache, 1998, "Financial Liberalization and Financial Fragility," *IMF Working Paper No. 98/83,* Washington, D.C.

Demirgüç-Kunt, A., and Huizinga, 2000, "Financial Structure and Bank Profitability," unpublished (Washington: World Bank).

Farrell, M.J., 1957, "The Measurement of Profit Efficiency," *Journal of the Royal Statistical Society, Series A,* CXX, Part 3, pp. 253–90.

Fixler, D., and K. Zieschang, 1992, "An Index Number Approach to Measuring Bank Efficiency: An Application to Mergers," *Journal of Banking and Finance*, Vol. 17, pp. 437–50.

Fleming, A., L. Chu, and M.-R. Bakker, 1996, "The Baltics – Banking Crises Observed," *The World Bank Policy Research Working Paper No. 1647* (Washington: World Bank).

Fried, H.O., C.A.K. Lovell, and S.S. Schmidt (eds.), 1993, "The Measurement of Productive Efficiency" (New York: Oxford University Press).

Hancock, D., 1991, "A Theory of Production for the Financial Firm" (Norwell, MA: Kluwer Academic Publishers).

Havrylyshyn, O., and R. van Rooden, 2000, "Institutions Matter in Transition, But So Do Policies," *IMF Working Paper No. 00/70* (Washington: International Monetary Fund).

Kim, H.Y., 1986, "Economies of Scale and Economies of Scope in Multiproduct Financial Institutions: Further Evidence from Credit Unions: A Note," in *Journal of Money, Credit, and Banking*, Vol. 18, No. 2, pp. 220–26.

King, R.G., and R. Levine, 1993, "Financial Intermediation and Economic Development," in *Capital Markets and Financial Intermediation*, pp. 156–89 (Cambridge, New York, and Melbourne: Cambridge University Press).

Knack, S., and P. Keefer, 1995, "Institutions and Economic Performance: Empirical Tests Using Alternative Measures of Institutions," *Economics and Politics*, Vol. 7, No.3.

Levine, R., and D. Renelt, 1992, "A Sensitivity Analysis of Cross-Country Growth Regressions," *American Economic Review,* Vol. 82, No. 4, pp. 942–63.

McAllister, P.H., and D. McManus, 1993, "Resolving the Scale Efficiency Puzzle in Banking," *Journal of Banking and Finance*, 17, 2–3, pp. 389–405.

Pastor, J.M., F. Perez, and J. Quesada, 1997, "Efficiency Analysis in Banking Firms: An International Comparison," *European Journal of Operational Research*, Vol. 98, No. 2, pp. 395–407.

Sealey, C.W., and J.T. Lindley, 1977, "Inputs, Outputs, and a Theory of Production and Cost at Depository Financial Institutions," *Journal of Finance*, Vol. 32, No. 4, pp. 1251–66.

Seiford, L.M., 1996, "Data Envelopment Analysis: The Evolution of the State of the Art," *Journal of Productivity Analysis*, Vol. 7 (July), pp. 99–137.

Tang, Helena, Edda Zoli, and Irina Klytchnikova, 2000, "Banking Crises in Transition Economies: Fiscal Costs and Related Issues," *World Bank Policy Research Working Paper No. 2484* (Washington: World Bank).

Wheelock, D.C., and P.W. Wilson, 1997, "Technical Progress, Inefficiency, and Productivity Change in U.S. Banking, 1984–93," *Journal of Money, Credit and Banking*, Vol. 31, No. 2 (May 1999), pp. 212–34.