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A NON-PARAMETRIC ANALYSIS OF THE CREDIT UNION PERFORMANCE IN LITHUANIA

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Benchmarking of the financial institutions is important for various groups of stakeholders, namely these institutions themselves, their customers, and public agencies. The Lithuanian credit unions, though, have not been analysed by the means of data envelopment analysis (DEA) or any other frontier technique so far. This paper, therefore, employed the DEA to estimate the efficiency of the Lithuanian credit unions. The aim of the research was to identify the prospective development trends of the Lithuanian credit unions in terms of their productive efficiency. The DEA was implemented to estimate the efficiency of the credit unions. The scale elasticity was analysed in the spirit of the neo-classical theory of the productive technology. Finally, some determinants of efficiency were discussed. The credit union data covering years 2008–2011 were used for the research. Specifically, the analysis focused on credit unions associated with the Lithuanian Central Credit Union.

Key words: credit unions, efficiency, scale elasticity, data envelopment analysis.
JEL codes: C140, C610, G210.

Introduction

Benchmarking of the financial institutions is important for various groups of stakeholders, namely these institutions themselves, their customers, and public agencies. Specifically, the institutions themselves might be interested in the level of the relative efficiency and competitiveness they achieved in order to increase their attractiveness and for the investors. The customers need to be informed about the current situation and prospective of their financial intermediaries. Finally, the public agencies need to detect the abnormal performance and thus mitigate the insolvency risk. The Lithuanian financial market currently comprises of (i) the credit and payment institutions, (ii) insurance market institutions, and (iii) traders in the financial instruments. The credit and payment institutions are further grouped into banks, credit unions, financial undertakings controlled by foreign banks, payment institutions, and electronic money institutions. Whereas the Lithuanian bank performance has been analysed in the literature (Ginevičius, 2011; Brauers, 2012), the Lithuanian credit union performance attracted less attention. The credit unions are non-profit mutually-owned financial intermediaries. J. Igarytė and J. Ramanauskas (2011) analysed the performance as well as the trends of the future development of the Lithuanian credit unions. Indeed, these institutions served some 120 thousand clients (both natural and legal

persons) during 1995–2011 (Igarytė, 2011). As of 2013, the total assets of the credit unions reached some 2 billion Litas, i. e. 2.6 % of the bank system assets (Central Bank …, 2013). There were 75 credit unions operating in Lithuania as well as the Lithuanian Central Credit Union (LCCU). Noteworthy, 63 credit unions were united under the LCCU with the total assets of 402 million Litas. The latter unions are mainly those operating in large cities and remote regions of Lithuania.

H. Fried et al. (1993, 1999) employed the data envelopment analysis (DEA) to measure the efficiency of the credit unions operating in the United States (US). Garden, Ralston (1999) and Ralston et al. (2001) analysed the impact of mergers on the efficiency of the Australian credit unions by the means of DEA. D. McKillop et al. (2002) used the radial and non-radial DEA to estimate the efficiency of the United Kingdom credit unions. The frontier methodology constitutes the primal tool for efficiency analysis. Liu et al. (2012) analysed the credit union performance by the means of the canonical regression and Cobb-Douglas frontier based on the aggregate outputs obtained via the linear programming. D. Wheelock and P. Wilson (2012) employed the bootstrap-based frontier methodology to measure the cost efficiency among the US credit unions.

The Lithuanian credit unions, though, have not been analysed by the means of DEA or any other frontier technique so far. This paper, therefore, employs the DEA to estimate the efficiency of the Lithuanian credit unions. The aim of the research is to identify the prospective development trends of the Lithuanian credit unions in terms of their productive efficiency. The followings tasks are therefore set: (i) to implement the DEA model and thus estimate the efficiency of the credit unions, (ii) to utilise the obtained production frontier for the neo-classical analysis of the underlying technology, (iii) to analyse the main determinants of efficiency. The DEA was used alongside with parametric and non-parametric regression in the analysis. The credit union data covering years 2008–2011 were used for the research. Specifically, the analysis focused on credit unions associated with the Lithuanian Central Credit Union.

1. Research Methodology

The efficiency analysis rests on the indicator set describing the certain inputs and outputs associated with a particular production process. In case of the financial intermediation, the two approaches prevail in the efficiency analyses, viz. the intermediation and production approach (Sathye, 2001). The production approach treats a financial intermediary as a producer of services for account holders. Under this approach, the numbers of loans and deposit accounts are considered as the relevant outputs of the financial activity (see, for instance, Fried et al., 1993).

