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Designing a DSS for the Assessment of Company Performance and Viability

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Abstract. In this article, a multicriteria financial evaluation system for the assessment of company performance and viability is proposed. The main advantage of the proposed system is that it combines qualitative and quantitative (financial) evaluation criteria. Company evaluation is performed by calculating a total score for each company based on its performance on every criterion and by ranking the companies from best to worst according to their total score. The system may also sort the companies into groups. The system capabilities are illustrated by a study of a group of 25 companies.

Key words. Financial ratios, multiple criteria decision method, decision support system (DSS).

1. Introduction

The assessment of company performance and company evolution are a daily occupation of its managerial staff who are interested in its viability. The study of the performance and viability of companies is a necessary action, since recently the number of companies facing difficulties or even going bankrupt has become quite large.

In this article, the assessment of performance and viability of companies is carried out with the aid of a multicriteria financial decision support system. The multicriteria nature of the system stems from the fact that the evaluation of a company is based on a number of evaluation criteria such as market trend, market niche/position, quality of management, level of research and development, profitability, solvency, managerial performance, etc. As is obvious from the last three criteria, the system is also financial. Every policy or strategy that a firm follows has financial consequences and influences the return on investment, the return on equity, the working capital, etc.

The simultaneous utilisation of qualitative and quantitative (financial) criteria for the assessment of performance and viability of companies is an important advantage for the proposed evaluation system. It should be noted that all systems

developed so far depend solely on financial criteria (financial ratios). According to Srinivasan and Kim [13], qualitative criteria are difficult to quantify through multivariate statistical models, such as in multiple discriminant analysis.

The solution of such a problem was aided by recent development in the field of computer science and especially microcomputing. The powerful desktop computers now available for every decision-maker in a company make possible the processing of large volumes of financial data which can be used to forecast the future of the company under different scenarios and to systematically study different development possibilities under diverse economic situations.

Two classes of such systems have mainly evolved: decision support systems (DSS) and Expert Systems (ES). The development and use of expert systems has been carried out by many authors [4, 7, 13]. This paper's proposed system is based on the DSS point of view.

In Section 2, the multicriteria financial evaluation system is described. In Section 3, a case study is presented while, in the concluding remarks, we discuss the merits of the proposed system and possible future research directions in the field of company assessment.

2. The Multicriteria Financial Evaluation System

The meaning of the term DSS is not always the same, but it is widely agreed that a DSS implies the role of electronic computers in the process of decision-making. DSSs were first introduced at the beginning of the 1970s and have since then grown rapidly (cf. [1, 6, 12] for a detailed exposition).

A multicriteria financial system which assesses the performance and viability of firms (or clients of a bank) is the BANKADVISER system of Brans and Maréschal [2].

The basic components of the proposed system are presented in Figure 1.

2.1. INFORMATION REQUIREMENTS AND THE DATA BASE

The analysis of a firm requires the basic financial statements, i.e. balance sheet and income statement. In order to perform a reliable and complete study of a firm there must be available consecutive basic financial statements for at least three years for every company. A number of consecutive basic financial statements help the decision-maker to verify the conditions under which the company has grown and to form important trends for certain classes of accounts of the balance sheet, and/or of the income statement.

Apart from the financial data that are contained in the basic financial statements, the decision-maker ought to possess additional information of a more general character so that his evaluation would be as objective and complete as possible. Such information about a company may be its size, industrial sector, structure of shareholder's capital, personnel, market, market share, management

