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MEASURING BANKING PRODUCTIVITY OF THE MOST RECENT EUROPEAN UNION MEMBER COUNTRIES; A NON-PARAMETRIC APPROACH

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Abstract

This paper evaluates the effectiveness of financial institutions in terms of productivity change of the ten latest members of the European Union for the period before their entry in the EU, 1996-2002. The non-parametric technique called Data Envelopment Analysis (DEA) is employed to calculate the Malmquist productivity index. Then the Malmquist index is decomposed into technological change and technical efficiency change index to determine the exact source of efficiency. The relationship between the size of financial institutions and productivity is also examined. The results indicated that the total level of productivity had increased for half of the countries during the six-year period. The decomposition of the Malmquist index revealed that the

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productivity increase was lower for the best practice Decision Making Units (DMUs) than the remaining institutions. Finally, the relationship between the size of banking institutions and productivity growth was not statistically significant, with the exception of Latvia, where this relationship was positive and significant.

KEYWORDS: Banking efficiency, Data Envelopment Analysis, Transitional Economies

JEL classification: G21, C49, P29

Introduction

On the 16th of April 2004 the European Union (EU) met a substantial expansion as ten new countries entered the Union. Indubitably, this was the most important and impressive extension of the EU as it was the first time that such a number of countries joined the EU all at once. These countries in alphabetical order are: Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovenia and Slovakia. With the exception of Cyprus and Malta, the other eight new members were transitional economies, whereby the political structure and the economic framework had begun reforming during the period before the entry date and will continue afterwards, till they meet the EU standards for all its members. Hence, it is essential to investigate the performance of these countries in their new economic and financial environment.

It is believed that the old fifteen members of the EU have a more powerful financial background and a more solid political framework. On the other hand, profit oriented financial institutions of the new country-members operate for about fifteen years. The length of this period is too short considering the experienced competitors of the rest EU are in business for almost two centuries. It is a very challenging issue for governments of these new members to be able to compete with the initial EU member countries.

The financial institutions are the corner stone of any economic system. Hence, a first step in investigating the level of effectiveness in a country's economy is to explore the performance of its financial institutions. Therefore, the focus of this study is on the ten latest EU members' financial institutions.

The objective of this paper is to measure the effectiveness of the performance and productivity of these financial institutions, before the new members' entrance in the EU, during the period 1996 to 2002. These banks operated

under an environment of national protectionism, before the countries where they were established, joined the EU. However, after their entry, these financial institutions had to operate in an integrated and highly competitive market.

The contribution of this research is to examine changes in banking productivity over the period 1996-2002 for each new EU member country within a frontier framework. As long as the level of productivity has an increasing trend, an optimistic omen for the future exists. Otherwise, the financial institutions and, as a result, the whole financial and economic system of the new member states, are under the threat of a potential economic recession. Hence, there is a need to take rapid and major precautionary measures to prevent a recession from happening. Based on these, it is clear that the results of this study will have major policy impact on the governments of the ten new EU member states and will enrich the literature of academicians on that specific topic.

The structure of this paper is as follows: Section 2 reviews the existing literature on the subject. Section 3 describes the methodology and the data. Section 4 presents and analyses the results and finally section 5 contains summary and concluding remarks.

Literature Review

One of the most frequently used methods to evaluate productivity change is the so-called Malmquist total factor productivity (TFP) index. This index was developed by Malmquist (1953) and measures changes in total output relative to inputs. Berg, Forsund and Jansen (1992) introduced the Malmquist index as a measurement of the productivity change in the banking industry. They focused on the Norwegian banking system during the deregulation period 1980-1989. Their results indicated that deregulation led to a more competitive environment. The increase of productivity was faster for larger banks, due to the increased antagonism they faced.

The global competition and the various deregulations of each country's financial institutions have led to changes in the nature of bank activities and banks' performance, which have attracted the attention of researchers. There is a plethora of studies that apply both econometric and non-parametric techniques to examine the efficiency and the productivity change of banks, for the US, European and other countries, developed and developing economies. [Glass and McKillop (1991), Fare, Grosskopf, Norris and Zhang (1994), Elyasiani and Mehdi (1995), Favero and Papi (1995), Fukuyama (1995), Miller and Noulas (1996), Dietsch (1997), Noulas (1997), Jackson, Fethi and

Ival (1998), Arcelus and Arozena (1999), Mörntinen (2002), Reddy (2004), Berger, Hasan and Zhou (2005)]

Although numerous studies about banking productivity exist, only a few refer to emerging economies. As a result, the comparison between the performance of financial institutions of developed and developing countries is not common. Since we focus on transition economies, we will briefly discuss those studies referring to these economies.