The intermediation approach considers a financial intermediary as an institution transferring the financial assets between the surplus units and deficit units. Accordingly, the outputs are defined as the sums of loans and deposits. This study follows the intermediary approach and employs the set of input-output indicators given in Table 1.

Table 1. Input-output indicators used for estimation of the credit union efficiency

No.	Indicator	Dimension	No.	Indicator	Dimension
Inputs			*Outputs*		
X1	Number of employees	Person	*Y1*	Deposits of the natural persons	Litas
X2	Capital	Litas	*Y2*	Deposits of the legal persons	Litas
X3	Debts to other financial institutions	Litas	*Y3*	Outstanding loans	Litas
X4	Operation expenses	Litas			

The aforementioned variables were used to construct the efficiency scores based on the DEA model (Banker, 1984):

$$\theta_t^{VRS} = \min\left\{\theta \left| \begin{array}{l} \sum_{k=1}^{K} \lambda_k x_{i,k} \le \theta x_{i,t}; i = 1,2,...,m; \\ \sum_{k=1}^{K} \lambda_k y_{j,k} \ge y_{j,t}; j = 1,2,...,n; \\ \sum_{k=1}^{K} \lambda_k = 1; \\ \lambda_k \ge 0, k = 1,2,...,K \end{array} \right.\right\}, \quad (1)$$

where θ_t^{VRS} is the efficiency score ranging in between 0 and 1 (in case of the full efficiency), λ_k are the intensity variables (peer weights), $x_{i,k}$ denotes the quantity of the *i*-th input for the *k*-th credit union, $y_{j,k}$ denotes the quantity of the *j*-th output for the *k*-th credit union, $k = 1,2,...,K$ is the index of credit unions with $t = 1,2,...,K$ denoting a certain credit union under assessment, $i = 1,2,...,m$ and $j = 1,2,...,n$ are input and output indexes. Eq. 1 rendered efficiency scores based on the variable returns to scale (VRS) production frontier. The constant returns to scale are imposed by removing the convexity constraint, $\sum_{k=1}^{K} \lambda_k = 1$, from Eq. 1 and the entailed efficiency scores are denoted by θ_t^{CRS}. Meanwhile, the non-increasing returns to scale are imposed by using the modified convexity constraint, $\sum_{k=1}^{K} \lambda_k \le 1$, in Eq. 1.

The credits unions were then grouped in terms of the range of the returns to scale they were operating in. It is due to S. Grosskopf (1986) that credit unions operating at the supra-optimal scale and thus experiencing increasing returns to scale (IRS) feature $\theta^{CRS} \ne \theta^{VRS} > \theta^{NIRS}$. Those operating at the optimal scale and thus experiencing CRS feature $\theta^{CRS} = \theta^{VRS}$. Finally, those credit unions operating at the supra-optimal scale and experiencing decreasing return to scale (DRS) are specific with $\theta^{CRS} \ne \theta^{VRS} = \theta^{NIRS}$.

The returns to scale can be quantified by considering some additional linear programming problems. The dual problem for Eq. 1 is given by:

$$\theta_t^{VRS} = \max\left\{\sum_{j=1}^{n} v_j y_{j,t} - v_0 \left| \begin{array}{l} \sum_{i=1}^{m} u_i x_{i,t} = 1; \\ \sum_{j=1}^{n} v_j y_{j,k} - \sum_{i=1}^{m} u_i x_{i,k} - v_0 \le 0, k = 1,2,...,K; \\ u_i, v_j \ge 0, i = 1,2,..,m, j = 1,2,...,n; \\ v_0 \text{ unrestricted} \end{array} \right.\right\}, \quad (2)$$

where $v_0 < 0$ is associated with increasing returns to scale, $v_0 = 0$ implies CRS and $v_0 > 0$ is associated with decreasing returns to scale. The initial inputs are scaled down by the factor of θ_t^{VRS} and then imputed to the model given by Eq. 2. The scale elasticity is then computed as (Førsund, 2004):

$$\varepsilon_t^{in} = \theta_t^{VRS} / \left(\theta_t^{VRS} - v_0^t \right), \tag{3}$$

where v_0^t solves Eq. 2 for the *t*-th credit union. The value of ε_t^{in} exceeds unity in case of IRS and is lower than unity in case of DRS. More specifically, the increase in aggregate input of 1 % renders an increase in the aggregate output of ε_t^{in} %. Indeed, similar computations are available for the output orientation. Note that the efficient credit unions should be treated differently (Førsund, 2004).

The obtained scale elasticities were then plotted against certain credit union size measures in order to determine the optimal credit union size. The non-parametric regression (Hayfield, 2008) was also employed to analyse the determinants of efficiency.