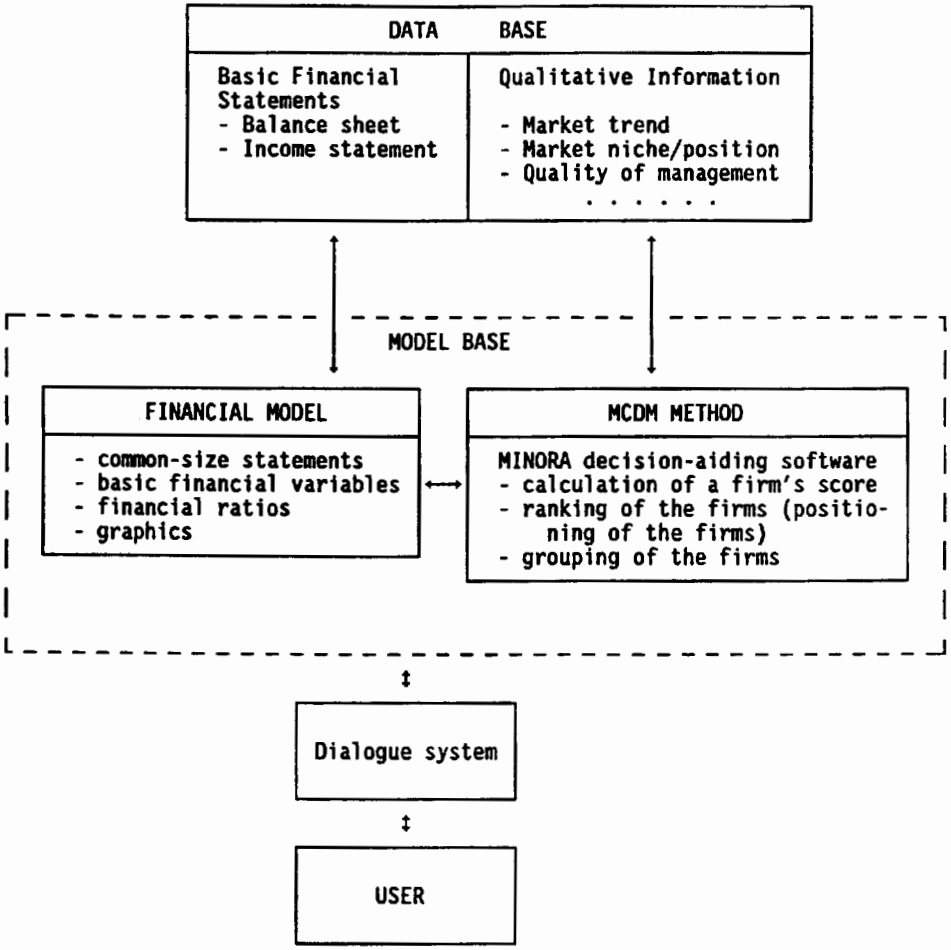


Fig. 1. The multicriteria financial evaluation system.

quality, etc. This qualitative information is sometimes more important than the financial, because if, for example, the company does not have good managers, its financial results (sales, net income) will not be satisfactory. This information will be used as evaluation criteria in the multicriteria decision method.

2.2. THE MODEL BASE

The model base consists of the financial model and the MINORA (*M*ulticriteria *IN*teractive *O*rdinal *R*egression *A*nalysis) decision-aiding software.

The financial model, performs a detailed financial analysis of the companies, based on their financial statements. More specifically it determines

- common-size statements (or common-size ratios),

- basic financial variables which are not contained in the basic financial statements,
- financial ratios.

Finally, the financial model can show, if requested, graphs of the evolution of some of the basic financial variables and ratios.

The common-size statements provide a quick and effective method for developing a system of very useful financial ratios (common-size ratios).

To calculate these ratios we simply divide every entry in the balance sheet by total assets and every entry in the income statement by sales. The usefulness of these ratios with common denominator is obvious, since it shows what is the portion, in percentage, of every subclass of the balance sheet (i.e. fixed assets, current assets, net worth, current liabilities, long-term debt) and of the income statement (cost of goods sold, gross profit, operating expenses, operating income, interest expense, net income) in relation to the total of the balance sheet, which is expressed by total assets and by the basic quantity of the income statement, sales. The determination of the common-size ratios for consecutive years shows the evolution of the basic accounts in relation to the totals. If, for example, the percentage of liabilities in the balance sheet total grows, then financial risk and dependence on its creditors increases as well. Increased liabilities result in more interest and this in turn results in decrease of net income.

Basic financial variables are calculated in order to give a fuller picture of a firm's performance. These variables could be working capital, working capital requirements, valued added, cash flow, etc. For example, if working capital is positive, it follows that financing of fixed assets is possible from stockholder's equity and long-term debt.

Financial ratios have become an accepted evaluative technique of financial analysts. They offer a quantitative view of every element that concerns the internal operation of a firm as well as its relations with the outer world, and permit fast processing of a large volume of financial data.

In the literature, one can find various methodologies for the classification of financial ratios in predetermined classes. Financial ratios have already been used in many fields of financial management. Lee [8] has grouped every financial ratio that has been used in the forecasting of firm failure, bond rating, market return, and mergers.

In the proposed financial model, the classification methodology developed basically by Courtis [3] is adopted. That is, ratios are classified into three basic classes: profitability, managerial performance, and solvency. Profitability ratios are further divided into three subclasses: return on investment, profit margin, and capital turnover. Managerial performance ratios are subdivided into credit policy, inventory, administration, and asset-equity structure. Finally, solvency ratios are subdivided into short-term liquidity, long-term solvency, and cash flow. Every subclass contains a certain number of ratios.

The decision-maker may select from each of the above categories the ones that he requires according to his preferences and the specific problem. For example, a commercial loan officer analyzing a loan application would be interested in determining the ability of the applicant to repay the loan when due. In this case, the financial analyst would be concerned with the profitability ratios and the level of cash flow of the firm. The financial ratios that are selected by the decision-maker for the analysis of the firms will form the input data, as criteria, to the multicriteria software MINORA.

The financial model constructs graphs of various financial variables and ratios. This helps the decision-maker to have a better view of the trend of these quantities.

The financial model with all the tools described earlier offers an approximate evaluation of performance (strong and weak points) of the various companies.

The next step in the evaluation procedure is the global evaluation of the companies, by combining the financial model results (quantitative data) with the qualitative data, in the multicriteria financial evaluation system. This global evaluation is achieved with the aid of the multicriteria decision-aiding software MINORA. The aim of MINORA software is to evaluate each company in two ways: first to calculate a total score from the financial (quantitative) and qualitative data for each company, and second to position the companies from the most promising to the most risky and untrustworthy (cf. [11]). The multicriteria MINORA software can also group the companies in categories, by suitably modifying the decision aim, as was done in [15].

