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DEA Application at Cross-Country Benchmarking: Latvian vs. Lithuanian banking sector

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Abstract

The present paper aims to make cross country analysis in banking sector. The relative efficiency of Latvian and Lithuanian banks is estimated, using non-parametric frontier technique Data Envelopment Analysis (DEA). Input-oriented DEA model under the assumption of variable returns to scale (VRS) is applied. The choice of variables is based on the intermediation and production approaches. Pre- and post-crisis periods of time are used to test the hypothesis about the relationship between bank size and efficiency scores. Besides, the yielded results are compared with traditional performance evaluation ratios, calculated for the whole banking sector of both countries for different periods. The research contributes to the existing analytical data on bank performance in new member states of the European Union.

Keywords: bank efficiency; DEA; Latvia; Lithuania.

1. Introduction

Taking into account a critically important role of banks in the national economy, the issue of managing and measuring bank performance still remains on the agenda and draws a great attention of scholars and non-academic researchers. Performance of banks can be expressed in terms of competition, concentration, efficiency, productivity and profitability (Bikker & Bos, 2008). Thus, a wide range of methods and underlying ratios can be used to evaluate it, depending on research purposes. Traditionally, single ratios, such as return to equity (ROE) or Cost-to-income ratio, are used to measure bank efficiency (Nenovsky, Chobanov, Mihaylova, & Koleva, 2008).

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There is still no consistent viewpoint about what performance measures better reflect a company's current position and its potential for growth. Valuation specialists assert that return to equity is still the primary performance measure for the most investors and analysts (Hagel, Brown, & Davison, 2010). However, „a good level of ROE may either reflect a good level of profitability or more limited equity capital" (ECB, 2009). Sometimes, ROA provides a better understanding of a company performance (Hagel, Brown, & Davison, 2010). On the other hand, ratio analysis cannot provide a comprehensive view of bank performance due to the complex operational environment of banks (Yang, 2009).

The present study focuses on measuring efficiency performance of banks, using a non-parametric frontier technique – data envelopment analysis (DEA). This method has an advantage over traditional accounting ratios, because it can accommodate multiple inputs and multiple outputs which is the usual case for banking sector (Nigmonov, 2010; Grigorian & Manole, 2006; Thanassoulis, Boussofiane, & Dyson, 1996). The goal of the research is to measure efficiency of individual banks in Latvia and Lithuania in order to make a comparative analysis and to test the established research hypotheses.

To test whether DEA method can be used complementary to the traditional ratio analysis, the following hypothesis was stated by the authors:

H1: There is a consistency between traditional bank performance ratios and DEA efficiency scores.

There are plenty of papers discussing the impact of different factors, such as capital structure, ownership, regulatory requirements etc., on bank efficiency. In particular, the relationship between the size of a bank and the overall efficiency was investigated by various researchers. In most cases large banks tend to be more efficient than small ones (Allen & Rai, 1996; Drake, Hall, & Simper, 2006; Karray & Chichi, 2013; Nenovsky, Chobanov, Mihaylova, & Koleva, 2008; Zreika & Elkanj, 2011). The second hypothesis was stated to test this assumption in Latvian and Lithuanian banking sector:

H2: Larger banks demonstrate higher efficiency in comparison with the smaller banks within the sample.

To achieve the established research goal and to test the research hypotheses, the input-orientated DEA model under Variable Returns to Scale (VRS) assumption was applied. The authors used two model's specifications with different input-output combinations, based on intermediation and production approach.

Data sample consists of 16 Latvian banks and 9 Lithuanian banks. Data basis comprises financials extracted from bank annual reports 2006, 2009 and 2012. Research period covers pre- and post-crisis times to get the overwhelming picture of bank efficiency in both countries.

Due to the limited amount of studies in the field of measuring bank efficiency in the Baltic States, the results of the present research are important for all bank stakeholders. Data received from DEA application complements the results of the traditional financial ratio analysis and provides additional information to banks' top executives. The empirical findings provide a background for further studies; in particular the effect of the ownership structure on bank efficiency should be examined.

2. Literature review

2.1. DEA application frequency

In 2007, Emrouznejad, Parker, & Tavares (2008) conducted a research that yielded a comprehensive listing of DEA-related publications. For research purposes the authors used such databases, as Science Direct, EBSCO, Google Scholar, JSTOR and Pro-Quest. Since 1978, when DEA method was introduced, till the year 1995, there was literally ''exponential'' growth in the number of publications. Since 1995 till 2006 rate of growth decreased, however, the interest to this topic has not languished.

