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EVALUATION OF PERFORMANCE OF LITHUANIAN COMMERCIAL BANKS BY MULTI-OBJECTIVE OPTIMIZATION

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Abstract. The aim of this study is to rank the banks registered in Lithuania by Multi-Objective Optimization (MOO). As these banks work in the same macro-economic environment the objectives are chosen on basis of the CAMEL classification ('C' Capital adequacy, 'A' Asset quality, 'M' Management quality, 'E' Earnings, 'L' Liquidity). Traditional Cost-Benefit does not respond to these purposes, translating all direct and indirect costs and benefits into money. On the contrary MOO takes care of different objectives, whereas the objectives keep their own units. Different methods exist for the application of MOO. These methods were tested after their robustness. Therefore, MULTIMOORA composed of three sub-methods: Ratio System, Reference Method using the ratios from the ratio system and the Full Multiplicative Form, showed positive results. Consequently registered in Lithuania commercial banks were ranked by MULTIMOORA.

Keywords: Multi-Objective Optimization, Commercial Banks, Bank Objectives, Robustness, Ratio System, Reference Point Method, Full Multiplicative Form, MULTIMOORA.

Jel classification: C44, C61, D81, D82, G21, O22

1. Introduction

In this paper Lithuanian banks are ranked by Multi-Objective Optimization. It is based on a categorization of banks comprising major types of objectives. A selection is proposed on basis of a classification of the stability criteria, which is very popular by the researchers namely CAMEL (Podviezko, Ginevicius 2010; Ginevicius, Podviezko 2011). CAMEL represents the abbreviation of Capital adequacy, Asset quality, Management quality, Earnings and Liquidity.

We have not to consider a macro-economic approach as described by Gonzalez-Hermosillo (1999), rather going for bank-specific variables (Ginevicius, Podvezko 2008). 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 whereas deposits made with these banks are insured by the same State Enterprise. Therefore branches of foreign banks, namely Danske Bank A/S and Nordea Bank Finland Plc are excluded as they are only branches, operating under Danish or Finnish law.

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 subprime 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 articles from Hall (2010), Ohanian (2010), and Auerbach, Gale, Harris (2010), also Baldwin 2010).

As far as we know no government or international official support was given to the Lithuanian banks with exception only indirectly to the AB Parex bankas, which head office was nationalized in Latvia on November 8, 2008. Most of the other banks registered in Lithuania as subsidiaries of international banks in their mother countries could have received official aid (there was government financial support to the banks in the US, Belgium, France, UK, the Netherlands and many other countries).

2. The list of objectives based on CAMEL

We concentrate on bank-specific variables, which disclose performance of each bank in the market in terms of soundness and stability. All data has been obtained from their annual reports (AB DnB NORD bankas Annual Report 2008, 2009; AB Parex bankas Annual Report 2008, 2009; AB SEB bankas Annual Report 2008, 2009; AB Siauliu bankas Annual Report 2008, 2009; AB bankas

SNORAS Annual Report 2008, 2009; AB Swedbank Annual Report 2008, 2009; AB Ukio bankas Annual Report 2008, 2009; UAB Medicinos bankas Annual Report 2008, 2009) 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 objectives representing stable and sound performance of banks should be chosen The following objectives are proposed based on the CAMEL categorization and the final matrix of responses of objectives for banks registered in Lithuania is presented in Table 1.

