Comparative analysis of the total factor of productivity changes for banks of Visegrad group for the period 2009-2013

Anatoliy Pilyavskyy[1], William Aaronson[2], Liběna Černohorská[3]

Abstract

The article studies the total factor of productivity (TFP) changes differences between banks of the Visegrad group (V4) (Czech Republic, Poland, Hungary and Slovak) during the period 2009-2013 .

The analysis of TFP changes has been done to determine the productivity changes of the selected banking sector in Visegrad group countries during and after the financial crisis.

We found that (TFP) changes across all countries were relatively stable in 3 of the 4 observation periods. Nevertheless, there was a substantial decline in TFP in 2011-12. Examination of the trends for each of the countries showed that Hungary overly influenced the sample mean. The TFP remained stable during this period for all Poland and the Czech Republic, declined slightly for Slovakia, but declined precipitously for Hungary in 2011-12.

Keywords: *Performance of Banks, Visegrad Group, Technical Efficiency, Total Factor of Productivity Changes*
JEL Classification: G34, M12

1 Introduction

In 2007-2008 a financial crisis struck the global economy. A number of large banks in the USA and the European Union required government bailouts. In the better cases, profit declined by tens of percentage points or showed actual losses. This was not, however, the case for Czech, Slovak and Polish banks. Banks from these countries survived the financial crisis without the need for government intervention and, in most cases, even achieved distinct profit. One of the reasons for these excellent – and, in Europe, unique – results is considered to be the fact that only a few years had gone by since a costly bailout of the banks by the governments. The result of government intervention was that the banks had not been able to accumulate poor quality assets. At that time, the governments were required to spend hundreds of millions of dollars to save the largest banks. Subsequently, foreign financial groups privatized these banks. As of now, foreign

[1] Lviv University of Trade and Economics, Dept of Mathematics and Quantitative Methods. 10 Tuhan Baranovsky Str, Lviv, 79011, Ukraine, e-mail: apiliavs@mail.lviv.ua.
[2] Temple University, Dept of Health Serv Admin & Policy, 521 Ritter Annex 1301 Cecil B Moore Ave, Philadelphia, PA 19122, USA, e-mail: william.aaronson@temple.edu.
[3] Univesity of Pardubice, Institute of Economic Sciences, 95 Studentská Str., Pardubice 2, 532 10, Czech Republic, e-mail: Libena.Cernohorska@upce.cz.

entities have acquired nearly all Czech, Slovak and Poland banks. The banking sectors in these three countries have been characterized by unprecedented stability and have shown very healthy profits, despite the global financial and economic crisis of 2007 and 2008 (Teplý et al., 2010). The competitive ability of transition economies within the global financial markets became apparent.

Of the Visegrad Group (VG) banks, only the Hungarian bank sector remains unprofitable after 2010 mainly due to the implementation of a bank tax (Dec & Maiukiewicz, 2011). However, the government of Hungary tried to resolve the situation through use of public funds. In 2013 a tax on financial transactions was imposed. All of this could have led to decreasing support from local branches from foreign parent banks in Hungary (The Economist, 2013).

Economic analyses are used as a foundation for decision making by bank management. At the same time, economic analyses are used extensively by government bodies that regulate and oversee the financial markets. They are also used when adopting adequate measures for preserving the stability of the banking sector (Vodová, 2013; Cernohorska and Cernohorsky, 2014).

As in previous studies (Pilyavskyy & Matsiv, 2009, 2010) we use Data Envelopment Analysis (DEA) (Charnes et al.,1978; Banker et al., 1984**)** for estimation of the Malmquist index for analysis of productivity changes (Malmquist, 1953; Fare et al., 1991, Fare et al., 1992). We applied this method to the study of banks of the Visegrad group from the beginning of 2009 till the end of 2013.In this paper we focus methods exclusively on the derivation and application of a Malquist type index, Total Factor of Productivity (TFP) to analyse banking productivity changes. This current study narrows the methodological focus compared to the methods we recently used in studying the Visegrad banking system. In previous studies we decomposed the index in order to discover potential sources of increasing TFP. This allows us to focus on the influence of exogenous change on TFP.

