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Ranking of the Lithuanian Banks During the Recession of 2008-2009 by the MULTIMOORA Method

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Abstract

The aim of this study is to do a critical analysis, on the basis of different objectives, the banks registered in Lithuania during the recession years 2008-2009. As these banks work in the same macro-economic environment, the objectives are chosen on the basis of the CAMEL classification ('C' Capital adequacy, 'A' Asset quality, 'M' Management quality, 'E' Earnings, 'L' Liquidity). Traditional Cost-Benefit Analysis is not suitable enough for this. Indeed Cost-Benefit analysis translates all direct and indirect costs and other objectives (benefits) into money terms. On the contrary, Multi-Objective Optimization takes care of the different objectives, with objectives keeping their own units. Different methods exist for the application of Multi-Objective Optimization. In our research, we tested these methods for their robustness. MOORA (Multi-Objective Optimization by Ratio analysis) and MULTIMOORA (MOORA plus a Full Multiplicative Form), showed positive results on these tests. Therefore MULTIMOORA was chosen for the ranking of the Lithuanian Banks during the recession years 2008-2009.

Keywords: *Multi-objective optimization, Lithuanian banks, bank objectives, robustness, ratio system, Reference point method, Full multiplicative form.*

1. Introduction

Applications of Multi-Objective Optimization in banking has already been done by some researchers in the Technical University of Crete. They use their own Multiple Optimal Decision Analysis method, under the name of UTA (Figueira et al., 2005; Zopounidis, Pardalos, 2010). UTA group of methods uses linear programming techniques for optimizing a utility function associated with the preferences of a decision-maker. Variations of UTA are UTADIS and M.H.DIS for classification of alternatives or banks into two classes: healthy or bankrupt banks or firms (Dimitras et al., 1999; Doumpos et al., 2002; Gaganis et al., 2006), or into three classes: acceptable or healthy banks or firms, uncertain and unacceptable banks or firms (Zopounidis & Doumpos, 1999, 2002). Ioannidis et al. (2010) use the same methods but they add a decision tree classification, Euclidean distance to the k-nearest neighbors and stacked generalization. A multi-objective research on client-based

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variables has been done by Ginevicius & Podvezko (2008).

A categorization of banks comprising major types of objectives forms the basis of this paper. A selection is made on the basis of a classification approach, known as CAMEL. CAMEL is very popular with scholars that do research in the areas of banking. It is an abbreviation for 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 & Ginevicius, 2010). The categorization comprises major types of objectives representing stability of banks. The well known international rating agency, Moody's Investors Inc., uses CAMEL-based objectives (Fanger, 2007).

It has also been applied by Bongini et al. (2002), Thomson (1991), Arena (2008), Ozkan-Gunay & Ozkan (2007), Ginevicius & Podviezko (2011). Wheelock & Wilson (2000) and Cole & Gunther (1995) found that CAMEL-based variables strongly correlate with bank failures. Hirtle & Lopez (1999) found that CAMEL-based examination of banks contain valuable information on bank condition for a 6-12 month period.

Contrary to the micro-economic approach of CAMEL, another stream of thought focuses on a rather macro-economic way of thinking. Let us recall that micro-economics concerns an individual person, a firm or a government as owner or shareholder of a firm or as a receiver of taxes. On the contrary, macro-economics concerns the general economic welfare in a welfare economy (Pigou, 1950). Gonzalez & Hermosillo (1999) cite as macro-economic factors: "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 crises in Asian countries of 1996-97, Demirguc et al., (1998) and Hardy & Pazarbasioglu (1998) argue that these models missed these crises. We have not considered a 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 (Seimas of the Republic of Lithuania, 2004) and the deposits made with these banks are insured by the same State Enterprise "Deposit and Investment Insurance". 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, respectively. They are registered in Lithuania only as branches, not as separate banks.

In this paper, Lithuanian banks, as defined above, are ranked for the recession years 2008-2009 using multi-objective optimization. 2007 is taken as base year as the later years were seriously biased. The years 2008 and 2009 were characterized by a severe recession largely due to sub-prime and bank crisis problems[1].

