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Evaluation of Criteria for the Classification of Enterprises

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Successful development and growth of enterprises is of great importance for the economic growth of the country, social stability and creation of new work places. However, the enterprise's activity is directly or indirectly influenced by internal and external factors. An effective strategy of companies might be one of the most important factors. Loss-making enterprises can improve their results following the strategy of profitable enterprises, however the question is, which enterprises could be attached to the domain of profitable ones and what classification criteria should be applied.

The analysis of special literature has shown that it is not enough to analyze separate activities of enterprises, but the whole system of variables should be analyzed. Cluster analysis is a statistical method, which allows classifying the selected objects into the classes according to their similarity within the class and significant difference between the classes. This classification is based on the analysis of all parameters of the system, so it could be effectively used for the grouping of enterprises into the classes.

The main purpose of this investigation was to determine the classification criteria for enterprises according to their Net Profit. Profit (loss) and balance sheet data of 50 profitable and 50 loss-making enterprises during the year 2002-2006 were taken for the investigation from the Lithuanian Department of Statistics.

After the first term analysis the financial data which were not characteristic for the majority of the analyzed enterprises were excluded from the investigation as well as the data with outliers. 30 parameters corresponding to the different profit (loss) and balance sheet lines were selected for the further analysis.

Collinearity diagnostics of data applying three different methods was performed in the second step. Not correlated parameters were included into regression model. Three profit describing regression equations were composed, variables of which were used for the classification of the enterprises.

Hierarchical clusterization methods were used for the classification of enterprises into profitable, loss-making and mixed (all others). Performing cluster analysis the selection of the linkage distance and the classification method was performed first of all. The best linkage distance and the best classification method is that one, according to which most of the profitable and loss-making enterprises match their classes. The investigation has shown that the Ward's method and Euclidian distance were most suitable for the classification. Due to this reason, the enterprises were classified using different variables, which were included into the regression equations. Only independent variables of the regression analysis equation were used in the first case; the independent variables and net profit (dependent variable) were used in the second case and weighted variables of the regression analysis equation were used in the last case.

The best result was achieved using independent variables selected by correlation analysis and included into regression analysis equation composed for the evaluation of net profit. In this case 17 profitable and 21 loss-making enterprises matched the classification criteria.

Mahalanobis-Taguchi system was used for the evaluation of the differences between profitable and loss-making enterprises.

Present paper discusses the necessity to establish standard set of profitable enterprises and provides a validation of this standard. Performed investigation has shown that the classification of enterprises according to selected variables credibly evaluates performance of the enterprises and makes it possible to classify them into the classes of profitable and loss-making companies.

Keywords: *performance criteria, classification of enterprises, cluster analysis, Mahalanobis distance.*

Introduction

Most of the companies are concentrating their competences to be profitable and to persist under present economic situation. Many authors agree that the development of small and medium size enterprises is of particular interest, because it is one of the most important economics growth factors having the basic impact on the general development of the country's economy, social stability and creation of new work places. It is therefore one of the most important country's economic politics' trends (Tamosiunas, Lukosius, 2009).

The expectations and financial results of organizations can be influenced by many external and internal factors. The external factors can be defined as the situation in global economy, competition, changes of science, business, technologies, politics and society (Strumickas, Valanciene, 2009). Three core elements: strategy, structure, and culture are aligned, which respond to external forces in successful organizations. The relationships among the core elements are dynamic and adaptive, both in relation to each other and in relation to the overall fit between the organization and its environment (Susniene, Sargunas, 2009).

The importance of these elements is widely discussed in a number of publications. Jarvis, Tint (2009) offer possible tools for the development and dissemination of safety culture in the company; Chen (2009) emphasizes the importance of working environment for the production of goods as a part of company's culture, which might be one of the factors defining successful work of the enterprise. Some researches (Buoziute Rafanaviciene, Pundziene, 2009) agree that even executive success becomes a critical event in business organizations when the structure of organization is discussed. However, company's strategy is the core element which is mostly disused in different publications. Strategic planning and decision making requires accounting of the impacts from cultural, social, moral, legislative, demographic, economic, environmental, governmental and technological changes, as well as changes in the business world on international, national, regional and local markets (Turskis, Zavadskas, 2009).

Management is the dynamic input that makes a big influence on organization's performance (Alinaitwe, Mwakali, 2009). Reasonable strategy is one of the most important enterprise's success factors. One of the possible solutions for loss-making companies to improve their business might be following up and implementation of the strategy from successful companies, trying to perform necessary changes. But the **problem** is, which companies are really successful and how to rate their success.

Markovic (2008) marked that successful companies are wise enough to harness the full potential of the entire organization in the rapidly changing business environment. However researchers are faced with continuously growing amounts of companies' performance criteria and methods are becoming more and more complicated. The main problem is that it is hardly possible to determine which of the available solutions or procedures is most effective, when considered from various perspectives (Sarka, Zavadskas, Ustinovicius, Sarkiene, Ignatavicius, 2008).

Ponikvar, Tainikar (2009) investigated the impact of firms' growth rate on various financial and non-financial performance ratios, such as profitability, liquidity, current assets, and solvency, as well as the break-even point, revenue per employee, average costs, capital costs, capacity utilization, productivity and efficiency.

Ginevicius, Podvezko (2008) grouped criteria describing the commercial-economic activities of enterprises to three major groups, including 1) solvency and financial risk; 2) turnover; 3) profitability. The third group of criteria is related to the performance of the enterprise. Shevchenko, Ustinovichius, Andruskevicius (2008) and Ginevicius, Podvezko (2009), suggested that multi-criteria methods for assessment of the objects must be evaluated. Jakimavicius, Burinskiene (2009) used multi-criteria-based analysis for ranking the transportation zones.

