Received: 07 February 2012; Accepted: 17 October 2013.
DOI: 10.2298/PAN1403349B
Original scientific paper

Willem Karel M. Brauers

Faculty of Applied Economics;
Institute for Development Policy and Management,
University of Antwerpen,
Belgium

willem.brauers@ua.ac.be

Romualdas Ginevičius

Department of Enterprise Economics and Business Management,
Gediminas Technical University,
Lithuania

romualdas.ginevicius@vgtu.lt

Askoldas Podviezko

Department of Enterprise Economics and Business Management,
Gediminas Technical University,
Lithuania

askoldas@gmail.com

Development of a Methodology of Evaluation of Financial Stability of Commercial Banks

Summary: The field of evaluation of financial stability of commercial banks, which emanates from persistent existence of financial crisis, induces interest of researchers for over a century. The span of prevailing methodologies stretches from over-simplified risk-return approaches to ones comprising large number of economic variables on the micro- and/or macro-economic level. Methodologies of rating agencies and current methodologies reviewed and applied by the ECB are not intended for reducing information asymmetry in the market of commercial banks. In the paper it is shown that the Lithuanian financial system is bank-based with deposits of households being its primary sources, and its stability is primarily depending on behavior of depositors. A methodology of evaluation of commercial banks with features of decreasing information asymmetry in the market of commercial banks is being developed by comparing different MCDA methods.

Key words: MOORA, MULTIMOORA, Bank evaluation, Financial stability, CAMEL.

JEL: C44, C61, G21, O22.

The history of scientific investigations of financial stability spans over a century. The first known to authors, source in which stability of banks was analysed is a monograph by the Assistant Professor of Banking and Finance in Harvard University, Oliver M. W. Sprague (1910), where attention is paid to measures of building confidence of depositors, and to outcomes of neglecting such an issue; tools, mostly qualitative, of attaining such confidence are elaborated. In general, the proposed tools are of the spontaneous nature and of the opportunistic character. Over the last century science has evolved numerous methods and methodologies of dealing with financial stability; more sophisticated computer-based methods are being used in the several last decades. In the continuously provided by the European Central Bank (ECB) and Bank for International Settlements (BIS) surveys of methodologies of assessment of financial stability the trend could be observed that the methodologies concentrate on the macroeconomic variables, very much in line with suggestions outlined in a comprehensive review of the problem of evaluation of financial stability made a decade ago (Aerdt Houben, Jan Kakes, and Garry Schinasi 2004). It could be observed that the focus has shifted from such an important instability cause as depositor's behaviour, which is an important cause of bank crisis (Emre O. Ergungor and James B. Thomson 2005).

The ECB tools for financial stability analysis comprise three branches. Namely, identification of important sources of system-wide vulnerabilities; assessment of the potential costs to the real economy in the case of a financial distress; fragilities of the financial institutions network and contagion (Vítor Constâncio 2012). In Irving Fisher Committee bulletin issued by the BIS a comprehensive review of attempts of central banks in creating a single aggregate measure for assessing financial stability is provided (Blaise Gadanecz and Kaushik Jayaram 2008). The reviewed methodologies concentrate on a wide variety of indexes, which are grouped to six categories by the sectors of the economy characteristics of which they describe: the real sector, the corporate sector's riskiness, the household sector's health, the external sector, the financial sector, and financial markets. The composite indicator of systemic stress developed by the ECB comprises five segments: money, bond, equity and foreign exchange markets, and financial intermediaries. Four categories of models of macroprudential supervision are described: early warning models, macro stress-testing models, contagion and spillover models, and the models indicating the current state of systemic instability are described (ECB 2010).

On the other hand, the information asymmetry is invariably listed among the causes of financial crisis, especially in the bank-based financial systems (Joseph R. Mason 2009; Houssem Rachdi 2010), which is also the case for Lithuania, which financial system is bank-based. In fact, based on data from Thorsten Beck, Asli Demirgüç-Kunt, and Ross Levine (2010) this conclusion can be made. To mention two the most important criteria, in 2009 the ratio of assets of the banking sector to the GDP in Lithuania was 0.735, and capitalisation of stock market of this country being 0.188 the same year. Proportion between the two criteria is considerably higher than in the historically known bank-based country, such as Germany, where the ratio of assets of the banking sector to the GDP in 2009 was 1.151, and stock market capitalisation was 0.747 the same year. Consequently, stability of the financial system of Lithuania depends primarily on stability of commercial banks. By the other hand, stability of commercial banks depends primarily on behavior of depositors as the major part of its assets is financed with household deposits.

As of January 2013 households and non-financial corporations' deposits in Lithuania account 90.92% of total deposits in this country. Consequently, it is the major part of the total of deposits. In the same period the structure of the deposits was short-term, as 90.47% of all households' and non-financial corporations' deposits in Lithuania were of up to one-year maturity (Lietuvos Bankas 2013). From the latter fact it becomes obvious that depositor's behavior primarily depends on the short-term considerations. In order to be successful evaluation methodology must promptly deliver results in understandable formats to depositors. Methodologies of rating agencies, which are known in developing rather clear rating scale, have serious shortcomings, which will be described in Section 3.

High information asymmetry levels influence several important factors, which increase severity of financial crisis, namely increase of moral hazard, increase of uncertainty, increase of price instability (Frederic S. Mishkin 1999). Increase of moral hazard in the banking industry due to information asymmetry was investigated, for example, in Elizabeth Webb Cooper (2009). Adoption of the approach of functional

perspective of financial intermediation (Robert C. Merton 1995) suggests that increase of competitiveness among financial institutions and increase of their efficiency consequently increase financial stability, which is to be understood in the way of stable and efficient performance of core functions of financial system. These major goals for achieving financial stability are in line with the goals outlined in Franklin Allen and Douglas Gale (2000), which attempt to offset deviations of the state of financial system from the model of the general equilibrium by Kenneth J. Arrow and Gerard Debreu (1954), aiming to attain the state of highest efficiency of financial system. Currently such a state is far from being reached because of the following: high information asymmetry, moral hazard, and the lack of competition. On the other hand, systemic risk is closely related to human behavior. Failure of a financial institution can lead to more significant failures causing distress or failure to perform functions of the financial system. Its prevention is seen in increase of transparency and increase of financial supervision.

We strive to influence confidence of depositors in financial intermediaries by reducing information asymmetry in the market. This requires methodologies of prompt evaluation of financial state of financial institutions, which deliver results in understandable formats to depositors. MCDA (multiple criteria decision aid) methods serve as a perfect tool for evaluation of the state of financial stability of commercial banks, which are major financial institutions in Lithuania. A methodology of evaluation of commercial banks with features of decreasing information asymmetry in the market of commercial banks is being developed by comparing different MCDA methods.

This paper is organized as follows. Section 1 carries the concept of evaluation of commercial banks registered in Lithuania. Section 2 describes variables used in the evaluation. Section 3 describes robustness of MOORA method and two possible ways of gathering objectives into a single super-objective. Section 4 describes MOORA method. Section 5 describes MULTIMOORA method, the theory of dominance, and the results of the evaluation. Section 6 concludes.

