Proceedings of the 11th International Symposium
on OPERATIONAL RESEARCH

SOR '11

Dolenjske Toplice, Slovenia
September 28-30, 2011

Edited by:
L. Zadnik Stirn • J. Žerovnik • J. Povh • S. Drobne • A. Lisec

A GOAL PROGRAMMING APPROACH TO RANKING BANKS

Višnja Vojvodić Rosenzweig
Ekonomski fakultet u Zagrebu
Kennedyjev trg 6, 10000 Zagreb
Phone: ++385 1 2383 333; E-mail: vvojvodic@efzg.hr

Hrvoje Volarević
Zagrebačka škola ekonomije i managementa
Jordanovac 110, 10000 Zagreb
Phone: ++385 1 2354 151; E-mail: hrvoje.volarevic@zsem.hr

Mario Varović
Zagrebačka škola ekonomije i managementa
Jordanovac 110, 10000 Zagreb
Phone: ++385 1 2354 151; E-mail: mario.varovic@zsem.hr

Abstract: Ranking of commercial banks based on seven proposed criteria is performed by using goal programming, in which the goal of every bank is the best business performance (evaluated with multiple criteria), and which is represented by a Score. The Score is obtained by calculating weights as a solution of a goal programming problem. Profitability indicators are the most important indicators for the five observed Croatian banks. Other indicators, for credit risk and productivity, are far less important for the final ranking of the chosen banks.

Key words: Commercial banks, Multi-criteria ranking, Goal programming, Business performance.

1. INTRODUCTION

Banks play an extremely important role in each country's economy, particularly in countries with a rather less developed financial system, as is the case with the Republic of Croatia. The banking sector in the Republic of Croatia consists of thirty banks that are mostly owned by foreign proprietors, generally by Italian, Austrian, French, and Hungarian banks. The dominant position, based on their total assets and the size of equity, is occupied by two largest Croatian Banks, Zagrebačka banka d.d. and Privredna banka Zagreb d.d. In addition to these, the top ten Croatian banks also include Erste & Steiermarkische bank d.d., Raiffeisenbank Austria d.d., Hypo-Alpe-Adria-bank d.d., Societe Generale - Splitska banka d.d., Hrvatska poštanska banka d.d., OTP banka d.d., Volksbank d.d., and Podravska banka d.d. The scope of this study encompasses the following five banks: Erste & Steiermarkische bank (ERSTE), Raiffeisenbank Austria (RBA), Hypo-Alpe-Adria-bank (HYPO), Hrvatska poštanska banka (HPB) and Podravska banka (POBA).

These banks were chosen primarily because of their comparability with regard to the criteria of total assets and size of equity, as well as for the online availability of their annual reports with financial statements for the year 2010. Moreover, because of the fact that only one out of the five - HPB bank has domestic (Croatian) ownership, these five banks represent a representative sample for the Croatian banking sector. The two largest banks that participate in over 50% of the Croatian banking sector are excluded from analysis since their results would not be comparable with the financial position of the other banks studied. Particular emphasis will be put on the interpretation of the results relating to the HPB Bank, since it is the only large bank in Croatia owned by domestic capital, i.e. mainly a state-owned bank. The results of the analyses will imply certain conclusions and recommendations for the purpose of repositioning the HPB bank, but also other banks covered in the study, on the Croatian banking market.

A mathematical multicriteria decision making model will be used, that will consist of seven individual criteria classified into three basic groups - profitability, credit risk, and productivity. Multicriteria business performance of each bank will be evaluated using a score calculated as the weighted sum of relative values of individual indicators. There is an assumption that each bank goal is the maximum score that they wish to obtain. The score is dependent on the weights assigned to individual indicators. The deviation from the goal will be measured using two distance functions. The formulated mathematical model uses goal programming to determine the weights and the score for each bank. This approach is used in paper [6]; however, in that paper the goal of each bank is the score closest to the performance of all indicators, which will not be the case here.