Siskina, Juodis (2009) recommended to classify companies into homogenous groups in order to evaluate the competitive advantages and disadvantages of a specific company by using statistical analysis. Cluster analysis is a statistical method that uses the whole system of variables and classifies objects into several classes so that the objects inside the class are similar and objects between different classes significantly differ from each other. Stirtautiene, Stirtautas (2009) used cluster analysis for a consumer market segmentation, Gudonavicius, Bartoseviciene (2009) evaluated imperatives for enterprise strategists by using cluster analysis as well.

Statistical analysis is widely used for the classification of different objects. It fits well for the classification of enterprises. Due to this reason the **main purpose** of this investigation is to evaluate criteria for classification of enterprises according to their Net Profit.

To achieve this purpose the following tasks must be performed:

- to compose Net Profit regression equations;
- to select cluster analysis method, distance measure and classification variables;
- to classify companies into different clusters according to selected criteria;
- to calculate Mahalanobis distances for profitable and loss-making companies.

The hollowing research methods were used in this investigation: analysis of scientific publications, regression and cluster analysis, as well as Mahalanobis-Taguchi system.

Primary data analysis

The investigation is based on statistical evaluation of the criteria for classification of enterprises according to their Net Profit. It covers the period of 2002 – 2006 and uses data of 50 profitable working and 50 loss–making companies from this period. One set of mixed enterprises has been created using data from annual reports (Profit and Loss and Balance sheets) of Lithuanian companies from Lithuanian Statistical Department and used for the evaluation of enterprises' classification criteria.

In the first stage preliminary selection of variables was made. In this stage the information from annual reports that was not characteristic to most enterprises was excluded. After this the indication of outliers was made and 4 enterprises (2 profitable working and 2 loss-making) indicating outliers in their data were eliminated from the further investigation.

30 variables of 96 companies were chosen for statistical data analysis. In practice, various variables taken from annual reports may have considerable different values. Due to this reason all variables were standardized.

Evaluation of the regression model

Further investigation was based on the evaluation of Net Profit (loss) regression model. In this stage collinearity diagnostics was performed in two ways:

- calculating Variance Inflation Factor (VIF);
- using Correlation analysis.

Tolerance and the Variance Inflation Factor of all 30 variables were calculated by using SPSS statistical software. The variable Total Liabilities and Stockholders' Equity had the highest VIF value (1397.68) and the lowest Tolerance value (0.01). This variable was eliminated from further investigation. In the same way Tolerance and VIF values were recalculated and the variables with highest VIF and lowest Tolerance values were excluded from the regression model. By following this rule Total Assets, Total current liabilities, Tangible assets, Profit before Tax, Revenue, Cost of sales, Account payable, Operating Costs and Gross profit were excluded from the model either.

The Net Profit regression model was evaluated including variables selected in two cases:

- VIF<10
- VIF<4

The significance level of 0.05 was selected and hypothesis H_0: "regression is not linear" tested. If p-value of the model is equal or higher than significance level, then the hypothesis is accepted, otherwise it is rejected (Ubius, Alas, 2009). The hypothesis was rejected and regression was considered to be linear in both cases.

In the next step the significance of each variable's coefficient was tested. The hypothesis H_0: "The coefficient is not significant in the model" vas made and it was tested on each variable of the model. For this reason Students statistics (t) and p- values were calculated. If p-value is less than significance level of 0.05, then hypothesis is rejected and the coefficient of the value is considered to be statistically significant in the model. In the first case, variables Trade debtors (X7), Profit (loss) brought forward (X13), Income taxes' liabilities (X18) and Profit (loss) from operations (X27) had statistical significant coefficients and the equation of linear regression was:

$$Y = -0.24 \cdot X7 + 0.43 \cdot X13 + 0.25 \cdot X18 + 0.56 \cdot X27$$

In the second case, the coefficients of variables Stocks, prepayments and contracts in progress (X3), Prepayments (X5), Amounts receivable within one year (X6), Reserves (X12), Income taxes' liabilities (X18) and Profit (loss) from operations X27 were statistically significant and the regression equation was written:

$$Y = -0.23 \cdot X3 + 0.22 \cdot X5 - 0.14 \cdot X6 + 0.15 \cdot X12 + 0.27 \cdot X18 + 0.83 \cdot X27$$

As it was discussed before, the other way to test collinearity between independent variables in the regression model is to perform correlation analysis.

For this purpose a correlation matrix for all 30 variables was calculated. Variables that have no statistical significant correlation with Net Profit (Y) were eliminated at first. The correlation considered to be significant, if p – value was les than significance level 0.01 (Lakstutiene, 2008). After that, other variables having correlation coefficients' values not greater than 0.7 to each other were left for the further investigation.

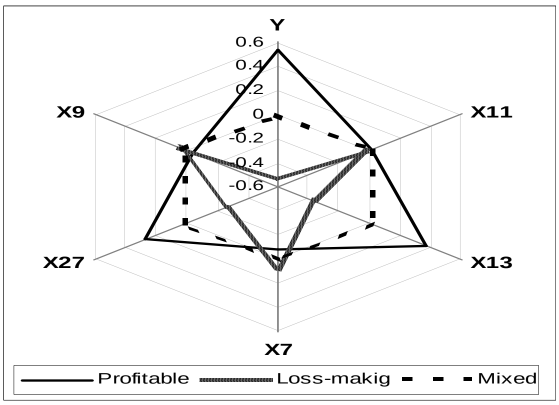

Figure 1. Centroids of weighted variables

The regression model using selected variables: Trade debtors (X7), Cash and cash equivalent (X9), Capital (X11), Profit (loss) brought forward (X13) and Profit (loss) from operations (X27) was created and the regression equation was evaluated:

$$Y = -0.25 \cdot X7 - 0.11 \cdot X9 + 0.15 \cdot X11 + 0.61 \cdot X13 + 0.57 \cdot X27$$

The centroids of weighted variables selected by using correlation analysis for profitable and loss-making companies are presented in Figure 1.