[1] The year 2008 was in the middle of 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, Ohanian,

As far as we know, no government or international official support was given to the Lithuanian banks. The only exception is AB Parex Bankas which was given indirect assistance. Indeed, AB Parex Bankas was assisted by the Latvian Government in accordance with the decision of European Bank for Reconstruction and Development on April 7, 2009 (EBRD, 2009), whereas the head office was nationalized in Latvia on November 8, 2008.

Most of the other banks registered in Lithuania are subsidiaries of international banks and their banks in the 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 CAMEL-Based Objectives

We concentrate on bank-specific variables, which reflect the performance of each bank in the market in terms of soundness and stability. All data used were obtained from the banks' annual reports. It was impossible to evaluate the banks directly by observing raw data. There were so many numerical data and figures contained in the 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). For evaluation purposes a limited number of essential objectives representing stable and sound performance of banks should be chosen. (Ginevicius & Podviezko, 2011). The following objectives are proposed based the CAMEL categorization.

a. Capital adequacy

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

The introduction of Basel 1 capital adequacy framework in 1988 has set capital adequacy requirements on banks and is considered to be a major regulatory measure, which reduces credit risk in activities of banks.

Whereas in Basel 1 capital adequacy framework credit risk is only considered, a new capital adequacy framework, referred to as Basel 2, considers 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 (Bank for International Settlements, 2004). We differently account Tier 1 and Tier 2 into CAPITAL variable, since Tier 2 capital is more risky than Tier 1 capital.

Auerbach et al. and Baldwin).

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.

Risk-weighted assets (RWA):
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 the RWA with higher scores: from 150% to 300%

In fact there is no need to calculate the RWA. It is easily derived from financial reports of the banks. Indeed, methodology for calculation of the RWA is set by the Bank for International Settlements domiciled in Basel. This procedure is included in "Basel 2". The methodology is obligatory for all banks in the European Union. Besides the EU most banks worldwide use it.

2) Tier 2 as a percentage of risk-weighted assets (RWA)

Tier 2, as a part of capital, fluctuates as revaluation of reserves fluctuates 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 to 15 million Euro 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 no problem. On the contrary, in the case of Siauliu bank, for instance, it means that 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 the capital adequacy ratio look bigger and nicer (Bank of Lithuania, 2006). Since Tier 2 capital is more risky than Tier 1 capital (Barrell et al., 2011), we shall take this into account. A difference in appreciation reveals the difference in the risks associated with the two types of capital. Therefore we allocate a coefficient of 2 to Tier 1, making quite a difference with the assumption of the Central Bank as shown in following table 1.

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

Table 1. Combination of Tier 1 with Tier 2

	Bank 1	Bank 2	Bank 3	Bank 4
TIER 1	100	75	50	40
TIER 2	0	25	50	60
_____	_____	_____	_____	_____
Central Bank	**100**	**100**	**100**	**100**
TIER 1 => coeff. 2	200	150	100	80
TIER 2=> coeff.1	0	25	50	60
_____	_____	_____	_____	_____
Proposition	**200**	**175**	**150**	**140**

b. Assets

Four ratios represent the assets category. These are:

i) 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, affect profitability of assets in terms of riskiness more than the case when interest income is divided by total assets. This view corresponds to risk-adjusted return on capital measurement model and is also employed by Moody's Investor's Service Inc. (Fanger, 2007).

ii) The ratio between loans as the most risky assets on the one side and total assets on the other: this ratio requires minimization.

iii) 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 decrease of loan value as a percentage of total loans:
This ratio requires minimization.

c. Management

A single ratio represents Management, which expresses the 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.

d. Earnings

Two ratios represent the category of *Earnings*. Both have to be maximized.

i) 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.
ii) 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.

All ratios described above conform to the findings of Wheelock & Wilson (2000): 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 much smaller.

e. Liquidity

Liquidity category is represented by:

i) The part of deposits to 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 on the most stable loan-financing from the customer-deposit source.
ii) 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.
Table 2 shows the reactions of Lithuanian banks on the defined objectives.

The maxima and minima optima, as indicated in Table 2, have only a relative and not an absolute meaning. That is they are limited to only the eight Lithuanian banks. An absolute meaning could be a utopian or an aspiration optimum. Therefore some authors speak of the relative meaning as a Satisficing Result or of Bounded Rationality (Wierzbicky, 1982; Harstad & Selten, 2013; Crawford, 2013).