Specifically, Yildirim and Philippatos (2002) examined the cost and profit efficiency of banking institutions in twelve transition economies of Central and Eastern Europe over the period 1993-2000. These sample countries are the following: the Czech Republic, Croatia, Estonia, Hungary, Latvia, Lithuania, FYR of Macedonia, Poland, Romania, the Russian Federation, Slovenia and the Slovak Republic. The authors used two out of the four main frontier approaches: [the data envelopment analysis (DEA), the thick frontier approach (TFA), the stochastic frontier approach (SFA) and the distribution free approach (DFA)]. These were the (SFA) and the (DFA) approaches in order to estimate the average cost and profit efficiency levels of the sample banks. Yildirim and Philippatos (2002) adopted the intermediation approach following Berger and Humphrey (1992). They determined the following variables as inputs: borrowed funds, labor and physical capital and the following variables as outputs: loans, investments and deposits. According to the SFA approach they found 76% average cost efficiency in their sample. Poland and Slovenia were the most efficient, while the Russian Federation, Lithuania, Latvia and Estonia were the least efficient ones. According to the DFA approach the authors found 72% average efficiency in their sample. Poland had again the highest level of efficiency, while Lithuania had the lowest one. The results indicated that different frontier methods yielded similar efficiency rankings of the sample banks. Regarding profit efficiency the results revealed one-third of banks to be inefficient based on the SFA approach and half of the sample banks to be inefficient based on the DFA approach. In this case, Estonia, Latvia and FYROM had the highest average profit efficiency, while Romania had the lowest one.

Yildirim and Philippatos also (2002) tried to determine which factors, bank or economy specific could explain bank efficiency. They examined the following bank-specific variables: a) the log of total assets, measured in thousands of US dollars, b) the performance measured by the ratio return on assets (ROA), which is net income divided by total assets, c) capitalization, measured by the ratio of book value of equity divided by total assets, d) risk measured by the ratio of total loans divided by total assets, e) funding, measured by two variables the ratio of interbank deposits to total deposits and the ratio of

customer and short term funds to total funds and f) off-balance sheet activity, measured by the ratio of off balance sheet items to total assets. The scores of cost and profit efficiency were the dependent variables. The regression results indicated that size was positively related to cost efficiency but was not linearly related to profit efficiency. Profitability (ROA), capitalization and off-balance sheet activity were positively related to both cost and profit efficiency. Finally, banks with higher ratios of loans to total assets, in other words higher risk, were most cost efficient and higher funding was associated with lower cost and profit efficiencies.

In addition, the authors examined some economy-specific variables: a) the degree of competition as measured by the Panzar and Rosse (1987) H – statistic, b) the GDP , as measured by the growth rate of the gross domestic product , c) the dummy variable that distinguished between foreign and domestic banks, d) the specialization variable that distinguished between commercial and cooperative banks and e) the dummy variable that distinguished between listed on the country exchange and private banks. The regression results revealed that the degree of competition was positively related to cost efficiency and negatively related to profit efficiency. The GDP was positively related to both forms of efficiency. The dummy variable for foreign and domestic banks indicated that foreign banks were more cost efficient but domestic banks were more profit efficient. The dummy variable for specialization showed that commercial banks were less cost efficient than cooperative ones. Finally, the fact that a bank was publicly traded or private had no significant effect on neither cost nor profit bank efficiency.

Fries and Taci (2002) examined the impact of banking and enterprise reforms and other factors on banking development in 16 transition economies, among which were included the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovenia and Slovakia, for the years 1994-1999. Based on their results, there was no gain in terms of banking development from the delayed implementation of banking, enterprise reforms and bank privatisation. Rather, there were needed comprehensive reforms which were fundamental to the development of a sound, market oriented banking sector. However, even in the cases where banking reforms had led to an expansion of bank loans, the banks had failed to keep pace with their output growth. While foreign majority ownership of a bank was not associated with stronger or weaker real growth in its customer loans, a greater presence of foreign banks in a transition country had a positive spillover effect in spurring the real expansion of loans.