1. Concept of Evaluation of Commercial Banks

In this paper Lithuanian banks are evaluated using multiple criteria decision aid methods. The authors use several MCDA methods for the purpose of increasing reliability of the evaluation and for comparison of different methods.

The topic of evaluation of financial stability of commercial banks is rather popular. In Lithuania a MCDA research on client-based variables has been attempted by Romualdas Ginevičius and Valentinas Podvezko (2008), Askoldas Podviezko and Ginevičius (2010), Ginevičius and Podviezko (2011, 2013), Willem Karel M. Brauers, Ginevičius, and Podviezko (2012), Podviezko (2012) etc.

MCDA methods' result is usually provided in the form of rankings, which is a convenient form of the initial perception of the stability level of a commercial bank by a depositor. Further enhancements of the MCDA methodology (Podviezko 2012) provide results in more precise forms: in the graphical way expressing stability level by each of CAMEL category, and in the form of tables revealing stability level by each criterion. The mentioned methodology is intended to reduce information asym-

metry level in the market of commercial banks and depositors by providing results of evaluation in different forms in order to suit the level of comprehension of every depositor thus enabling him as a decision-maker to obtain adequate perception of bank financial stability in accordance with his level of comprehension. The list of criteria could be extended to comprise both micro- and macro-economic criteria; stress-testing could be performed using deviated values of criteria for calculations.

Our paper is based on a categorization of banks comprising major types of objectives. A selection is proposed on basis of a classification which is very popular by the researchers on bank activities, namely CAMEL. CAMEL represents the abbreviation of Capital adequacy, Asset quality, Management quality, Earnings and Liquidity. This categorization is used by the American Federal Reserve, FDIC (deposit insurance) and the OCC (Office of the Comptroller of the Currency), (Podviezko and Ginevičius 2010). It comprises major types of objectives representing stability of banks. The well known international rating agency, Moody's Investors Service uses CAMEL-based objectives (David Fanger 2007).

Brenda González-Hermosillo (1999) cites as macro-economic factors of financial instability: "cyclical output downturns, adverse terms of trade shocks, declines in asset prices, rising real interest rates, boom-bust cycles in inflation, credit expansion, losses of foreign exchange reserves and capital inflows". With the banking crisis in Asian countries of 1996-1997 Demirgüç-Kunt and Enrica Detragiache (1998) and Daniel C. Hardy and Ceyla Pazarbasioglu (1998) argue that these models missed these crisis. Nevertheless, we have not to consider the macro-economic approach as the banks we investigate are registered in Lithuania and therefore are operating in the same macro-economic environment, governed by the same Law on Banks (Lietuvos Respublikos Seimas 2011) and deposits made with these banks are insured by the same State Enterprise "Deposit and Investment Insurance". The year 2007 is taken as basis as the later years were seriously biased. The years 2008 and 2009 were characterized by a serious recession largely due to the sub-prime and bank crisis problems. The year 2008 was in the middle of the serious recession in the high-income countries from the end of 2007 until the end of 2009 (Symposium Macroeconomics after the Financial Crisis 2010 with the following articles: Alan J. Auerbach, William G. Gale, and Benjamin H. Harris 2010; Richard Baldwin 2010; Robert E. Hall 2010; Lee E. Ohanian 2010).

2. The List of Objectives Based on the CAMEL

We concentrate on bank-specific variables, which disclose performance of each bank in the market in terms of soundness and stability. All data are available from their annual reports and it becomes immediately clear that it is impossible to evaluate the banks directly by observing raw data and enormous number of different figures contained in the reports. For evaluation purposes a limited number of essential criteria representing stable and sound performance of banks must be chosen (Ginevičius and Podviezko 2011). The following objectives are proposed based on the CAMEL categorization and by cost and profit efficiency (Nicholas Apergis and Effrosyni Alevizopoulou 2010).

2.1 Capital Adequacy

In 1988 the introduction of Basel I capital adequacy framework has set capital adequacy requirements on banks and is considered to be a major regulatory measure, which reduces credit risk in activities of banks. While in Basel I capital adequacy framework credit risk is only considered, in addition a new capital adequacy framework, referred to as Basel II, accounts operational and market risk. Capital adequacy ratio is calculated by dividing capital by risk-weighted assets accounted separately for credit, market and operational risks (BIS 2004). Calculation of capital adequacy ratio in banks is required to hold total capital equivalent to at least 8% of their risk-weighted assets (Board of the Bank of Lithuania 2006).

The Central Bank of Lithuania adds up the two. We also add both Tier 1 and Tier 2 capital ratios, but since Tier 2 capital is more risky than Tier 1 capital (Ray Barrell et al. 2011), we rather assume that Tier 1 is two times more important than Tier 2. This difference in appreciation reveals the difference of risk for the two types of capital.

The resulting single CAPITAL objective is clearly a maximising one, since the larger the capital, the more it can absorb losses, including ones arising from bad loans, low cost and earning efficiency as from interest rate and trading.

2.2 Assets

Assets category is represented by four ratios:

(i) The first ratio requires the maximization of net interest income as a percentage of RWA (risk-weighted assets). We have undertaken a conservative view as we believe that this objective, as well as two other following objectives in Earnings category, more adequately accounts profitability of assets in terms of riskiness than in the case if interest income was divided by total assets. This view corresponds to risk-adjusted return on capital measurement model and is also employed by Moody's Investors Service (Fanger 2007);

(ii) The second is the ratio between loans as the most risky assets and total assets. This ratio requires minimization;

(iii) The third ratio is delinquent loans to total assets. In Lithuania, loans are considered to be delinquent if they are overdue for 60 days or longer. This ratio requires minimization;

(iv) The fourth ratio within the category is the decrease of value of assets over the reported year divided by total assets. This ratio requires minimization.

2.3 Management

Management category is represented by a single ratio, expressing cost-efficiency of a bank. Since the aim of the research is to consider only quantitative financial objectives, we did not include the qualitative objectives to the analysis. The ratio employed is between non-interest costs and total income. This ratio requires minimization.

2.4 Earnings

The category of *earnings* is represented by two ratios, which both have to be maximized:

(a) Pre-provision profits compared to risk-weighted assets. This ratio reveals the capability of a bank to generate cash, which could then serve as a remedy for various losses;
(b) Net income compared to risk-weighted assets. This second ratio expresses profitability of a bank by revealing remaining profits after all deductions have been made;
(c) The chosen above described ratios form the set of criteria for our multiple criteria evaluation. Some of the criteria are maximising, some are minimising as their effect on bank stability is different. The higher the earnings, the larger the capital ratios, the more efficient expenditure management and the better loan portfolio, then the likelihood of failure is smaller (David C. Wheelock and Paul W. Wilson 2000), and as values of all criteria cannot be simultaneously improved in the real economic environment without making trade-offs between them, multiple criteria evaluation is designed to expose the general level of stability of each bank.