Table 2. Objectives for banks registered in Lithuania

	2007									
	CAPITAL as a % of RWA	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
	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

3. Multi-Objective Optimization

Cost-Benefit Analysis is traditionally used for objectives optimization. Cost-Benefit takes a monetary unit as the common unit of measurement for benefits and costs. In this way, cost-benefit presents a materialistic approach, whereby, for instance, unemployment and health care are degraded to monetary items. Multi-Objective Optimization will take care of the disadvantages of cost-benefit analysis as *the objectives keep their own units.*

In order to give a better definition of an objective, we have to focus on the notion of attribute. Keeney & Raiffa (1993, 32-38) present the example of the objective "reduce sulfur dioxide emissions" to be measured by the attribute "tons of sulfur dioxide emitted per year". An attribute should always be measurable. We aim to satisfy multiple objectives simultaneously, whereas several alternative solutions or projects are possible, characterized by several attributes.

An alternative should be quantitatively well defined. An attribute is a common characteristic of each alternative such as its economic, social, cultural or ecological significance, whereas an objective consists in the optimization (maximization or minimization) of an attribute.

Economic welfare (the term was invented by professor Pigou, 1950) comprises micro- and macroeconomics. Microeconomics would include attributes such as: yearly capacity to be reached, Net Present Value (NPV), Internal Rate of Return (IRR) and Payback Period. Macro-economics would include increase in GDP, surplus in the current account of the balance of payments, direct and indirect employment increase and ENPV. Indirect employment is measured by Input-Output techniques. ENPV means Economic Net Present Value, i.e. discounted revenues

before national taxes, minus discounted investments, exclusive of subsidies. ENPV is different from GDP, but represents in macro-economics the counterpart of NPV, also with deduction of investments.

Satisfaction of all stakeholders is still another series of objectives. Stakeholders mean everybody interested in a certain issue. Due to consumer sovereignty and the economic law of decreasing marginal utility, consumer surplus, level of salaries, leisure time and again employment at the local and national level have to be taken into consideration.

Some attributes like NPV, ENPV, GDP, balance of payments surplus and consumer surplus are expressed in monetary units such as dollars or Euros. However, a Euro in consumer surplus cannot be compensated for instance with a GDP-Euro. In addition, IRR is expressed in a percentage, the payback period in months or years, employment in number of persons per year, production, for instance, in TEU, etc. Consequently, a serious problem of normalization is present.

Normalization means reduction to a normal or standard state. However, the term has many interpretations, but the stress is mainly to unify diverse measurement systems. As decision making requires measurements and normalization, normalization in technology could be a main starting point, whereas scales of measurement and measurement of quality may remain troublesome (for more on normalization, see: Brauers, 2007).

4. Conditions of Robustness in Multi-Objective Methods

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: Condorcet (the Condorcet Paradox, against binary comparisons, 1785, LVIII), Gossen (Law of Decreasing Marginal Utility, 1853), Minkowski (Reference Point, 1896, 1911) and Pareto (Pareto Optimum and Indifference Curves analysis 1906, 1927) and the pioneers like Kendall (ordinal scales, since 1948), Roy et al. (ELECTRE, since 1966), Miller & Starr (Multiplicative Form, 1964), Hwang & Yoon (TOPSIS, 1981), Saaty (AHP, since 1988), Opricovic & Tzeng (VIKOR, 2004), Brauers (MOORA, 2004a, 2004b), Brans & Mareschal (PROMETHEE 2005) and Brauers & Zavadskas (MULTIMOORA, 2010,c).

We intend to give some guidelines for an effective choice. Elsewhere, we tried to define robustness in connection with multiple objectives (Brauers & Zavadskas, 2010,a and b) and finally seven conditions of robustness were set (Brauers & Ginevicius, 2009). MOORA and later MULTIMOORA seemed to satisfy these seven conditions of robustness. The tests were made as non-subjective as possible, but as we the authors of this article were involved in setting up the test, it necessary that we avoid any element bias. Therefore Chakraborty (2011), as an outsider, could give a better judgment about MOORA. Chakraborty considered the seven conditions for robustness and tested six famous methods of Multi-Objective Decision Making in manufacturing on them. The results are presented in Table 3 below:

Table 3. Comparative performance of some MODM methods

MODM	**computational time**	**simplicity**	**mathematical calculations**	**stability**	**information type**
MOORA	Very less	Very simple	Minimum	Good	Quantitative
AHP	Very high	Very critical	Maximum	Poor	Mixed
TOPSIS	Moderate	Moderately critical	Moderate	Medium	Quantitative
VIKOR	Less	Simple	Moderate	Medium	Quantitative
ELECTRE	High	Moderately critical	Moderate	Medium	Mixed
PROMETHEE	High	Moderately critical	Moderate	Medium	Mixed

5. The Data Organized in a Matrix

The data are organized in a matrix with objectives or criteria (a more general term than objectives) or indicators along the columns and alternative solutions, like projects, along the rows.