Classification of enterprises

Hierarchical cluster analysis with SPSS software was performed in order to classify all 98 enterprises into 3 main classes: profitable, loss-making and other (mixed). Hierarchical cluster analysis is a statistical method for finding relatively homogeneous clusters of cases based on measured characteristics. It starts with each case in a separate cluster and then combines the clusters sequentially, reducing the number of clusters at each step until only one cluster is left (Li, Zhang, 2008).

First of all, when each object represents its own cluster, the distances between those objects can be defined by a chosen distance measure. However, the main question is how to determine the distances between new clusters. For this reason a linkage or amalgamation rule must be chosen to determine when two clusters are sufficiently similar to be linked together.

In this investigation the Euclidean distance was chosen and 7 linkage rules were tested in order to determine, which rule gives the best classification result, e.g. causes the highest class matching probability for each tested company (profitable and loss-making). The number of profitable and loss-making companies was calculated using each rule separately ant the average matching probability was found.

Graphical interpretation of testing results is shown in Figure 2.

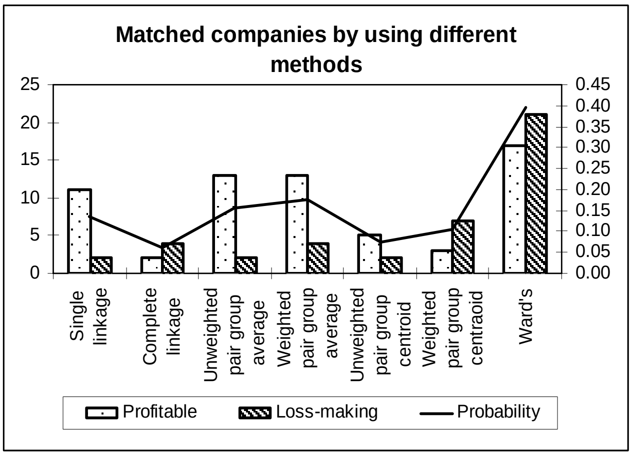

Figure 2. Matched companies by using different linkage rules

This classification showed that the best result was obtained by using Ward's method. 17 profitable and 21 loss-making enterprises matched their classes by using this method. Ward's method is designed to optimize the minimum variance within clusters. The algorithm begins with one large cluster encompassing all objects to be clustered. In this case, the error sum of squares is 0. The program searches objects that can be grouped together while minimizing the increase in error sum of squares. Ward's method creates many clusters of near equal size and is described by formula:

$$d(U,V) = \left\| \overline{U} - \overline{V} \right\|^2 / (1/n_u + 1/n_v), \qquad (1)$$

where d (U,V) is the distance between U and V clusters;

$\overline{U}, \overline{V}$ – centroids of U and V clusters;

n_u, n_v – number of objects in clusters U and V.

The next step was to determine which distance measure causes the best classification result by using Ward's method. For this purpose all enterprises were classified by using 5 different distance measures. Classification results are presented in Figure 3.

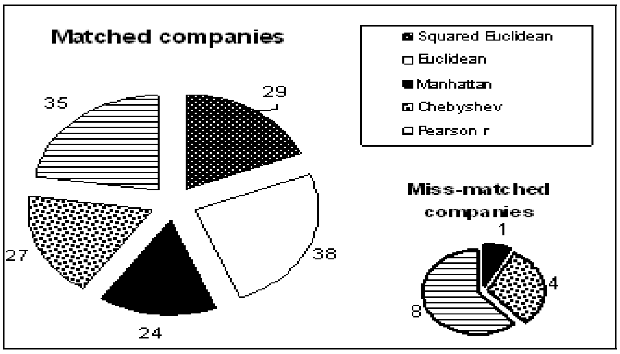

Figure 3. Matched companies when different distances are used

In general, the highest number (38) of enterprises matched their classes and no one enterprise mismatched its class by using Euclidean distance. Pearson's r distance measure caused the result of 35 matched companies, but using this measure the highest number (8) of wrongly recognized enterprises (profitable companies were classified as loss-making and otherwise) was obtained.

The Euclidean distance is a geometric distance in the multidimensional space. The main advantage of this estimation method is that the distance between any two objects is not affected when new objects, which may be outliers, are added to the analysis (Mimmack, Mason, Galpin, 2001).

Euclidean distance between clusters X and Y is calculated as:

$$d(X,Y) = \sqrt{\sum_{i=1}^{k} (x_i - y_i)^2}, \qquad (2)$$

where k is the number of variables.

The third step chosen for the clustering of enterprises was to investigate which variables suit best for this classification.

Sets of variables selected in regression analysis were combined and 9 different cases were analysed as it is presented in the Table 1.

Three cases for composed sets of unweighted variables which were selected using VIF (VIF<4 and VIF<10) and correlation analysis and other three cases – for the same set of variables including additional variable of regression equation - Net profit, were investigated as well as the last three cases for the composed sets of weighted variables selected by using coefficients of the regression analysis.