Havrylchyk (2003) investigated the efficiency of the Polish banking industry from 1998 to 2000. The empirical results revealed that bank efficiency had not improved during these examined years. Foreign banks were found to be more

efficient than their domestically owned counterparts since the former had managed to utilize their comparative advantage, which was employment, at less but better remunerated staff than their domestic competitors. Although the size of banks had no effect on efficiency, banks with higher market power were more prone to sacrifice efficiency to other objectives, such as risk aversion. Additionally, loan portfolio quality, higher productivity of labour and market power had the largest impact on efficiency.

Stavárek (2003) estimated commercial banks' efficiency in the Visegrad countries before joining the European Union and examined differences in efficiency across the Czech Republic, Hungary, Poland, and Slovakia. The time period of his analysis was 1999-2002. He employed the DEA approach to calculate efficiency. The results revealed that the Czech Republic had the most efficient banking sector. In Hungary the analysis showed a great increase in efficiency between 1999 and 2002, putting the Hungarian banking sector second in efficiency. Poland and Slovakia had almost the same bank efficiency levels during the whole period. Stavárek (2003) offered as explanations of the lower efficiency in the financial institution of these transition countries, the fact that these were bad past loans, low credit scores of most potential borrowers, the low capacity of lending to households, and the high domestic interest rates that lead companies to seek loans from foreign banks. The author tried to determine which factors caused differences if any, on the efficiency of the four countries he studied. Company size was found to be positively related to efficiency for the years 2000 and 2001 only. Profitability also had a positive influence on efficiency for all banks in the sample during the whole time period selected. Foreign ownership had a positive impact on banking efficiency. Country specific variables such as: the level of GDP, the restructuring of the business sector, the FDI inflows, the tendency to savings and investments, the proportion of customer deposits and interbank deposits and the quality of capital markets are the most differentiating factors of the efficiency levels among banks in the Visegrad countries.

Fries and Taci (2003) examined the relative cost efficiency of banking institutions in 15 transition economies for the years 1994-2002. Their sample included: Bulgaria, Croatia, the Czech Republic, Estonia, FYR Macedonia, Hungary, Kazakhstan, Latvia, Lithuania, Poland, Romania, Russia, the Slovak Republic, Slovenia and Ukraine. The authors estimated a stochastic cost frontier and then used the distribution free approach (DFA) to determine the levels of efficiency for each bank in their sample, compared to the best bank in that sample. Their results indicated that the sample banks operated inefficiently and that there were significant unrealized economies of scale. Fries and Taci (2003) checked also some factors that could explain the variation in the

banking efficiency among sample countries. These factors were: the origin (foreign versus domestic) and the ownership structure of banks (private versus state-owned), the quality of legal and regulatory environment in which banks operated, their market shares, bank capitalization, GDP and nominal interest rates. The results indicated that private banks were more efficient than state-owned. More prudent regulations promoted higher bank efficiency. High GDP increased total costs, that could be due to higher wage costs and higher nominal interest rate costs. Higher capitalization and higher foreign ownership of banks reduced costs. The country with the highest bank efficiency improvement was Latvia, then Lithuania and Bulgaria. The country with the least efficient banks was Romania. When the authors included country environment factors to determine the cost efficiency frontier, Slovenia had the highest bank efficiency followed by Latvia, Croatia and Bulgaria. The country with the least efficient banks was again Romania.

Hasan and Marton (2003) analysed the experiences and developments of the Hungarian banking sector during the transition process from a centralized economy to a market oriented system. The data of the study were comprised of commercial banks' financial statements during the whole period 1993-1998. The authors used the stochastic frontier approach to estimate profit and cost inefficiency. Banks with foreign involvement were found to be significantly less inefficient than their domestic counterparts. Among foreign institutions, a higher share of foreign ownership was associated with lower inefficiency. Foreign institutions that managed to acquire local banks were also associated with lower inefficiency.

Voleková (2004) studied the banking industries of fourteen countries from three different alliances in Europe. There were countries from the European Union (Austria, Belgium, Finland, France, Germany, Italy, Ireland, Netherlands and Spain) the old Visegrad four countries (the Czech Republic, Slovakia, Poland and Hungary) and the European Free Trade Agreement countries (Norway and Switzerland). The analysis included data for the year 2002 only. The conclusion of the paper was that the efficiency of the banks was not related to the economic or political array the relevant countries adhered to. So, financial institutions of developing countries could keep up with their competitors from developed economies. Even the Visegrad countries were efficient, which was a sign that they were prepared for their entry into the European Union.