Table 1. Objectives for banks registered in Lithuania

2007										
OBJECTIVES	1	2	3	4	5	6	7	8	9	10
BANKS	MAX.	MAX.	MIN.	MIN.	MIN.	MIN.	MAX.	MAX.	MAX.	MAX.
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
SIAULIU	10.04	2.36	76.79	0.41	0.26	29.46	2.15	1.71	78.72	44.03
UKIO	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
SIAULIU	10.04	2.44	82.06	0.69	0.36	25.73	1.54	1.00	74.90	38.75
UKIO	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
SIAULIU	9.26	1.52	80.05	0.95	2.08	22.15	0.78	-1.67	92.74	34.61
UKIO	8.05	0.80	71.82	5.51	2.12	32.25	0.08	-2.08	110.93	50.86

Notes. Objectives are 1 - CAPITAL; 2 -Net Interest Income, % of RWA; 3 - Loans, % of Assets; 4 - Delinquent Loans, % of Assets; 5 - Loan Value Decrease, % of Total assets; 6 - Non-interest Cost, % of Total Income; 7 - Pre-provision profit, % of RWA; 8 - Net Income, % of RWA; 9 - Deposits, % of Loans; 10 - Regulatory Liquidity Ratio

2.1. Capital adequacy

The traditional solvability ratio relates the own capital of the banks to their balance totals without taking in consideration any risk level. This ratio amounts in all Lithuanian banks to at least 8%. Therefore we consider this ratio rather as a lower bound and not as an objective. An objective in this direction has to be risk related.

Whereas in Basel I capital adequacy framework credit risk is only considered, in addition a new capital adequacy framework, referred to as Basel 2, accounts operational and market risks.

Capital adequacy ratio is calculated by dividing capital by risk-weighted assets (accounted

Separately for credit, market and operational risks) after multiplying them by prescribed coefficients.

Assets of banks consist of several types of assets like loans, buildings, bonds and cash balances with the Central Bank. It is clear that assets vary by risk. For example, cash is the least risky. Consequently cash goes with a zero score; “Normal loans” with a 100 % score. Risky loans and bonds are accounted in Risk-Weighted Assets (RWA) with higher scores: from 150 % to 300 %.

We differently account Tier 1 and Tier 2 into CAPITAL variable, since Tier 2 capital is more risky than Tier 1 capital.

1) Tier 1 as a percentage of Risk-Weighted Assets (RWA).

Tier 1, as a part of capital, is fully paid capital plus the reserves, which banks accumulate from profits.

2) Tier 2 as a percentage of Risk-Weighted Assets (RWA).

Tier 2, as a part of capital, is fluctuating like revaluating of reserves fluctuating with the market or subordinated debt as loans from financial institutions, which will have to be eventually repaid or claimed before maturity. For example, the subordinate loan amounting 15 mln. euros was claimed by Skandinaviska Enskilda Banken AB and repaid by its subsidiary AB SEB Bankas on 30 April, 2008 (AB SEB bankas 2009). If Tier 2=0, there is nothing wrong. On the contrary, in the case of Siauliu bank, for instance, it means that the capital is of better quality.

3) Combination of Tier 1 and Tier 2 to come to a single Capital Ratio

The Central Bank of Lithuania adds up the two, to make look the capital adequacy ratio bigger and nicer. We also add both Tier 1 and Tier 2 capital ratios. Since Tier 2 capital is more risky than Tier 1 capital), we shall take into account 2/3 of Tier1 and 1/3 of 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 as well as from bad loans, low cost and earning efficiency as from interest rate and trading.

2.2. Assets

Assets category is represented by four ratios.

1) The first ratio presents the maximization of 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 the Assets category, more adequately accounts profitability of assets in terms of riskiness than in the case if interest income was divided by total assets.

2) The ratio between loans as the most risky assets and total assets is the second one. This ratio requires minimization.

3) 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.

4) The fourth ratio within the category is the decrease of loan value as a percentage of total loans. This ratio requires minimization.

2.3. Management

The 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.

1) 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.

2) 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.

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, the Bank of Lithuania. This ratio indicates the short-term liquidity position of a bank within a month.

3. The data assembled in a matrix

The Table 2 (a matrix) assembles the data with vertically numerous objectives, criteria (a weaker form of objectives) or indicators and horizontally alternative solutions like projects.

The data originate from statistics, desk research, Project Engineering (UNIDO, 1978) or from simulated figures. In this way, alternatives, solutions or projects enter the response matrix as rows. When it concerns projects information has to be as intensive as possible. For this paper the commercial banks of Lithuania represent the alternatives.

