

PROFIT EFFICIENCY IN LITHUANIAN CREDIT UNIONS – A DEA APPROACH

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Abstract. *The paper proceeds by discussing the different definitions of credit unions. The research focuses on the efficiency of the credit unions in Lithuania. Indeed, efficiency is the degree to which the rational use of limited economic resources is ensured. More specifically, we focus on the economic efficiency of the credit unions.*

The methodology that is followed in the paper comprises the measures of cost and profit efficiency. Further on, profit efficiency is defined in terms of both standard profit efficiency and alternate profit efficiency. The measures of efficiency are implemented via the data envelopment analysis (DEA). The frontier model comprises the two outputs and the three inputs. The calculations confirm the operationality of the proposed methodology for rating credit unions according to the efficiency of their activity.

Keywords: *credit unions, efficiency activity, the measures of efficiency, data envelopment analysis.*

Introduction

In the wake of the 21st century, large commercial and investment banking was supposed to dominate within the developed financial systems. These banks were to fuel economic growth through facilitations of investment funds. However, the financial turmoil of 2008 has had a great impact upon the financial sector worldwide. The major banks faced significant losses and were forced to seek for capital inflow from different sources. All of these circumstances have raised increased attention to banking and its modes of operation.

The disturbance of banking activities, among other factors, has contributed to the development of alternate means of financial intermediation. Credit unions have emerged as one of the options. Indeed, credit unions are particularly important in terms of small-scale financial intermediation, which allows for the development of financial services in remote areas, small and medium enterprises and agricultural business. The operation of a credit union also encourages cooperative activities, as investors with different sizes of assets are able to participate in the financial intermediation. Therefore, credit unions both

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stimulate economic activities and strengthen cooperation among investors belonging to specific groups of interests.

These issues have been addressed in research carried out across different parts of the world (A. Lozano-Vivas et al. 2002; Y. Altunbas et al. 2007; F. Pasiouras et al. 2009; C. Girardone 2009; S. Tanna 2009; A. Kontolaimou, K. Tsekouras 2010; A. G. Assaf et al. 2011; F. Battaglia et al. 2010; F. Fiordelisi and D. S. Mare 2013; C. Spulbar et al. 2015; F. A. Shawtari et al. 2015; K. Harimaya and K. Kondo 2016). Regarding the Lithuanian context, research by Jasevičienė and Kėdaitis (2015), F. Jasevičienė (2014), Kėdaitis and Žilinskas (2013) and V. Terleckas (2010) are presented as studies on Lithuanian credit unions.

However, the measurement of credit union performance still requires much attention as comprehensive assessment techniques are needed in order to identify the best practices and paths for further improvements. In particular, the performance of Lithuanian credit unions rewards more detailed analysis given the recent trends in their development and the cases of insolvency or restricted operation. The use of multidimensional techniques is needed to facilitate the assessment of credit union performance and draw empirically and theoretically based evidence.

The objects of our investigation are analytical calculations in the assessments of Lithuanian credit unions performance.

The purpose of the investigation is to present a data envelopment analysis (DEA) model for the assessment of performance of Lithuanian credit unions.

The aim of this investigation covers the following tasks:

- The analysis of the peculiarities of activity in credit unions and the role of analytical calculations in assessing the effectiveness of this activity;
- The establishment of a methodology for analytical calculations using the DEA method and the assessment of the situation in Lithuanian credit unions.

Methods of investigation: systematic analysis of literature, synthesis, comparison, data envelopment analysis.