Table 1

Classification results

Cases					Variables	Number of Matched companies			Number of Miss-Matched companies
						Profitable (1)	Loss-making (2)	Sum (1)+(2)	
Unweighted	VIF analysis	VIF<4	1	independent	X3, X5, X6, X12, X18, X27	13	13	26	10
			2	Y included	X3, X5, X6, X12, X18, X27,Y	12	10	22	4
		VIF<10	3	independent	X7, X13, X18, X27	9	19	28	
			4	Y included	X7, X13, X18, X27,Y	10	20	30	
	Correlation analysis		**5**	**independent**	**X7, X9, X11, X13, X27**	**17**	**21**	**38**	
			6	Y included	X7, X9, X11, X13, X27,Y	18	14	32	
Weighted	VIF analysis	VIF<4	7		X3, X5, X6, X12, X18, X27	12	11	23	1
		VIF<10	8		X7, X13, X18, X27	10	10	20	1
	Correlation analysis		9		X7, X9, X11, X13, X27	12	21	33	

According to the presented results, variables selected by using VIF's analysis (VIF<4) were less suitable for the classification than other data. Only 22 companies (12 profitable working and 10 loss making) were matched in each class and 4 companies were miss-matched for the Case 2. The highest number of matched companies (38) was determined by using variables selected by using correlation and regression analysis (Case 5). Not a single company was mismatched in this case.

In order to test the reliability of the selected variables, the centroids of all 30 variables from profit (loss) and balance sheets were calculated for all profitable and loss-making companies during the period of 2002-2006. Obtained centroids were compared to centroids calculated for 5 selected variables during the same period. The same variation tendencies were observed in both cases (Figure 4).

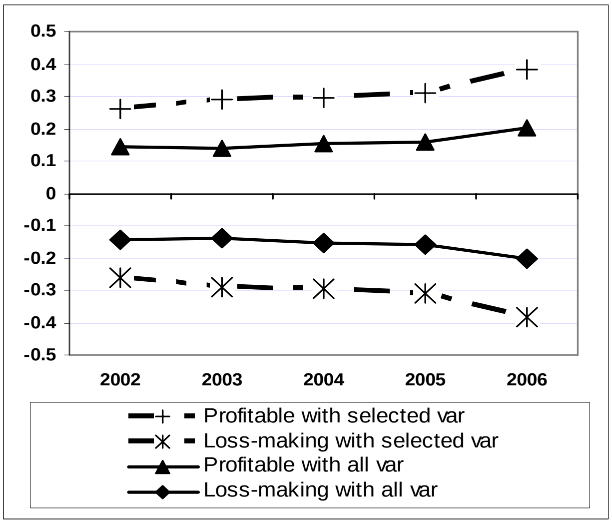

Figure 4. Centroids of all and selected variables

The dendrogram (Figure 5) shows graphically the results of the classification using selected variables. Each step of hierarchical clustering of enterprises is represented as a fusion of two branches of this tree-like plot into a single one.

Observations C_1 to C_17 correspond to profitable enterprises. Observations C-18 to C_30 are linked to loss-making companies (The class of mixed companies is not represented in the Figure 5).

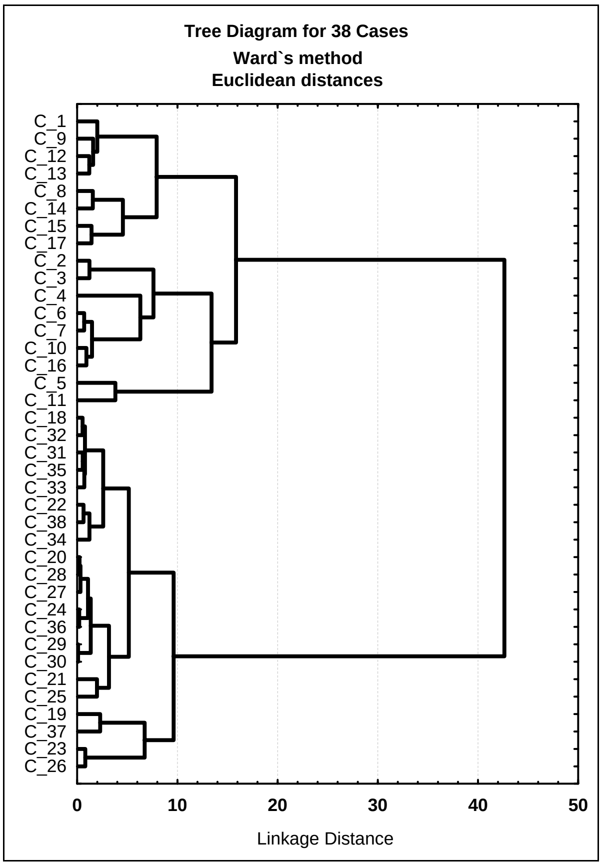

Figure 5. The dendrogram

Applying Mahalanobis-Taguchi system

The Mahalanobis - Taguchi System (MTS) is a pattern recognition technology that aids in quantitative decisions by constructing a multivariate measurement scale using a data analytical method. The main objective of MTS is to make accurate predictions in multidimensional systems by constructing a measurement scale (Cudney, Hong, Jugulum, Paryani, Ragsdel, Taguchi, 2007). The patterns of observations in a multidimensional system highly depend on the correlation structure of the variables in the system. The construction of multidimensional measurement scale is mostly important for the determination of a distance measure. The distance measure is based on the correlation between the variable and the different patterns that could be identified and analyzed with respect to a base or reference point.