Table 2. Matrix of Responses

Alternatives	Objectives					
	obj.1	obj.2	……	obj.i	…..	obj.n
A_1	X_{11}	X_{21}	...	X_{i1}	...	X_{n1}
A_2	X_{12}	X_{22}	...	X_{i2}	...	X_{n2}
……	X...	X...	...	X...	...	X...
A_j	X_{1j}	X_{2j}	...	X_{ij}	...	X_{nj}
…….	X...	X...	...	X...		X...
A_m	X_{1m}	X_{2m}	...	X_{im}	...	X_{nm}

The question remains how to find and how to decide on the choice of the objectives. One decision maker like a captain of industry will focus on his own objectives. Different decision makers do not change the picture. In some industrial countries the large companies are obliged to have some directors from outside the company in the board of directors. Even this group of decision making will stick to their own limited objectives. Rather all stakeholders, which mean all persons interested in a certain issue, have to be found. For this study a consensus about the objectives for banks in Lithuania was derived from the scientific literature and from official sources like the Basel Agreements.

Once agreement reached about alternatives and objectives, a decision has to be taken how to read the Response Matrix, either horizontally or vertically.

3.1. Horizontal reading of the Response Matrix

SAW and usual Reference Point Methods read the response matrix in a horizontal way. It is one of the most popular MCDA methods used by researchers (Podvezko 2011). Other popular MCDA methods have been described by Ginevicius 2011; Ginevicius, Podvezko (2007, 2008), Podvezko (2009), Podvezko, Podviezko (2009), Podvezko, Mitkus, Trinkuniene (2010), Podvezko, Podviezko (2010a, b), Zavadskas, Turskis (2011).

The Additive Weighting Procedure (MacCrimmon 1968, which was called SAW, Simple Additive Weighting Method, by Hwang and Yoon (1981) starts from:

$$MaxU_j \omega_1 x_1 + \ldots \omega_i x_i + \ldots \omega_n x_n$$

U_j = overall utility of alternative j with

$j = 1,2,\ldots,m$, m the number of alternatives

w_i = weight of attribute i indicates as well as normalization as the level of importance of an objective

$$\sum_{i=1}^{i=n} w_i = 1$$

$i = 1,2,\ldots,n$; n the number of attributes and objectives

x_{ij} = response of alternative j on attribute i.

As the weights add to one a new super-objective is created and consequently it gets difficult to speak still of multiple objectives.

Usual Reference Point Theory is non-linear, whereas non-additive scores replace the weights. The non-additive scores take care of normalization. But being non-additive the comments on the weights adding to one and consequently creating a super-objective is absent here.

With weights and scores importance of objectives is mixed with normalization. Indeed weights and scores are mixtures of normalization of different units and of importance coefficients.

3.2. Vertical reading of the Response Matrix

Vertical reading of the Response Matrix means that normalization is not needed as each column is expressed in the same unit. In addition if each column is translated in ratios dimensionless measures can be created and the columns become comparable to each other. Indeed they are no more expressed in a unit. Different kind of ratios are possible but Brauers, Zavadskas (2006) proved that the best one is based on the square root in the denominator. The Ratio System which forms the basis of the MOORA method follows the vertical reading of the matrix. Fig. 1 shows the exact relation between the two methods of MOORA and in addition to MULTIMOORA, MOORA plus the Full Multiplicative Form, to be explained later.

3.3. Choice of a Method for Multi-Objective Optimization: MULTIMOORA

The method runs as is shown on Fig.1.

The figures between brackets refer to the formulae (1-7) shown below.

$$x_{ij} = \frac{x_{ij}}{\sqrt{\sum_{j=1}^{m} x_{ij}^2}} \quad (1)$$

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

The **Ratio System** ranks the results in a descending order.

Reference Point Approach

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

The results are ranked in an ascending order.