The Concept of Credit Unions

Literature presents multiple concepts of credit unions, yet certain common features prevail. For instance, Taylor (1971) noted that credit unions are financial entities of a particular form that operate as intermediaries among their members by collecting deposits and issuing loans. Following McKillop and Wilson (2014), credit unions are non-profit cooperative financial entities facilitating financial services to their members and thereby reducing financial and social exclusion. Walker and Chandler (1997) pointed out that credit unions are cooperative financial entities managed by their members. Smith et al. (1981) stressed that these entities are non-profit ones and, first of all, seek for social

benefits for their members. Furthermore, operation of the credit unions improves the financial welfare of their members and, in turn, contributes to economic development of regions. Battaglia et al. (2010) defined credit unions as small-scale financial entities usually operating within distinct geographical locations. They claim credit unions have been an important actor within financial systems of Europe and other regions. Black and Dugger (1981) referred to credit unions as distinctive institutions acting as cooperatives of consumers, offering credits and saving services only within a limited market (i.e., credit union members). Davis (2001) argued that credit unions are cooperative-based financial institutions engaged in retail banking.

The discussed examples confirm that credit unions can be considered as a kind of distinctive financial entities in regard to several criteria. First, they cannot offer their services to an unlimited circle of clients (as opposed to banks) and confine their activities to serving their members. Indeed, the members of credit unions are usually interrelated among themselves by mutual interests. These interests can therefore be considered as “social glue,” which sticks the members of credit unions together (McKillop, Wilson 2015). Regional communities and professional communities often appear as the main driving forces for establishment of the credit unions. However, credit unions face difficulties in maintaining balance among the goals of socially and philosophically oriented activity on the one side and the receiving of proper remuneration for acting as a financial intermediary on the other side.

Preliminaries for the Assessment of Credit Union Efficiency

Neoclassical economic theory defines the technical efficiency via the Pareto optimality. More specifically, Koopmans (1951) proposed the formal definition of efficient production by noting that an efficient production plan is the one where expansion in outputs (resp. contraction in inputs) is not feasible unless the quantities of inputs (resp. outputs) are increased (resp. reduced). As one can note, this definition is a qualitative one rather than a quantitative one. Due to its similarity to definition of the Pareto optimum, it is often termed the Pareto-Koopmans efficiency.

It was Farrell (1957) who put forward the quantitative definition of technical efficiency. The measures defined by Farrell (1957) allow measuring the degree of efficiency rather than just identifying efficient production plans. Therefore, in the production microeconomics theory, efficiency is defined as the ratio of the observed input quantity to the optimal one (Coelli et al. 2005). The similar reasoning applied to the output side. Furthermore, generalized measures have been offered that capture the optimization of multiple variables simultaneously. The optimal quantities of inputs or outputs are those on the boundary of the production frontier. Therefore, a production frontier has to be established in order to determine the technically feasible quantities of inputs and outputs.

There should be a delineation made between the concepts of productivity and efficiency. While efficiency compares the observed values to the optimal ones, productivity focuses on the ratio (difference) between the aggregate output and the aggregate input. Therefore, efficiency boils down to a comparison of the observed productivity to the maximum possible one if inputs (or other variables depending on the models applied) are optimized. Therefore, changes in efficiency correspond to changes in productivity if the comparison is facilitated against the same frontier. Note that the economically efficient production plan locates on the intersection of an input isoquant (which is a representation of the underlying production possibility frontier) and the expansion path.

Focusing on economic efficiency, one can define it as the ratio (difference) between the observed and optimal profit (revenue minus cost). The notion of economic efficiency thus rests on both quantity and price data for inputs and outputs. In the input-output space, the economically efficient production plan is defined as the intersection of the production frontier (production function) and the isoprofit line. Note that the production frontier is established based on the input and output quantities, whereas the isoprofit line requires the price data, too. The difference between the observed and optimal profits can be decomposed into the two parts, with each of them associated with the technical and allocative inefficiency (Uri 2001; Outtara 2012).

As we have already discussed, the technical efficiency represents a firm's ability to transform inputs into outputs (this, indeed, corresponds to the concept of productivity). Allocative efficiency is a more subtle concept, which is related to the input- and output-mix rather than quantity. Indeed, the allocative efficiency is measured by moving along the isoquant, whether an input or output one. Therefore, it defines the technically feasible changes in the input-mix (resp. output-mix) while keeping the output (resp. input) level fixed. In the efficiency analysis, the measurement of the allocative efficiency basically corresponds to the movement along the technically efficient production plans until an economically and allocatively efficient plan is reached. In its essence, allocative efficiency represents a firm's ability to construct input- and output-mixes with regards to the market prices (Porcelli 2009). Therefore, allocative efficiency contributes to revenue maximization and/or cost minimization (Rodriguea-Alvarez 2007).