Table 4. Matrix of Responses

	obj.1	**obj.2**	**……**	**obj.i**	**…..**	**obj.n**
Alternative 1	**X**	**X**	**X**	**X**	**X**	**X**
Alternative 2	**X**	**X**	**X**	**X**	**X**	**X**
……	**X**	**X**	**X**	**X**	**X**	**X**
Alternative j	**X**	**X**	**X**	**X**	**X**	**X**
…….	**X**	**X**	**X**	**X**	**X**	**X**
Alternative m	**X**	**X**	**X**	**X**	**X**	**X**

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 is projects, information has to be as intensive as possible. In this paper, the commercial banks of Lithuania represent the alternatives.

The question that remains is 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 on their board of directors. Even this group of decision makers will stick

to their own limited objectives. All stakeholders, that is, all persons interested in a certain issue, have to be found. For this study a consensus on the objectives for banks in Lithuania was derived from the scientific literature and from official sources like the Basel Agreements.

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

5.1. Horizontal Reading of the Response Matrix

SAW and all Methods of Partial Aggregation read the response matrix in a horizontal way. The Additive Weighting Procedure (MacCrimmon, 1968), which was called SAW, Simple Additive Weighting Method, by Hwang & Yoon (1981, 99) starts from:

$$Max.U_j = w_1 x_{1j} + w_2 x_{2j} + \ldots + w_i x_{ij} + \ldots + w_n x_{nj}$$

U_j = overall utility of alternative j with j = 1,2,…..,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,.....,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 of multiple objectives. In addition weights are in a dual position: to solve the problem of normalization on the one side and to give more importance to some objectives on the other.

The usual Reference Point Theory is non-linear, whereas non-additive scores replace weights. The non-additive scores do not need normalization and being non-additive the constraint that the weights must add to one and, consequently, creating a super-objective is non-existent.

5.2. Vertical Reading of the Response Matrix

Vertical reading of the Response Matrix per objective 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 are 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. Figure I shows the relation between the two methods of MOORA and MULTIMOORA -

MOORA plus the Full Multiplicative Form, which will be explained later.

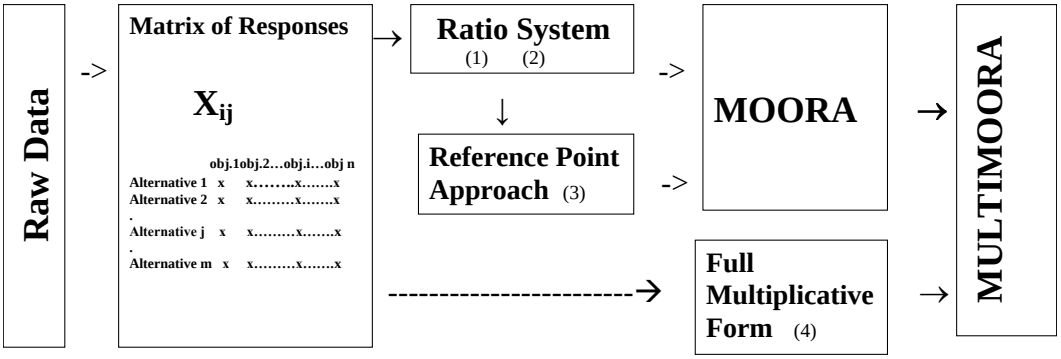

Fig. I Diagram of MULTIMOORA

The figures in brackets refer to the formulas on the next page

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

6.1. 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
$i=1,2,\ldots,n$ as the objectives
$j=1,2,\ldots,m$ 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, & Zavadskas (2006) proved that this is the most robust choice:

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

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 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 the case of maximization and subtracted in the case of minimization:

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

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 assessment of alternative j with respect to all objectives.