Full Multiplicative Form

This sub-section refers to Brauers, Zavadskas (2010).

$$U_j = \prod_{i=1}^{n} x_{ij} \quad (4)$$

$$U'_j = \frac{A_j}{B_j} \quad (5)$$

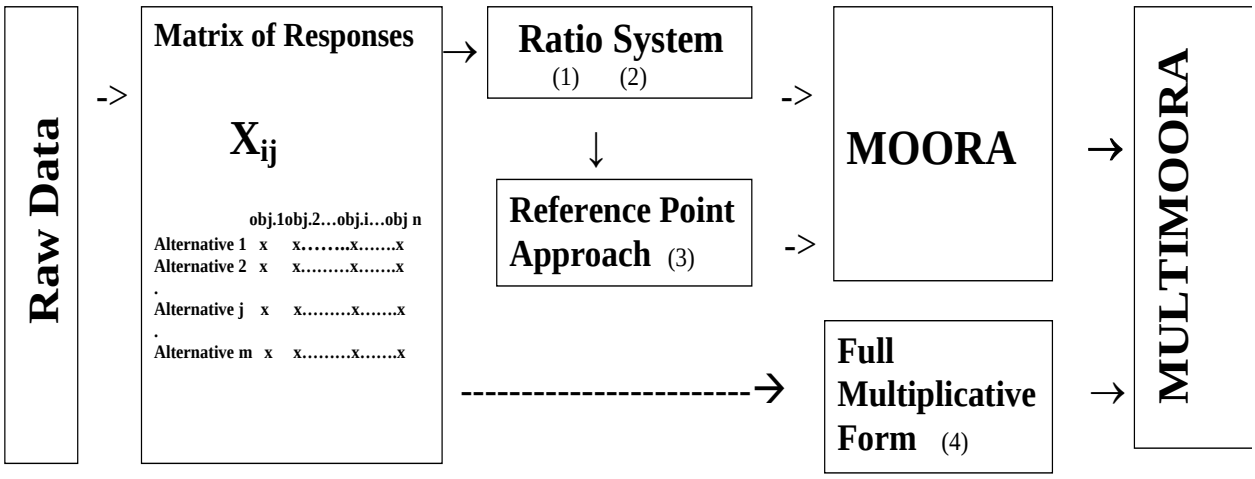

Fig.1. Diagram of MULTIMOORA

$$\text{with} \quad A_j = \prod_{g=1}^{i} x_{gi} \qquad (6)$$

$$B_j = \prod_{k=i+1}^{n} x_{kj} \qquad (7)$$

4. The theory of dominance

In the most of the not too complicated cases a summary of the ranking of the three MULTIMOORA methods is made. For very large matrices Brauers et al. developed a Theory of Dominance with success (Brauers, Ginevicius, Podvezko 2010; Brauers, Zavadskas 2011; Brauers, Balezentis, Balezentis 2011).

4.1. Axioms on ordinal and cardinal scales

1. A deduction of an Ordinal Scale, a ranking, from cardinal data is always possible (Arrow 1974).

2. An Ordinal Scale can never produce a series of cardinal numbers (Arrow 1974).

3. An Ordinal Scale of a certain kind, a ranking, can be translated in an ordinal scale of another kind.

In application of axiom 3 we shall translate the ordinal scale of the three methods of MULTIMOORA in another one based on Dominance, being Dominated, Transitivity and Equability.

4.2. Dominance, being dominated, transitiveness and equability

The three methods of MULTIMOORA are assumed to have the same importance. Stakeholders or their representatives may give a different importance in ranking but this is not the case with the three methods of MULTIMOORA. These three methods represent all existing methods with dimensionless measures in multi-objective optimization and all the three have the same important significance.

Dominance

Absolute Dominance means that an alternative, solution or project is dominating in ranking all other alternatives, solutions or projects which are all being dominated. This absolute dominance shows as rankings for MULTIMOORA: (1-1-1).