In order to construct a measurement scale, it is necessary to collect a set of "normal" observations and standardize the variables of these observations to calculate the Mahalanobis distances (MDs). Calculation of MDs is performed using following formula (Cudney, Paryani, Ragsdell, 2007):

$$MD_j = \frac{1}{k} \cdot Z_{i,j}^T \cdot R^{-1} \cdot Z_{i,j},\ i = \overline{1,k},\ \ j = \overline{1,n}, \qquad (3)$$

where:

k is a total number of selected variables,

n – total number of observations,

Z_{ij} - standardized vector of normalized variables of x_{ij} •

$$Z_{i,j} = (x_{i,j} - \overline{x}_i) / s_i$$

x_{ij} - value of the i-th characteristic in the jth observation

$\overline{x_i}$ - mean of the i-th variable of normal group

s_i - standard deviation of the i-th variable of normal group

R^{-1}- inverse of the correlation matrix of normal group

The average value of MDs is 1 for all the observations in Mahalanobis space (MS):

$$E(MD) = E(\frac{1}{k} \cdot Z^T \cdot R^{-1} \cdot Z) \approx 1 \qquad (4)$$

For the construction of the measurement scale, the group of 9 profitable enterprises was selected as the set of normal observations. Selected companies matched in each dendrogram, which was evaluated using Ward's method and Euclidean distance.

The mean and standard deviation values of each variable (X7, X9, X11, X13, X27) selected in the cluster analysis stage were calculated and the variables were standardised. After this procedure the following correlation matrix was obtained:

$$R := \begin{pmatrix} 1.00 & -0.49 & -0.31 & -0.46 & -0.48 \\ -0.49 & 1.00 & 0.83 & 0.42 & 0.80 \\ -0.31 & 0.83 & 1.00 & 0.06 & 0.68 \\ -0.46 & 0.42 & 0.06 & 1.00 & 0.68 \\ -0.48 & 0.80 & 0.68 & 0.68 & 1.00 \end{pmatrix}$$

The purpose of the Mahalanobis-Taguchi system is to effectively identify new abnormal observations by the magnitude of the scaled Mahalanobis distance. So the sensitivity of the scaled Mahalanobis measure to abnormal observations must be tested. It is certainly desirable that scaled Mahalanobis distances calculated for "abnormal" objects are significant larger than 1 (the larger the better). For testing purpose the class of loss-making enterprises as a set of abnormal observations was selected.

The Mahalanobis distances (MDs) for both: normal and abnormal sets were calculated. Testing results are presented in Figure 6.

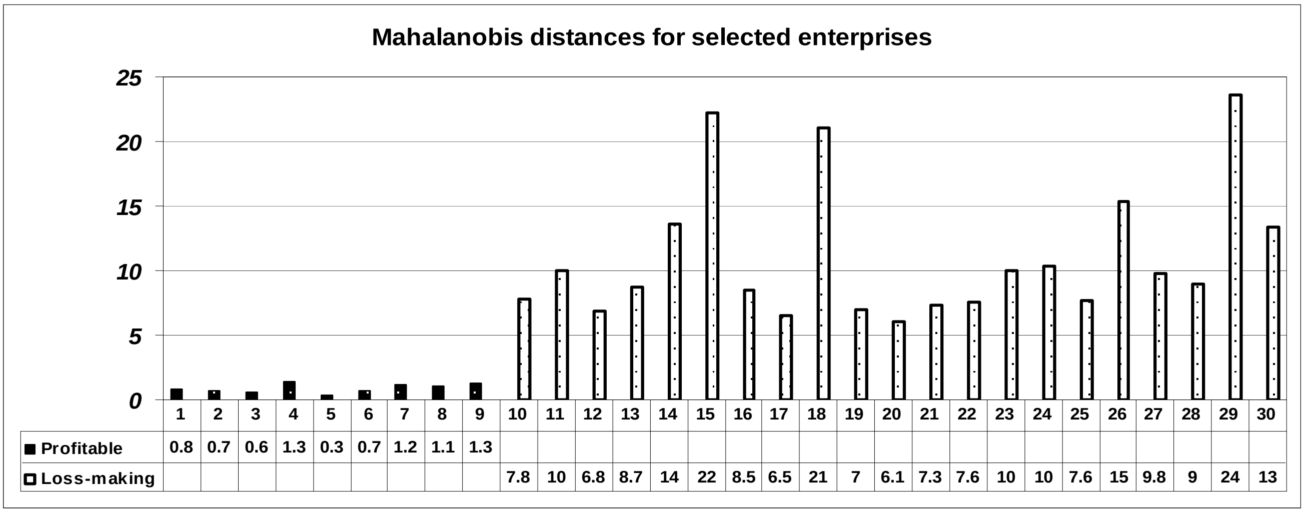

Figure 6. Mahalanobis distances for profitable and loss-making companies

The purpose of useful variables screening is to find the important variables to assist in the model analysis or diagnosis in the future. For this purpose, orthogonal arrays (OA) and signal to noise ratio (S/N) are very useful to identify which attributes are important.

In the experiment, every factor is assigned to a column in the OA, and every row represents the experiment combination of a run. In a two level OA, 1 indicates the level that corresponds to the presence of a variable and 2 indicates the level that corresponds to the absence of the variable. Each attribute is used or neglected with respect to the OA (Wang, Chiu, Su, 2004). In general, in each run of the orthogonal array experiment, according to the experimental layout in each run, a subset of variables was selected to compute the scaled Mahalanobis distances for all abnormal observations (Table 2).