As for banking, DEA is a frequently used technique to evaluate efficiency of individual banks and banking sector as a whole. Fethy & Pasiouras (2010) in their review of performance-related literature in banking identified 136 studies that apply DEA for measuring bank efficiency.

In turn, the amount of DEA-related papers published by Latvian and Lithuanian researchers is very limited. DEA was applied in such fields, as higher education (Mezeniece, 2012), national economy (Krasnopjorovs, 2013), regional economy (Galiniene & Dzemydaite, 2012), agriculture (Balezentis & Krisciukaitiene, 2012) and transport (Balezentis & Balezentis, 2011). As for banking sector, only few papers related to DEA application in banking were found (Arsinova, 2011; Erina & Erins, 2013; Adamauskas & Krusinskas, 2012). The lack of information confirms the necessity of continuing studies in the field of bank efficiency measuring in the Baltics.

2.2. DEA in measuring of efficiency

The concept of efficiency is closely related to the concept of productivity. Sometimes the terms are used interchangeably, assuming by them the output-input ratio (Cooper, Seiford, & Tone, 2007).

Daraio & Simar (2007) state that „measures of efficiency are more accurate than those of productivity in the sense that they involve a comparison with the most efficient frontier".

One of the most important contributions in the field of measuring of efficiency was done by M. J. Farrell. In 1957 he published the work "The Measurement of Productive Efficiency" (Farrell, 1957) with the introduction of the term "efficient production function", that is the function constructed from the empirical data.

Operating (productive) efficiency denotes whether a firm is cost minimising (consuming less inputs for the same level of outputs) or profit maximising (producing more outputs for the same amount of inputs) (Beccalli, Casu, & Girardone, 2006). Thus, there are two types of technical efficiency based on the orientation: input-oriented and output-oriented.

The approach proposed by Farrell was empirically applied and extended by Charnes, Cooper & Rhodes (1978). They proposed a model that was called Data Envelopment Analysis (DEA). In academic literature it is referred to as CCR model. In the original paper the authors used the term „decision making units" (DMU) to emphasize their interest to measuring performance of non-profit organizations. DEA helps to identify efficient DMU and to construct efficient production frontier. DEA models measure the relative efficiency that is the efficiency of each DMU relative to similar DMUs in the sample. Thus, applying DEA in evaluating performance of a set of companies, it is possible to form two clusters: companies that comprise an efficient frontier and inefficient companies lying below the frontier.

Applying DEA model, the efficiency score is estimated as the ratio of weighted outputs to weighted inputs (Charnes, Cooper, & Rhodes, 1978). Weights are selected for each variable of every DMU in order maximize its efficiency score.

Weights are determined by solving the following problem:

$$\max h_0 = \frac{\sum_{r=1}^{s} u_r y_{r0}}{\sum_{i=1}^{m} v_i x_{i0}} \text{ subject to: } \frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \le 1; \quad (1)$$

$u_r , v_i \ge 0;$ $\quad r = 1,\ldots,s; \quad i = 1,\ldots,m; \quad j = 1,\ldots, n.$

The efficiency rate for each DMU of the reference set of j = 1,…, n DMU's is evaluated relative to other set members (Charnes, Cooper, & Rhodes, 1978). The maximal efficiency score is equal to 1, and the lower values indicate relative inefficiency of analyzed objects.

2.3. DEA specifications

DEA model can be either input- or output-orientated. The choice of the orientation primarily is based on industry specifics. As for banking, some researchers measure efficiency with output-oriented models (Thagunna & Poudel, 2013; Casu & Girardone, 2005) or apply both in their studies (Beccalli, Casu, & Girardone, 2006). However, the

input-orientated models are the most frequently used in measuring bank efficiency with DEA (Arshinova, 2011; Nigmonov, 2010; Yang, 2009; Zreika & Ekanj, 2011). The possible reason assumed by Fethy & Pasiouras is that bank managers have higher control over inputs rather than over outputs (Fethy & Pasiouras, 2010).