There are a number of studies of bank efficiency in Visegrad countries that employ Data Envelopment Analysis (DEA). This region provides an excellent opportunity to study efficiency. Each published study provides a different perspective on bank efficiency in the Visegrad region. Due to the importance of banking sector efficiency to macroeconomic stability and strong competitive pressure in this sector, a substantial research was done to measure efficiency of banking institutions in developed countries and to benchmark them (Zimková, 2014). As to studies which cover individual banking systems in Visegrad countries, Stavárek & Řepková

(2013) analysed the Czech banking sector and its efficiency over the period of 2000 to 2009. They founded that the average efficiency in the Czech commercial banks in the period 2001 – 2010 remained nearly unchanged during the periodof estimation. Řepková (2014) applied DEA window analysis on the data of the Czech commercial banks and to examine the efficiency of the Czech banking sector during the period 2003–2012. The paper employed an extended DEA approach, specifically DEA window analysis for the efficiency assessment of commercial banks in the Czech Republic. The group of large Czech banks were lower efficient than other banks in the banking industry. The reasons of the inefficiency of the group of large banks were the excess of deposits in balance sheet and inappropriate size of operation. Wozniewska (2008) examined the efficiency of the Polish banking sector over the period of 2000 to 2007. Palečková (2015) examined the efficiency of the banking sectors in Visegrad countries during the period 2009–2013.The results show that average efficiency was slightly decreasing within the period 2010–2011. But significant decrease in efficiency in 2012, it was probably as a result of financial crisis. Then average efficiency increased in 2013. This finding confirms results of Anayiotos et al. (2010) who presented that banking efficiency decreased during the crisis period.

Stochastic Frontier Analysis (SFA) is also frequently used for the analysis of banks performance. The disadvantage of this method is that the analytic model must be exactly defined. On the other hand, parametric methods allow for random error in the estimation process, while nonparametric methods do not. There is no agreement in the literature as to which of the methods is preferable (Holod & Lewis, 2011). Casu & Molyneux (2000) compare parametric and non-parametric estimates of productivity change in European banking between 1994 and 2000. They find that the competing methodologies do not yield markedly different results in terms of identifying the main components of productivity growth.

The paper is organized as follows. In section 2 DEA method for the calculation of Malmquist index is considered. In section 3 the data and model that we made use of for the calculations are presented. In section 4 the main results of the research are discussed. In section 5 we make conclusions.

2 Method

Let us consider N banks, each of them uses n inputs for producing m outputs. Then, let $x_i \in \Re_+^n$ and $y_i \in \Re_+^m$ denote input and output vectors for the $i-\text{th}$ bank. We consider each bank in two

periods of time $t=0$ and $t=1$. Then a production technology transforming inputs into outputs can be presented in the form of the following set S^t:

$$S^t = \left\{(x^t, y^t) \mid x^t \text{can produce } y^t\right\}.$$

A set of outputs $P^t(x^t)$ then is defined as:

$$P^t(x^t) = \left\{y^t \mid (x^t, y^t) \in S^t\right\}.$$

Note that the set S^t can represent a certain production technology only when it meets certain properties (for more details see Fare & Primont, 1995).

For the analysis of the productivity changes of banks we use Malmquist-type Index and the output distance function offered by Shephard, 1970.