Weill (2004) compared the efficiency of banks from Western European and Eastern European countries to assess the gap in performance between these two groups of banks. He measured cost efficiency on a sample of 640 banks from eleven Western European countries (Austria, Belgium, Denmark, France,

Germany, Greece, Italy, Netherlands, Portugal, Spain and the UK) and six Eastern European countries (the Czech Republic, Hungary, Latvia, Poland, Slovenia and Slovakia) for the period 1996-2000 using the stochastic frontier approach for the definition of input and output variables. Weil followed the intermediation approach. The results indicated an efficiency gap for the banks in Eastern European countries in comparison to Western European countries. Some Eastern countries (e.g. Czech Republic) had higher efficiency levels than some Western countries (e.g. Greece), but it was the exception rather than the rule. The Hungarian banks had similar levels of efficiency compared to Portuguese and Greek banks which were the least efficient banks in the European Union. The efficiency gap could be explained neither by differences in environmental variables (e.g. per capita income, rate of inflation, population density) nor by differences in risk preferences (level of equity), suggesting lower managerial performance, due to weak managerial expertise in a free market economy, in Eastern countries. The bank efficiency in the Czech Republic had the highest increase among the Eastern countries, next were the banks in Hungary and Latvia with a strong efficiency improvement. The least efficient banks were in Poland, the Slovak Republic and Slovenia.

Mamatzakis, Staikouras and Koutsomanoli-Filippaki(2005) investigated operating efficiency of the banks in the South Eastern Europe for the period 1998-2003. The sample countries were: Albania, Bulgaria, Bosnia, Croatia, FYROM, Romania and Serbia. They used regression analysis to determine which variables affected the bank operating costs among numerous variables that represented bank and market/country characteristics. The results revealed that the region's banks had similar cost structures. There was a negative relationship between operating cost efficiency and the ratio of loan loss reserves to gross loans. Finally, the results showed that operating costs declined over the period 1998 to 2003, implying that the restructuring of these transitional economies had positive outcomes.

Methodology and Data

Methodology

This section describes the methodology used to measure the level of productivity of the ten latest EU (European Union) member countries' banking industry. Berger and Mester (1997) compared three different parametric techniques with cost and profit efficiency approaches. Their results revealed that there was little effect from the choice of parametric estimation procedure,

but reinforced the view of superiority of profit-based approaches. There have been studies using both DEA and standard regression techniques, but their findings reveal only minor differences between both measures. [Resti (1997), Stanton (1998)]. Berger, Hunter and Timme (1993) explained the difficulties in applying the translog cost function to test efficiencies. Furthermore, they stated that the assumptions required by parametric approaches regarding the distribution of the error terms are very restrictive. DEA is an alternative approach which holds that all deviations from the frontier are inefficiencies without any prior assumptions.

Hence, in this study only the Data Envelopment Analysis (DEA) technique is employed to calculate the Malmquist indices of Total Factor Productivity (TFP) change. Two different performance indices for the evaluation of efficiency and productivity change in economic units have been applied: the stochastic Tornqvist index introduced in 1936 and the non-stochastic Malmquist (1953) index. With the stochastic approaches deviations from the frontier are attributed to purely random shocks and inefficiency whereas non-stochastic approaches ascribed all such deviations to inefficiency. Therefore, this study adopts the Malmquist index in examining the productivity change of the financial institutions of the most recent European Union member countries. DEA is a non-parametric approach of frontier estimation. The term DEA was suggested by Charnes, Cooper and Rhodes (1978). DEA measures the relative efficiency of a set of firms. In production theory there are two types of efficiency measures at the firm level. The first is the technical or production efficiency which measures the level of success a firm has reached in producing maximum output from a given set of inputs. The second one is the price or allocative efficiency, which measures a firm's success in choosing an optimal set of inputs for a given set of input prices. DEA is a technique that places a non-parametric surface frontier (a piecewise linear convex isoquant) over data points to determine the efficiency of each firm in relation to the frontier. It is using linear programming to construct from data the production-possibilities frontier. The aim of DEA is to estimate relative efficiency among similar decision units that have the same technology (processing procedure) to pursue similar objectives (outputs) by using similar resources (inputs). Charnes, Cooper and Rhodes (1978) offered a model with an input orientation and assumed constant returns to scale. The present paper follows the above model. Since then, a large number of papers used and extended the DEA methodology. Tavares (2002) stated that until January of 2002 the DEA bibliography database consisted of 3,203 publications written by 2,152 distinct authors.