Applying the input-oriented DEA model, it is possible to answer the question "By how much can input quantities be proportionally reduced without changing the output quantities produced?" The opposite question is "By how much can output quantities be proportionally expanded without altering the input quantities used?" is addressed to the output-orientated model.

Besides, DEA can be applied under the assumption of constant return to scale (CRS) and variable returns to scale (VRS).The term „economies of scale" can be applied in a case, when all the inputs of a company's production process are variable. CRS assumption is taken to mean that equiproportionate increases in factor inputs yield an equiproportionate increase in output. In turn, by VRS is meant that equiproportionate increases in factor inputs yield a greater (or less) than equiproportionate increase in output (Heffernan, 2005).

Original DEA model was introduced, assuming constant returns to scale (Charnes, Cooper, & Rhodes, 1978). DEA model with VRS assumption was developed by Banker, Charnes & Cooper (1984). Pro and contra of using CRS or VRS specifications is a frequent topic of debates in the academic literature.

As for studies in banking industry, there is also no consensus on the matter between the researchers. Some of them use CRS models (Nigmonov, 2010; Noulas, 1997; Thagunna & Poudel, 2013), arguing that CRS „allows the comparison between small and large banks" (Noulas, 1997). Others select VRS model, asserting that CRS is „only appropriate when all firms are operating at an optimal scale" (Coelli, Rao, & Battese, 1998). In many studies both CRS and VRS assumptions are applied (Arshinova, 2011; Hogue & Rayan, 2012; Karray & Chichti, 2013; Nenovsky, Chobanov, Mihaylova, & Koleva, 2008).

It should be considered that the choice of a model specification has a significant impact on research results. For instance, using VRS assumption, the number of efficient banks will be larger than under CRS assumption, because the data space under the VRS curve is smaller than under the CRS curve.

One of the main advantages of DEA model is that it allows incorporating multiple inputs and outputs. However, the choice of appropriate variables is even more complicated than the choice of model specifications. The most disputable question is "how to treat bank deposits – as inputs or outputs?" (Heffernan, 2005; Karray & Chichti, 2013; Thagunna & Poudel, 2013).

Examination of the production process in banking is based on two fundamental approaches: intermediation approach and production approach.

Traditionally, bank is considered to be an intermediary between ultimate savers and borrowers. Thus, according to the intermediation approach, total loans and securities are outputs, whereas deposits, labour and capital are inputs (Sealey & Lindley, 1977). Production approach assumes that banks use capital and labour to produce different categories of deposit and loan accounts (Heffernan, 2005).

Most of researchers use intermediation approach in their studies either along with other approaches, or separately (Beccalli, Casu, & Girardone, 2006; Nenovsky, Chobanov, Mihaylova, & Koleva, 2008; Nigmonov, 2010; Staub, Souza, & Tabak, 2009; Thagunna & Poudel, 2013).

3. Research methodology

3.1. Banking sector in Latvia and Lithuania

As a result of a transition process from planned economies into market economies, new member states (NMS) of EU, including Latvia and Lithuania, were forced to liberalize their financial systems. The restrictions for foreign financial institutions' entrance into domestic banking markets were abolished. This, in turn, exacerbated a competition and activated processes of banking capital consolidation. The number of banks decreased significantly during the period since 1991 till 2000 (Haan, Oosterloo, & Schoenmaker, 2009).

Today, twenty commercial banks and nine financial service providers from the European Economic Area operate in Latvia. Banking business is concentrated in a few major banks, with the top five banks accounting for more than 50% of the sector's total assets. Latvian banking market concentration ratios are presented in the Table 1 (Financial and Capital Market Commission).

Table 1. Banking market concentration in Latvia (%)

Market share of five largest banks	2008	2009	2010	2011
Assets	69.5	68.2	59.3	58.4
Loans	74.5	74.2	67.1	67.3
Deposits	63.4	59.9	54.9	59.3

In Lithuania, seven commercial banks and five subsidiaries of foreign banks operates at the moment. Lithuanian subsidiaries of Danske Bank and Nordea Bank Finland are especially active in banking sector, including granting of mortgage loans. The major players in the Lithuanian banking sector are Scandinavian banks (SEB bankas, Swedbank and DNB bankas) with the market share over 60 per cent in terms of assets. Lithuanian banking market concentration ratios are presented in the Table 2 (Bank of Lithuania).