An ordinal ranking of the y_j^* in a descending order 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 (Karlin & Studden, 1966):

$$\min_{(j)} \{ \max_{(i)} | r_i - x_{ij}^* | \} \qquad (3)$$

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 dimensionless ratios defined in the MOORA method presented in (1) above. 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 Objective 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 Objective Reference Point R_m (100;100).

The results of the Reference Point Method are ranked in an ascending order.

6.2. The Importance given to an Objective by the Attribution Method in MOORA

It may appear as if one objective cannot be much more important than another one as all their ratios are smaller than one (see formula 1). Nevertheless, it is necessary to stress that some objectives are more important than others. In order to give more importance to an objective, its ratios could be multiplied with a *Significance Coefficient*.

To attach more importance to an objective in the Ratio System, its response on an alternative under the form of a dimensionless number could be multiplied with a Significance Coefficient:

$$\ddot{y}_j^* = \sum_{i=1}^{i=g} s_i x_{ij}^* - \sum_{i=g+1}^{i=n} s_i x_{ij}^* \qquad \text{(2 bis)}$$

with:
$i = 1,2,\ldots,g$ as the objectives to be maximized.
$i = g+1, g+2,\ldots, n$ as the objectives to be minimized
s_i = the significance coefficient of objective i
$\ddot{y}_j^*$ = the total assessment with significance coefficients of alternative j with respect to all objectives.

We assume that significance coefficients could be assigned to the bank objectives, but up till now no significance coefficients were attributed to the bank objectives.

7. MULTIMOORA

In his book of 2004, Brauers described separately the three parts of MULTIMOORA as: a Ratio System Approach, a still based on scores Reference Point Approach and a Full Multiplicative Form (2004a). Somewhat later Brauers switched over to a Reference Approach with the ratios found in the Ratio System replacing the scores (2004b) and much later Brauers & Zavadskas (2010) gave the name of MULTIMOORA to the three linked approaches. Dimensionless measurement lies at the basis of the three approaches.

Up till now, no other method is known to satisfy all previously mentioned robustness conditions and the three or more approaches. MULTIMOORA becomes the most robust system of multiple objectives optimization.

7.1. MOORA

We refer our readers to section 6.1 above where we have already explained MOORA (Multi-Objective Optimization by Ratio Analysis).

7.2. The Full Multiplicative Form of Multiple Objectives

Mathematical economists are familiar with the multiplicative models like production functions (e.g. Cobb-Douglas and Input-Output formulas) and demand functions (Teekens & Koerts, 1972) but the multiplicative form of multi-objectives was introduced in 1964 by Miller & Starr (2nd ed. 1969, 237-239) and was further developed by Brauers (2004a).

Henceforth, the following *n*-power form for multi-objectives will be referred to as *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.

An objective is emphasized by an additional α-term or by an exponent allocation (a *Significance Coefficient*) on condition of unanimity or at least with a strong convergence in opinion of all the stakeholders concerned. Once again, no significance coefficients are assumed in this study on Lithuanian banks.

In order to combine a minimization some objectives with maximization of other objectives, the minimization objectives are represented as denominators in the formula:

$$U_j' = \frac{A_j}{B_j} \tag{5}$$

with:

$$A_j = \prod_{i=1}^{g} x_{ij}$$

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

$$B_j = \prod_{i=g+1}^{n} x_{ij}$$

$n-g$ = the number of objectives to be minimized

U_j' : the utility of alternative j with objectives to be maximized

and objectives to be minimized.

A problem may arise in the Full Multiplicative Form for zero and negative values making the results senseless. Therefore an index number 100 replaces the zero number. Thus, 96.6 represents minus 3.4 and 103.4 represents the positive value of 3.4.

The Full Multiplicative Form is read horizontally in the Response Matrix of Table 4. 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" (De Jong, 1967). *"In the full-multiplicative form, an attribute of the size 10, 10^2, 10^3, 10^6, 10^9 etc. can be replaced by the unit size without changing the relationship between the utilities of the alternatives"* (Brauers 2004a).

8. The Theory of Dominance

In the not too complicated applications, a summary of the ranking of the three MULTIMOORA methods was done on view. However, for very large matrices Brauers et al. developed a *Theory of Dominance* (Brauers & Zavadskas 2011; Brauers, Balezentis & Balezentis 2011).