2. Results

The summary statistics of the variables involved in the analysis are given in Table 2. As one can note there were significant differences between the largest and smallest credit unions in terms of the analysed inputs and outputs.

Table 2. Summary statistics for the input and output variables (2008–2011)

	X1	*X2*	*X3*	*X4*	*Y1*	*Y2*	*Y3*
Min.	2	104493	8944	47099	674069	42	392355
Mean	8	1556275	1599485	430871	10765359	282624	8546307
Max.	80	13716041	55970336	5029680	79555422	2217875	63124875

The obtained efficiency scores are reported in Table 3. As one can note the efficiency level was quite high: The average VRS efficiency was 88 %, whereas average CRS efficiency was 82 %. These findings imply that an average credit union should contract its inputs by some 12–18 % in order to operate efficiently. The lowest values of efficiency were 55 % and 49 % respectively under VRS and CRS. The results do also suggest that the credit union efficiency was rather stable during the research period. Furthermore, it can be considered as a slightly increasing one.

Table 3. Mean efficiency scores for the Lithuanian credit unions (2008–2011)

Year	Mean VRS efficiency	Min. VRS efficiency	Mean CRS efficiency	Min. CRS efficiency
2008	0.86	0.57	0.82	0.49
2009	0.86	0.61	0.79	0.54
2010	0.90	0.55	0.84	0.49
2011	0.90	0.68	0.84	0.56
The whole sample	0.88	0.55	0.82	0.49

The qualitative analysis of the underlying returns to scale was implemented according to S. Grosskopf (1986). The results are presented in Fig. 1. Analysis of the returns to scale implied that most of the analysed credit union operated under the sub-optimal scale during 2008–2009 (more than 60 % of the credit unions experienced increasing returns to scale during that period). Later on, however, the credit unions improved their scale efficiency by increasing their scale size. The share of credit unions operating at the optimal scale (CRS) increased from 13 % in 2008 up to 18 % in 2011. Noteworthy, even 25 % of the credit unions were operating at the optimal scale during 2010. The share of credit unions operating at the supra-optimal scale (DRS) increased from 24 % up to 36 % during 2008–2011. Still, the highest share of the credit unions, viz. 47 %, remained operating in the range of IRS. Therefore, the Lithuanian credit unions increased their scale size during 2008–2011, although there are still some possibilities to increase the share of credit unions operating under the most productive scale size.

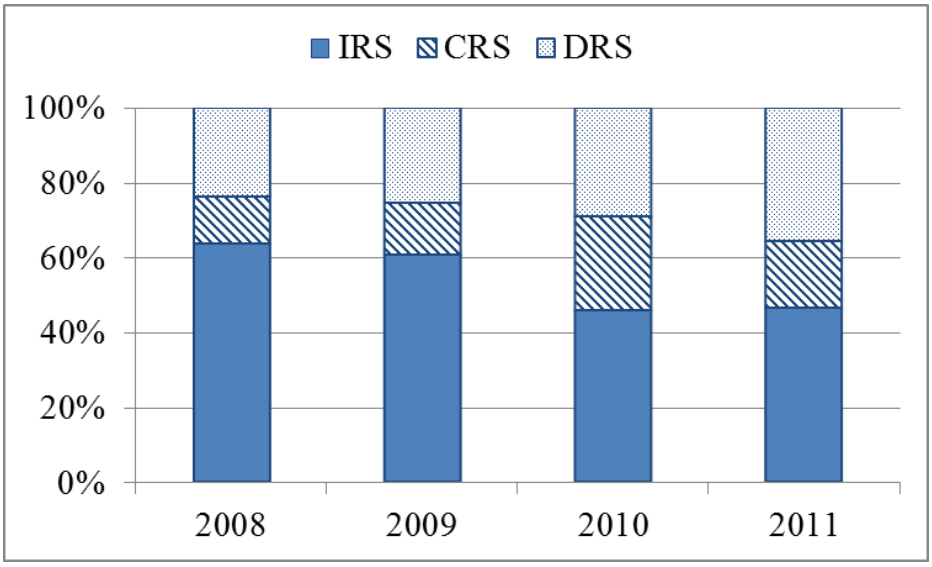

Fig. 1. The structure of the Lithuanian credit unions in terms of the returns to scale (2008–2011)

The quantitative analysis of returns to scale was employed to estimate the scale elasticities (Førsund, 2004) for inefficient points (credit unions). The obtained scale elasticity estimates were then regressed against the measures of credit union size, namely capital, number of employees, and outstanding loans. Fig. 2 depicts the relationship between the amount of capital and scale elasticity (note that the scale elasticity values were truncated at 2 and capital values were truncated at 4 million in order to enhance the visualisation). The log-log regression was then fitted to describe the relationship.