Table 2. Banking market concentration in Lithuania (%)

Market share of three largest banks	2008	2009	2010	2011
Assets	65.5	64.2	60.8	69.1
Loans	60.4	57.5	56.4	58.1
Deposits	65.5	60.3	58.5	70.1

Banking sector in both countries is strongly dominated by foreign investors. Over 70 per cent of total contributed capital of Latvian banking system belongs to foreign financial groups and institutions, mainly from Scandinavia and Russia (Financial and Capital Market Commission). The contribution of the foreign capital in Lithuanian banking sector exceeds 80 per cent. The biggest investors are Scandinavian financial groups (Bank of Lithuania).

Worldwide financial crisis has had a large negative effect on the banking sector performance in the Baltic States, but especially in Latvia and Lithuania. Since 2008 almost all banks demonstrate decreasing ROE (see Fig. 1). In 2009–2010 all Latvian banks had negative or closed-to-zero return on equity. Lithuanian banking sector suffered the most from the crisis among the Baltic States, and even comparing with all other members of the European Union. Despite of economic recovery ROE of several banks in both countries was still negative in 2012 (BankScope, European Central Bank).

Fig. 1. Return on equity of the banking sector in the Baltic States

Since Latvian and Lithuanian banks mostly engaged in the traditional banking business, the main reason for rapid ROE decrease is the decrease of net interest income that, in turn, was caused by a sharp decrease of loans.

Despite the recovery from the global financial crisis, some turbulence is still observed in the banking sector of Latvia and Lithuania. Since 2011 Lithuanian banking sector lost two banks: Snoras collapsed in the end of 2011 and Ukio bankas – in the beginning of 2013 (accounts were transferred to Siauliu bankas). One financial institution – Finasta Investment Management was reorganized into a bank in 2008. Since Snoras Bank was the main stockholder

of Latvian bank “Latvijas Krajbanka”, in 2011 "Latvijas Krajbanka" was declared insolvent. Three years earlier, in 2008, one of the largest Latvian banks – “Parex banka” – collapsed and Latvian government was forced to take it over. In 2010, Parex Bank was split into a new Bank (Citadele Bank) and a Resolution Bank (Reverta). In September of 2013, Ge Money Bank stopped all the operations and its customers’ accounts were transferred to Citadele bank.

3.2. Research design and methods applied

To achieve the research purpose, data extracted from the annual reports of Latvian and Lithuanian banks was analysed. Branches of foreign banks were not included into the sample, because the only full banks’ reports are publicly available without branch-related information.

The sample size includes 25 banks in total. To ensure data consistency, all the financials were converted into the euro currency, using the fixed exchange rates (1LVL = 0.702804 EUR; 1 EUR = 3.4528 LTL).

To examine the effect of the global financial crisis on the efficiency of Latvian and Lithuanian banks, data on banks’ financials was extracted from annual reports 2006, 2009 and 2012.

The authors applied input-oriented DEA model under VRS assumption. The choice of a model specification was based on theoretical and empirical findings from previously conducted studies in the field of DEA application in banking. For instance, VRS assumption was applied in this research due to the large difference between the banks’ size within the research sample, because VRS „compares each unit only against other units of similar size, instead of against all other units” (Avkiran, 1999).

The authors used two DEA models with different input-output combinations, based on intermediation and production approach to banking business (see Table 3).

Table 3. Inputs and outputs of the applied models

Model	Inputs	Outputs
Model 1 (M1) Intermediation approach	Deposits	Loans Investments
Model 2 (M2) Production approach	Interest expenses Staff costs	Deposits Loans

To test whether DEA results are consistent with traditional performance ratios, the authors performed correlation analysis by means of SPSS 21 software. BankScope data basis provided data on ROE and ROA values in 2006, 2009 and 2012 for each separate bank of Latvian and Lithuanian banking sector. Efficiency scores of each bank were calculated by the authors. Spearman rank correlation coefficient was determined for each particular period and separately for each DEA model’s specification.

Initially, it was planned to perform the analysis of the relationship between efficiency and return to equity ratio, based on the results of previously conducted studies. However, there is no sufficient amount of data on efficiency of Latvian and Lithuanian banking sector in the academic literature. Besides, the researchers are more likely to use Stochastic Frontier Analysis (SFA) in their studies on measuring bank efficiency (Kosak, Zajc, & Zoric, 2009; Koutsomanoli-Filippaki, Margaritis, & Staikouras, 2009). We found only two papers with DEA efficiency scores, calculated for Latvian and Lithuanian banking sector for sufficiently long period of time to get the reliable results from correlation analysis.