The basic MINORA model is the ordinal regression method UTA (*UT*ilités *A*dditives) which is an algorithm for the ranking of potential alternatives (firms). The problem which UTA solves may be stated as:

Given a policy R of overall reference which has the mathematical structure of a preordering (the decision-maker's judgement policy) and a consistent family $(g_1, g_2, \ldots, g_n)$ of n criteria which are defined on monotone value scales, determine n functions of partial utilities $u(g_1), u(g_2), \ldots, u(g_n)$ and a set of weights $p_1, p_2, \ldots, p_n$ under normalisation constraints, such that the additive utility function,

$$u(\mathbf{g}) = p_1 u_1(g_1) + p_2 u_2(g_2) + \cdots + p_n u_n(g_n)$$

is as consistent as possible with the overall policy R.

In the firm evaluation case, the UTA method is initially accepting as input the ranking of some firms (the decision-maker's judgement policy) and their multicriteria evaluations (modelling of quantitative and qualitative criteria). A decision-maker's judgement policy can be collected or externalized by means of a set of reference alternatives which the decision-maker either has or can order (from best to worst) through simple questionnaires, familiar decision-making situations, past repeated decisions, etc. Then, by means of powerful linear programming techniques, the UTA method optimally estimates the multicriteria additive utility

functions which are as consistent as possible with the decision-maker's ranking (cf. [5, 10] for more details). The mathematical expression of the additive utility function is given by

$$u(\mathbf{g}) = \sum_{i=1}^{n} p_i u_i(g_i)\,, \tag{1}$$

$$u_i(g_{i*}) = 0\,, \quad \text{for } i = 1, 2, \ldots, n\,, \tag{2}$$

$$u_i(g_i^*) = 1\,, \quad \text{for } i = 1, 2, \ldots, n\,, \tag{3}$$

$$\sum_{i=1}^{n} p_i = 1\,, \quad p_i \geq 0\,, \tag{4}$$

where $\mathbf{g} = [g_1, g_2, \ldots, g_n]$ is the vector of performance of an alternative (firm) on n criteria; g_{i*} and g_i^*, respectively being the least and most desirable levels of criterion g_i; p_i the relative weight of utility $u_i(g_i)$ which is associated to criterion g_i, and $u(\mathbf{g})$ the global utility of $\mathbf{g}$.

The global utility $u(\mathbf{g})$, which is calculated by the UTA method represents, for each company, its score based on its performance under each criterion. The ranking of the firms is achieved according to this score, as follows:

Using (1)–(4) and for every pair of alternatives (a_i, a_j):

$$u[\mathbf{g}(a_i)] > u[\mathbf{g}(a_j)] \Leftrightarrow a_i > a_j \quad \text{(preference)}\,, \tag{5}$$

$$u[\mathbf{g}(a_i)] = u[\mathbf{g}(a_j)] \Leftrightarrow a_i \sim a_j \quad \text{(indifference)}\,. \tag{6}$$

Every marginal utility $u_i(g_i)$ is estimated on a finite number of points for each criterion scale

$$g_{i*} \equiv g_i^1, g_i^2, \ldots, g_i^l, \ldots, g_i^{ai} \equiv g_i^*]\,,$$

If the scale is continuous (the case of quantitative criterion), the distances between the g_i^j points are taken equal and $u_i(g_i)$ is estimated in a piecewise linear form, using linear interpolation.

The MINORA software is a computerized trial-and-error process seeking to analyze and improve the consistency between the judgement policy of a decision-maker (financial manager) and the additive utility model. Full consistency is achieved when the maximum utility corresponds to the top of the ranking and falls progressively towards its tail (Figure 2a). The cases of reference alternatives (firms) with high rank and low utility or alternatives with low rank and high utility are, respectively, considered as overestimation and underestimation errors by the decision-maker (Figure 2b). In this case, the decision-maker is invited to make various adjustments.

The MINORA software allows the decision maker to analyze and correct the inconsistencies, through a man-machine dialogue based on the illustrated information of Figure 2. In the course of this dialogue, the decision-maker could either accept to underevaluate or overevaluate reference alternatives according to the