The efficiency of a firm, or a decision making unit (DMU) as firms are mentioned in most DEA literature, using "n" different inputs to produce "m"

outputs, is measured by the ratio of weighted outputs to weighted inputs. Once the frontier is built, the measure of efficiency for any DMU is derived by comparing Euclidean distances from points on the frontier, with corresponding distances from the axis to points which are below the frontier. DMUs that lie on the frontier are efficient, while DMUs under the frontier are considered inefficient, since they use the same level of inputs but produce less output, or have the same output but employ more inputs. The higher efficiency is denoted by one, while the lowest is denoted by zero.

The basic short coming of the DEA method is its assumption that the entire deviation from the frontier is considered as inefficiency. Hence, measurement errors and other stochastic effects will be incorporated into the DEA measure as inefficiency. According to Stanton (1998) the use of financial data brings about some specific problems for all efficiency-measurement approaches and thus, DEA as well. The basic difficulty is the need to translate financial data when some negative values are present. Then the estimation procedure and the available software have either or both to be accommodated.

The Malmquist TFP index measures changes in total output in relation with inputs. The idea was developed by the Swedish statistician Malmquist (1953). The Malmquist TFP index is the banking sector, one of the most frequently used methods to evaluate productivity change. Regarding the banking sector it was initially introduced by the pioneer study of Berg, Forsund and Jansen (1992) in order to capture the examined banks' productivity changes. Since then, many banking studies have used the Malmquist TFP index to assess the productivity of financial institutions. It uses only quantity information. Hence, problems regarding problematic price information on inputs and outputs and restrictive behavioral assumptions are avoided in its calculations, (profit maximization or cost minimization). The process can be described as follows: In a banking industry the production technology of a fully efficient firm or decision unit is not known, thus it is estimated based on the observations carried out in practice. The first step is to map firms in an input-output space, to determine the best-practice firm or the production frontier, which indicates the maximum limit of performance possible by firms. Then the existing firms are compared to this frontier because it represents a set of efficient observations. Over time, production technology can change causing shifts in the best practice technical frontier. These shifts could be brought about by more experience as time passes, increased knowledge, innovations in management or in production processes, financial liberalization or deregulation, competition increase, etc.

The Malmquist TFP index calculates the change in productivity between two points by estimating the ratio of the distances of each point relative to a common technology. The Malmquist input oriented TFP change index between

the base period t and the following period $t+1$ according to Fare et al. (1994) is defined as:

$$M(y_t, x_t, y_{t+1}, x_{t+1}) = \left[\frac{d_{t+1}(Y_{t+1}, X_{t+1})}{d_t(Y_t, X_t)} \times \frac{d_t(Y_{t+1}, X_{t+1})}{d_{t+1}(Y_{t+1}, X_{t+1})} \right]^{1/2} \quad (1)$$

A value of M greater than unity implies a positive TFP growth from the period t to period $t+1$. Otherwise, a value of M less than one indicates a TFP decline. Equation (1) is the geometric mean of two TFP indices. The first index is calculated with respect to period t technology, while the second index is evaluated with respect to period $t+1$ technology.

The advantage of the Malmquist index is that it allows the researcher to distinguish between shifts in the production frontier (technological change, TC) and movements of firms towards the frontier (technical efficiency change, TEC). Hence, the total productivity factor change (M) can be decomposed into technical efficiency change (TEC), how much closer a firm gets to the efficient frontier and technological change (TC), how much the benchmark production frontier moves at each firm's observed input mix. The measure of technical efficiency must be between zero and one.

Using symbols for this decomposition, Equation (1) can be written as follows:

$$M(y_t, x_t, y_{t+1}, x_{t+1}) = \frac{d_{t+1}(Y_{t+1}, X_{t+1})}{d_t(Y_t, X_t)} \left[\frac{d_t(Y_{t+1}, X_{t+1})}{d_{t+1}(Y_{t+1}, X_{t+1})} \times \frac{d_t(Y_t, X_t)}{d_{t+1}(Y_t, X_t)} \right]^{1/2} \quad (2)$$

The ratio outside the square brackets calculates the TEC between period t and $t+1$. The remaining part of the TFP index in Equation (2) measures the TC. This is the geometric mean of the improvement in technology between the period t and $t+1$. In parallel, technical efficiency change reflects the convergence towards, or divergence from the best practice by the remaining DMUs. The benefit extracted by this decomposition is the information that can be gained about the sources of the total productivity change. This study uses the DEA program developed by Tim Coelli (1996) and the Centre for Efficiency and Productivity Analysis of the University of New England in Australia to measure the distance functions that compose the TFP index and its components.

