Slovak Firms Robust Multiple Criteria Risk and Performance Analysis

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Abstract
A firm position on the selected market is very important for trading and investment decisions. The paper presents a decision support system methodology for the selection of a firms set that satisfy person interested (investor or business partner requirements. It is assumed that the requirements are stated in the form of relative or absolute financial indicators for a specified classification of the goal firms set. The experimental applications of combined PROMETHEE methods use data form the Slovak Republic register of balances of accounts for the year 2018 for over 100 000 firms. The data are adapted from a view point of mutual comparability. The applied approach shows how one can use multiple criteria approaches in confrontation with selected benchmark for risk minimization decisions concerning investment opportunities or business relation looking for.

Keywords: financial indicators, outranking methods, benchmark, investment opportunities

1   INTRODUCTION

In business environment a distinguished attention is devoted to business subject analyses that are available from public information. The financial analyses are needed mainly for qualified decisions about financial flows direction among businessmen, banks, investor, state, and so on. The paper offers the methodological tool for using financial data from the Slovak register of balance accounts for such aims. This tool on the base of evaluation of statistical relevant financial data and selected criteria for examination of importance compared set gives possibility to help in decisions concerning business partner risk evaluation, investment opportunities looking for, and so on.

For mutual comparisons of firms in the whole Slovak firms system (over 450 000 units) is important to start from comparable quality of financial data. The company CRIF (Slovak Credit Bureau) suggest on the base of analyses to create for statistical analysis for year 2018 the firms set that have equal properties from the view point of continues business period (at least three years), marketing season, and approved balanced of accounts. For the year 2018 this basic set consists of more than 105 000 firms. The selected firms then serve for definitions of statistical benchmarks for sector characteristics of relative financial indicators. This set of firms with their financial data we assume as a representative one for all type of tasks that will satisfy described modeling methodology.

2   MODEL STRUCTURE CREATION
For a purpose to define a feasible (requested) firms field we will use
  a) database of absolute financial data from the register of balance accounts from book of profit and loss and form balance sheet;
  b) database of relative financial indicators;

    c) database of administrative firms classification according economic activities SK NACE and database of regional classification.

These databases were made available by the non-profit organization PROFINI and CRIF – Slovak Credit Bureau as part of the project "Sectoral Standards for Double-Entry Entrepreneurs" project code 314011L717, Call code: OP EVS DOP-PO1-SC1.1-2017-1.

Let us note that a specification of the set of firms can be also stated by the specific selection of individual firms according to own decisions. From the practical point of view the specific databases can be linked to one in such forms, where each firm will be characterized by data from all blocks. The firms set creation wit specified properties can by restricted by simple filters. For example one can be interested from specified reasons in firms from car industry with property over 4 million EUR in Košice region. For selected field of firms we will formulate analytical tasks concerning our decisions.

To selected firms set we assign absolute and relative value if financial indicators that really influence source of complex information for decision process. These data are used for a complex evaluation of financial quality of the selected set. One of the known approaches to complex ranking of selected alternatives (firms) represents the family of PROMETHEE methods. The methodology is well known a one can finds details e.g. in [1], [2], or [4].This approach application requires defining a group of evaluation criteria. For this purposes on can select some or all from relative indicators, absolute indicators or otherwise defined criteria as well. It depends on the purpose for which the model is constructed. For example, one can select criteria for:
1. liquidity – an ability to pay liabilities in one year horizon,
2. activity – assets liability or exploitation,
3. indebtedness, which describe a level of external sources using, their structure and repayment ability,
4. rent ability and performance – a firm efficiency or firm capital appreciation.

The paper uses model structure for the PROMETHEE II method where in the form of criteria we use a selected group from relative indicators described in the Table 1.

The importance role in the PROMETHEE method pays the selection of preference functions for selected criteria that reflect the preference power of the criterion values difference between each couple of variants. In our case the preference function value for criterion C_j will depend on the difference of criteria C_j values for firms x_1 and x_2, it means from $C_j(x_1) - C_j(x_2)$. Let us denote this difference as d_j. Owing to great number of variants we use for all criteria *Gaussian* preference function that for $d \geq 0$ can be written in the form

$$P(d) = 1 - e^{\frac{-d^2}{2\sigma^2}}$$

where σ is the standard deviation of data set for selected criterion. In this case the power of preference is ascending function of criterion values differences that for high values of d approaches to 1 and in the value of difference equal σ the convexity of the function changes into concavity and growth of the preference slows down. The advantages of such function consists in the fact that the function take into account statistical properties of criterion data and for higher value of standard deviation the preference *P(d)* is less sensitive on the difference *d.* These properties of preference function are illustrated on the Figure 1. It is well

known that besides preference function selection in PROMETHEE approach one can define the nonnegative weight of importance for each criterion. Usually one can start with same weights for all criteria and then on the result of sensitivity analysis can they change in desired selection. Corresponding multiple criteria approach results are then confronted with specified benchmark as it was suggested e.g. in [3].