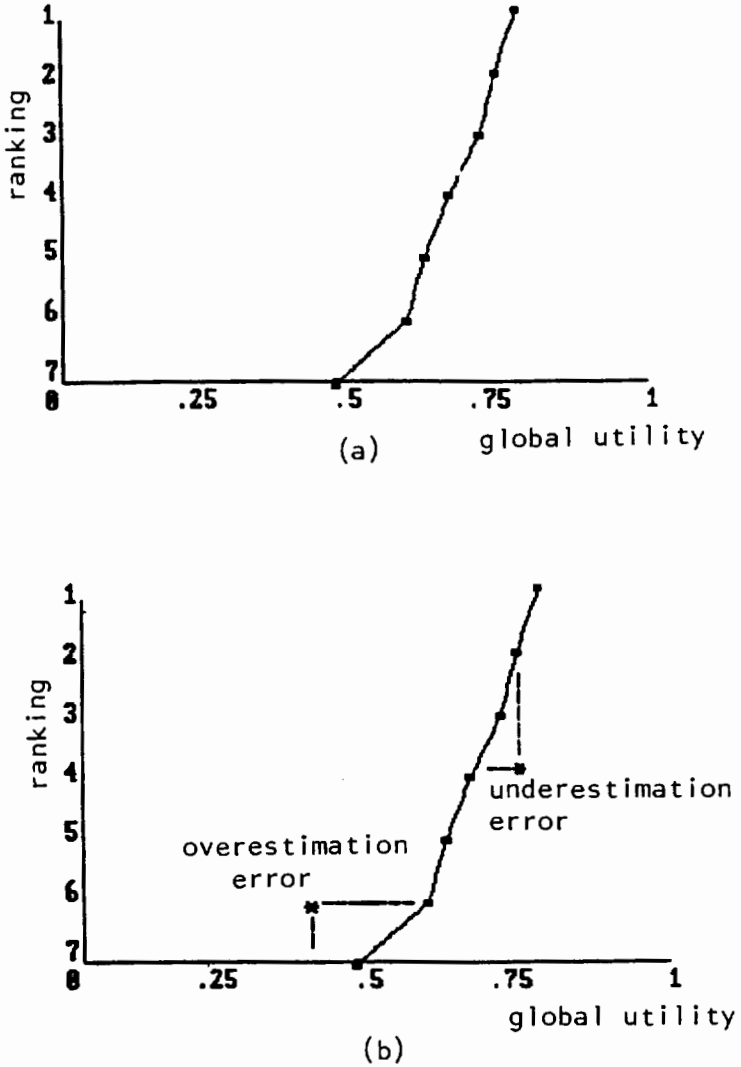


Fig. 2. Ordinal regression curves. (a) Full consistency achieved; (b) inconsistencies present.

MINORA suggestions, whereat he modifies his judgement policy, or, he could even correct the model itself altering either the criteria modelling (modification of the scale of one or more criteria, elimination or addition of criteria, . . .) or the marginal utilities (trade-off analysis). The software, thus, turns to a new use of the UTA method (cf. [9, 11, 14, 16] for a complete description). Following the achievement of full consistency between decision-maker model and the construction of the ranking model, the ranking is extrapolated to the full set of possible alternatives (firms).

The software uses two consistency measures:

(1) the F indicator, which is the sum of the positive and negative horizontal deviations from the regression curve of Figure 2. In the optimal case $F = 0$.
(2) Kendall's τ, measuring from -1 to $+1$ the goodness of fit in terms of distance between the decision-maker's ranking and that resulting from the global utility.

3. An Applied Study of the Proposed System

An ideal system for the evaluation of performance and viability of companies should contain the information and models described in the proposed multicriteria financial evaluation system. The top executives of a financial organization (financial managers, financial analysts) can use such a system to effectively analyze the performance of firms, to evaluate their competitiveness and finally to select the most promising among them. For many credit institutions which have investment portfolios, the proposed evaluation system promises a good management of invested capital.

In the following study an attempt is made to show the feasibility and value of the system. An important aspect of this system will be the actual reaction of the financial personnel to the computer system and the various problems that are associated with this man-machine interaction. This version has slight differences from the proposed theoretical evaluation system, which do not affect the evaluation approach adopted.

In Table I, the basic financial data, needed for a financial analysis of a firm are shown. As seen, the data span a period of 5 years. Also, note that value added, working capital, working capital requirements, and cash flow are in the data base.

The calculated common-size ratios and the financial ratios are shown in Tables II and III. The financial ratios are classified in the three main groups that were described in Section 2, according to the following:

- Profitability ratios: 11 to 15,
- Managerial performance ratios: 16 to 20,
- Solvency ratios: 21 to 25.

Table III also contains the qualitative criteria which complete the set of criteria. The definitions of these criteria and their evaluation scale are described in [16].

In Figures 3 and 4, sales and the total liabilities to total assets ratio evolution are shown graphically for the 5-year period. The financial manager can view the graphed trend of any quantity he desires.

In the rest of this study, a portfolio of 25 companies is considered for investment evaluation, based on nine selected criteria. It is supposed that the financial manager of a credit institution can rank up to 15 firms according to its experience and previous financing decisions (cf. Table IV).

The financial manager's preordering (judgement policy) can be explained as follows:

Table I. Financial data for firm F16 (2 screens)

F16 Financial Data	1984	1985	1986	1987	1988
1. Sales	83130	102827	123125	123548	159572
2. Cost of products sold	42564	50324	58674	58670	72389
3. Net income	5641	5026	6272	1410	17889
4. Earnings before interest and . . .	12649	13535	17287	10273	40082
5. Added value	33083	39889	49008	47795	82899
6. Number of employees	296	349	386	371	298
7. Stock purchases	35270	45819	51046	50690	52300
8. Salary expenses	18923	24567	29758	35667	39392
9. Interest expenses	1966	3272	3816	5270	2761
10. Selling expenses	2523	2501	2765	1232	3456
11. R & D expenses	0	0	0	0	0
12. General and administrative ex . . .	0	0	0	0	0
13. Cash	3619	4133	10396	9738	30357
14. Marketable securities	17776	22545	23046	21514	19086
15. Accounts receivable	26179	32447	37770	36880	45026
16. Inventories	8707	14665	19593	16586	18397
17. Total current assets	48796	62432	78716	69495	100324
18. Total assets	66572	84977	101762	91009	119410
19. Accounts payable	12686	19287	24552	15420	18745
20. Total current liabilities	36924	47588	58350	46404	55383
21. Total liabilities	48916	61849	72104	59455	70153
22. Long term liabilities	11992	14261	13754	13049	14770
23. Total long term liabilities a . . .	29648	37389	43412	44603	64027
24. Capital stock	3000	3000	3000	3000	3000
25. Retained earnings	7855	13496	18522	24294	24704
26. Stockholder equity	12015	18102	23386	30144	31368
27. Total liability and stockhold . . .	66572	84977	101762	91009	119410
28. Working capital	11872	14844	20366	23089	44941
29. Working capital requirements	17008	23812	25045	28919	14643
30. Cash flow	6730	7843	9272	5506	21760

