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HOW TO MEASURE ORGANIZATIONAL PERFORMANCE IN SEARCH FOR FACTORS OF COMPETITIVENESS

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Abstract

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The aim of this paper is to find an appropriate method of expressing a company's performance in order to offer it to researchers for the purpose of subsequent searches for factors affecting corporate competitiveness.
Of the possible approaches to performance measuring, and after considering their advantages and limitations, we have chosen long-term financial indicators, Assets Growth and Return on Assets, because each of these indicators represents one of two possible strategies to improve financial performance.
This article thus presents the alternatives that are offered for that purpose as well as several means of using selected indicators (cluster analysis, etc.). While verifying the suitability of the various means, we assumed that the better the financial performance is expressed, the higher the accuracy of methods seeking competitiveness factors will be under otherwise similar conditions.
We have employed the Sequential Floating Forward Selection (SFFS) as the appropriate factors seeking method, which has already been used for similar types of tasks in other fields. The best results of expressing a company's performance were achieved using the method of adding the standardized values of both indicators.

competitiveness, financial performance, Sequential Floating Forward Selection, *k*-Nearest Neighbours

Research on the competitiveness of companies has been an attractive and frequent topic, not only currently, but for decades. Most interest in this area has been always raised by looking for competitiveness factors. First in the viewfinder appeared the factors price and quality (Schumpeter, cited by Jirásek, 2000) followed in the 80's by a long time unsurpassed Michael Porter (1980, 1985) who focused on the structure of company`s microenvironment. Next studies paid attention to the internal factors. Many authors have managed to prove influence of various factors on the performance of a business, such as research and development (Lev and Zarowin, 1998), expenses on advertising purposes (Chauvin and Hirschey, 1993), brands (Kim and Chung, 1997), human resources (Wright *et al.*, 1994, Truss and Gratton, 1994, Hand, 1998, Huselid, 1999), efficiency of decision-making (Ulrich and Lake, 1990, Molina *et al.*, 2004) and more. Efforts of the Research Centre for the Competitiveness of the Czech Economy[1] (RCCCE) were developing in a similar direction, which confronted authors of the article with a problem of expressing competitiveness at the enterprise level.

Unfortunately, there is no consensus in the literature on how to express a company's competitiveness and the problem is multilevel. In the first place, it is necessary to deal with how

1 More about the Centre on http://www.econ.muni.cz/t244/

to actually understand the competitiveness of a company. Then one needs to select the appropriate indicators to measure it and, last but not least, there is the nontrivial question of how to use these specific indicators. Here we offer a comparison of several different approaches with an analysis of their advantages and disadvantages. The goal is to find a single expression of company competitiveness without having to give up the advantages of using multiple indicators.

Theoretical background

It is obviously necessary to work with concepts and relations that are not vague but easy to comprehend. It is therefore necessary to transform the rather ambiguous central concept of "competitiveness" into a concept that can be operationalized and expressed in quantitative or measurable units.

In the Czech environment, competitiveness is defined e.g. by Jirásek (2000) as, "a term expressing a market potential of a company, industry or country in a competition for its position on the market against other companies, industries or countries". Other authors either use this term or do not define it, (Nečadová *et al*., 2007), or they define it vaguely (Hučka, 2005). However, even Jirásek's (2000) mentioned definition is not operational enough for research purposes. Therefore, we can use the traditional concept to assess the rate of a company's competitiveness and define it as the ability to achieve a market success (Michalet, 1981; Mathis *et al*., 1988).

From the above-mentioned definition, we can infer that competitiveness is a potential (capability) of a company to succeed in economic competition with other companies. We assume that the result of this competition is a success (or failure) of the company that can be expressed by some performance measure. We will thus transform the problem of "identification of competitiveness factors of companies" into a concept that can be operationalized into the problem of "identification of performance factors of companies".

Organizational performance is so common in management research that its structure and definition are rarely explicitly expressed. In general, performance says how well goals are achieved. According to the organization goals, we recognize financial performance, operational performance and overall effectiveness (Hult *et al*., 2008).

The dominant model in empirical strategy research is financial performance. It is based on financial indicators that are assumed to reflect the fulfilment of the economic goals of the firm (Venkatraman, Ramanujam, 1986). Operational performance refers to non-financial dimensions, and focuses on operational success factors that might lead to financial performance. It includes measures like product quality, cycle time, and productivity. Overall effectiveness is a broad domain reflected in most conceptual literature in strategic management and organization theory. Effectiveness refers to the extent to which customer requirements are met (Neely *et al*., 2005). Measurement of overall effectiveness includes e.g. reputation, perceived performance, achievement of goals, survival and needs good knowledge about organization and its industry.

Hult *et al*. (2008) examined articles published in prestigious journals focused on research of international trade between 1995 and 2005. In a total of 96 articles, financial performance was measured in 69 cases, the operating performance in 41 cases and the overall effectiveness in 30 cases (the sum is greater than 96 because some studies multiple types of performance were measured).

Financial measures

Among the wide range of financial performance measurements belong traditional indicators compiled on the basis of data from an existing and relatively easily accessible source of relevant and verified data from the financial statements and financial analysis. The other possibilities are indicators of market value. Combining both types are hybrid methods, which include indicators expressing economic profit.