Ferreira (2012) published the data on banking sector efficiency, estimated for the period since 1996 till 2008. Intermediation approach-based DEA model with six variables was used in the study.

The European Central Bank provides data on banking sector ROE of both countries since 2008 (European Central Bank, 2013). BankScope data basis contains the information since 2006. As for Latvia, banking sector statistics since 2000 is available on the web page of the Financial and Capital Market Commission (www.fktk.lv). Thus, we performed the analysis only for Latvian banking sector, using the statistics on ROE, provided by FCMC.

Erina & Erins (2013) estimated efficiency scores for both countries, analyzing the period 2006–2011. Production approach-based DEA model under CRS and VRS assumptions was applied.

Thus, the authors failed to perform a comprehensive correlation analysis, based on the literature review. The main conclusions regarding to the first research hypothesis was made, based on the analysis of the data on bank efficiency from the authors' conducted study.

To determine whether there is a relationship between bank size and its efficiency, all the Latvian banks within the sample were grouped according to the volume of their total assets in 2012. For grouping, Excel function QUARTILE was used. The Lithuanian banks were added to the corresponding groups:

- Micro-banks: banks with the total amount of assets less than 300 million euro;
- Small banks: banks with the total amount of assets less than 500 million euro;
- Medium banks: banks with the total amount of assets less than 2 billion euro;
- Large banks: banks with the total amount of assets over 2 billion euro.

4. Research results and discussions

Efficiency scores, calculated for each individual Latvian bank, using both DEA model's specifications, are presented in the Table 4. The number of banks differed in the analyzed periods. In 2012, 16 banks were in the sample, while in 2006 the sample involved only 13 banks.

Table 4. Efficiency scores of Latvian banks

Bank name	2006		2009		2012	
	M1	M2	M1	M2	M1	M2
ABLV Bank	0.84499	1.00000	0.49901	0.72497	1.00000	1.00000
Baltikums Bank	1.00000	1.00000	0.75324	1.00000	0.19300	1.00000
Baltic International Bank	0.63484	0.93478	0.30259	0.89426	0.39644	0.68548
GE Money Bank	0.43302	0.61454	0.21847	0.29710	0.92684	0.19313
Swedbank	1.00000	1.00000	1.00000	0.88053	1.00000	1.00000
Norvik Banka	1.00000	0.65604	0.46499	0.46905	1.00000	0.46791
SEB banka	1.00000	1.00000	0.65212	0.91638	1.00000	1.00000
DNB banka	1.00000	1.00000	1.00000	1.00000	1.00000	0.95681
PrivatBank	0.54963	1.00000	0.25279	0.38832	0.17656	0.85280
Regionala investiciju banka	0.76497	1.00000	0.38296	0.63404	0.26399	1.00000
Rietumu Banka	0.26902	1.00000	0.41591	1.00000	0.27816	1.00000
Trasta Komercbanka	0.17906	1.00000	0.16984	0.97609	0.37055	0.46672
UniCredit Bank	1.00000	1.00000	0.63565	1.00000	0.88803	1.00000
SMP Bank	n/a	n/a	0.35091	1.00000	0.52449	1.00000
Latvijas pasta banka	n/a	n/a	1.00000	0.46502	1.00000	1.00000
Citadele banka	n/a	n/a	n/a	n/a	0.71281	0.55259
Mean	0.74427	0.93887	0.53990	0.77638	0.67068	0.82346
Median	0.84499	1.00000	0.46499	0.89426	0.80042	1.00000

Efficiency scores of Lithuanian banks are presented in the Table 5.