- Equivalent classes 1 and 2: dynamic firms which are European or world leaders in their fields, having high development rates, high profitability and good financial structure.
- Equivalent classes 3 and 4: medium quality companies which the financial manager judges as capable of improving their position, thus joining the better classes; in the adverse case they would be relegated.
- Equivalent classes 5 and 6: risky companies characterized by a medium level of management, operating in a recessing market sector, having high salary expenses, low profitability (sometimes negative), etc.
- Equivalent class 7: unsuccessful firms characterized by nonsatisfactory performance on every criterion (bad management, bad financial structure, high salary expenses, etc.)

Note that these criteria are a subset of those shown in Table III.

The financial manager may use the MINORA software consecutively for the

Table II. Common-size ratios for firm F16 (2 screens)

F16 Financial Data	1984	1985	1986	1987	1988
1. Sales	1.00000	1.00000	1.00000	1.00000	1.00000
2. Cost of products sold	0.512017	0.489405	0.476540	0.474876	0.453645
3. Net income	0.067858	0.048878	0.050940	0.011413	0.112106
4. Earnings before interest and . . .	0.152159	0.131629	0.140402	0.083150	0.251184
5. Added value	0.397967	0.387923	0.398035	0.386854	0.519508
6. Number of employees	0	0	0	0	0
7. Stock purchases	0.424275	0.445593	0.414587	0.410286	0.327752
8. Salary expenses	0.227631	0.238916	0.241689	0.288689	0.246860
9. Interest expenses	0.023650	0.031820	0.030993	0.042655	0.017303
10. Selling expenses	0.030350	0.024322	0.022457	0.009972	0.021658
11. R & D expenses	0	0	0	0	0
12. General and administrative ex . . .	0	0	0	0	0
13. Cash	0.054362	0.048637	0.102160	0.107000	0.254225
14. Marketable securities	0.267019	0.265307	0.226470	0.236394	0.159836
15. Accounts receivable	0.393243	0.381833	0.371160	0.405235	0.377071
16. Inventories	0.130791	0.172576	0.192537	0.182246	0.154066
17. Total current assets	0.732981	0.734693	0.773530	0.763606	0.840164
18. Total assets	1.00000	1.00000	1.00000	1.00000	1.00000
19. Accounts payable	0.190561	0.226967	0.241269	0.169434	0.156980
20. Total current liabilities	0.554648	0.560010	0.573397	0.509884	0.463805
21. Total liabilities	0.734783	0.727832	0.708555	0.653287	0.587497
22. Long term liabilities	0.180136	0.167882	0.135159	0.143381	0.123691
23. Total long term liabilities a . . .	0.445352	0.439990	0.426603	0.490094	0.536195
24. Capital stock	0.045064	0.035304	0.029481	0.032964	0.025124
25. Retained earnings	0.117993	0.158819	0.182013	0.266941	0.206884
26. Stockholder equity	0.180481	0.213022	0.229811	0.331220	0.262692
27. Total liability and stockhold . . .	1.00000	1.00000	1.00000	1.00000	1.00000
28. Working capital	0	0	0	0	0
29. Working capital requirements	0	0	0	0	0
30. Cash flow	0.080958	0.076274	0.075306	0.044566	0.136365

data of each year of Table III. In this way he will construct a ranking model of firms for each year. He may, however, construct his ranking model by considering the latest year's data (which for this study is 1988). This is a clear indication of the flexibility that a multicriteria evaluation system offers to the study of firm evaluation.

The first three criteria (g_1, g_2, g_3) are qualitative while the rest are financial ratios. Also, the first six criteria (g_1–g_6) have positive rate, that is the greater their value the greater the satisfaction to the financial manager, while criteria g_7, g_8, g_9 have negative rate, that is the lower their value the higher the satisfaction to the financial manager. For example, the higher the value of net income to net worth, the more profitable the company is, resulting in higher dividend for the credit organization.

These data, when fed in the MINORA software, produce the results shown in Figure 5 and Table V.

Table III. Evaluation criteria for firm F16 (2 screens).