2.5 Liquidity

Finally, the last *liquidity* category is represented by two ratios:

(1) The part of deposits in total loans. We chose the deposits represented only by customer deposits and excluded more volatile inter-bank deposits. This ratio requires maximization, thus setting the goal for a bank of the most stable loan-financing from the customer-deposit source;
(2) The regulatory liquidity ratio imposed by the Central bank, i.e. the Bank of Lithuania. This ratio indicates the short-term liquidity position of a bank within a month.

Table 1 shows values of the chosen criteria representing performance of Lithuanian banks on the defined objectives. Data is taken from annual audited financial statements of Lithuanian commercial banks as such approach is reliable and popular among researchers (Sami Mensi 2010).

3. Evaluation Methodology

Upon investigation of popular available methods of evaluation of bank stability, namely methodologies applied by rating agencies and statistical methods, the authors made a choice in favour of the MCDM methods (Ginevičius and Podviezko 2012).

Methodologies applied by rating agencies are primarily based on the qualitative analysis, on judgment of one-two experts, are slowly reacting to changes in the market, focus on qualitative evaluation are declared features of rating agencies (Richard Cantor 2001; Moody's Investors Service 2011). As a consequence, ratings are among the worst indicators of financial crisis (Herwig Langohr and Patricia Langohr 2008). Among other shortcomings thus making such methodologies less

Table 1 Objectives for Lithuanian Banks

	Capital % of RWA	Net interest income % RWA	Loans % assets	Delinquent >60d loans % assets	Loan value decrease % assets	Non-interest cost % total income	Pre-provision profit % RWA	Net income % RWA	Deposits % loans	Liquidity
	Max.	Max.	Min.	Min.	Min.	Min.	Max.	Max.	Max.	Max.
					2007					
DNB NORD	5.61	2.64	83.42	0.26	0.19	30.61	1.71	1.23	48.08	36.24
MEDICINOS	5.50	2.91	64.21	1.15	0.39	46.41	1.52	0.87	97.04	45.51
PAREX	7.62	1.54	78.93	0.05	0.24	50.38	0.26	0.00	52.95	32.79
SEB	5.45	2.59	71.35	0.31	0.13	23.23	3.02	2.47	61.42	42.78
SNORAS	7.15	2.55	46.03	0.74	-0.20	34.64	2.14	2.08	155.43	50.63
SWEDBANK	6.17	3.55	71.21	0.43	0.10	34.28	3.03	2.34	90.48	42.20
ŠIAULIU	10.04	2.36	76.79	0.41	0.26	29.46	2.15	1.71	78.72	44.03
ŪKIO	6.95	2.90	75.71	0.29	0.61	42.34	3.20	2.43	89.85	49.43
					2008					
DNB NORD	6.59	2.60	85.95	1.06	0.50	24.62	1.58	0.62	34.27	37.47
MEDICINOS	10.08	3.86	65.53	8.39	1.21	36.27	2.20	0.85	102.62	59.43
PAREX	7.78	2.36	67.14	0.26	0.84	43.99	-0.05	-1.67	29.86	32.93
SEB	6.59	2.50	77.92	1.14	0.59	21.87	2.35	1.49	50.72	38.99
SNORAS	6.47	2.33	60.60	3.00	0.67	34.33	1.54	0.51	113.17	36.37
SWEDBANK	9.28	4.56	76.57	1.10	0.25	29.14	3.78	2.92	72.06	39.76
ŠIAULIU	10.04	2.44	82.06	0.69	0.36	25.73	1.54	1.00	74.90	38.75
ŪKIO	7.85	2.61	82.19	1.29	0.72	36.77	2.53	1.57	87.93	42.45
					2009					
DNB NORD	6.39	2.58	86.36	3.36	4.77	24.33	2.47	-3.93	33.10	37.61
MEDICINOS	10.29	2.77	66.17	3.02	1.88	30.95	1.98	0.05	113.31	55.31
PAREX	10.14	2.17	87.00	5.56	4.33	52.82	-0.75	-7.77	41.55	40.74
SEB	7.31	2.09	71.10	2.94	6.45	29.61	1.25	-10.60	56.57	60.31
SNORAS	6.43	0.08	53.18	7.66	1.39	27.66	1.95	0.18	148.07	41.26
SWEDBANK	11.29	3.15	76.60	6.45	5.52	27.61	3.16	-9.11	84.11	45.50
ŠIAULIU	9.26	1.52	80.05	0.95	2.08	22.15	0.78	-1.67	92.74	34.61
ŪKIO	8.05	0.80	71.82	5.51	2.12	32.25	0.08	-2.08	110.93	50.86

Source: AB Bankas SNORAS (2008, 2009), AB DnB NORD Bankas (2008, 2009), AB Parexbankas (2008, 2009), AB SEB Bankas (2008, 2009), AB Swedbank (2008, 2009), AB Šiauliu Bankas (2008, 2009), AB Ūkio Bankas (2008, 2009), UAB Medicinos Bankas (2008, 2009); compiled by authors.

attractive for the purpose of reducing information asymmetry in the market of commercial banks are: informal relationship with bank management; the fact that rating agencies are paid by financial institutions; formed oligopoly of rating agencies. Also, ratings of financial intermediaries are bounded by ceilings of sovereign ratings, while they do not relate to financial statements of the evaluated intermediaries (Ginevičius and Podviezko 2011). The above contrasts with the feature of the quantitative evaluation to produce objective evaluation based on quantitative data, chosen by the authors.

A researcher who made a choice in favour of quantitative methods obviously should not overlook statistical methods. Statistical methods have a history spanning from the sixth decade. Even if the methods are very popular, they have the following limitations: logit and probit, and OLS methods could be applied only in such cases, when financial variables have normal distribution, sample size is large, data is stable over time, multicollinearity is precluded, and data is complete (Ran Barniv and James B. McDonald 1999). Unfortunately, this is not the case for the data describing performance of Lithuanian commercial banks. As Lithuania joined the EU only in May 2004, banks adopted International Financial Reporting Standards after a few

years. This means that the uniform standard is being applied for the relatively short period of time. Financial crisis introduce distortions to the data, which cannot be considered as sufficiently stable to apply statistical methods. The number of commercial banks existing in Lithuania even decreased after bankruptcy of AB Bankas SNORAS in 2011, and AB Ūkio Bankas in 2012 to seven, which precludes from considering the set of banks as being sufficiently large.

In cases, when the sample and data are scarce and exact information cannot be obtained, operational research methods are the best option. Fast-gained popularity of the methods after their introduction to finance proved advantages over already having been used statistical methods and the methods used by credit agencies. Evaluation of a financial firm or a bank encompasses more complex considerations and goals and is not narrowing to solely the risk-return modelling (Ginevičius and Podviezko 2011). The MCDA methods have been created to deal with complex objectives (Jaap Spronk, Ralph E. Steuer, and Constantin Zopounidis 2005).