The rest of this paper is presented in the following manner. All seven criteria are presented in the second section, followed by formulation of the multicriteria optimalisation model in the third. The approach to solving this kind of a model is illustrated in the fourth section on the basis of the examples that include five banks and seven selected attributes (criteria). The closing considerations are presented in the final section of this paper.

2. SELECTION OF CRITERIA

Ranking of commercial banks is a classic problem of multicriteria decision-making. In the first place, it is necessary to select the criteria on the basis of the ranking of the banks in a descending order (from the best to the worst). In this paper seven individual criteria have been chosen, categorized in three fundamental groups (profitability, credit risk, and productivity) as follows:

1. Return on average assets – ROAA represents one of the most well-known indicators of profitability that is often used not only in the banking sector, but also in the real sector. The value of this indicator is obtained from the next relation:

X_1 = Return on average assets (ROAA) = profit before taxation / average assets of the bank (1)

Profit before taxation can be found in the Income statement (P&L), while the average assets of the bank are calculated as the arithmetical mean of the balance sheet's positions on the asset side for two consecutive business years (in this case for the years 2009 and 2010). The obtained values are expressed as percentages, and are desirable to be as high as possible for each bank.

2. Return on average equity – ROAE also represents a well-known profitability indicator, as well as Return on average assets. The value of this indicator is obtained as follows:

X_2 = Return on average equity (ROAE) = profit after taxation / average equity of the bank (2)

Profit after taxation is the final entry of the Income statement, while the average equity of the bank is calculated in the same way as the average assets of the bank (arithmetical mean of the balance sheet's positions of the equity for the two sequential business years). The obtained values are also expressed as percentages, and are desirable to be as high as possible for each bank.

3. Income from interest bearing assets and expenses on interest bearing liabilities represents a specific indicator of profitability that is solely applied to the banking sector. The value of this indicator is obtained as follows:

X_3 = Income from interest bearing assets and expenses on interest bearing liabilities = (interest income / average interest bearing assets) / (interest expenses / average interest bearing liabilities) (3)

Interest income and interest expenses represent the initial positions in the Income statement of every business bank because they define the financial result that is derived from basic banking activity - receiving deposits and lending loans. Interest bearing assets are the total of all positions on the asset side of the balance sheet that represent the ground for calculating active interest, by which banks' income is generated. On the other hand, interest bearing liabilities are the total of all positions on the liability side of the balance sheet as the ground for calculating passive interest that make banks' expenditures. The obtained values are expressed as absolute values and it is desirable that the obtained results of this ratio be as high as possible in order to confirm the profitability of banks dealings.

4. Coverage represents the indicator commonly used in banks for credit risk evaluation. The value of this indicator is obtained as follows:

X_4 = Coverage = (total of investments impairment + provisions) / (total of investments + contingent liabilities) (4)

The numerator of the ratio consists of the total of investments impairment and provisions, where the impairment stands for the cumulative of all recognized losses for bad and doubtful loans that are not expected to be repaid, that is reimbursed, while the term provisions refers to the balance sheet position on the liability side that is recognized in the banks expenses as future observed and estimated liabilities (for example provisions for legal actions, that is lawsuits filed against the bank). The denominator of the ratio consists of the total of investments comprised divided by the total of all balance sheet positions on the asset side of the bank that represent the basis for generating income, and the other part of the denominator relates to contingent liabilities that are, as a rule, booked on the off-balance sheet, and consist of given guarantees and open letters of credit as typical banking affairs. The obtained values are expressed as percentages, and it is desirable that the obtained results of this ratio should be as high as possible, which implies that the bank management is aware of possible credit risk in business activities and of the necessity for its anticipation.

5. Quality of investments represents an indicator that pertains to the credit risk assessment, as well as coverage, because it assesses the percentage of bank investments that can be reimbursed. The value of this indicator is obtained as follows:

X_5 = Quality of investments = (1 – (total of investments impairment / total of investments)) (5)

The equation listed above puts in ratio two positions from the asset side of the bank's balance sheet. The obtained values are expressed as percentages and their maximum value is 100%, which means that all the bank's investments can be repaid and that

there is no need for investment impairment. Taking into account the existing risk when making credit investments, this situation should not be expected to be realistic.