Table 2

Experimental Layout and S/N ratios

Exp. no.	X1	X2	X3	X4	X5	S/N
1	1	1	1	1	1	4.38
2	1	1	1	2	2	1.79
3	1	2	2	1	1	5.11
4	1	2	2	2	2	1.91
5	2	1	2	1	2	4.05
6	2	1	2	2	1	3.92
7	2	2	1	1	2	4.00
8	2	2	1	2	1	4.54

S/N values were calculated according to the formula (5) and the average S/N for the different levels of variables was estimated (Table 3).

$$SN = -\log_{10}\left[\frac{1}{n}\cdot\sum_{j=1}^{n}\left(\frac{1}{MD_{i,j}}\right)^{2}\right], \quad i=1,2,..,8, \qquad \textbf{(5)}$$

where n is a number of abnormal observations.

Table 3

Average S/N for Different Levels of Variables

Variables	X1	X2	X3	X4	X5
Level 1 (S/N^+)	3.30	3.54	3.68	4.38	4.49
Level 2 (S/N^-)	4.13	3.89	3.75	3.04	2.94
Gain (S/N^+-S/N^-)	-0.83	-0.35	-0.07	1.34	1.55

A useful set of variables was obtained by evaluating the gain in the S/N ratio. Two of the five variables were determined to be useful for the identification of the abnormality of enterprises. The values of gains are provided in Figure 7.

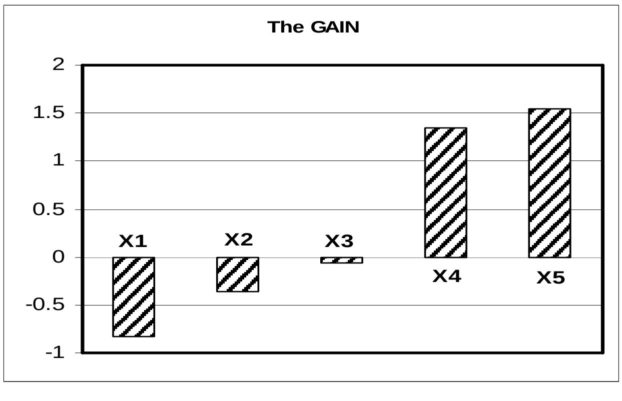

Figure 7. The gains

Mahalanobis distances using two selected variables for profitable (normal) and loss-making (abnormal) companies are shown in Figure 8. According to this figure, only variables Profit (loss) brought forward and Profit (loss) from operations can be used to calculate Mahalanobis distances.

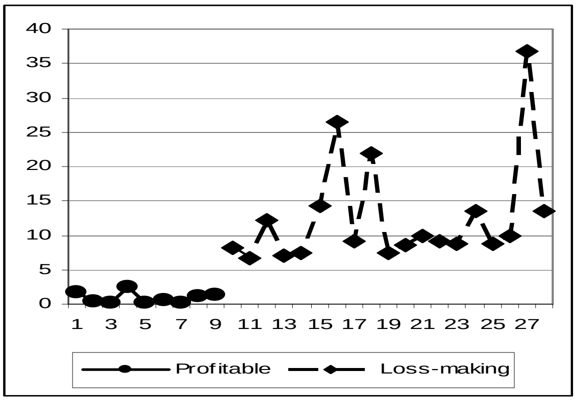

Figure 8. Mahalanobis distances for profitable and loss-making companies calculated by using 2 variables

Conclusions

The investigation has shown that the classification of enterprises according to selected variables credibly evaluates the performance of enterprises and makes it possible to classify them into profitable and loss-making companies.

In order to evaluate criteria for the classification of enterprises the set of 50 profitable and 50 loss-making companies were selected. 9 different combinations of classification variables were determined by using correlation and regression analysis.

It was shown that the most suitable variables for classification of enterprises were: Trade debtors, Cash and cash equivalent, Capital, Profit (loss) brought forward and Profit (loss) from operations. The best classification result was gained by using Euclidian distance and Ward's linkage rule for cluster analysis. In this case 17 profitable and 21 loss-making enterprises matched their classes.

The group of 9 profitable enterprises that matched their class in each case of the investigation was selected as the set of normal observations. Mahalanobis distances were calculated for these profitable enterprises and for 21 other loss-making (abnormal) companies.

The average value of Mahalanobis distances for normal observations was approximately equal to 1. This value for abnormal observations was significantly larger than 1. Mahalanobis-Taguchi system application for selected companies showed that it is enough to use only two variables: Profit (loss) brought forward and Profit (loss) from operations, for effective classification of enterprises according to Mahalanobis distances.

So the necessity to establish standard set of profitable enterprises was determined and the selection importance of classification criteria was approved.

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Įmonių klasifikavimo kriterijų tyrimas

Santrauka

Sėkmingas įmonių plėtojimasis yra svarbus visos šalies ekonomikos augimui, socialiniam stabilumui ir naujų darbo vietų kūrimui. Tačiau įmonių veiklai tiesioginę arba netiesioginę įtaką daro skirtingi išoriniai ir vidiniai veiksniai.

Efektyvi įmonės strategija gali būti vienas iš svarbiausių įmonės sėkmės faktorių. Nuostolingai dirbančios įmonės galėtų pasekti sėkmingai veikiančių (pelningų) įmonių pavyzdžiu, siekdamos pagerinti savo veiklą. Tačiau kyla klausimas, kokias įmones galima laikyti sėkmingai veikiančiomis ir pagal kokius kriterijus jos turėtų būti klasifikuojamos.

Mokslininkai susiduria su tuo, kad nuolat daugėja įmonių veiklos vertinimo kriterijų, o metodai tampa vis labiau sudėtingesni. Taigi pagrindinė problema yra ta, kad sunku įvertinti, kuris iš galimų vertinimo metodų yra efektyviausias konkrečiu atveju.