The methodology of evaluation of financial stability of commercial banks comprises several stages. Results of evaluation are provided in several formats: in the form of ranking, in graphical format exposing performance of commercial banks in terms of CAMEL categories, in analytical format by all chosen criteria of financial performance of banks (Podviezko 2012). Recently an additional useful tool commenced to be developed: the evaluation of economic objects and processes using MCDA methods by comparison of alternatives with hypothetic objects (Ginevičius, Podvezko, and Podviezko 2012; Podvezko and Podviezko 2013), which is also designed to be used in the methodology of evaluation of financial stability of commercial banks.

The whole variety of MCDA methods are being used by researchers. For the researcher in multi-objective decision support systems the choice between many methods is not very easy. Indeed numerous theories were developed since the forerunners: Nicolas de Condorcet (1785), Hermann H. Gossen (1853), Hermann Minkowsky (1896, 1911), Vilfredo Pareto (1906) and pioneers like Maurice G. Kendall (1948), Bernard Roy, Raphaël Benayoun, and Bernard Sussman (1966), David W. Miller and Martin K. Starr (1969), Ching-Lai Hwang and Kwangsun Yoon (1981), Thomas L. Saaty (1988), Brauers (2004a, b), Serafim Opricovic and Gwo-Hshiung Tzeng (2004), Jean-Pierre Brans and Bertrand Mareschal (2005), see also Podvezko and Podviezko (2010a, b).

In Ginevičius and Podviezko (2013) Lithuanian bans were analysed using four MCDA methods: SAW, TOPSIS, COPRAS, PROMETHEE II. In this paper we use an alternative MCDA method MULTIMOORA and make a comparison with the above-mentioned methods. The MULTIMOORA is composed of two MOORA methods and of the Full Multiplicative Form of Multiple Objectives thus making a composite of three methods of multiple objectives optimization. In his book, Brauers (2004a) described the three parts of MOORA: the Ratio System Approach, the Reference Point Approach but still based on scores and the Full Multiplicative Form. Sometime later Brauers (2004b) switched over to a Reference Approach with instead of scores uses the ratios found in the ratio system. In this way dimensionless measures were obtained.

4. Multi-Objective Optimization by Ratio Analysis (MOORA)

4.1 The Two Parts of MOORA

The method starts with a matrix of responses of different alternatives on different objectives (x_{ij}), with x_{ij} as the response of alternative j on objective i:

$i=1, 2,..., n$ as the objectives
$j=1, 2,..., m$ as the alternatives.

MOORA goes for a ratio system in which each response of an alternative on an objective is compared to a denominator, which is representative for all alternatives concerning that objective. For this denominator the square root of the sum of squares of each alternative per objective is chosen. Brauers and Edmundas K. Zavadskas (2006) proved that this is the most robust choice:

$$x_{ij}^* = \frac{x_{ij}}{\sqrt{\sum_{j=1}^{m} x_{ij}^2}} \tag{1}$$

with:

x_{ij} = response of alternative j on objective i,
$j = 1, 2,..., m$; m the number of alternatives,
$i = 1, 2,..., n$; n the number of objectives,
x_{ij}^* = a dimensionless number representing the normalized response of alternative j on objective i.

Dimensionless numbers, having no specific unit of measurement, are obtained for instance by deduction, multiplication or division. The normalized responses of the alternatives on the objectives belong to the interval [0; 1]. However, sometimes the interval could be [-1; 1]. Indeed, for instance in the case of productivity growth some sectors, regions or countries may show a decrease instead of an increase in productivity i.e. a negative dimensionless number.

For optimization these responses are added in case of maximization and subtracted in case of minimization:

$$y_j^* = \sum_{i=1}^{i=g} x_{ij}^* - \sum_{i=g+1}^{i=n} x_{ij}^* \tag{2}$$

with:

i = 1, 2,…, g as the objectives to be maximized,
i = g+1, g+2,…, n as the objectives to be minimized,
y_j^* = the normalized assessment of alternative j with respect to all objectives.
An ordinal ranking of the y_j shows the final preference.

For the second part of MOORA the Reference Point Theory is chosen with the *Min-Max Metric* of Tchebycheff as given by the following formula (Samuel Karlin and William J. Studden 1966):

$$\underset{(j)}{Min}\ \{\underset{(i)}{max}|\ r_i\ -\ x_{ij}*\ |\} \tag{3}$$

with $|\ r_i - x_{ij}^*|$ the absolute value if $x_{ij}*$ is larger than r_i for instance by minimization.

This reference point theory starts from the already normalized ratios as defined in the MOORA method, namely Equation (1). Preference is given to a reference point possessing as co-ordinates the dominating co-ordinates per attribute of the candidate alternatives and which is designated as the Maximal Criterion Reference Point. This approach is called realistic and non-subjective as the co-ordinates, which are selected for the reference point, are realized in one of the candidate alternatives. The alternatives A(10; 100), B(100; 20) and C(50; 50) will result in the maximal criterion reference point R_m(100; 100).

4.2 The Full Multiplicative Form of Multiple Objectives

Mathematical economics is familiar with the multiplicative models like in production functions (e.g. Cobb-Douglas and Input-Output formulas) and demand functions (Rudolf Teekens and Johan Koerts 1972), but the multiplicative form for multi-objectives was introduced in 1969 by Miller and Starr (1969) and further developed by Brauers (2004a).

The following *n*-power form for multi-objectives is called from now on a *full-multiplicative form* in order to distinguish it from the mixed forms:

$$U_j = \prod_{i=1}^{n} x_{ij} \tag{4}$$

with:

$j = 1, 2, ..., m$; m the number of alternatives,
$i = 1, 2, ..., n$; n being the number of objectives,
x_{ij} = response of alternative j on objective i,
U_j = overall utility of alternative j.

The overall utilities (U_j), obtained by multiplication of different units of measurement, become dimensionless. Stressing the importance of an objective can be done by adding an α-term or by allocating an exponent (a *Significance Coefficient*) on condition that this is done with unanimity or at least with a strong convergence in opinion of all the stakeholders concerned. Once again it is assumed that no significance coefficients have to given in this study on the Lithuanian banks for the reasons given above.

How is it possible to combine a minimization problem with the maximization of the other objectives? Therefore, the objectives to be minimized are denominators in the formula:

$$U'_j = \frac{A_j}{B_j} \tag{5}$$

$$A_j = \prod_{g=1}^{i} x_{gi} \tag{6}$$

where:

$j = 1, 2,..., m;$ m the number of alternatives,
i = the number of objectives to be maximized.

$$B_j = \prod_{k=i+1}^{n} x_{kj}, \tag{7}$$

where:

n-i = the number of objectives to be minimized,
U_j' = the utility of alternative j with objectives to be maximized and objectives to be minimized.

The Full Multiplicative Form is read horizontally in the Response Matrix of Table 5 presented in the Appendix. Nevertheless with the full-multiplicative form, the overall utilities, obtained by multiplication of different units of measurement, become dimensionless measures. This situation would not bias the outcomes amidst the several alternatives as the last ones are represented by dimensionally homogeneous equations, being: "formally independent of the choice of units" (Fritz J. de Jong 1967).