8.1. 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).*
3. *An Ordinal Scale of a certain kind, a ranking, can be translated in an ordinal scale of another kind.*

By axiom 3 any ordinal scale in the three MULTIMOORA approaches can be translated in another one based on Dominance, Transitivity and Equability. It is assumed that the three MULTIMOORA Methods are equally important.

8.2. Dominance, being Dominated, Transitiveness and Equability

Here we will briefly define dominance, being dominated, transitiveness, and equability.

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 transitiveness plays fully.

Overall Dominance of one alternative on another:

(a-a-a) is overall dominating (b-b-b) which is overall being dominated.

Transitiveness:

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

Equability:

Absolute Equability: has the form: for instance (e-e-e) for 2 alternatives.
Partial Equability: Partial equability of 2 on 3 exists e. g. (5-e-7) and (6-e-3).

Circular Reasoning:

Despite all classifications differences, few contradictions could still remain in a Circular Reasoning. We can cite the case of:

Object A (11-20-14) dominates generally object B. (14-16-15)
Object B. (14-16-15) dominates generally Object C (15-19-12)
but Object C (15-19-12) dominates generally Object A (11-20-14).

In such a case the same ranking is given to the three objects.

9. MULTIMOORA as Applied for the Banks Registered in Lithuania

More details about MOORA and Multiplicative Form calculations concerning commercial banks registered in Lithuania are tabulated in Appendices A and B.

In Tables 5a to 5c, we present the rankings of the banks on the objectives under the MOORA Ratio System, MOORA Reference Point and Multiplicative Form (MULTIMOORA).

Table 6 presents a summary of the rankings for the Lithuanian banks on the objectives for the years 2007, 2008, and 2009 using MULTIMOORA. The ranking

of the banks for the year 2007 is to be able to compare the performances of each individual bank before the recession with their performances during the 2008-2009 recession.

Table 5a. The reaction of the banks on the objectives after the MULTIMOORA approach for the year 2007

Banks	**MOORA Ratio System**	**MOORA Reference Point**	**Multiplicative Form**	**MULTIMOORA**
Snoras	**1**	**3**	**1**	**1**
Swedbank	**2**	**1**	**2**	**2**
SEB	**3**	**2**	**3**	**3**
Siauliu	**4**	**5**	**4**	**4**
Ukio	**5**	**7**	**5**	**5**
Parex	**6**	**4**	**8**	**6**
Medicinos	**7**	**6**	**7**	**7**
DnB NORD	**8**	**8**	**6**	**8**

Table 5b. The reaction of the banks on the objectives after the MULTIMOORA approach for the year 2008

Banks	**MOORA Ratio System**	**MOORA Reference Point**	**Multiplicative Form**	**MULTIMOORA**
Swedbank	**1**	**1**	**1**	**1**
Siauliu	**2**	**4**	**2**	**2**
Ukio	**3**	**2**	**3**	**3**
SEB	**4**	**3**	**4**	**4**
DnB NORD	**6**	**5**	**6**	**5**
Snoras	**5**	**6**	**8**	**6**
Medicinos	**7**	**7**	**7**	**7**
Parex	**8**	**8**	**5**	**8**

Table 5c. The reaction of the banks on the objectives after the MULTIMOORA approach for the year 2009

Banks	MOORA Ratio System	MOORA Reference Point	Multiplicative Form	MULTIMOORA
Medicinos	**1**	**1**	**1**	**1**
Siauliu	**2**	**3**	**3**	**2**
Snoras	**3**	**4**	**2**	**3**
Swedbank	**4**	**5**	**4**	**4**
DnB NORD	**5**	**2**	**6**	**5**
Ukio	**6**	**6**	**7**	**6**
SEB	**7**	**7**	**5**	**7**
Parex	**8**	**8**	**8**	**8**

Table 6. Comparison of the rankings of the Lithuanian Banks before and during the Recession 2008-2009 using the MULTIMOORA Method

Normal Period 2007	Recession Years (2008-2009)	
	2008	2009
1. SNORAS	**1. SWEDBANK**	**1. MEDICINOS**
2. SWEDBANK	**2 SIAULIU**	**2. SIAULIU**
3. SEB	**3. UKIO**	**3. SNORAS**
4. SIAULIU	**4. SEB**	**4. SWEDBANK**
5. UKIO	**5 DNB NORD**	**5. DNB NORD**
6. PAREX	**6. SNORAS**	**6. UKIO**
7. MEDICINOS	**7. MEDICINOS**	**7. SEB**
8. DNB NORD	**8. PAREX**	**8. PAREX**