6. Assets per employee is a typical banking indicator that belongs to the category of productivity indicators because it represents the ratio of the realized output (total of assets, i.e. total bank's property) against actors in bank business operations (which means all bank's employees). The value of this indicator is obtained as follows:

$$X_6 = \text{Assets per employee} = \text{total assets / total number of employees} \quad (6)$$

The values in this equation are obtained from the balance sheet and the notes accompanying financial statements (information about the number of employees). The obtained values are expressed as absolute values, i.e. money units, and are desirable to be as high as possible.

7. Interest income per employee represents the banking indicator that also belongs to the category of productivity indicators. The value of this indicator is obtained as follows:

$$X_7 = \text{Interest income per employee} = \text{Interest income / total number of employees} \quad (7)$$

The numerator of the ratio is obtained from the Income statement, while the denominator consists of the number of employees that can be found in the notes accompanying financial statements. The obtained values are also expressed as absolute values, i.e. money units, and are desirable to be as high as possible, just as with all the previous indicators.

Based on the former formulas, the calculated values of all seven individual criteria (X_1,...,X_7) for the five selected banks, and all the obtained results are presented in the following decision-making table (Tab. 1):

Table 1. The values of seven individual indicators (X_1, X_2, X_3, X_4, X_5, X_6 and X_7), categorized into three basic groups (profitability, credit risk, and productivity) for the five selected banks (ERSTE, HPB, HYPO, POBA and RBA).

BANK:	PROFITABILITY:			CREDIT RISK:		PRODUCTIVITY:	
	X_1	X_2	X_3	X_4	X_5	X_6	X_7
1. ERSTE	1,52%	10,55%	2,26	4,37%	95,65%	26,17	1,51
2. HPB	0,40%	5,55%	2,05	5,44%	94,10%	14,61	0,81
3. HYPO	0,72%	3,56%	1,77	5,71%	93,90%	22,82	1,24
4. POBA	0,58%	3,52%	2,20	5,58%	94,53%	9,11	0,54
5. RBA	1,13%	6,77%	2,17	2,85%	96,97%	17,44	0,97

All obtained results of individual indicators are positively directed, but the benefit criteria are not displayed in the same measurement units. Therefore the next step is the transformation of the positively directed criteria values. The percentage transformation is used here as it leads to proportional changes in the results. The obtained results are presented in Table 2.

Table 2. The transformed values of seven individual criteria (X_1, X_2, X_3, X_4, X_5, X_6 and X_7) as part of the three basic groups (profitability, credit risk, and productivity) for the five selected banks (ERSTE, HPB, HYPO, POBA and RBA).

BANK:	PROFITABILITY:			CREDIT RISK:		PRODUCTIVITY:	
	X_1	X_2	X_3	X_4	X_5	X_6	X_7
1. ERSTE	0,3508	0,3522	0,2163	0,1825	0,2013	0,2903	0,2979
2. HPB	0,0912	0,1854	0,1964	0,2271	0,1980	0,1621	0,1597
3. HYPO	0,1663	0,1189	0,1692	0,2383	0,1976	0,2531	0,2436
4. POBA	0,1326	0,1176	0,2108	0,2329	0,1989	0,1011	0,1071
5. RBA	0,2591	0,2259	0,2072	0,1191	0,2041	0,1934	0,1918

3. MULTICRITERIA PROBLEM AND GOAL PROGRAMMING

The weighted sum model is the most frequently used approach for the estimation of multicriteria performance of specific alternatives that are also used in this paper. To each bank i we assign score S_i based on the values of individual indicators (attributes) and weights assigned to them. The weights w_j of indicators j determine the score and by varying different weight different scores can be obtained for the same bank. Since the score of the alternative is its multicriteria value, it is assumed here that the goal of each bank is the maximum value of the score. In that sense the goal programming problem will be formulated. The notations in the model are as follows:

i - Bank, $i = 1,\ldots,n$.
j – Indicator (Attribute), $j = 1,\ldots,p$.
w_j –Weight of Attribute j, $j = 1,\ldots,p$.
x_{ij} – Value of Indicator j of Alternative i.
S_i - Score Alternative i, $S_i = w_1 x_{i1} + \ldots + w_p x_{ip}$.