5. MULTIMOORA as Applied for the Banks Registered in Lithuania

Appendix gives details in Tables 3-6 for MOORA and the Multiplicative Form (Equations 1-6) concerning commercial banks registered in Lithuania. Following Tables 2a, b and c, gives the reaction of the projects on the objectives after the MULTIMOORA approach, a summary of the three methods in accordance with the theory of dominance (Brauers, Alvydas Balezentis, and Tomas Balezentis 2011; Brauers and Zavadskas 2011).

Table 2a The Reaction of the Banks on the Objectives after the MULTIMOORA Approach for 2007

Banks	MOORA ratio system	MOORA reference point	Multiplicative form	MULTIMOORA
5. SNORAS	1	3	1	1
6. SWEDBANK	2	1	2	2
4. SEB	3	2	3	3
7. ŠIAULIU	4	5	4	4
8. ŪKIO	5	7	5	5
3. PAREX	6	4	8	6
2. MEDICINOS	7	6	7	7
1. DNB NORD	8	8	6	8

Source: Authors' calculations.

Table 2b The Reaction of the Banks on the Objectives after the MULTIMOORA Approach for 2008

Banks	MOORA ratio system	MOORA reference point	Multiplicative form	MULTIMOORA
6. SWEDBANK	1	1	1	1
7. ŠIAULIU	2	4	2	2
8. ŪKIO	3	2	3	3
4. SEB	4	3	4	4
1. DNB NORD	6	5	6	5
5. SNORAS	5	6	8	6
2. MEDICINOS	7	7	7	7
3. PAREX	8	8	5	8

Source: Authors' calculations.

Table 2c The Reaction of the Banks on the Objectives after the MULTIMOORA Approach for 2009

Banks	MOORA ratio system	MOORA reference point	Multiplicative form	MULTIMOORA
2. MEDICINOS	1	1	1	1
7. ŠIAULIU	2	3	3	2
5. SNORAS	3	4	2	3
6. SWEDBANK	4	5	4	4
1. DNB NORD	5	2	6	5
8. ŪKIO	6	6	7	6
4. SEB	7	7	5	7
3. PAREX	8	8	8	8

Source: Authors' calculations.

Results are showing satisfactory correspondence with the previously obtained results using four MCDA methods SAW, TOPSIS, COPRAS, and PROMETHEE II (Ginevičius and Podviezko 2013). Rankings of banks in 2007 deviate by no more than two positions in 2007-2008, and are identical in 2009 with few exceptions, namely AB Šiaulių Bankas in 2007 was assigned with the 4-th position, while in the previous research it was assigned the 1-st position; UAB Medicinos Bankas in 2008 reached the 7-th position, while in Ginevičius and Podviezko (2013) it attained a higher 3-rd position. The deviations could be decreased in case levels of importance were assigned to each criterion.

6. Conclusion

The results of evaluation of financial stability of registered in Lithuania commercial banks obtained using the MULTIMOORA method showed a satisfactory correspondence with the previously obtained results using four MCDA methods SAW, TOPSIS, COPRAS, and PROMETHEE II (Ginevičius and Podviezko 2013). The authors believe that in the case levels of importance to criteria are used, increase robustness of the MULTIMOORA method will be observed. However there is something more. A difficulty in the Multiplicative Form is inherited whenever the negative numbers are present as in such criteria as the net income as a percentage of RWA, namely for all banks with exception of UAB Medicinos Bankas and AB Bankas SNORAS in financial statements of the banks of 2009, therefore the way of dealing with the negative numbers in the Multiplicative Form must be developed.

References

Allen, Franklin, and Douglas Gale. 2000. *Comparing Financial Systems*. Cambridge: MIT Press.

Apergis, Nicholas, and Effrosyni Alevizopoulou. 2010. "Bank Efficiency: Evidence from Panel of European Banks." *Panoeconomicus*, 58(3): 329-341.

Arrow, Kenneth J., and Gerard Debreu. 1954. "Existence of an Equilibrium for a Competitive Economy." *Econometrica*, 22(3): 265-290.

Auerbach, Alan J., William G. Gale, and Benjamin H. Harris. 2010. "Activist Fiscal Policy." *Journal of Economic Perspective*, 24(4): 141-164.

Baldwin, Richard. 2010. *The Great Trade Collapse, Causes, Consequences and Prospects.* London: Centre for Economic Policy Research.

Bank for International Settlements - BIS. 2004. *International Convergence of Capital Measurement and Capital Standards: A Revised Framework*. Basel: BIS.

Barniv, Ran, and James B. McDonald. 1999. "Review of Categorical Models for Classification Issues in Accounting and Finance." *Review of Quantitative Finance and Accounting*, 13(1): 39-62.

Barrell, Ray, Philip E. Davis, Tatiana Fic, and Dilruba Karim. 2011. "Tier 2 Capital and Bank Behaviour." National Institute of Economic and Social Research Discussion Paper 375.

Beck, Thorsten, Asli Demirgüç-Kunt, and Ross Levine. 2010. "Financial Institutions and Markets across Countries and over Time: The Updated Financial Development and Structure Database." *World Bank Economic Review*, 24(1): 77-92.

Board of the Bank of Lithuania. 2006. "On the General Regulations for the Calculation of Capital Adequacy." Board of the Bank of Lithuania Resolution 138.

Brans, Jean-Pierre, and Bertrand Mareschal. 2005. "PROMETHEE Methods." In *Multiple Criteria Decision Analysis: State of the Art Surveys*, ed. Jose Figueira, Salvatore Greco, and Matthias Ehrgott, 163-195. Boston: Springer.

Brauers, Willem Karel M. 2004a. *Optimization Methods for a Stakeholder Society, a Revolution in Economic Thinking by Multi-Objective Optimization.* Boston: Kluwer.

Brauers, Willem Karel M. 2004b. "Multi-Objective Optimization for Facilities Management." *Journal of Business Economics and Management*, 5(4): 173-182.

Brauers, Willem Karel M., and Edmundas K. Zavadskas. 2006. "The MOORA Method and Its Application to Privatization in a Transition Economy." *Control and Cybernetics*, 35(2): 443-468.

Brauers, Willem Karel M., Alvydas Balezentis, and Tomas Balezentis. 2011. "MULTIMOORA for the EU Member States Updated with Fussy Number Theory." *Technological and Economic Development of Economy*, 17(2): 259-290.

Brauers, Willem Karel M., and Edmundas K. Zavadskas. 2011. "MULTIMOORA Optimization Used to Decide on a Bank Loan to Buy Property." *Technological and Economic Development of Economy*, 17(1): 174-188.

Brauers, Willem Karel M., Romualdas Ginevičius, and Askoldas Podviezko. 2012. "Evaluation of Performance of Lithuanian Commercial Banks by Multi-Objective Optimization." In *The 7th International Scientific Conference "Business and Management 2012"*, ed. Romualdas Ginevičius, Aleksandras V. Rutkauskas, and Jelena Stankeviciene, 1042-1049. Vilnius: Technika.

Cantor, Richard. 2001. "Moody's Investors Service Response to the Consultative Paper Issued by the Basel Committee on Bank Supervision 'A New Capital Adequacy Framework'." *Journal of Banking and Finance*, 25(1): 171-185.