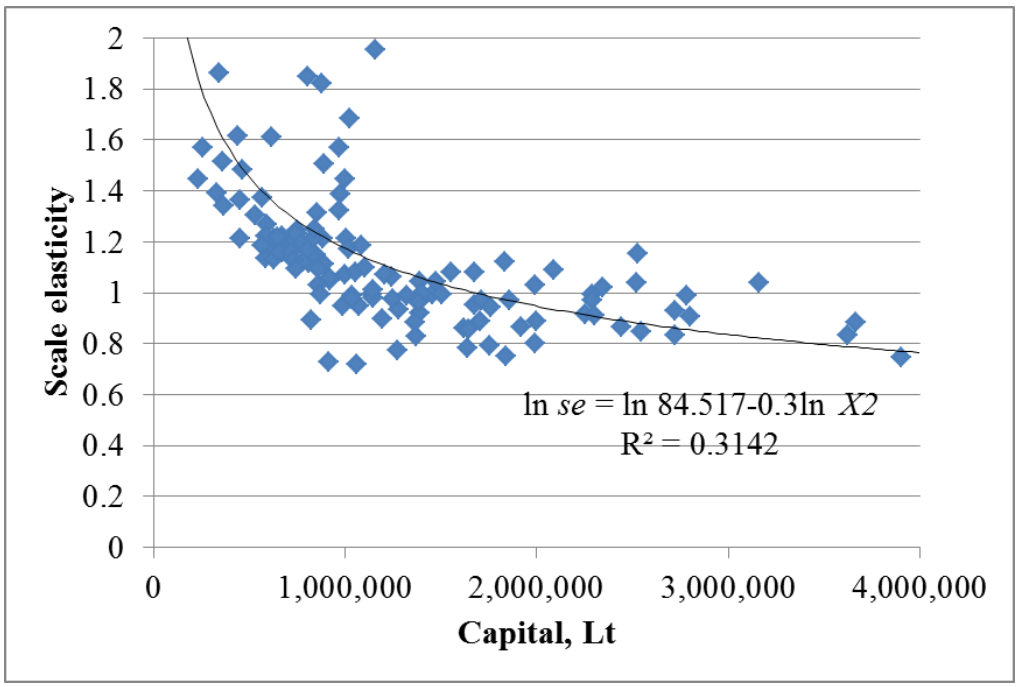

Fig. 2. Capital size and scale elasticity

The equation describing relationship between the capital size and scale elasticity solves for 1 (i. e. CRS) at 1.6 million Litas. The latter value should be considered as a guideline for the credit union activity in the short run. However, some specialised credit unions will certainly remain below this value. The survey of credit union managers (Igarytė, 2011) suggested that the expected amount of capital for year 2015 was 6.3 million Litas. Obviously, this value exceeds the optimal one based on data from 2008–2011.

The same procedure was carried out for number of employees. The resulting optimal figure was 9 employees. The latter finding implies that an average credit union could slightly increase its labour force in order to increase its operation scale. As for the outstanding loans, their optimal amount was 8.7 million Litas. Therefore, an average Lithuanian credit union could increase its loan portfolio (cf. Table 2).

The non-parametric regression was utilised to identify the impact of some environmental variables on the credit union efficiency. Eventually, the two variables remained significant, i. e. the number of clients and the share of the deposits kept by legal persons. The results are presented in Figs. 3–4. The dashed lines represent the confidence intervals obtained by the means of bootstrapping.

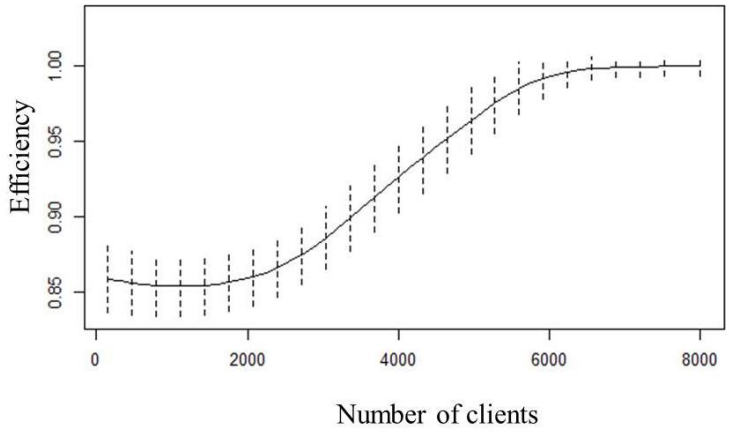

Fig. 3. Relationship between the number of clients and credit union efficiency

The results (Fig. 1) did indicate that small credit unions serving less than 2000 clients are likely to exhibit lower efficiency scores. The highest efficiency gains are achieved for those credit unions serving some 2000–6000 clients. The larger credit unions are likely to be fully efficient. Anyway, the specialised credit unions are not likely to expand their scale.