The first ratio in Equation (1) represents the TEC and the second ratio represents the TC. The technological change captures the improvement or the

deterioration in the performance of the best practice decision making units (DMUs). Financial firms tend to be called DMUs in the DEA literature. DMU is a more appropriate term than firm when, for example, a bank is studying the performance of its branches. Although in this paper we are examining banks' performance and not their branches performance we keep the term. In parallel, technical efficiency change reflects the convergence towards, or divergence from the best practice by the remaining DMUs.

Next, the relationship between a DMU's size and the levels of productivity growth is examined. The size of financial institutions is measured by the sum of their total assets. To examine if there is a connection between the Malmquist TFP index and total assets, the correlation coefficient ρ is calculated. The ρ is calculated with the following formula:

$$\rho_{XY} = \frac{Cov(X, Y)}{\sigma_X \sigma_Y} \quad (3)$$

Where $Cov(X, Y)$ is the covariance between the variables X and Y , σ_X is the standard deviation of the variable X , and σ_Y is the standard deviation of the variable Y .

The correlation coefficient is more appropriate than the covariance coefficient for the present study. This is because covariance, as a mean of the simultaneous change of variables, is affected by the units of measurement of these variables. On the other hand, the correlation coefficient does not have this handicap of variables' units of measurement. In addition, to test for the significance of the correlation coefficients the corresponding p -values will be calculated. According to Sengupta (2000) all input and output values are measured in logarithmic units.

Data

The source of this study's data is Thompson's BankScope database. Information is obtained from the banks' balance sheets for the period 1996 - 2002. The sample consists of 994 observations from 10 countries. Specifically, these countries are: Cyprus (103), the Czech Republic (134), Estonia (47), Hungary (94), Lithuania (57), Malta (50), Poland (208), the Slovak Republic (94) and Slovenia (88). The figures inside the parenthesis illustrate the number of observations during the whole period for each country. To avoid the double calculation of a DMU the selected consolidation codes from Bankscope are: 1) consolidated statements with an unconsolidated companion, 2) consolidated

statements with no unconsolidated companion and 3) unconsolidated statements with no consolidated companion.

The definition of a bank's inputs and outputs is an issue related directly to its function description. As a result, a variety of definitions about variables exists in the appropriate literature. For example, Nathan and Neave (1992) in examining the efficiency of Canadian banks, addressed the difficulty of determining whether deposits of banks were inputs, which were converted into loans and other assets, or whether they were outputs of the banking services. They followed the intermediation approach, regarding deposits as inputs. According to Stanton (1998) there was co-linearity between loans and deposits so he had to eliminate either loans or deposits in the input vector. He finally chose deposits as an input variable. He also supported the view that larger numbers of inputs increased the likelihood of an observation to be improperly enveloped.

The various definitions can be classified into three categories based on the preferred approach: *the value added approach*, *the intermediation approach* and *the user cost approach*. The value added approach considers deposits as outputs. The idea is that funds are collected from depositors and there is competition among DMUs to attract customers. Berger and Humphrey (1992) modified this approach and considered deposits as both outputs and inputs. According to the intermediation approach [Sealey and Lindley (1977)], only banks' assets are thought as outputs, while deposits are regarded as inputs. The notion of this approach is that DMUs buy and sell funds acting as intermediaries between borrowers and receivers of funds. Finally, the user cost approach defines a variable as output or input oriented according to its contribution to bank revenue. That means that if the financial return on the assets exceeds the opportunity cost of funds, DMU's assets are considered as outputs.

Although no approach can be considered as superior to others, the value added method has been chosen for the present paper according to Voleková (2004). Consequently, the variables that are defined as outputs are: 1) total deposits, 2) total customer loans and 3) investments. The variable "investments" is the sum of equity investments and government securities. On the other hand, as input variables are characterized: 1) personnel expenses, 2) other operating expenses and 3) total fixed assets. All variables are expressed in millions of euros. This selection was due to different local currencies. Exchange rates between the local currencies and euro were obtained by the International Monetary Fund. Finally, the variables were used in the analysis as the natural logarithms of their nominal values [Sengupta (2000)].