Economic efficiency can be measured by taking different approaches. The most general one is the measurement of the standard profit efficiency (SPE). In this case, input and output quantities are altered with respect to the corresponding price vectors and the underlying technology. More restrictive cases are those of revenue and cost efficiency, in which, respectively, output and input quantities are adjusted in regards to relative prices and technology (Maudos et al. 2002).

More specifically, let us define cost efficiency as the ratio of the optimal cost, C^* , to the observed cost, C . In this way, full efficiency is maintained when the observed and minimal costs coincide, and the discrepancies yield values of the cost efficiency below

unity. The product of the observed cost and unity minus the cost efficiency renders the potential saving in cost due to shifts in the input-mix.

The profit efficiency can be defined as a ratio of the observed profit, π , to the optimal one, π^* . Following Berger and Meister (1997), the two types of profit efficiency emerge: SPE and alternate profit efficiency (APE). In case of SPE, π^* is obtained by manipulating input quantities x and output quantities y given the production frontier and profit function $\pi^{SPE}(w, p)$, where w and p are prices of the inputs and outputs, respectively. In case of APE, output quantities remain fixed and the profit function becomes $\pi^{APE}(w, y)$. The latter setting assumes the presence of market power in the output markets.

Berger and Mester (1997) argued that the presence of either of the following circumstances implies the need for an application of the profit efficiency measures (as opposed to technical efficiency ones):

- When credit institutions cannot produce the optimal quantity of outputs;
- When differences exist in the quality of the outputs (banking services);
- When the markets are imperfect and credit institutions can influence the prices.

DEA Models for Empirical Analysis

In this paper, we apply the measures of cost and profit efficiency. As regards the measures of profit efficiency, we focus on both SPE and APE. The measures of efficiency are implemented via the DEA. Therefore, we estimate piece-wise a linear empirical production frontier. The models presented below rest on Maudos and Pastor (2002).

Let there be n decision making units (i.e., credit unions) indexed over $i = 1, 2, \dots, n$, the activity of which is defined in terms of:

- q types of outputs with their quantities arranged into vector $y_i = (y_{i1}, y_{i2}, \dots, y_{iq}) \in R_{++}^q$ sold at prices $p_i = (p_{i1}, p_{i2}, \dots, p_{iq}) \in R_{++}^q$ and
- r types of inputs with their quantities arranged into vector $x_i = (x_{i1}, x_{i2}, \dots, x_{ir}) \in R_{++}^r$ purchased at prices $w_i = (w_{i1}, w_{i2}, \dots, w_{ir}) \in R_{++}^r$.

Then, optimal cost level for an arbitrarily chosen credit union $i = 1, 2, \dots, n$ is estimated by employing the following linear program:

$$\begin{aligned}
 \min_{x_j, \lambda_i} C_i^*(w_i) &= \sum_{j=1}^r w_{ij} x_j \\
 \text{s.t. } \sum_{i=1}^n \lambda_i x_{ij} &\leq x_j, j = 1, 2, \dots, r, \\
 \sum_{i=1}^n \lambda_i y_{ik} &\geq y_{i'k}, k = 1, 2, \dots, q, \\
 \sum_{i=1}^n \lambda_i &= 1, \\
 \lambda_i &\geq 0, i = 1, 2, \dots, n,
 \end{aligned} \tag{1}$$

where λ_i are intensity variables and x_j are the optimal input levels. Note that the variable returns to scale technology is assumed by imposing a restriction over the sum of the intensity variables. Then, cost efficiency can be obtained by comparing the optimal cost level obtained from Eq. 1 to the observed cost level, $C_{i'}(w_{i'}) = \sum_{j=1}^r w_{i'j} x_{i'j}$.