As it was mentioned earlier, the goal for every bank i is the highest score, and therefore it is valid to define:

$$g_i = \max \{S_i(w): w_1 + \ldots + w_p = 1,\ w_1,\ldots,w_p \geq 0\} \tag{8}$$

If $d = (d_1,\ldots,d_n)$ represents a vector whose components d_i are deviations from components g_i of the goal $g = (g_1,\ldots,g_n)$, and S is vector $S = S(w) = (S_1,\ldots,S_n)$, the problem (GP) that we are solving is as follows:

$$\text{(GP)} \qquad \text{Min } \|g - S(w)\|_a \tag{9}$$

$$\text{With limitations:} \qquad S(w) + d = g,\ d \geq 0$$

$$w_1 + \ldots + w_p = 1$$

$$w_1,\ldots,w_p \geq 0$$

The solution of the problem depends on the selection of the norm i.e. on the values of the weights (w_j) of the goal programming problem (GP).

4. IMPLEMENTATION

The problem is solved for the five selected banks and the seven individual indicators. In this paper, the norm suggested by Dinckelbach and Isermann is used, as the first one:

$$\| g\text{-}S(w) \|_\alpha = \| g\text{-}S(w) \|_\infty + (1/\alpha) \| g\text{-}S(w) \|_1, \ \alpha \geq 1 \qquad (10)$$

The problem is solved for α = 1, 10 and 100. For all mentioned values of parameter α, the same solution is obtained. The following weights for every individual criterion are obtained:

$$w_1 = 0.3951,\ w_2 = 0.2235,\ w_3 = 0,\ w_4 = 0.3783,\ w_5 = 0,\ w_6 = 0 \text{ and } w_7 = 0.032.$$

The banks scores are (S_1 – ERSTE, S_2 – HPB, S_3 – HYPO, S_4 – POBA, S_5 – RBA):

$$S_1 = 0.2855,\ S_2 = 0.1655,\ S_3 = 0.1855,\ S_4 = 0.1665,\ S_5 = 0.2001.$$

Apart from using the Dinckelbach and Isermann's norm, the problem is also solved using the Euclid's norm in which the sum of square deviations is the smallest. The following weights are obtained for every individual criterion:

$$w_1 = 0.24,\ w_2 = 0.22,\ w_3 = 0.19,\ w_4 = 0.22,\ w_5 = 0,\ w_6 = 0 \text{ and } w_7 = 0.13.$$

The banks' scores are (S_1 – ERSTE, S_2 – HPB, S_3 – HYPO, S_4 – POBA, S_5 – RBA):

$$S_1 = 0.28,\ S_2 = 0.17,\ S_3 = 0.19,\ S_4 = 0.16,\ S_5 = 0.20.$$

The results are rounded up to two decimal points, unlike the previous problem, since this is a square programming problem.

The final ranking list of the five selected banks for both norms we used is as follows:

I. Dinckelbach and Isermann's norm:

ERSTE (S_1)
RBA (S_5)
HYPO (S_3)
POBA (S_4)
HPB (S_2)

II. Euclid's norm:

ERSTE (S_1)
RBA (S_5)
HYPO (S_3)
HPB (S_2)
POBA (S_4)

As one can see from the obtained results, the score (S_i) of every bank is approximately the same regardless of the norm used in the model, and the ranking is approximately the same in both cases. The only difference in the ranking is between the two banks with the lowest rank (HPB and POBA); their rank changes according to the norm used.