Results and Analysis

Using the data envelopment analysis computer program, created by Tim Coelli (1996) and the center for efficiency and productivity analysis of Australia, the input oriented Malmquist Total Factor Productivity (TFP) change index has been calculated. Table 1 depicts the three productivity change indices per country.

A value of the index greater than unity implies a positive growth of total productivity. An index equal to unity underlines no change in the productivity level and a value less than one indicates a decline in productivity from period t to period $t+1$.

The Malmquist index can be decomposed into two components. As we have previously stated, the relationship among the three indices is given by Equation 4:

$$TFP=TC * TEC \quad (4)$$

Where, TFP = total factor productivity

TC = technological change index

TEC = technical efficiency change index

A value of TC greater (less) than one indicates an improvement (deterioration) in the frontier created by best practice decision making units (DMUs). At the same time, if the TEC index is higher (lower) than unity, the remaining DMUs are moving towards (away from) the best practice frontier. Productivity change indices are presented in Table 1.

Based on the results in Table 1 we observe that the banking institution in five out of ten countries have a total factor productivity (TFP) index greater than one. These countries are Cyprus, Estonia, Lithuania, Malta and the Slovak Republic. Cyprus and Malta are two new EU members with a history of a free market system. The technical efficiency change index for the banks in both of these countries is also greater than one, while the TC index is less than unity. The TEC indicates how well a given technology is employed. We observe that for the banks in six out of ten countries this index is greater than one, showing that the given technology is employed very well by those institutions, in the following countries: Cyprus, the Czech Republic, Estonia, Malta, Poland and the Slovakia Republic.

Table 1. Productivity Change Indices Per Country

Country	N	TEC	TC	Malmquist TFP
Cyprus	103	1.063	0.983	1.045
Czech Republic	134	1.087	0.913	0.993
Estonia	47	1.116	1.054	1.176
Hungary	94	0.954	1.029	0.982
Latvia	119	0.993	0.993	0.987
Lithuania	57	0.996	1.011	1.007
Malta	50	1.031	0.996	1.027
Poland	208	1.012	0.983	0.995
Slovak Republic	94	1.157	0.911	1.054
Slovenia	88	0.994	0.994	0.988

The technological change (TC) is less than one in seven countries: Cyprus, the Czech Republic, Estonia, Malta, Poland, the Slovak Republic and Slovenia. The TC index indicates the extent of use of new technologies. This index is greater than the technical efficiency change index only in the case of banks in Hungary and Lithuania.

The highest average increase in productivity is recorded in Estonian banks and is equal to 17.6%, $[(1.176-1)*100]$ while the greatest drop in efficiency is recorded in Hungarian banks and is equal to 1.8 % $[(0.982-1)*100]$. Our results regarding the bank efficiency in the Czech Republic, Hungary and the Slovak Republic are in contrast with Stavárek (2003). His study revealed an increase in bank efficiency in Hungary and the Czech Republic, while our findings show a decrease in efficiency of 0.7 % for the banks in the Czech Republic and of 1.8 % for the banks in Hungary. On the other hand, his study revealed approximately no change in the efficiency of the Slovak banks while our results show an increase in bank efficiency of 5.4% in the Slovak Republic. This is in

accordance to Voleková (2004) regarding only the year 2002. Our results concerning the Czech Republic, Hungary and the Slovak Republic are also in contrast to Weill's (2004), although his time period was up to 2000. Voleková (2004) found increased bank efficiency in Poland, Hungary and the Czech Republic, only for the year 2002. Our results revealed a small decrease in bank efficiency for these three countries from 1996 to 2002. Our results indicated that Estonian banks had the highest improvement in their efficiency and that Lithuanian banks had an increase of 0.7% in efficiency, which is in accordance to Yildirim and Philippatos (2002). They found that these countries had the least cost efficient banks but the most profit efficient ones during 1993-2002. Our results in general disagree with almost all the previous studies on bank efficiency of transitional economies, because we examine efficiency from the point of view of productivity, while the studies of Fries and Taci (2003), Stavárek(2003) and Weill (2004) examined cost efficiency.