F16 Evaluation Criteria	1984	1985	1986	1987	1988
1. Quality of management	2.000	3.000	3.000	4.000	4.000
2. R & D effort	1.000	1.000	2.000	2.000	2.000
3. Market trend	3.000	3.000	2.000	3.000	3.000
4. Market niche/position	4.000	3.000	4.000	4.000	4.000
5. World market share	3.000	3.000	4.000	4.000	5.000
6. Extent of diversification	4.000	3.000	4.000	4.000	4.000
7. Sensitivity to economic condit . . .	2.000	2.000	2.000	2.000	3.000
8. Information security	3.000	3.000	3.000	3.000	3.000
9. Accessibility of financial mar . . .	2.000	1.000	3.000	2.000	3.000
10. Technique capacity	4.000	3.000	4.000	4.000	4.000
11. Gross profit to sales	48.798	51.059	52.346	52.512	54.635
12. Net income to sales	6.785	4.887	5.094	1.141	11.210
13. EBIT to total asset	19.000	15.927	16.987	11.287	33.566
14. Net income to net worth	71.814	37.240	33.862	5.803	72.413
15. Activity ratio	0	23.694	19.740	0.343	29.157
16. Added value to no. of employees	111.767	114.295	126.964	128.827	278.185
17. Interest expenses to sales	2.364	3.182	3.099	4.265	1.730
18. Accounts receivable to daily	114.944	115.176	111.968	108.955	102.991
19. Accounts payable to purchases	131.284	153.643	175.557	111.034	130.821
20. Salaries to value added	0.571	0.615	0.607	0.746	0.475
21. Total liabilities to total as . . .	73.478	72.783	70.855	65.328	58.749
22. Long term liabilities to tota . . .	40.447	38.142	31.682	29.255	23.068
23. Total current assets to total . . .	1.321	1.311	1.349	1.497	1.811
24. Working capital to working ca . . .	69.802	62.338	81.317	79.840	306.911
25. Total liabilities to cash flow	7.268	7.885	7.776	10.798	3.223

The following model of additive utility,

$$u(\mathbf{g}) = 0.114u_1(g_1) + 0.101u_2(g_2) + 0.075u_3(g_3) + \\ + 0.127u_4(g_4) + 0.149u_5(g_5) + 0.135u_6(g_6) + \\ + 0.129u_7(g_7) + 0.128u_8(g_8) + 0.041u_9(g_9),$$

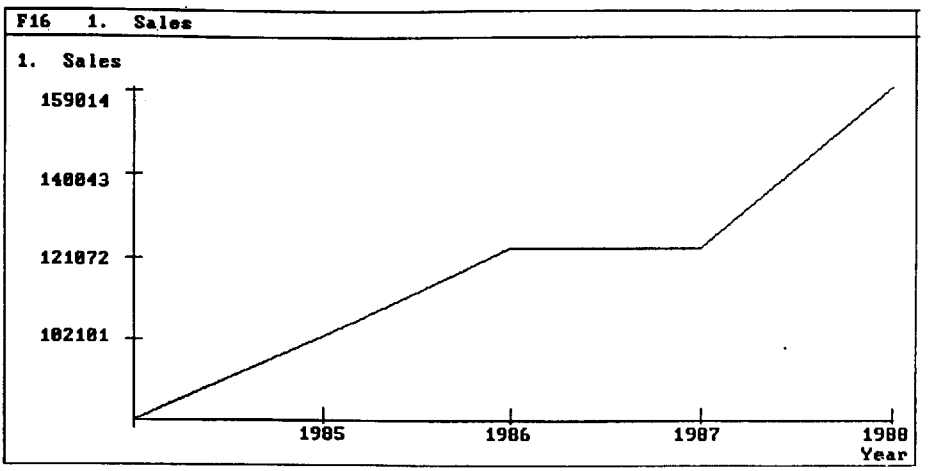


Fig. 3. Sales evolution of F16.

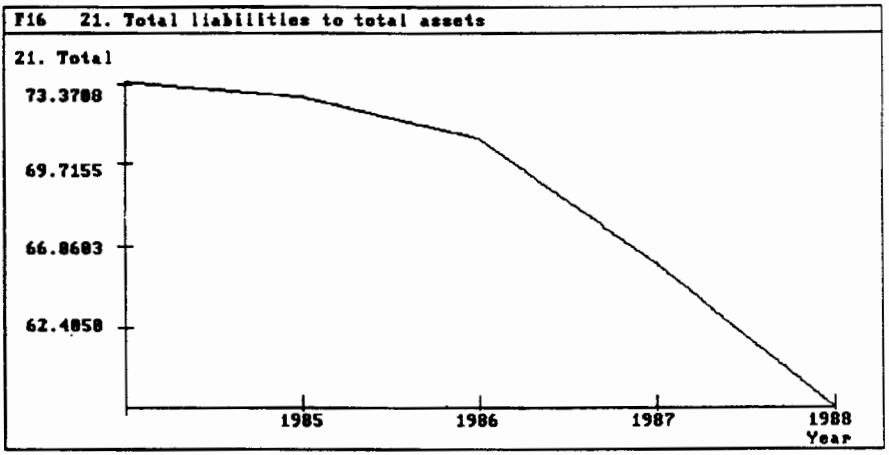


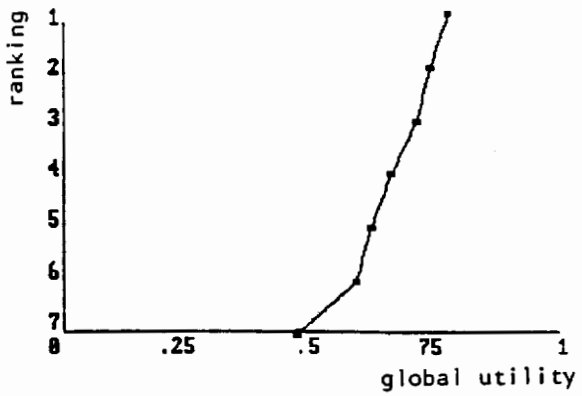
Fig. 4. Total liabilities to total assets (ratio) evolution for F16.