Kai kurie autoriai grupuoja kriterijus, apibūdinančius įmonių komercinę ekonominę veiklą į tris pagrindines grupes: mokumo ir finansinės rizikos, apyvartumo ir pelningumo. Autoriai pabrėžia, kad trečioji grupė yra tiesiogiai susijusi su įmonių veiklos vertinimu.

Literatūros analizė parodė, kad, norint efektyviai įvertinti įmonės veiklą, nepakanka analizuoti atskirų jos rodiklių, reikia į analizę įtraukti visą rodiklių sistemą. Klasterinė analizė yra statistinės analizės metodas, kuriuo pasirinkti objektai klasifikuojami į skirtingas klases taip, kad klasės viduje jie būtų panašūs, o tarp klasių reikšmingai skirtųsi. Kadangi šis klasifikavimas remiasi visos rodiklių sistemos analize, jis efektyviai gali būti taikomas įmonėms grupuoti į klases.

Šio tyrimo tikslas – nustatyti įmonių klasifikavimo kriterijus, atsižvelgiant į jų grynąjį pelną.

Tikslui pasiekti buvo taikyti šie metodai:

- mokslinės literatūros analizė,
- koreliacinė, regresinė ir klasterinė analizė,
- Mahalanobio atstumo matų nustatymas.

Tyrimui naudoti Lietuvos statistikos departamento 50 pelningai ir 50 nuostolingai veikiančių įmonių 2002 – 2006 metų pelno (nuostolių) ir balanso ataskaitų duomenys.

Atlikus pirminę duomenų analizę, iš tyrimo pašalinti finansinių atskaitų straipsniai, nebūdingi daugeliui analizuojamų įmonių, taip pat pašalinti įmonių duomenys su išskirtimis. Paaiškėjo, kad 4 įmonių rodikliai labiausiai skyrėsi nuo kitų įmonių rodiklių, todėl jos į tyrimą nebuvo įtrauktos. Peržiūrėjus likusiųjų 96 įmonių duomenis, statistinei analizei atrinkta 30 finansinių ataskaitų straipsnių. Būtina pažymėti, kad praktikoje finansinių ataskaitų straipsnių reikšmės gali gerokai skirtis, todėl šie kintamieji pirmiausia buvo standartizuojami.

Antrame tyrimo etape sudarytas grynojo pelno regresijos modelis. Siekiant išvengti nepriklausomų regresijos lygties kintamųjų multikolinearumo, buvo skaičiuojami dispersijos mažėjimo daugikliai VIF ir atliekama kintamųjų koreliacinė analizė.

Analizė atlikta naudojant SPSS statistinės analizės programinę įrangą. Buvo apskaičiuotos kiekvieno iš 30 kintamųjų VIF reikšmės ir nustatyta, kad didžiausią VIF reikšmę (1397,68) turi suminis nuosavybės ir įsipareigojimų balanso straipsnis. Taigi šis kintamasis buvo pašalintas iš tolesnio tyrimo, o visų likusių kintamųjų VIF reikšmės perskaičiuotos. Analogiškai iš tolesnio tyrimo buvo pašalinti viso turto, trumpalaikių įsipareigojimų, materialiojo turto, pelno prieš mokesčius, pardavimo pajamų ir pardavimo sąnaudų bei kiti straipsniai.

Pirmuoju atveju į grynojo pelno regresijos modelį buvo įtraukti kintamieji, kurių VIF < 10. Tokiu būdu buvo atrinkti šie kintamieji: pirkėjų skolos, nepaskirstytasis pelnas, pelno mokesčio įsipareigojimai ir tipinės veiklos pelnas.

Antruoju atveju buvo atrinkti kintamieji, kurių VIF<4: atsargos, išankstiniai apmokėjimai ir nebaigtos vykdyti sutartys, išankstiniai apmokėjimai, per vienerius metus gautinos sumos, rezervai, pelno mokesčio įsipareigojimai ir tipinės veiklos pelnas.

Atliekant koreliacinę analizę, buvo atrinkti tarpusavyje nekoreliuojantys, tačiau turintys statistiškai reikšmingą koreliacinį ryšį su grynuoju pelnu kintamieji: pirkėjų skolos, pinigai ir pinigų ekvivalentai, įstatinis kapitalas, nepaskirstytasis pelnas, tipinės veiklos pelnas.

Panaudojant atrinktus kintamuosius, atlikta klasterinė įmonių analizė. Klasterių sudarymo metodai skiriami pagal tai, kaip parenkami panašumo matai, atstumo tarp klasterių nustatymo kriterijai ir kokia skirstymo į klasterius strategija. Tyrimo metu įmonėms klasifikuoti buvo taikomi hierarchiniai

jungimo metodai. Hierarchinių metodų rezultatai nusako klasterių tarpusavio hierarchiją (visi objektai laikomi vienu dideliu klasteriu, sudarytu iš mažesnių klasterių). Pritaikant hierarchinius jungimo metodus, smulkūs klasteriai jungiami į vis stambesnius, kol galiausiai susidaro vienas klasteris.

Remiantis šiuo metodu, visos tirtos įmonės buvo suskirstytos į tris pagrindines klases: pelningos, nuostolingos ir mišrios (likusios) įmonės. Tariant, kad kiekvienas objektas yra klasteris, galima nustatyti atstumą tarp klasterių, pasirenkant atstumo matą. Tačiau iškyla atstumo tarp naujų klasterių nustatymo problema. Šiuo atveju tenka parinkti jungimo metodus, leidžiančius nustatyti, ar du klasteriai yra pakankamai panašūs, kad juos būtų galima sujungti. Taigi atliekant klasterinę analizę visų pirma buvo atliktas klasifikavimo metodo parinkimo tyrimas.