Shephard's output distance function $D_i^t(x^t, y^t)$ (Shephard, 1970) for bank i is defined on the output set $P^t(x^t)$ as:

$$D_i^t(x^t, y^t) = \inf\left\{\theta \mid \theta > 0, \frac{y_i^t}{\theta} \in P^t(x^t)\right\}. \quad (1)$$

In practice the output distance function $D_i^t(x^t, y^t)$ for bank i can be calculated solving the following linear programming (LP) problem (Charnes et al., 1979); Banker et al., 1984),:

$$\left[D_i^t(x_i^t, y_i^t)\right]^{-1} = \max\left\{\varphi_i \mid -\varphi_i y_i^t + Y^t\lambda \geq 0, \lambda \geq 0, \vec{1}\lambda = 1, \lambda \geq 0\right\}. \quad (2)$$

Note, that solving of the LP problem (2) makes it possible to receive a value of parameter that measures bank's efficiency, if a technology is characterized by variable return to scale (VRS). But in the case it is characterized by constant return to scale (CRS), the LP problem (2) must be solved without the constraint: $\vec{1}\lambda = 1$.

If there are data about activity of a bank for two periods of time $t=0$ and $t=1$, outputs distance function for bank i in the period $t=0$ can be defined with respect to the technology of the period $t=1$:

$$D_i^1(x_i^0, y_i^0) = \inf\left\{\theta \mid \theta > 0, \frac{y_i^0}{\theta} \in P^1(x^1)\right\}.$$

Distance function $D_i^0(x_i^1, y_i^1)$ is built analogically.

Building of such functions (solving the 4 appropriate linear programming (LP) problem (2)) allows us to use Malmquist's idea (Malmquist, 1953)] for analysis of banking productivity.

In the article we use the following Malmquist-type index (Total Factor of Productivity (TFP))

$$TFP^{0,1} = \left(\frac{D^0(x^1, y^1)}{D^0(x^0, y^0)} \bullet \frac{D^1(x^1, y^1)}{D^1(x^0, y^0)} \right)^{\frac{1}{2}}, \quad (3)$$

that was suggested by Fare and colleauges (Fare et al., 1991, 1992). A value of the index (3) greater than 1 indicates increasing of productivity, a value less than 1 indicates decreasing.

3 Data and Model

3.1 Data

This study is based on annual data published in the database, Bankscope. The data extracted for use in estimating the models included net loans, total securities, fixed assets, deposits and short term funding. We included number of employees derived from annual reports of banks included in the sample. We used activity data from Czech, Slovak, Polish and Hungarian commercial banks for each year in the period 2009-2013. Our data set contained 205 observations. We chose ten banks from the Czech Republic, eight banks from Hungary, eleven from Poland and twelve from Slovak.

Several banks (four banks from the Czech Republic, fifteen banks from Hungary, seventeen from Poland and five banks from Slovak) were removed from the data set as they were not purely commercial banks. We also excluded banks that had missing data for our key variables. Once these banks were excluded, we were left with 205 observations. Therefore, we are confident that we included comparable decision making units which is a fundamental requirement of DEA.

3.2 Model

The two methods that are most frequently used are *production and intermediation* approaches. Using production approach banks are considered to be “producers” of services for debtors and investors. For the first time this approach was suggested in (Benston, 1965). In intermediation approach banks are considered financial intermediaries between debtors and investors. This approach was used in one of the early research studies of bank efficiency (Colwell & Davis,1992).

Specification of inputs and outputs is one of the major problems for measurement of productivity changes. To determine inputs and outputs, we made use of an assets approach (Sealey & Lindley, 1977) that treats banks as classical intermediators between depositors and borrowers.

We have determined that three inputs (personnel, physical capital, purchased funds) and two outputs: net loans, total securities best model efficiency. All of the financial data are presented in USD. Physical capital can be measured by the book value of fixed assets. Purchased funds consist of loanable funds that include all the kinds of bank deposits and short term funding and securities emitted by bank. Net loans of a bank contain all the kinds of loans (either for legal entities or individuals) reduced on the sum of reserves. Total securities consist of public and private funds in other banks. Descriptive statistics of inputs and outputs is given in Table 1.