is the most appropriate, since it orders correctly all the companies. As seen from Figure 5, the two consistency measures have optimum values (i.e. $F = 0$ and $T = 1$), indicating complete agreement between the financial manager and the model. In the same figure are also shown: the preordering of the financial manager (PO), the company names (ACT), the global utility representing the

Table IV. Firms, financial manager's judgment and multicriteria evaluation

Firm	Rank	g_1	g_9	g_2	g_8	g_3	g_7	g_6	g_5	g_4
F16	1	4.0	3.2	2.0	59.0	5.0	47.5	29.2	57.0	33.6
F2	1	4.0	4.5	3.0	67.3	5.0	43.8	44.7	51.6	31.4
F3	2	3.0	5.2	2.0	54.5	5.0	53.9	11.9	18.6	25.4
F4	2	3.0	5.1	3.0	63.7	2.0	58.6	13.4	27.9	23.5
F5	2	3.0	8.1	3.0	64.3	3.0	75.8	33.3	9.6	10.2
F6	3	3.0	10.4	3.0	64.7	2.0	70.6	12.3	14.2	16.2
F7	3	2.0	6.5	3.0	72.8	2.0	74.0	9.1	13.1	18.5
F8	4	2.0	3.7	2.0	59.2	1.0	57.3	10.0	13.6	26.9
F9	4	2.0	20.9	2.0	81.1	1.0	66.4	53.2	10.8	21.5
F10	5	2.0	8.4	1.0	59.9	2.0	71.6	4.7	14.3	16.0
F11	5	2.0	17.7	2.0	61.1	1.0	85.2	13.9	9.5	5.3
F12	6	2.0	9.5	1.0	39.9	3.0	81.5	−20.1	−7.1	3.7
F13	6	2.0	42.6	1.0	93.0	3.0	79.1	17.4	−7.4	9.5
F14	7	1.0	17.8	1.0	80.3	2.0	75.4	2.4	2.9	11.5
F15	7	1.0	2809.4	2.0	99.7	2.0	87.2	7.9	−18.4	6.4

g_1: quality of management (criterion No. 1)
g_2: market trend (criterion No. 3)
g_3: world market share (criterion No. 5)
g_4: EBIT to total assets (criterion No. 13)
g_5: net income to net worth (criterion No. 14)
g_6: activity ratio (criterion No. 15)
g_7: salaries to value added (criterion No. 20)
g_8: total liabilities to total assets (criterion No. 21)
g_9: total liabilities to cash flow (criterion No. 25)



PO	ACT	UTIL	NO	SIG+	SIG-
1	F16	.781	1	.000	.000
1	F2	.781	1	.000	.000
2	F3	.746	2	.000	.000
2	F4	.746	2	.000	.000
2	F5	.746	2	.000	.000
3	F6	.718	3	.000	.000
3	F7	.718	3	.000	.000
4	F8	.665	4	.000	.000
4	F9	.665	4	.000	.000
5	F10	.623	5	.000	.000
5	F11	.623	5	.000	.000
6	F12	.594	6	.000	.000
6	F13	.594	6	.000	.000
7	F14	.474	7	.000	.000
7	F15	.474	7	.000	.000

TAU=1.000 I(*)=0.000

Fig. 5. Firms' ranking vs. global utility.

score for every company (UTIL), the new ordering which is the result of the global utility (NO) and the overestimation and underestimation errors (SIG+ and SIG− respectively). The score values (global utility) vary from 0.781 which corresponds to the two best companies F2, F16, down to 0.474 for the worst companies F14, F15. The usefulness of the additive utility model is not limited to the calculation of the score and the ordering of the companies which were used for its assessment (15 companies), but it is extended to the ordering of every company of the portfolio of the credit institution. Table V shows the results of the

Table V. Global utility for every firm under consideration (extrapolation phase)

No.	Company	Utility	No.	Company	Utility
1	F1	0.808	12	F11	0.623
2	F16	0.781	12	F10	0.623
2	F2	0.781	13	F12	0.594
3	F3	0.746	13	F13	0.594
3	F5	0.746	14	F15	0.474
3	F4	0.746	14	F14	0.474
4	F23	0.741	15	F25	0.468
5	F17	0.739	16	F19	0.242
6	F21	0.726			
6	F22	0.725			
7	F7	0.718			
7	F6	0.718			
8	F18	0.702			
9	F9	0.665			
9	F8	0.665			
10	F24	0.638			
11	F20	0.627			

extrapolation phase, in which the remaining 10 firms of the portfolio are also ranked. As can be seen, the best company is now F1 scoring 0.808 while the worst company is F19 with score 0.242.