Pasirinkus Euklido atstumo matą, buvo analizuojami skirtingi klasterių jungimo metodai. Įmonės buvo klasifikuojamos taikant vienetinės, pilnosios, vidutinės jungties, centrų ir Vordo jungimo metodus. Geriausias rezultatas gautas, t. y. daugiausiai pelningų ir nuostolingų įmonių priskirta atitinkamai pelningų ir nuostolingų įmonių klasėms, taikant Vordo (Ward's) metodą.

Nustačius efektyviausią jungimo metodą, atlikta geriausiai tinkančio atstumo mato paieška. Įmonės klasifikuotos naudojant Manheteno, Chebyševo, Pirsonor, Euklido atstumų ir Euklido atstumo kvadrato matus. Tyrimas parodė, kad šiuo atžvilgiu tinkamiausias yra Euklido atstumo matas.

Taigi šiuo metodu įmonės klasifikuotos naudojant skirtingus kintamuosius, kurie buvo įtraukti į regresijos lygtis ankstesniame analizės etape. Pirmuoju atveju panaudoti tik nepriklausomi regresijos lygčių kintamieji, antruoju atveju – nepriklausomi kintamieji ir grynasis pelnas (priklausomas kintamasis), trečiuoju atveju kintamiesiems suteikti svoriniai koeficientai, atitinkamai lygūs regresijos lygties koeficientams.

Geriausias rezultatas gautas naudojant nepriklausomus kintamuosius, atrinktus koreliacinės analizės būdu ir įtrauktus į grynojo pelno regresijos lygtį. Minėti kintamieji yra šie: pirkėjų skolos, pinigai ir pinigų ekvivalentai, įstatinis kapitalas, nepaskirstytasis pelnas, tipinės veiklos pelnas. Klasifikuojant šiuo būdu, 17 pelningai veikiančių ir 21 nuostolingai veikianti įmonė buvo teisingai priskirtos atitinkamoms klasėms.

Norint įsitikinti atrinktų kintamųjų reprezentatyvumu, pelningai ir nuostolingai veikiančių įmonių rodiklių centroidai buvo apskaičiuoti remiantis 2002 – 2006 metų finansinių ataskaitų duomenimis. Pirmuoju atveju centroidų reikšmės apskaičiuotos naudojant visus įmonių rodiklius, antruoju atveju – atrinktus kintamuosius. Grafinė rezultatų interpretacija parodė, kad skirtingais atvejais apskaičiuoti centroidai turėjo tas pačias kitimo laike tendencijas.

Įmonėms klasifikuoti buvo pritaikyta Mahalanobio-Taguchi sistema siekiant išryškinti skirtumus tarp sėkmingai ir nuostolingai veikiančių įmonių klasių. Mahalanobio atstumo erdvė sudaryta panaudojant devynių įmonių, kurios, atliekant klasterinę analizę, kiekvienu klasifikavimo atveju buvo priskirtos pelningai veikiančių įmonių klasei, kintamuosius. Apskaičiuoti pelningai ir nuotolingai veikiančių įmonių Mahalanobio atstumai. Tyrimas parodė, kad nuostolingai veikiančių įmonių Mahalanobio atstumai yra reikšmingai didesni už pelningai veikiančių įmonių ir reikšmingai skiriasi nuo vieneto.

Siekiant padidinti klasifikavimo efektyvumą, Taguchi ortogonaliųjų vektorių sistema ir S/N (signalas/triukšmas) koeficientai buvo panaudoti reikšmingiems kintamiesiems atrinkti. Eksperimento metu kiekvienas kintamasis vaizduojamas kaip ortogonaliųjų vektorių sistemos stulpelis, o kiekvienoje eilutėje įrašoma atskirų bandymų kintamųjų kombinacija. Dviejų lygių ortogonaliųjų vektorių sistemoje 1 žymi atvejį, kai kintamasis įtraukiamas į bandymo kintamųjų kombinaciją, o 2 – atvejį, kai kintamasis nėra įtraukiamas į bandymo kintamųjų kombinaciją. Tyrimo metu buvo atlikti 8 eksperimentiniai skaičiavimai, naudojant nuostolingai veikiančių įmonių duomenis, ir apskaičiuoti Mahalanobio atstumai. Panaudojant nustatytus Mahalanobio atstumus, buvo apskaičiuotos S/N koeficientų reikšmės ir nustatyti skirtumai tarp vidutinių S/N reikšmių, gautų įtraukiant kintamąjį (1 lygis) ir jo neįtraukiant (2 lygis) į atskirų bandymų kintamųjų kombinacijas. Tyrimas, atliktas skirtingoms kintamųjų kombinacijoms nustatyti, parodė, kad kintamieji: nepaskirstytasis pelnas ir tipinės veiklos pelnas sąlygoja didžiausius skirtumus tarp pelningai ir nuostolingai veikiančių įmonių Mahalanobio atstumų, t. y. naudojant šiuos kintamuosius įmonės gali būti klasifikuojamos efektyviausiai.

Tyrimo rezultatai parodė tai, kad būtina nustatyti standartą, reikalingą sėkmingai veikiančių įmonių veiklai apibūdinti. Taip pat buvo nustatyta, kad pelningai ir nuostolingai veikiančių įmonių kriterijų reikšmės reikšmingai skiriasi.

Raktažodžiai: *įmonių veiklos kriterijai, įmonių klasifikavimas, klasterinė analizė, Mahalanobio atstumo matas.*

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