Table 5. Efficiency scores of Lithuanian banks

Bank name	2006		2009		2012	
	M1	M2	M1	M2	M1	M2
SEB bankas	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
Bankas Finasta	n/a	n/a	1.00000	1.00000	0.58031	1.00000
DNB bankas	0.95459	1.00000	1.00000	1.00000	1.00000	1.00000
Citadele bankas	1.00000	1.00000	0.89105	0.74083	1.00000	0.90770
Siauliu bankas	1.00000	0.70581	0.54904	1.00000	1.00000	1.00000
Swedbank	1.00000	0.73076	1.00000	1.00000	1.00000	1.00000
Medicinos bankas	1.00000	1.00000	1.00000	0.85729	0.10066	0.91940
Bankas Snoras	1.00000	1.00000	0.22231	0.86863	n/a	n/a
Ukio bankas	1.00000	1.00000	0.68246	1.00000	n/a	n/a
Mean	0.99432	0.92957	0.81610	0.94075	0.81157	0.97530
Median	1.00000	1.00000	0.94552	1.00000	1.00000	1.00000

Analyzing average efficiency scores of both countries, the initial conclusion could be that Lithuanian banks and banking sector in a whole is more efficient, comparing with Latvian banking sector. However, we should be careful while making cross-country comparison. By means of DEA, the relative efficiency is estimated, comparing a particular company with the set of companies included into the sample. Quoting Farrell: when "additional firms are introduced into the analysis, they may reduce, but cannot increase the technical efficiency of a given firm" (Farrell, 1957). It means, in turn, that efficiency scores calculated for banks from a smaller sample will be higher than those, which were calculated for a larger banking sector. It is impossible to overcome this problem making a cross-country comparison, because the number of banks in each particular country could differ widely. In this case complementary methods should be applied to confirm the reliability of results.

The figures in the Table 4 and Table 5 indicate the fact that efficiency variation corresponds to the changes in market situation. Banking sector in both countries demonstrated the lowest efficiency in 2009. It is quite obvious considering the negative repercussions of a global financial crisis. Yielded results also correspond to the results of the analysis of bank performance, represented by ROE ratio (Fig. 1). In 2009 average return on equity of banking sector in Latvia and Lithuania reached its maximal negative value.

Analysis of the efficiency scores of separate banks can also be used for testing the validity of results. The research sample involves Snoras bankas and Ge Money Bank, which stopped their business activities in 2011 and 2013 respectively. These banks demonstrated the worst results in terms of efficiency within the sample.

Besides, the authors analysed the relationship between efficiency scores and the values of ROE of individual banks in 2012. The banks with ROE lower than the average ratio of a whole banking sector demonstrated the relative inefficiency. For instance, the average ROE of Latvian banking sector was 6.38% in 2012, based on BankScope data. Six Latvian banks had lower than average ratio in 2012 – DNB banka, Trasta Komercbanka, PrivatBank, UniCredit Bank, Baltic International Bank, Ge Money bank and Norvik Banka (5.95%, 3.27%, 2.29%, 2.03%, 1.88%, –50.93% and –126.85% respectively). All these banks are relatively inefficient in 2012 according to the results of an application of either one or both models (Table 4).

The sensitivity of efficiency scores to the choice of inputs and outputs is a frequent topic for academic discussions. Comparing the results yielded from the application of different models in the present study, this fact should be emphasized again. Applying M2 model, in all cases, except of year 2006 in Lithuania, average efficiency scores are higher than the efficiency scores yielded from the application of M1 model. In turn, looking at separate banks, equal or closed values were estimated in only 27 cases from 68. Efficiency gap is the most obvious analysing the results of separate banks. Perfect examples are Baltikums bank, Rietumu banka and UniCredit Bank. For instance, applying M2 model Rietumu banka was relatively efficient in all the years. However, in case of M1 application it demonstrated one of the worst results within the peer group. Significant difference between the received results indicates the problem of data reliability, measuring efficiency by means of DEA.

Table 6 represents the results of testing the first research hypothesis about the relationship between DEA efficiency and traditional performance measures.

Table 6. Spearman rank correlation coefficients – relationship between efficiency scores and financial ratios

Data	2006		2009		2012		All data	
Correlation between :	M1	M2	M1	M2	M1	M2	M1	M2
Efficiency scores and ROE								
Latvian sample	–0.370	0.382	0.165	0.338	–0.029	**0.694**	0.115	**0.603**
Lithuanian sample	0.247	–0.546	–0.475	–0.347	0.045	–0.445	0.259	–0.169
Efficiency scores and ROA								
Latvian sample	–0.500	0.382	0.211	0.356	0.058	**0.694**	0.137	**0.579**
Lithuanian sample	0.412	–0.546	–0.511	–0.455	0.401	–0.356	0.321	–0.154

The correlation analysis has not detected the link between bank efficiency scores and performance ratios ROE and ROA. Statistically significant correlation coefficients were received in only two cases: 1) applying M2 model for Latvian sample in 2012, and 2) applying M2 for Latvian sample, using data of three periods.