Constâncio, Vítor. 2012. "Financial Stability - Measurement and Policy." http://www.bis.org/review/r120619a.pdf.

De Condorcet, Nicolas. 1785. *Essai sur l'application de l'analyse à la probabilité des décisions rendues à la pluralité des voix.* Paris: L'Imprimerie Royale.

De Jong, Fritz J. 1967. *Dimensional Analysis for Economists.* Amsterdam: North-Holland.

Demirgüç-Kunt, Asli, and Enrica Detragiache. 1998. "Financial Liberalization and Financial Fragility." International Monetary Fund Working Paper 98/83.

Ergungor, Emre O., and James B. Thomson. 2005. "Systemic Banking Crisis." Federal Reserve Bank of Cleveland Policy Discussion Paper 9.

European Central Bank - ECB. 2010. *Financial Stability Review June.* Frankfurt am Main: ECB.

Fanger, David. 2007. "Bank Financial Strength Ratings: Global Methodology." https://www.moodys.com/researchdocumentcontentpage.aspx?docid=PBC_102151.

Gadanecz, Blaise, and Kaushik Jayaram. 2008. "Measures of Financial Stability - A Review." Irving Fisher Committee Bulletin 31.

Ginevičius, Romualdas, and Valentinas Podvezko. 2008. "Multicriteria Evaluation of Lithuanian Banks from the Perspective of Their Reliability for Clients." *Journal of Business Economics and Management*, 9(4): 257-267.

Ginevičius, Romualdas, and Askoldas Podviezko. 2011. "A Framework of Evaluation of Commercial Banks." *Intellectual Economics*, 1(9): 37-53.

Ginevičius, Romualdas, Valentinas Podvezko, and Askoldas Podviezko. 2012. "Evaluation of Isolated Socio-Economical Processes by a Multi-Criteria Decision Aid Method ESP." In *The 7th International Scientific Conference "Business and Management 2012"*, ed. Romualdas Ginevičius, Aleksandras V. Rutkauskas, and Jelena Stankeviciene, 1083-1089. Vilnius: Technika.

Ginevičius, Romualdas, and Askoldas Podviezko. 2012. "Sprendimų paramos metodų taikymo ypatumai komercinių bankų finansinio stabilumo vertinime." *Business: Theory and Practice*, 13(4): 314-323.

Ginevičius, Romualdas, and Askoldas Podviezko. 2013. "The Evaluation of Financial Stability and Soundness of Lithuanian Banks." *Ekonomska istraživanja: znanstveno stručni časopis*, 26(2): 191-208.

González-Hermosillo, Brenda. 1999. "Determinants of Ex-Ante Banking System Distress: A Macro-Micro Empirical Exploration of some Recent Episodes." International Monetary Fund Working Paper 99/33.

Gossen, Hermann H. 1853. *Entwicklung der gesetze des Menschlichen Verkehrs und der daraus Flieszenden Regeln für Menschliches Handeln, 3 Auflage.* Berlin: Prager.

Hall, Robert E. 2010. "Why Does an Economy Fall to Pieces after a Financial Crisis?" *Journal of Economic Perspectives*, 24(4): 3-20.

Hardy, Daniel C., and Ceyla Pazarbasioglu. 1998. "Leading Indicators of Banking Crisis: Was Asia Different?" International Monetary Fund Staff Papers, 46(3): 247-258.

Houben, Aerdt, Jan Kakes, and Garry Schinasi. 2004. "Toward a Framework for Safeguarding Financial Stability." International Monetary Fund Working Paper 04/101.

Hwang, Ching-Lai, and Kwangsun Yoon. 1981. *Multiple Attribute Decision Making, Methods and Applications*: *A State-of-the-Art Survey*. Berlin: Springer.

Karlin, Samuel, and William J. Studden. 1966. *Tchebycheff Systems: With Applications in Analysis and Statistics*. New York: Interscience Publishers.

Kendall, Maurice G. 1948. *Rank Correlation Methods*. London: Charles Griffin.

Langohr, Herwig, and Patricia Langohr. 2008. *The Rating Agencies and Their Credit Ratings: What They Are, How They Work and Why They Are Relevant*. Chichester: Wiley.

Lietuvos Bankas. 2013. *Monthly Bulletin 2013*. Vilnius: Lietuvos Bankas.

Lietuvos Respublikos Seimas. 2011. Valstybės Žinios. http://www3.lrs.lt/pls/inter3/dokpaieska.showdoc_l?p_id=230458&p_query=&p_tr2= (accessed June 25, 2011).

Mason, Joseph R. 2009. "Regulating for Financial System Development, Financial Institutions Stability, and Financial Innovation." http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1393409.

Mensi, Sami. 2010. "Measurement of Competitiveness Degree in Tunisian Deposit Banks: An Application of the Panzar and Rosse Model." *Panoeconomicus*, 57(2): 189-207.

Merton, Robert C. 1995. "A Functional Perspective of Financial Intermediation." *Financial Management*, 24(2): 23-41.

Miller, David W., and Martin K. Starr. 1969. *Executive Decisions and Operations Research*. New Jersey: Prentice-Hall Inc.

Minkowsky, Hermann. 1896. *Geometrie der Zahlen*. Leipzig: Teubner.

Minkowsky, Hermann. 1911. *Gesammelte Abhandlungen.* Leipzig: Teubner.

Mishkin, Frederic S. 1999. "Global Financial Instability: Framework, Events, Issues." *Journal of Economic Perspectives*, 13(4): 3-20.

Moody's Investors Service. 2011. "Moody's Ratings System in Brief." http://www.moodys.com/uploadpage/2005700000433096.pdf (accessed December 27, 2011).

Ohanian, Lee E. 2010. "The Economic Crisis from a Neoclassical Perspective." *Journal of Economic Perspectives*, 24(4): 45-66.

Opricovic, Serafim, and Gwo-Hshiung Tzeng. 2004. "Compromise Solution by MCDM Methods: A Comparative Analysis of VIKOR and TOPSIS." *European Journal of Operational Research*, 156(2): 445-455.

Pareto, Vilfredo. 1906. *Manuale di Economia Politica.* Milano: Societa Editrice.

Podvezko, Valentinas, and Askoldas Podviezko. 2010a. "Dependence of Multi-Criteria Evaluation Result on Choice of Preference Functions and Their Parameters." *Technological and Economic Development of Economy*, 16(1): 143-158.

Podvezko, Valentinas, and Askoldas Podviezko. 2010b. "Use and Choice of Preference Functions for Evaluation of Characteristics of Socio-Economical Processes." In *The 6th International Scientific Conference "Business and Management 2010"*, ed. Romualdas Ginevičius, Aleksandras V. Rutkauskas, and Remigijs Pocs, 1066-1071. Lithuania: Technika.

Podvezko, Valentinas, and Askoldas Podviezko. 2013. "Naujos absoliutaus daugiakriterio vertinimo galimybės." *Lietuvos Matematikos Rinkinys*, 54(B):54-59.