SPE is based on the maximum profit level obtained by changing both input and output quantities. The optimal profit level for SPE is obtained via

$$\begin{aligned}
\max_{x_j, y_k, \lambda_i} \pi_{i'}^{*,SPE}(p_{i'}, w_{i'}) &= \sum_{k=1}^q p_{i'k} y_k - \sum_{j=1}^r w_{i'j} x_j \\
\text{s.t. } \sum_{i=1}^n \lambda_i x_{ij} &\leq x_j, j = 1, 2, \dots, r, \\
\sum_{i=1}^n \lambda_i y_{ik} &\geq y_k, k = 1, 2, \dots, q, \\
\sum_{i=1}^n \lambda_i &= 1, \\
\lambda_i &\geq 0, i = 1, 2, \dots, n,
\end{aligned} \tag{2}$$

where x_j and y_k are the optimal input and output levels, respectively. Subsequently, SPE can be obtained by comparing the optimal profit level obtained from Eq. 2 to the observed profit level, $\pi_{i'}(p_{i'}, w_{i'}) = \sum_{k=1}^q p_{i'k} y_{i'k} - \sum_{j=1}^r w_{i'j} x_{i'j}$.

The optimal profit for APE is obtained by solving the following problem:

$$\begin{aligned}
\max_{x_j, R, \lambda_i} \pi_{i'}^{*,APE}(w_{i'}) &= R - \sum_{j=1}^r w_{i'j} x_j \\
\text{s.t. } \sum_{i=1}^n \lambda_i R_i &\leq R, \\
\sum_{i=1}^n \lambda_i x_{ij} &\leq x_j, j = 1, 2, \dots, r, \\
\sum_{i=1}^n \lambda_i y_{ik} &\geq y_{i'k}, k = 1, 2, \dots, q, \\
\sum_{i=1}^n \lambda_i &= 1, \\
\lambda_i &\geq 0, i = 1, 2, \dots, n,
\end{aligned} \tag{3}$$

where $R_i = \sum_{k=1}^q p_{ik} y_{ik}$ is the observed revenue for the i -th credit union. The APE can be obtained by comparing the optimal profit level obtained from Eq. 3 to the observed profit level, $\pi_{i'}(p_{i'}, w_{i'}) = \sum_{k=1}^q p_{i'k} y_{i'k} - \sum_{j=1}^r w_{i'j} x_{i'j}$.

Data Used

The performance of the Lithuanian credit unions is assessed against multiple inputs and multiple outputs by applying the DEA. The frontier model comprises the two outputs and the three inputs. Specifically, the following variables are used:

- Outputs: y_1 – outstanding loans (Euro), y_2 – debt securities (Euro);
- Output prices: r_1 – the ratio of operating income to outstanding loans, r_2 – the ratio of returns on securities to debt securities;
- Inputs: x_1 – deposits (Euro), x_2 – the number of employees, x_3 – the share capital (Euro);
- Input prices: w_1 – the ratio of deposit interests to deposits, w_2 – the ratio of remuneration to the number of employees, w_3 – the ratio of other expenses to the share capital.

Therefore, the costs incurred by the credit unions comprise both operating and financial costs. As regards the revenue, it comprises interest and non-interest income.

The research covers credit unions belonging to the association Lithuanian Credit Unions. As of 2015, 57 credit unions belong to the association. Three size groups of the credit unions are considered in the analysis. Small-size credit unions are those with share capital equal to less than 1% the total share capital of the credit unions. Medium-sized credit unions are those with share capital in between 1% and 2% of the total share capital. Finally, large-size credit unions are those with share capital equal to more than 2% of the total share capital. The DEA is applied for each group independently. The credit unions established at similar years have been chosen for the analysis. Table No. 1 presents the sample. Due to the small sample size, we include a hypothetical credit union within each group. The hypothetical credit union is attributed with the lowest (resp. highest) values of inputs (resp. outputs).

TABLE No. 1. The grouping of Lithuanian credit unions chosen for the analysis.