The results of the analysis of data from the previously conducted studies also rejected the stated hypothesis. Using efficiency scores, calculated by Ferreira (2012), estimated correlation coefficients are equal to –0,167 (Sig. = 0.668) and –0,160 (Sig = 0.682), comparing efficiency scores with ROE and ROA values respectively.

Based on data provided by Erina & Erins (2013), correlation analysis yielded the correlation coefficient equal to 0.143 (Sig. = 0.787) for both variables in case of Latvia. Lithuanian data did not fit for research purposes, because the efficiency of Lithuanian banking sector was equal to 1 during all the period, i. e. there was no deviation from the maximal value.

Testing the second hypothesis about the link between bank size and its relative efficiency, all the banks within the sample were grouped into four clusters according to the volume of their total assets (Table 7).

Table 7. Bank groups

Micro banks	Small banks	Medium banks	Large banks
SMP Bank	Baltic International Bank	PrivatBank	Swedbank (LV)
GE Money Bank	Trasta Komercbanka	Norvik Banka	Swedbank (LT)
Latvijas pasta banka	Baltikums Bank	UniCredit Bank	SEB banka
Bankas Finasta	Regionala investiciju banka	Snoras bankas	SEB bankas (LT)
Medicinos bankas		Ukio bankas	DNB banka
Citadele bankas (LT)		Sialiu bankas	DNB bankas (LT)
			ABLV Bank
			Citadele banka (LV)
			Rietumu Banka

The largest banks in both countries in terms of assets – Swedbank, SEB bank and DNB bank – had the maximal efficiency scores in 2012 (except of only DNB banka (LV) with 0.95681 according to M2 results). However, there are no unambiguous results within the peer group of micro banks. Ge Money Bank was relatively inefficient in 2012 applying M1 and M2 models, while Latvijas pasta banka had the maximal scores in both cases.

Average efficiency score for each banks' group was calculated, based on data received from the application of both models (Table 8).

Table 8. Average efficiency scores for bank groups

Bank group	2006		2009		2012	
	M1	M2	M1	M2	M1	M2
Micro banks	1.00000	1.00000	0.94552	0.79906	0.75357	0.95970
Small banks	0.69990	1.00000	0.34278	0.93517	0.31727	0.84274
Medium banks	1.00000	1.00000	0.50702	0.93432	0.94401	0.92640
Large banks	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000

Obviously, the group of large banks demonstrates the highest efficiency. However, the sample of 25 banks is not a sufficiently good basis for performing such kind of studies. The present research should be extended either by more banks into the sample (data of other countries), or by analyzing the longer period of time to get more observations. Besides, the regrouping of banks could be executed in order to form clusters with an approximately equal number of objects.

5. Conclusive remarks

The yielded research results allow making conclusions about the stated hypotheses. The first hypothesis can be rejected. No statistically significant correlation coefficients were estimated, analyzing the relationship between efficiency scores and financial ratios. However, the list of traditional performance ratios is not limited with return on equity and return on assets. The correlation between efficiency and other measures should be tested. Besides, the larger data basis could be used in further studies to receive more reliable results.

As for relationship between bank size and efficiency, the results of the present study indicate the fact that large banks are more efficient within the sample.

The present paper contributes to the existing literature in the field of measuring bank efficiency, providing the empirical data on efficiency of Latvian and Lithuanian banking sector. The research findings provide a background for further studies; in particular, the studies regarding the choice of DEA model's specification. The possible directions could be: 1) to test the hypothesis about the difference between bank efficiency scores, applying DEA models with different input-output combinations, and 2) to determine the most appropriate model for Latvian and Lithuanian banking sector. Besides, the hypotheses of the current research can be tested once more with the increased number of observations.

Despite the fact that the validity of the received results is disputable in some cases, DEA method provides wide opportunities for researchers to expand horizon of their studies in the area of performance measurement. Its relative simplicity and variability of application allows making both research shortcuts and comprehensive investigations. The necessity of implementation of DEA practice into the process of bank performance measurement in Latvia and Lithuania is also confirmed by the continued interest to this technique demonstrated by foreign scholars and practitioners.

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