The recession of 2008-2009 altered the rankings of the banks. AB Parex Bankas had the worst performance during the recession. In 2007, it is still ranked as number 6 among the 8 banks registered in Lithuania. This excludes the branches of foreign banks operating under foreign law. In that year Parex bankas still have positive ratings on all objectives, except that it already had a zero Net Income as a percentage of Risk-Weighted Assets then (see table 2). However, in 2008 and 2009, its Pre-Provision Profit as a percentage of Risk-Weighted Assets became negative and with a serious deficit on Net Income as a percentage of Risk-Weighted Assets. The parent of this AB Parex Bankas in Latvia (on 26 August, 2010 its name was changed to AB "Citadele" bankas) was close to bankruptcy. This made its quasi-nationalization by the Latvian government understandable.

On the positive side, the performance of the UAB Medicinos Bankas, an independent bank, during the recession is amazing . It ranked 1st in 2009. Medicinos Bankas is a bank with a single dominant or major shareholder. Medicinos Bankas

and Bankas SNORAS, which ranked third in the 2009 ranking, were the only banks that have positive rating on Net Income as a percentage of Risk-Weighted Assets in that year. However the position of Bankas SNORAS was rather unstable moving from a first position in 2007 to a sixth position in 2008 and finally to a third position in 2009. As a last positive note, Siauliu Bankas, ranking second in 2009, had a tier 2 of zero, which means that the capital was of better quality.

This basic research can be a good blueprint for other researchers who may like to do further investigations in this area, for instance about more recent years or when the regulations of Basel III would come completely into effect, or who may like to conduct similar investigations in other countries.

Finally, we recommend that this research should be done regularly as a form of proactive approach for providing early warning system for banks. During each regular repetition of the research, the multiple objectives should be set in accordance with the successive regulations of the different Basel Agreements.

10. Remarks and Conclusions, and Recommendations for Future Research

10.1. Remarks and Conclusions

For any researcher in multi-objective decision support systems, making a choice among many methods is not at all easy. We believe that this research will provide good guidelines that can help researchers to make effective choices. In order to distinguish among the different multi-objective methods with respect to their performances or effectiveness we used a qualitative definition of robustness, following which an outsider or neutral person judged MULTIMOORA most favourably than other methods.

Multi-Objective Optimization by Ratio Analysis (MOORA), consists of two methods: ratio analysis and reference point theory. Starting with previously determined ratios, it solves the difficult problem of normalization.

If MOORA is joined with the Full Multiplicative Form for Multiple Objectives, a total of three methods, based on dimensionless measures, is formed under the name of MULTIMOORA, a mighty instrument for Multi-Optimization in a Well Being Society.

In applying MULTIMOORA, some Lithuanian banks' performances were compared during the recession years 2008-209 using 2007 as base year. The comparisons are based on 10 objectives derived from the CAMEL classification for banks. Among the important observations made from the comparisons is that some banks' dropped during the recession. The presence of a Bad Bank is a first result of this investigation. On the contrary, another important observation is that the rankings of some banks do improve remarkably during the recession. Namely, it was observed that banks with a single major or dominant shareholder show good performance with a positive Net Income as a percentage of Risk-Weighted Assets. Good results are also noticed for banks with a tier 2 of zero, meaning that the capital was of better quality.

10.2. Recommendations for Future Research

We believe that this basic research is a good blueprint for other researchers who may like to do further investigations in this area or who may like to conduct similar investigations in other countries.

Finally, we recommend that this research should be done regularly as a form of proactive approach for providing early warning system for banks. During each regular repetition of the research, the multiple objectives should be set in accordance with the successive regulations of the different Basel Agreements.