Groups of the credit unions					
Small-size credit unions		Medium-size credit unions		Large-size credit unions	
<i>Credit union</i>	<i>Licence issued at</i>	<i>Credit union</i>	<i>Licence issued at</i>	<i>Credit union</i>	<i>Licence issued at</i>
Credit Union Šešiagrašis	1996	Plungė Credit Union	1996	Credit union Tikroji Viltis	1997
Radviliškis Credit Union	1996	Credit Union Giminėlė	1997	Farmers Credit Union of Pakruojis	1996
Vilkaviškis Credit Union	1996	Credit Union Sūduvos Parama	1996	Academic Credit Union	1997
Credit Union of Kaunas Archbishopric	1997	Credit Union Žemdirbio Gerovė	1997	Credit union Germanto Lobis	1997
Aukštaitija Credit Union	1997			Šilutė Credit Union	1996
				Panevėžys Credit Union	1997

Results

The cost, standard profit and alternate profit efficiencies were computed within the three groups of credit unions. Tables Nos. 2–4 present the results. Results for the large-size credit unions are presented in Table No. 2.

TABLE No. 2. The economic efficiency of large-size credit unions.

	Credit Union Tikroji Viltis	Farmers Credit Union of Pakruojis	Academic Credit Union	Credit Union Germanto Lobis	Šilutė Credit Union	Panevėžys Credit Union	Average
Optimal costs (thousand €)	226,75	168,87	262,44	208,42	280,32	173,70	
Cost efficiency	0,80	0,73	0,76	0,45	0,44	0,35	0,59
SPE-profit (thousand €)	953,07	1514,98	1245,87	910,23	1391,01	2068,50	
SPE	0,14	0,15	0,60	0,40	0,48	0,29	0,34
APE-profit (thousand €)	919,25	977,13	883,56	937,58	865,68	972,30	
APE	0,10	0,15	0,69	0,30	0,59	0,44	0,38

The value of cost efficiency indicator gets closer to unity as a credit union opts for a cost-saving input-mix. Table No. 2 indicates that the credit union Tikroji Viltis managed to adjust its input-mix to a better extent than the other credit unions in the group did and could reduce its observed cost by some 20%. The worst performance in the sense of input-mix adjustment is observed for the Panevėžys Credit Union, where savings of some 65% are possible. The low performance of the latter credit union might be attributed to the excessive number of employees and high values of deposits.

SPE indicates the gap between the observed and optimal profits considering output prices as given ones. The Academic Credit Union showed the highest SPE (0.6). The lowest SPE was observed for the credit union Tikroji Viltis and the Farmers Credit Union of Pakruojis (0.14 and 0.15, respectively). Turning to APE, the Academic Credit Union was ranked the best, whereas the credit union “Tikroji Viltis” appeared as the worst performing one with an APE of just 0.1.

Results for medium-sized credit unions are given in Table No. 3.

Results in Table No. 3 indicate that the credit union Giminėlė has approached the optimal input-mix and could reduce its operation cost by just 1%. The Plungė Credit Union and the credit union Sūduvos Parama showed cost efficiencies of 59% and 66%, respectively. Within the size group, the credit union Žemdirbio Gerovė showed the lowest cost efficiency of 49%. A high value of deposits in the latter credit union might be the major factor causing cost inefficiency there.

TABLE No. 3. The economic efficiency of medium-size credit unions.

	Plungė Credit Union	Credit Union Giminėlė	Credit Union Sūduvos Parama	Credit Union Žemdirbio Gerovė	Average
Optimal costs (thousand €)	49,03	105,68	86,47	79,57	
Cost efficiency	0,59	0,99	0,66	0,49	0,68
SPE-profit (thousand €)	156,19	181,89	173,94	214,43	
SPE	0,27	0,07	0,34	0,62	0,33
APE-profit (thousand €)	218,97	162,32	181,53	188,43	
APE	0,19	0,07	0,30	0,57	0,28

The highest SPE was observed for the credit union Žemdirbio Gerovė (62%). The credit union Giminėlė exhibited the worst performance in terms of SPE (7%). This result implies that an increase of 93% is needed in its profit. Considering the APE, the credit union Žemdirbio Gerovė showed the highest efficiency score of 57%, whereas the lowest efficiency score was observed for the credit union Giminėlė (7%).