General Dominance in two of the three methods is of the form with a < b < c <d:

(d-a-a) is generally dominating (c-b-b)

(a-d-a) is generally dominating (b-c-b)

(a-a-d) is generally dominating (b-b-c)

and further on transitiveness will play fully.

Transitiveness

If a dominates b and b dominates c than also a will dominate c.

Overall Dominance of one alternative on another For instance (a-a-a) is overall dominating (b-b-b) which is overall being dominated

Equability

Absolute Equability has the form: for instance (e-e-e) for 2 alternatives.

Partial Equability of 2 on 3 exists e. g. (5-e-7) and (6-e-3).

Circular Reasoning

Despite all distinctions in classification some and further transitiveness plays fully.

5. MULTIMOORA as applied for the banks registered in Lithuania

Following table 3 gives the reaction of the banks on the objectives after the MULTIMOORA approach.

The recession of 2008-2009 was altering the rankings of the banks. During the recession the promotion of the UAB Medicinos Bankas, an independent bank, is amazing. On the other side, the parent of AB Parex Bankas (on 26 August, 2010 its name was changed to AB "Citadele" bankas) in Latvia is balancing to bankruptcy, which makes the quasi-nationalization by the Latvian government understandable.

Table 3 a. The reaction of the banks on the objectives after the MULTIMOORA approach for 2007

Banks	*MOORA Ratio System*	*MOORA Reference Point*	*Multipl. Form*	*multi-MOORA*
5	1	3	1	1
6	2	1	2	2
4	3	2	3	3
7	4	5	4	4
8	5	7	5	5
3	6	4	8	6
2	7	6	7	7
1	8	8	6	8

Table 3 b. The reaction of the banks on the objectives after the MULTIMOORA approach for 2008

Banks	*MOORA Ratio System*	*MOORA Reference Point*	*Multipl. Form*	*multi-MOORA*
6	1	1	1	1
7	2	4	2	2
8	3	2	3	3
4	4	3	4	4
1	6	5	6	5
5	5	6	8	6
2	7	7	7	7
3	8	8	5	8

A stronger over accentuation of the extreme data in the Multiplicative Form is understandable. This remark disfavors the ranking in a descending order of the banks in 2009, together with even negative results in the maximization process for the net income as a percentage of RWA, namely for all banks with exception of UAB Medicinos Bankas and AB Bankas SNORAS.

Table 3c. The reaction of the banks on the objectives after the MULTIMOORA approach for 2009

Banks	*MOORA Ratio System*	*MOORA Reference Point*	*Multipl. Form*	*multi-MOORA*
2	1	1	1	1
7	2	3	3	2
5	3	4	2	3
6	4	5	4	4
1	5	2	6	5
8	6	6	7	6
4	7	7	5	7
3	8	8	8	8

Notes. Banks are: 1 - AB DnB NORD; 2 - UAB Medicinos bankas; 3 - AB Parex bankas; 4 - AB SEB; 5 - AB bankas SNORAS; 6 - AB Swedbank; 7 - AB Šiaulių bankas; 8 - AB Ūkio bankas

6. Conclusions

For a researcher in multi-objective decision support systems the choice between many methods for multi-objective optimization is not easy at all. We intended to assist the researcher with some guidelines for an effective choice.

Multi-Objective Optimization by Ratio Analysis (MOORA), composed of two methods: ratio analysis and reference point theory starting from the previous found ratios, solves the difficult problem of normalization. If MOORA is joined with the Full Multiplicative Form for Multiple Objectives a total of three methods is formed under the name of MULTIMOORA, a mighty instrument for Multi-Optimization in a Well Being Society. MULTIMOORA represents the most robust approach for multi-objective optimization up to now (Brauers, Zavadskas 2009, 2010; Zavadskas, Turskis 2011).

If the application on the commercial banks of Lithuania would have no practical consequences, in any case it provides a learning experience with MULTIMOORA in its triple composition.

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