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APPENDIX A

The MOORA Figures

7a - Matrix of Responses of Alternatives on Objectives: (x_{ij})

	CAPITAL as a % of RWA	Net Interest Income % RWA	Loans % of Assets	Delinquent >60d loans % Assets	Loan Value Decrease% of Total Assets	Non-interest Cost % Total	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
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

7b - Sum of squares and their square roots

	CAPITAL as a% of RWA	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
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

7c - Objectives Divided by their Square Roots and MOORA

	CAPITAL as a% of RWA	Net Interest Income % RWA	Loans % Assets	Delinquent >60d loans % Assets	Loan Value Decrease % Total assets	Non-interest Cost % Totall 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**
Siauliu	**0.510**	**0.311**	**0.378**	**0.259**	**0.309**	**0.278**	**0.328**	**0.329**	**0.309**	**0.359**	**0.920**	**4**
Ukio	**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**
Siauliu	**0.432**	**0.287**	**0.386**	**0.075**	**0.181**	**0.281**	**0.248**	**0.234**	**0.347**	**0.330**	**0.957**	**2**
Ukio	**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**
Siauliu	**0.371**	**0.253**	**0.379**	**0.068**	**0.184**	**0.244**	**0.151**	**0.100**	**0.354**	**0.263**	**0.417**	**2**
Ukio	**0.323**	**0.132**	**0.340**	**0.398**	**0.187**	**0.355**	**0.016**	**0.125**	**0.423**	**0.386**	**0.124**	**6**

7d - Reference Point Theory with Ratios: Co-Ordinates of the Reference Point Equal to the Maximal Objective Values

	CAPITAL as a % of RWA	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
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**

7e Reference Point Theory: Deviations from the Reference Point with Min-Max Ranking

	CAPITAL as % of RWA	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	MAX.	RANK of MIN.
	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
Siauliu	0.000	0.157	0.151	0.226	0.308	0.059	0.160	0.147	0.301	0.054	0.308	5
Ukio	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
Siauliu	0.001	0.248	0.101	0.047	0.056	0.042	0.362	0.447	0.177	0.176	0.447	4
Ukio	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
Swedbank	0.197	0.000	0.124	0.239	0.119	0.104	0.026	0.025	0.255	0.069	0.255	1
Siauliu	0.000	0.157	0.151	0.226	0.308	0.059	0.160	0.147	0.301	0.054	0.308	5
Ukio	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
Siauliu	0.001	0.248	0.101	0.047	0.056	0.042	0.362	0.447	0.177	0.176	0.447	4
Ukio	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
Siauliu	0.081	0.270	0.463	0.110	0.211	0.195	0.127	0.000	0.061	0.000	0.463	3
Ukio	0.130	0.391	0.597	0.135	0.142	0.072	0.088	0.330	0.065	0.111	0.597	6

Appendix B

The Full Multiplicative Form

Table 8. The Full Multiplicative Form

	maxima	minima	max/min	rank
2007				
DnB NORD	**54136**	**123.1**	**439.7**	**6**
Medicinos	**93425**	**1321.4**	**70.7**	**7**
Parex	**13**	**50.6**	**0.3**	**8**
SEB	**276642**	**66.5**	**4160.3**	**3**
SNORAS	**638466**	**1.2**	**543394.1**	**1**
Swedbank	**594217**	**105.8**	**5614.9**	**2**
Siauliu	**301861**	**239.7**	**1259.4**	**4**
Ukio	**696901**	**572.4**	**1217.4**	**5**
2008				
DnB NORD	**21718**	**1108.5**	**19.6**	**6**
Medicinos	**441976**	**24109.4**	**18.3**	**7**
Parex	**18056**	**651.0**	**27.7**	**5**
SEB	**114202**	**1140.3**	**100.1**	**4**
SNORAS	**49184**	**4197.2**	**11.7**	**8**
Swedbank	**1336184**	**606.4**	**2203.4**	**1**
Siauliu	**109763**	**524.5**	**209.3**	**2**
Ukio	**303798**	**2804.8**	**108.3**	**3**
2009				
DnB NORD	**50.84**	**33650**	**0.0015107**	**6**
Medicinos	**17075.51**	**11613**	**1.470387244**	**1**
Parex	**0.04**	**110676**	**0.00000003**	**8**
SEB	**65.28**	**39869**	**0.00163726**	**5**
SNORAS	**1094.41**	**15622**	**0.07005738**	**2**
Swedbank	**430.27**	**75266**	**0.00571670**	**4**
Siauliu	**35.15**	**3493**	**0.01006394**	**3**
Ukio	**3.00**	**27013**	**0.00011191**	**7**