Furthermore, in both cases the largest weights are assigned to profitability indicators (over 60%) while the weight of the fifth indicator equals zero because all the banks have approximately the same values of that indicator (quality of investments). Moreover, the

weight of the sixth indicator (assets per employee) equals zero because its values are approximately the same as the values of the seventh indicator from the list of indicators (interest income per employee).

The first place of the ranking list is taken by a bank with moderate risk in business activities (ERSTE), while the bank with the highest risk in business activities (RBA) sits in the second place

On the other hand, HPB has small risk and small productivity, and therefore has small profitability, which puts the bank in the last or next to the last place in the total ranking (it changes places with POBA depending of the norm used). HYPO bank in both observed cases firmly holds the third position.

5. CONCLUSION

The commercial bank ranking problem can be efficiently solved with goal programming. The first step is to determine the criteria in advance, as the basis for executing multicriteria ranking and find the best business performance of the selected banks accordingly. The second step consists of using a goal programming mathematical model, in which the decision maker has the choice of using different norms. Two norms (Dinckelbach and Isermann, and Euklid's norm) are used in this paper, and the obtained results, weights, and scores are approximately the same in both cases. The obtained results for the five proposed banks suggest that the most important indicators in the model are profitability indicators, whose weights prevail in relation to the remaining two groups of indicators – credit risk and productivity – that have far less importance for the final bank ranking. This conclusion exclusively applies to the banking sector in the Republic of Croatia, while results might be different for some other countries and their banking markets [6].

Having analyzed the obtained score values for every bank selected in the model, it is beyond question that the two banks with the best score (ERSTE and RBA) have the adequate ratio for accomplished profitability and productivity, related to embedded risk in the business process. On the other hand, the same cannot be said for HPB and POBA that achieve just the opposite results, while HYPO is somewhere in between, which means there is room for improvement. HPB bank needs to improve its productivity and increase embedded risk in the business process. In that way, the bank ought to strengthen its market share in the Croatian banking sector, which would eventually lead to its repositioning regarding other banks. An alternative solution for HPB bank, as the only large bank in Croatia owned by domestic capital, would be referring to the possible recapitalization from its strategic partner, which should lead to necessary restructuring of its current business activity.

References

[1] Atrill, P., McLaney, E., 2006, Accounting and Finance for Non-Specialists, 5th edition, Prentice Hall, Harlow, England.

[2] Blocher, E., J., Chen, K., H., Lin, T., W., 2002, Cost Management: A Strategic Emphasis, McGraw-Hill/Irwin, New York, USA.

[3] Ehrgott, M., Klamroth, K., Schwehm, C., 2004, An MCDM approach to portfolio optimization, European Journal of Operational Research, Vol. 155, pp. 752-770.

[4] Feroz, E., H., Kim, S., Raab, R., L., 2003, Financial Statement Analysis: A Data Envelopment Analysis Approach, Journal of the Operational Research Society, Vol. 54, pp. 48-58.

[5] Gallizo, J., L., Jimenez, F., Salvador, M., 2003, Evaluating the effects of financial ratio adjustment in European financial statements, European Accounting Review, Vol. 12(2), pp. 357-377.

[6] Garcia, F., Guijarro F., Moya I., 2010, Ranking Spanish savings banks: A multicriteria approach, Mathematical and Computer Modeling, Vol.52, pp. 1058-106.

[7] Horngren, C., T., Oliver, M., S., 2010, Managerial Accounting, Upper Saddle River, New Jersey, Pearson Prentice Hall.

[8] Ng, W., L., 2007, An Efficient and simple model for multiple criteria supplier selection problem, European Journal of Operational Research, doi:10.1016/j.ejor.2007.01.018.

[9] Sawaragi, Y., Nakayama, H., Tanino, T., 1985, Theory of Multiobjective Optimization, Academic Press, Inc., Orlando, USA.

[10] Triantaphyyllou, E., 2000, Multi-Criteria Decision Making Methods: A Comparative Study, Kluwer Academic Publishers.