	Net Loans (th USD)	**Total Securities (th USD)**	**Fixed Assets (th USD)**	**Deposits & Short term funding (th USD)**	**Number of Employees**
Mean	7535614	3308057	149959.7	10095488	4057.532
Median	4617496	1255396	57590	5367297	2302
Standard Deviation	8903289	4682699	214246	11793878	5732.452
Minimum	36875	3579	42	89761	14
Maximum	46417473	23172151	992808	48691992	32811

Table 1. Descriptive statistics of inputs and outputs.

4 Results of the research

The TFP across all countries (see Table 2, the last column) was relatively stable in 3 of the 4 observation periods. However, there was a substantial decline in TFP in 2011-12 to 0.954). Examination of the trends for each of the countries showed that Hungary overly influenced the sample mean (see Table 2 for Hu). The TFP remained stable at about 1.000 during this period for all Poland and Czech Republic, declined slightly for Slovakia, but declined precipitously for Hungary in 2011-12 to 0.751. Let us notice also that the index of TFP change for Hungarian banks from 2012 to 2013 was the highest (1.212).

In order to understand this trend we examined the underlying variables to see if there was a root cause of the decline. Input variable trended similarly across the four countries. At the same time the output variable “net loans” increased for Polish, Slovak and Czech banks throughout the

4 years (see Table 3). However, the value for Hungarian banks declined each year (from 5151004.38 th. USD in 23009 to 3313570.50 th. USD in 2013). The value of "total securities" grew for Slovak and Czech banks, but declined for Hungarian banks between 2010 and 2012 (from 1835760.00 th. UDS in 2010 to 1479625.63 in 2011) (see Table 4).

We then asked why the TFP change would be anomalous for Hungary. Hungary had been a trailblazer among the Visegrad group resulting from decades of experience with economic reform beginning in the 1960s (Valentinyi, 2012). However, due to growing indebtedness Hungary's economic position was on the decline when the European banking crisis of 2008 hit. In 2010 a center-right party (Fidesz) was elected in Hungary (Than, 2012). The new government instituted important economic reforms that precipitated a financial crisis in 2011-12 (Valentinyi, 2012; Simon, 2012). The general economic decline coupled with the financial crisis in 2011-12 can be seen clearly in the declining value of the output variables compared to the other three countries studied. This largely explains the anomalous results we observed in terms of the TFP change in 2012-2013.

Years	Cz	Hu	Po	Sk	Total
2009/2010	0.994	1.095	1.016	1.191	1.074
2010/2011	1.012	1.038	1.081	1.058	1.049
2011/2012	1.036	**0.751**	0.986	1.016	**0.954**
2012/2013	1.049	1.212	1.012	1.017	1.059

Table 2. Comparative Total factor of Productivity Chang.

Years	Cz	Hu	Po	Sk
2009	8927011.40	5151004.38	11245522.82	2953844.17
2010	9448379.10	4704462.38	12440336.82	3157286.50
2011	9377627.20	4264459.88	12950572.64	3221320.42
2012	9572748.10	3597873.88	12802936.45	3429124.83
2013	10326889.30	3313570.50	14480369.91	3647279.42

Table 3. Net loans for countries during the study period.

Years	Cz	Hu	Po	Sk
2009	4539182.80	1673907.75	4146345.18	1206250.17
2010	5619595.00	1995547.13	4374193.55	1455116.25
2011	5853310.10	1835760.00	4646055.55	1455812.92
2012	5742468.20	1479625.63	4334709.55	1417588.58
2013	6150271.40	1901441.13	4537195.36	1597707.25

Table 4. Total Securities for countries during the study period.

Conclusions

The use of TFP to understand differences in productivity is proving to be an invaluable tool that can benefit banking policy and the actions of banks in response to changes in government policy. The Visegrad banking system presented a unique opportunity to demonstrate the value of TFP. Due to a set of circumstances that immunized Visegrad banks from a global banking crisis, we were able to study the impact on each of the Visegrad country's banking policies on productivity in the banking sector.

This type of analysis can be applied to study of productivity in banking systems in other countries. This study clearly shows the value of TFP in cross-national as well as intra-national studies of banking productivity and efficiency.

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