The results for small-size credit unions are outlined in Table No. 4.

TABLE No. 4. The economic efficiency of small-size credit unions.

	Credit union Šešiagrašis	Radviliškis Credit Union	Vilkaviškis Credit Union	Credit Union of Kaunas Archbishopric	Aukštaitija Credit Union	Average
Optimal costs (thousand €)	64,92	64,85	35,33	53,39	89,52	
Cost efficiency	1,00	0,83	0,36	0,53	0,61	0,67
SPE-profit (thousand €)	396,37	195,09	150,45	156,89	124,88	
SPE	0,04	0,08	0,45	0,23	0,55	0,27
APE-profit (thousand €)	129,82	129,89	159,41	141,35	105,22	
APE	0,13	0,12	0,43	0,25	0,46	0,28

The credit union Šešiagrašis appeared as a fully efficient one in terms of cost efficiency. The Radviliškis Credit Union showed a rather high level of cost efficiency (83%). Among the small-size credit unions, the Vilkaviškis Credit Union appeared as the least efficient one (36%) in terms of cost efficiency. Turning to SPE, the highest efficiency score was obtained for the Aukštaitija Credit Union (55%). The credit union Šešiagrašis and the Radviliškis Credit Union turned out to be the least efficient in regard to SPE with efficiency scores of 4% and 8%, respectively. The Aukštaitija Credit Union showed the highest APE of 46% with the Vilkaviškis Credit Union ranking second (43%).

A comparison of the average efficiency scores presented in Tables Nos. 2–4 allows comparing different size groups of the credit unions. Looking at the cost efficiency, small- and medium-size credit unions performed better (average efficiency scores of 67% and 68%, respectively) if contrasted to large-size ones (59%). As regards the SPE, large-size credit unions appeared as the best performing ones with an average efficiency score of 34%. Medium-size credit unions lagged behind with an average efficiency score of 33%. Finally, large-size credit unions appeared as the most efficiency in terms of APE (38%).

The findings suggest that the small-size credit unions did not achieve the highest ranks in either of the approaches (cost efficiency, SPE or APE). Large-size credit unions dominated the other size groups in both approaches of the profit efficiency (SPE and APE). Medium-size credit unions were ranked as the first or second ones in accordance with the three approaches. These results show, in general, that small-size credit unions face difficulties in adjusting their input- and output-mixes and, therefore, achieve lower levels of economic efficiency.

Conclusions

In the related literature, there are different definitions of credit unions. In general, it can be stressed that credit unions are specific financial institutions pursuing for both profits and the welfare of their members.

Achieving efficiency is a foremost goal of any organization, regardless its scope or size. Neoclassical economic theory defines the technical efficiency via the Pareto optimality. On the other hand, efficiency is related to the rational use of limited economic resources, which leads to the best possible result (output).

Typically, efficiency analysis focuses on technical and cost efficiency, whereas profit efficiency often remains neglected. The methodology applied in the present research included the measures of both cost and profit efficiency. As regards profit efficiency, standard profit efficiency and alternate profit efficiency were considered. The measures of efficiency were implemented via the data envelopment analysis (DEA).

The performance of the Lithuanian credit unions was assessed against multiple inputs and multiple outputs by applying the DEA. The frontier model comprised the two outputs and the three inputs. Specifically, the following variables were used: outstanding loans, debt securities, deposits, the number of employees, the share capital.

It is rational to determine which group of credit unions works most effectively; the results of the DEA study are ranked in accordance with the place occupied. The calculations showed that the efficiency of large and medium-sized credit unions was of best performance, while the worst performance was observed for the smaller credit unions.

Further research could aim to apply the measures of productivity change to identify the main sources of changes in the total factor productivity. This can be done for dif-

ferent groups of credit unions in order to identify the underlying differences in their performance. What is more, robust methodologies could be applied in order to account for statistical noise.

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