Table 1: Relative indicators

| Criterion	Name	Type
C_1	liabilities/assets * 100	Min
C_2	Inventories/turnover * 360	Min
C_3	short term trade receivables/turnover * 360	Min
C_4	short term trade payables/ turnover * 360	Min
C_5	receivables/turnover * 360	Min
C_6	payables/turnover * 360	Min
C_7	long term payables/turnover * 100	Min
C_8	EBIDTA/revenues * 100	Max
C_9	gross profit/ assets * 100	Max
C_10	short term property without inventories/short term external sources	Max
C_11	short term property/ short term external sources	Max
C_12	turnover/assets	Max
C_13	PO_EBITDA/revenues * 100	Max
C_14	newly-formed value/ revenues * 100	Max
C_15	value-added/revenues * 100	Max
C_16	profit or loss from ordinary activities/revenues * 100	Max
C_17	net profit/equity * 100	Max
C_18	liabilities/ balance cash flow	Min
C_19	gross profit and interest expense/interest expense	Max
C_20	bank credits/ assets * 100	Min
C_21	equity/liabilities	Max
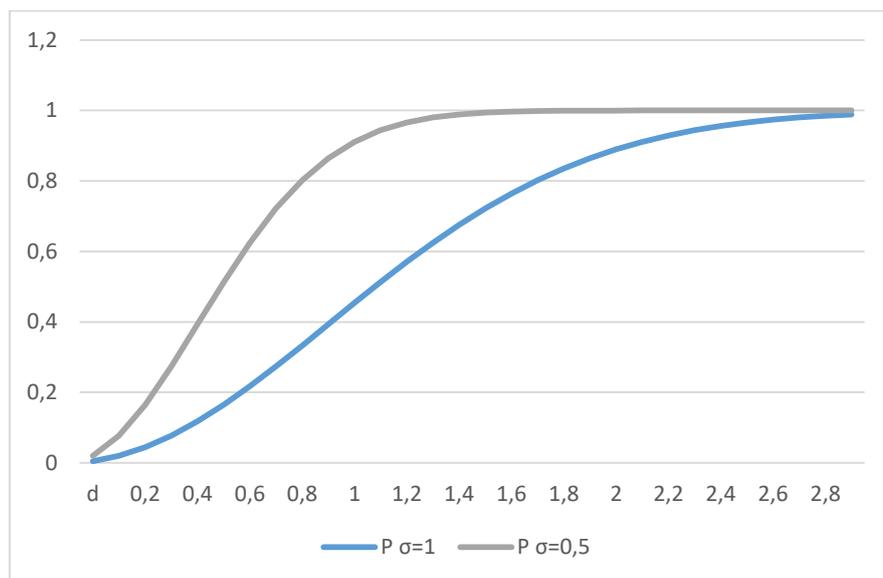
Figure 1: Gaussian preference function

3 DECISION MAKING APPLICATIONS OF MODEL STRUCTURE

At the first step we select such firms from the whole set of firms that satisfy decision maker requirements. From the set of criteria we select decision maker relevant ones assign weights of their importance. Application of PROMETHEE II method then provide ordering of the firm on the base so called net flows. The net flows can be interpreted as the difference between average value of firm preference index owing to the other firms and average preference index of the other firms owing to the firm. As a result we have firms with positive net flow (*good firms*) and firms with negative net flow (*bad firms*)

For each couple of firms x_1 and x_2 we compute the index of multiple criteria preference (the preference of the firm x_1 owing to the firm x_2) $\pi(x_1, x_2)$ according to the relation

$$\pi(x_1, x_2) = \sum_{j=1}^{k} d_j(x_1, x_2) \, w_j,$$

where w_j are the criteria importance weights. Then so called outgoing and ingoing flows are computed for each firm $x_j, j = 1, 2, \ldots, n$, in the form

$$F^+(x_j) = \frac{1}{n-1} \sum_{x_2} \pi(x_j, x_2), \qquad F^-(x_j) = \frac{1}{n-1} \sum_{x_2} \pi(x_2, x_j),$$

and the net flow in the form

$$F(x_j) = F^+(x_j) - F^-(x_j)$$

Ordering of the selected set of the firms gives possibility to choice for decisions firms among so called *good firms* with positive net flows. Such firms can be from the viewpoint of decision maker assumed as best candidates that have the least risk for selected criteria. In the following stage the investor, producer or trader looks for its goals the most advisable partner or investment opportunity, where the advisability can be described trough values of absolute and relative financial indicators.