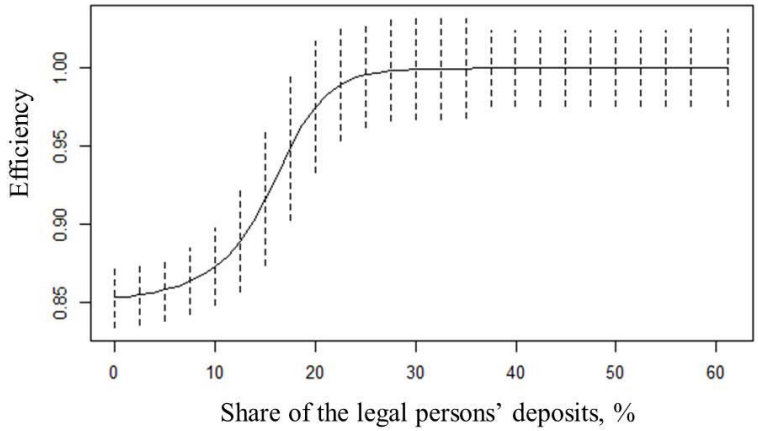

Fig. 4. Relationship between the number of clients and credit union efficiency

The presence of the legal persons among the clients of the credit unions positively impacted their efficiency (Fig. 2). Indeed, the credit unions having more than 20 % deposits kept by the legal persons were likely to be fully efficient. The latter finding might be explained by the fact that the legal persons usually keep larger deposits and thus stimulate the credit union activity by increasing their lending capacity.

Conclusions

The analysis showed that the Lithuanian credit unions operated closely to the efficiency frontier during 2008–2011.The mean efficiency level was under variable returns to scale technology was 88 %, whereas that under constant returns to scale technology was 82 %. As a result, the scale efficiency was 93 %. These findings imply

that an average credit union should contract its inputs by some 12–18 % in order to operate efficiently.

The quantitative analysis of the returns to scale implied that most of the analysed credit union operated under the sub-optimal scale during 2008–2009 (more than 60 % of the credit unions experienced increasing returns to scale during that period). Later on, however, the credit unions improved their scale efficiency by increasing their scale size.

The analysis of relationships between the capital size and scale implied that the optimal capital amount was 1.6 million Litas. As for the labour input, the resulting optimal figure was 9 employees. The estimated optimal amount of the outstanding loans was 8.7 million Litas.

The highest efficiency gains were achieved for those credit unions serving some 2000–6000 clients. Even larger credit unions were likely to be fully efficient. Anyway, the specialised credit unions are not likely to expand their scale. Indeed, the credit unions having more than 20 % deposits kept by the legal persons were likely to be fully efficient. Therefore, the Lithuanian credit unions should increase their scale size in order to reach higher efficiency.

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NEPARAMETRINĖ LIETUVOS KREDITO UNIJŲ VEIKLOS ANALIZĖ

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Santrauka

Lyginamoji finansinių institucijų veiklos analizė yra svarbi įvairioms interesų grupėms: pačioms finansinėms institucijoms, jų klientams, valstybinėms įstaigoms. Lietuvos kredito unijų veikla iki šiol nebuvo nagrinėta duomenų apgaubties analizės ar kitų ribinių metodų pagalba. Šio darbo tikslas – pritaikius duomenų apgaubties analizę, ištirti kredito unijų veiklos efektyvumą ir plėtros perspektyvas. Duomenų apgaubties analizė buvo pritaikyta siekiant gauti kredito unijų veiklos efektyvumo rodiklių įverčius. Masto elastingumas buvo apskaičiuotas ir analizuojamas pagal neoklasikinę ekonomikos teoriją. Taip pat buvo įvertinta pasirinktų efektyvumo veiksnių įtaka. Tyrimui naudoti 2008–2011 m. kredito unijų, priklausančių Lietuvos centrinei kredito unijai, veiklos duomenys.

Raktiniai žodžiai: kredito unijos, efektyvumas, masto elastingumas, duomenų apgaubties analizė.
JEL kodai: C140, C610, G210.