One of the interesting points of the multicriteria financial evaluation system is that it can serve as an early warning system, if for example a company finds itself at the bottom of the ranking for two consecutive years.

However, as already pointed out, the multicriteria financial evaluation system, permits the decision-maker to interact either with the data base or the model base in order to effect certain modifications which may lead, hopefully, to solutions which are better suited to his preferences. Such interactions between decision-maker and system are reported in detail in [11, 15].

4. Concluding remarks

In this paper, a multicriteria financial evaluation system was developed. The proposed system is a new supportive tool for financial organizations in the evaluation of a portfolio of companies and in the financing decision-making.

Specifically, the system includes initial data which identify the companies. These data are financial (balance sheets, income statements) and qualitative. Next, the system calculates the performance ratios (profitability, managerial performance, solvency) for each company based on the financial data, and appends these to the qualitative ones. These ratios serve as criteria for the classification of companies, a process carried out by the MINORA multicriteria decision-aiding software. The classification (ordering) of the companies shows clearly their competitiveness level, their viability and indicates which of them are in a financially alarming state. The ability of the system to group the classified companies, is of great assistance to the financial organizations when an immediate decision on financing is needed (cf. [15]). Finally, the system gives important information on the criteria that the financial organization is using for evaluating prospective investments and on their relative significance in the decision-making (shown by the weights of partial utilities of every criterion).

Apart from the supporting role in the evaluation process, the proposed system innovates in some other areas as well:

- The complex problem of assessing company performance and viability is structured.
- The time and cost for the study of the companies' dossiers are minimized, since this is now computerized.
- The competitiveness and effectiveness of the financial institutions are increased, through the learning of scientific methods and models by their personnel.
- Since more reliable data is needed for computerized systems, this is sought after more keenly.

- The financial art is upgraded by the use of even more sophisticated methods (multicriteria decision-making methods, etc.).
- The computerized system offers transparency in the selection of the companies to be financed, since every decision can be argued on firm scientific grounds.

Future improvements of the present system will refer to the data base and the model base. The data base may be improved by the addition of more quantitative (financial) and qualitative criteria. The model base may be expanded by the inclusion of new financial techniques such as the statement of source and application of funds, the DuPont model and new multicriteria methods.

The field of applications of the system is very broad. It can be used for the appreciation of industrial clients of banks, of industrial clients of insurance companies, of firms of venture capital firms or of firms of particular industrial sectors (motor car industry, agriculture, chemistry, electrical equipment, and appliance industries, hardware industries, distribution, etc.).

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References

1. Alter, S. L. (1982), *Decision Support Systems: Current Practice and Continuing Challenges*, Addison-Wesley, Reading, Mass.
2. Brans, J. P. and Maréschal, B. (1989), The PROMETHEE methods for MCDM, the PROMCALC, GAIA and BANKADVISER software, 224, Vrije Universiteit, Brussels.
3. Courtis, J. K. (1978), Modelling a financial ratios categoric framework, *J. Business Finance and Accounting* **5**, 371–386.
4. Duchessi, P. and Belardo, S. (1978), Lending analysis support system (LASS): An application of a knowledge-based system to support commercial loan analysis, *IEEE Trans. Systems Man Cybernet.* **SMC-17**, 608–616.
5. Jacquet-Lagrèze, E. and Siskos, J. (1982), Assessing a set of additive utility functions for multicriteria decision making: The UTA method, *European J. Oper. Res.* **10**, 151–164.
6. Keen, P. G. W. and Scott Morton, M. S. (1978), *Decision Support Systems: An Organizational Perspective*, Addison-Wesley, Reading, Mass.
7. Klein, M. and Methlie, L. B. (1990), *Expert Systems: A Decision Support Approach with Applications in Management and Finance*, Addison-Wesley, Reading, Mass.
8. Lee, C. F. (1985), *Financial Analysis and Planning: Theory and Applications*, Addison-Wesley, Reading, Mass.
9. Siskos, J. (1986), Evaluating a system of furniture retail outlets using an interactive ordinal regression method, *European J. Oper. Res.* **23**, 179–193.
10. Siskos, J. and Yannacopoulos, D. (1985), UTASTAR: An ordinal regression method for building additive value functions, *Investigación Oper.* **5**, 39–53.
11. Siskos, J. and Zopounidis, C. (1987), The evaluation criteria of the venture capital investment activity: An interactive assessment, *European J. Oper. Res.* **31**, 304–313.

12. Sprague, R. H., Jr. and Carlson, E. D. (1982), Building effective decision support systems, Prentice-Hall, Englewood Cliffs, New Jersey.
13. Srinivasan, V. and Kim, Y. H. (1988), Designing expert financial systems: A case study of corporate credit management, *Financial Management*, 32–44.
14. Yannacopoulos, D. (1985), Mise en place et expérimentation d'un système interactif d'aide à la décision multicritère: Le système MINORA, Thèse 3e cycle, Université de Paris-Dauphine.
15. Zopounidis, C. (1987), A multicriteria decision-making methodology for the evaluation of the risk of failure and an application, *Found. Control Engrg.* **12**, 45–67.
16. Zopounidis, C. (1990), *La gestion du capital risque*, Editions Economica, Paris.