Podviezko, Askoldas, and Romualdas Ginevičius. 2010. "Economic Criteria Characterising Bank Soundness and Stability." In *The 6th International Scientific Conference*

"Business and Management 2010", ed. Romualdas Ginevičius, Aleksandras V. Rutkauskas, and Remigijs Pocs, 1072-1079. Lithuania: Technika.

Podviezko, Askoldas. 2012. "Augmenting Multicriteria Decision Aid Methods by Graphical and Analytical Reporting Tools." In *Workshops on Business Informatics Research*, ed. Laila Niedrite, Renata Strazdina, and Benkt Wangler, 236-251. Berlin: Springer.

Rachdi, Houssem. 2010. "The Link between International Supervision and Banking Crisis." *Panoeconomicus*, 57(3): 321-331.

Roy, Bernard, Raphaël Benayoun, and Bernard Sussman. 1966. *ELECTRE*. Paris: Société d'Economie et de Mathématique appliquées.

Saaty, Thomas L. 1988. *The Analytic Hierarchy Process*. New York: Mcgraw-Hill.

Sprague, Oliver M. W. 1910. *History of Crisis under the National Banking System.* Washington: Government Printing Office.

Spronk, Jaap, Ralph E. Steuer, and Constantin Zopounidis. 2005. "Multicriteria Decision Aid/Analysis in Finance." In *Multiple Criteria Decision Analysis: State of the Art Surveys*, ed. José Figueira, Salvatore Greco, and Matthias Ehrgott, 799-857. New York: Springer.

Teekens, Rudolf, and Johan Koerts. 1972. "Some Statistical Implications of the Log Transformation of Multiplicative Models." *Econometrica*, 40(5): 793-819.

Webb Cooper, Elizabeth. 2009. "Monitoring and Governance of Private Banks." *The Quarterly Review of Economics and Finance*, 49(2): 253-264.

Wheelock, David C., and Paul W. Wilson. 2000. "Why Do Banks Disappear? The Determinants of U.S. Bank Failures and Acquisitions." *The Review of Economics and Statistics*, 82(1): 127-138.

Appendix

Sources for Table 1

AB Bankas SNORAS. 2008. "2008 Separate and Consolidated Financial Statements." http://www.snoras.com/files/Snoras-2008-EN.

AB Bankas SNORAS. 2009. *Bankas Snoras AB (SRS1L) 2009 Annual Report.* Vilnius: Bankas Snoras.

AB DnB NORD Bankas. 2008. "Consolidated Annual Report, Separate and Consolidated Financial Statements for the Year Ended 31 December 2008." http://www.dnb.lt/sites/default/files/dokumentai/ataskaitos/dnb_nord_fs_31_12_2008_en_with_ar.pdf.

AB DnB NORD Bankas. 2009. "Consolidated Annual Report, Separate and Consolidated Financial Statements for the Year Ended 31 December 2009." http://www.nasdaqomxbaltic.com/upload/reports/ndl/2009_ar_en_ltl_con_ias.pdf.

AB Parexbankas. 2008. "Konsoliduotas Metinis Vadovbös Pranešimas 2008." https://www.citadele.lt/uploads/PB_FS_2008_LT_final2.pdf.

AB Parexbankas. 2009. "Konsoliduotas Metinis Pranešimas 2009." https://www.citadele.lt/uploads/finansine-atskaitomybe-2010-01-01.pdf.

AB SEB Bankas. 2008. "Annual Report 2008." http://sebgroup.com/Documents/Investor_Relations/Annual_Reports/Annual_Report_2008.pdf?epslanguage=en.

AB SEB Bankas. 2009. "Annual Report 2009." http://sebgroup.com/Documents/Investor_Relations/Annual_Reports/Annual_Report_2009.pdf.

AB Swedbank. 2008. "Annual Report 2008." http://www.swedbank.com/idc/groups/public/@i/@sbg/@gs/@ir/documents/financial/cid_006911.pdf.

AB Swedbank. 2009. "Annual Report 2009." http://www.swedbank.ru/filemanager/download/452.

AB Šiauliu Bankas. 2008. "Šiauliu Bankas AB Financial Statements 31 December 2008." http://www.sb.lt/file/repository/Finansin%C4%97s%20ataskaitos%20EN/2008/1_%202008%20metine%20Engl%20new.pdf.

AB Šiauliu Bankas. 2009. "Independent Auditor's Report Financial Statements and Annual Report 31 December 2009." http://www.sb.lt/file/repository/Finansin%C4%97s%20ataskaitos%20EN/2009/2_%20annual%20report%20_2009.pdf.

AB Ūkiobankas. 2008. "2008 Metiné Ataskaita." http://www.tyliai.lt/pub/showreel/flash/ub/ub_annual_report_2008/pages/UB_Metine_Ataskaita_2008.pdf.

AB Ūkiobankas. 2009. "Ūkio Banko Racionalaus Investavimo Fondas 2009 Metu Ataskaita." http://www.ukiobankas.lt/files/investiciniai_fondai_racionalaus_investavimo/UBRIF_2009_ataskaita.pdf.

UAB Medicinos Bankas. 2008. "Financial Statements as of 30 September, 2008." http://www.medbank.lt/wp-content/uploads/2013/01/2008_2.pdf.

UAB Medicinos Bankas. 2009. "Financial Statements as of 30 June, 2009." http://www.medbank.lt/wp-content/uploads/2013/01/2009_I_pusmetis_eng.pdf.

Table 3 Sum of Squares and Their Square Roots

	Capital	Net interest income % RWA	Loans % assets	Delinquent >60D loans % assets	Loan value de-crease % assets	Non-interest cost % total income	Pre-provision profit % RWA	Net income % RWA	Deposits % loans	Liquidity
2007	19.69	7.58	203.03	1.57	0.84	105.86	6.57	5.20	254.80	122.54
2008	23.22	8.51	212.80	9.23	1.98	91.52	6.19	4.29	215.67	117.25
2009	24.95	6.03	211.48	13.83	11.31	90.97	5.15	16.69	262.23	131.64

Source: Authors' calculations.