Finally, the relationship between banks' size (based on their total assets) and levels of productivity growth is examined. To test whether there is a connection between the Malmquist TFP index and total assets, the Pearson correlation coefficient ρ is utilized. These empirical results are illustrated in Table 2.

Based on the empirical findings in Table 2, it can be concluded that there is no clear relationship between the banks' size and their productivity. This is so because in six cases (Estonia, Hungary, Lithuania, Poland, Slovenia and the Slovak Republic) the correlation coefficients between total assets and Malmquist TFP indices are negative and for other countries these coefficients are positive but not statistically significant. Therefore, it can be inferred that the size of banks does not affect the productivity level of the sample financial institutions. The correlation coefficient between these two variables is statistically significant in only one country, Latvia. Hence, it can be concluded that the larger banks in Latvia were more productive than their smaller counterparts for the period 1996-2002. This result is consistent with the study of Weill (2004) which found that Latvian banks had a strong improvement in their efficiency (9.62%) coming third among the Eastern countries after the banks in the Czech Republic and Hungary. These results of no significant linear relationship between bank size and bank efficiency are in accordance with Yildirim and Philippatos (2002) and Havrylchuk (2003). Our results are in contrast to Stavárek (2003) who found a positive relation between company size and efficiency for the years 2000 and 2001.

Table 2. Correlation Coefficients between Malmquist TFP Indices and Total Assets

Country	N	ρ	P-value
Cyprus	103	0.1428	0.150
Czech Republic	134	0.0934	0.283
Estonia	47	-0.0028	0.985
Hungary	94	-0.1190	0.248
Latvia	119	0.1978*	0.029
Lithuania	57	-0.0117	0.930
Malta	50	0.0533	0.710
Poland	208	-0.0200	0.771
Slovak Republic	94	-0.0007	0.995
Slovenia	88	-0.0057	0.957

*→ Significant at the 5% significance level

Summary

By April 2004 ten new countries became members of the European Union (EU). These countries are the Czech Republic, Cyprus, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovenia and the Slovak Republic. This study investigated the productivity of these economies, as the entrance into the EU involved new macro-economic environments as well as new competitors. The banking industry was selected as a representative and an extremely important sector in each economy. The main objective of the paper was to measure the levels of productivity growth of the banking institutions in these countries as they approached the date of their integration with the EU. We would expect that productivity growth would have increased by 2002.

The results could be used as a helpful guide to the appropriate policy makers to improve their banking operations and in time their whole economy. To evaluate productivity growth we used the non-parametric approach called Data Envelopment Analysis (DEA) to calculate the Malmquist indices of total productivity. Then productivity change was decomposed into technical efficiency change and technological change. The sample consisted of 994 of

decision making units (DMUs) from the ten most recent EU member countries for the period 1996-2002. The value added approach was chosen for the definition of the participating variables.

The empirical results indicated that the levels of productivity increased for the banks of the new members of EU (Estonia, Lithuania, Malta, the Slovak Republic and Cyprus) and decreased for the rest of the other countries (the Czech Republic, Hungary, Latvia, Poland and Slovenia) . Furthermore, the TC index was higher than the TEC index only for Hungary and Lithuania..

Moreover, the results revealed that no particular pattern existed between the size of the bank institutions and their profit efficiency level. This is because the coefficients of correlation were not statistically significant with the exception of Latvia, where a positive and statistically significant relationship between size and productivity was identified.

For further insights we should estimate bank efficiency for each year per country. Hence, we will be able to see the trend and the level of efficiency each year as we approach 2002. We will be able to distinguish cases where the technical efficiency is higher and drives up the total factor productivity index and those cases where the technological change index is higher, driving upwards the total factor productivity index. We examined the efficiency for each country separately for the seven year period 1996-2002. Hence, we looked at the efficiency improvement or deterioration for each country. We did not examine the relative efficiency among banks of all the sample countries to determine which country has the most and the least efficient and productive financial institutions as other studies have done. This aspect could be examined in a future complementary study.

Finally an area for future research could be an analysis of the determinants of productivity growth on the basis of different macro-economic environments for each country, such as GDP (Gross Domestic Product), the imports and exports, the FDI (Foreign Direct investments), and the educational level of the population. In addition it would be quite interesting to evaluate the banking performance in these countries during a time period after their entry into the EU. Finally, in order to have a more completed view of productivity growth it would be useful to compare the productivity of the new ten members to the productivity of the old members of EU.

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