Table 2: Selected criteria

Criteria	Name	Type	Weight	sigma
C_1	liabilities/assets * 100	min	7,692%	22,351
C_7	long term payables/turnover * 100	min	7,692%	23,500
C_8	EBIDTA/revenues * 100	max	7,692%	4,847
C_9	gross profit/ assets * 100	max	7,692%	12,945
C_12	turnover/assets	max	7,692%	1,754
C_13	PO_EBITDA/revenues * 100	max	7,692%	4,787
C_14	newly-formed value/ revenues * 100	max	7,692%	5,392
C_15	value-added/revenues * 100	max	7,692%	16,021
C_16	profit or loss from ordinary activities/revenues * 100	max	7,692%	4,639
C_17	net profit/equity * 100	max	7,692%	23,500
C_19	gross profit and interest expense/interest expense	max	7,692%	6190,4
C_20	bank credits/ assets * 100	min	7,692%	2,081
C_21	equity/liabilities	max	7,692%	0,709

4   INVESTMENT OPPORTUNITY SELECTION

As an illustration of the decision process for investment opportunity selection assume the intention to buy a share of the firm in the Slovak car industry at about for 5 million EUR. We create the group of the firms from car industries and as a result we have 148 potential firms. Then we select firms with property at least 4 million EUR, turnover at least 8 million EUR and work in Bratislava region. Finally we have 11 firms. We would like to stress that such reduction of the size is only owing to illustration purposes. Developed decision support system can really process problems with high dimensions. Selected criteria are present in the Table 2. PROMETHEE II results are presented in the Table 3 and graphical illustration on the Figure 2. As a benchmark form PROMETHEE II results the difference between equity and liabilities was selected. One can see that this benchmark is positive for firms on the first, third and eight places. It says that final decision will between firms on the first and third places.

Table 3: Results

Sorted results			
ID Firms	Ranking flows (%)	Equity less liabilities (mil EUR)	ranking of companies
44996365	44,61	8,139021	1
35881704	23,04	-1,887987	2
31364217	19,17	12,726491	3
35825251	18,70	-30,230066	4
35799218	4,36	-100,882635	5
36859893	-2,85	-34,458793	6
35785136	-4,66	-4,629802	7
35798513	-9,45	7,431317	8
35779594	-11,08	-2,743019	9
31392482	-35,83	-4,408073	10
35811650	-46,00	-27,450555	11
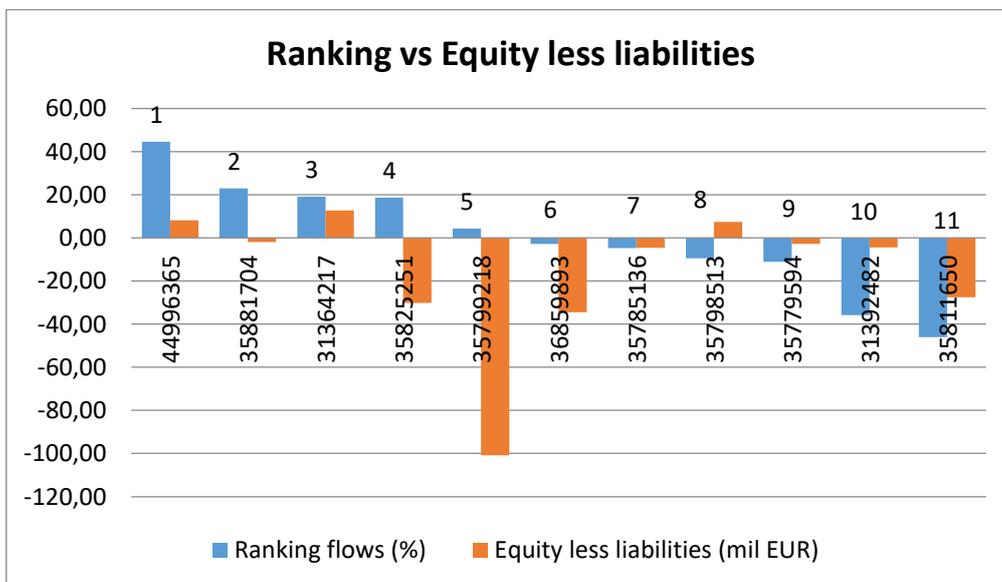
Figure 2: Ranking flows vs Equity less liabilities

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