Table 4 Objectives Divided by Their Square Roots and MOORA Ranks

	Capital	Net interest income % RWA	Loans % assets	Delinquent >60d loans % assets	Loan value decrease % total assets	Non-interest cost % total income	Pre-provision profit % RWA	Net income % RWA	Deposits % loans	Liquidity	Sum	Rank
	Max.	Max.	Min.	Min.	Min.	Min.	Max.	Max.	Max.	Max.		
						2007						
DNB NORD	0.285	0.348	0.411	0.982	0.220	0.289	0.261	0.236	0.189	0.296	-0.288	8
MEDICINOS	0.280	0.384	0.316	0.732	0.459	0.438	0.232	0.167	0.381	0.371	-0.131	7
PAREX	0.387	0.203	0.389	0.034	0.286	0.476	0.040	0.000	0.208	0.268	-0.079	6
SEB	0.277	0.341	0.351	0.199	0.152	0.219	0.460	0.476	0.241	0.349	1.221	3
SNORAS	0.363	0.336	0.227	0.469	0.001	0.327	0.326	0.400	0.610	0.413	1.424	1
SWEDBANK	0.313	0.468	0.351	0.273	0.120	0.324	0.462	0.451	0.355	0.344	1.326	2
ŠIAULIU	0.510	0.311	0.378	0.259	0.309	0.278	0.328	0.329	0.309	0.359	0.920	4
ŪKIO	0.353	0.382	0.373	0.186	0.726	0.400	0.488	0.468	0.353	0.403	0.762	5
						2008						
DNB NORD	0.284	0.305	0.404	0.255	0.251	0.269	0.256	0.146	0.159	0.320	0.290	6
MEDICINOS	0.434	0.453	0.308	0.909	0.610	0.396	0.356	0.198	0.476	0.507	0.200	7
PAREX	0.335	0.277	0.316	0.028	0.427	0.481	-0.009	-0.390	0.138	0.281	-0.618	8
SEB	0.284	0.294	0.366	0.124	0.295	0.239	0.379	0.349	0.235	0.333	0.849	4
SNORAS	0.279	0.274	0.285	0.325	0.340	0.375	0.249	0.120	0.525	0.310	0.432	5
SWEDBANK	0.400	0.535	0.360	0.119	0.125	0.318	0.610	0.681	0.334	0.339	1.978	1
ŠIAULIU	0.432	0.287	0.386	0.075	0.181	0.281	0.248	0.234	0.347	0.330	0.957	2
ŪKIO	0.338	0.307	0.386	0.140	0.363	0.402	0.410	0.365	0.408	0.362	0.899	3
						2009						
DNB NORD	0.256	0.429	0.408	0.157	0.422	0.267	0.480	-0.236	0.126	0.286	0.086	5
MEDICINOS	0.413	0.459	0.313	0.218	0.166	0.340	0.384	0.003	0.432	0.420	1.074	1
PAREX	0.407	0.360	0.411	0.402	0.383	0.581	-0.145	-0.466	0.158	0.309	-1.153	8
SEB	0.293	0.347	0.336	0.212	0.570	0.325	0.243	-0.635	0.216	0.458	-0.523	7
SNORAS	0.258	0.014	0.251	0.554	0.123	0.304	0.378	0.011	0.565	0.313	0.306	3
SWEDBANK	0.452	0.523	0.362	0.466	0.488	0.304	0.613	-0.546	0.321	0.346	0.089	4
ŠIAULIU	0.371	0.253	0.379	0.068	0.184	0.244	0.151	-0.100	0.354	0.263	0.417	2
ŪKIO	0.323	0.132	0.340	0.398	0.187	0.355	0.016	-0.125	0.423	0.386	-0.124	6

Source: Authors' calculations.

Table 5 Reference Point Theory with Ratios: Co-Ordinates of the Reference Point Equal to the Maximal Objective Values

	Capital	Net interest income % RWA	Loans % assets	Delinquent >60D loans % assets	Loan value de-crease % assets	Non-interest cost % total income	Pre-provision profit % RWA	Net income % RWA	Deposits % loans	Liquidity
2007	0.510	0.468	0.227	0.034	0.001	0.219	0.488	0.476	0.610	0.413
2008	0.434	0.535	0.285	0.028	0.125	0.239	0.610	0.681	0.525	0.507
2009	0.452	0.523	0.251	0.068	0.123	0.244	0.613	0.011	0.565	0.458

Source: Authors' calculations.

Table 6 Reference Point Theory: Deviations from the Reference Point

	Capital	Net interest income % RWA	Loans % assets	Delinquent >60d loans % assets	Loan value decrease % total assets	Non-interest cost % total income	Pre-provision profit % RWA	Net income % RWA	Deposits % loans	Liquidity	Sum	Rank
	Max.	Max.	Min.	Min.	Min.	Min.	Max.	Max.	Max.	Max.		
						2007						
DNB NORD	0.225	0.120	0.184	0.948	0.219	0.070	0.227	0.240	0.421	0.117	0.948	8
MEDICINOS	0.230	0.084	0.090	0.698	0.457	0.219	0.256	0.309	0.229	0.042	0.698	6
PAREX	0.123	0.265	0.162	0.000	0.285	0.257	0.448	0.475	0.402	0.146	0.475	4
SEB	0.233	0.127	0.125	0.166	0.151	0.000	0.028	0.000	0.369	0.064	0.369	2
SNORAS	0.147	0.132	0.000	0.435	0.000	0.108	0.162	0.076	0.000	0.000	0.435	3
SWEDBANK	0.197	0.000	0.124	0.239	0.119	0.104	0.026	0.025	0.255	0.069	0.255	1
ŠIAULIU	0.000	0.157	0.151	0.226	0.308	0.059	0.160	0.147	0.301	0.054	0.308	5
ŪKIO	0.157	0.086	0.146	0.153	0.724	0.181	0.000	0.008	0.257	0.010	0.724	7
						2008						
DNB NORD	0.150	0.230	0.119	0.227	0.126	0.030	0.355	0.535	0.366	0.187	0.535	5
MEDICINOS	0.000	0.082	0.023	0.881	0.486	0.157	0.254	0.483	0.049	0.000	0.881	7
PAREX	0.099	0.258	0.031	0.000	0.302	0.242	0.619	1.071	0.386	0.226	1.071	8
SEB	0.150	0.242	0.081	0.096	0.171	0.000	0.231	0.332	0.290	0.174	0.332	3
SNORAS	0.155	0.261	0.000	0.296	0.215	0.136	0.362	0.561	0.000	0.197	0.561	6
SWEDBANK	0.034	0.000	0.075	0.091	0.000	0.080	0.000	0.000	0.191	0.168	0.191	1
ŠIAULIU	0.001	0.248	0.101	0.047	0.056	0.042	0.362	0.447	0.177	0.176	0.447	4
ŪKIO	0.096	0.228	0.101	0.112	0.238	0.163	0.201	0.316	0.117	0.145	0.316	2
						2009						
DNB NORD	0.196	0.094	0.133	0.246	0.438	0.172	0.157	0.089	0.299	0.024	0.438	2
MEDICINOS	0.040	0.064	0.229	0.008	0.133	0.038	0.061	0.150	0.044	0.097	0.229	1
PAREX	0.046	0.163	0.759	0.476	0.406	0.149	0.160	0.333	0.261	0.337	0.759	8
SEB	0.159	0.176	0.371	0.646	0.349	0.000	0.085	0.144	0.448	0.082	0.646	7
SNORAS	0.195	0.510	0.235	0.000	0.000	0.145	0.000	0.485	0.000	0.061	0.510	4
SWEDBANK	0.000	0.000	0.000	0.557	0.244	0.113	0.111	0.398	0.365	0.060	0.557	5
ŠIAULIU	0.081	0.270	0.463	0.110	0.211	0.195	0.127	0.000	0.061	0.000	0.463	3
ŪKIO	0.130	0.391	0.597	0.135	0.142	0.072	0.088	0.330	0.065	0.111	0.597	6

Source: Authors' calculations.