Accounting measures have several strengths: they are relatively easy to calculate and understandable, they are widely available because governments require firms to publish accounting data, and they are reliable due to the fact that they are subject to internal and external controls (Richard *et al*., 2009). Limitations of accounting measures are focusing on historical performance and not attempting to anticipate future results. They do not provide information on whether a company is increasing its long-term value, as they only provide a measure of short-term performance (CIMA, 2004). Accounting measures can be distorted by a variety of factors including government policy, and inconsistency in the rules on the accounting systems (Richard *et al*., 2009). They also do not include the opportunity cost of the equity capital invested by shareholders (Kimbal, 1998).

Market measures are mainly based on stock prices, so they may change a lot due to external factors not related to the organizational performance. Using market measures in countries with non-efficient financial markets (from which the Czech Republic can be considered) could give misleading conclusions. Competition-based measures compare how a firm is performing relative to its competitors. Their problem is that they are not comparable across industries and are not easy to calculate.

Hybrid measures are more complex than previous categories. They combine their advantages and limitations. The Tobin's q, the Altman's Z score provide information about the risk and future contingencies that may arise in an organization, they may be very volatile over a period of time. Economic value added (or economic profit) provides information about short- and long-term performance under both an investment and competitive point of view. EVA is not easily

calculable, and some of its components vary significantly across industries and countries. In the case of hybrid measures, there is a problem in using them in Czech environment due to the need to estimate or modify some accounting data for their calculation.

Richard *et al.* (2009) examined 722 papers published in the years 2005 to 2007 in five of the top business academic journals. In 213 of them, organizational performance was measured as a dependent, independent, or control variable. The most used performance measures were based on accounting data (53%). Indicators based on financial market were used in 17%, sales, market share, or related measure in 15%, Tobin's q or other mixed measure in 11%. Overall, organizational performance was measured in 8% by survival.

Whichever measure is used, the methodology of financial performance measurement is not stable and there is no single, agreed upon and overall financial measure of a company's performance. Therefore, researchers have often used multiple measures to get a more complete understanding of an organization's results and prospects. It is also evidenced by the above-mentioned research by Richard *et al.* (2009), where different performance measures were used in 207 of the 213 papers that involved measures of organizational performance. In approximately half of them, the performance was measured using a single indicator; in the second half, several indicators were used. Multiple measures were used in multiple separate analyses (67%), or in aggregation (factor analysis or averaging).

Devinney and Johnson (2010) identified three different ways of using multiple measures of performance: the first consists of performing different quantitative techniques with each of the variables used and comparing the results. Most of the literature has used this methodology. The second combines different measures to create a single score. The third approach, which has been scarcely used in the literature, employs the data envelopment analysis (DEA) by using frontier analysis.

We have not yet mentioned one distinct category of competitiveness measures. For research purposes, the objective measures are typically used (Richard *et. al.*, 2009; Hult *et al.*, 2008), but subjective measures are also possible. Using subjective measures like perceived organizational performance or perceived market position assumes that respondents are well-informed experts. The weakness of this approach is obvious.

For reducing errors and overcoming random noise and disposable fluctuations, it is appropriate to use longitudinal data There are not many studies in this field using time periods longer than five years: Artiach *et al.* (2010) five years, Abor and Biepke (2007) six years, Hansen and Wernerfelt (1989) five years. On the other hand, most studies use a single year`s result: Andrews and Boyne (2010), Bottazzi *et al.* (2008), Kessler (2007) and many others.

Methods used

Based on the above-mentioned advantages and disadvantages of different methods of performance measurement, we have, for further data processing, decided to compare companies based on their financial performance. Thus, we have decided to measure using accounting measures. The primary reason for this was an effort to use objective indicators; and given the size of the studied sample, the data for our calculations was easily accessible in the CreditInfo database. Generally, Allouche and Laroche (2005), who found a much stronger relationship between accounting indicators and competitiveness factors, than between market indicators, also support the use of accounting data.

The decision to use traditional accounting measures was supported by the present authors' experience in the world's most successful performance measurement system, the Balanced Scorecard method, which states: 'Financial objectives typically relate to profitability – measured, for example, by operating income and return on investment. Basically, financial strategies are simple; companies can make more money by (1) selling more, and (2) spending less. Everything else is background music. …Thus, the company's financial performance gets improved through two basic approaches – revenue growth and productivity' (Kaplan and Norton, 2004). Two of the possible approaches to increase financial performance require the use of a combination of at least two indicators so that each of the above guidelines was represented by at least one indicator.

L. Šiška and Lízalová (2011) looked for the best expression of overall long-term company performance with a small number of indicators. They found that return on assets/return on sales in association with sales growth cover the most aspect of company performance.

When measuring the financial performance of companies, similarly to the research of the RCCCE, it was based on assumptions and experiences of authors of the above-mentioned literature, that an organization may increase their financial performance by implementation of the growth strategy or the strategy to increase productivity.

Financial performance achieved using strategy to increase productivity has been measured by indicators of Return on Assets (ROA) constructed as follows:

$$ROA_t = \frac{NOPBT_t}{\frac{TA_{t-1} + TA_t}{2}} \times 100, \quad (1)$$

where:
NOPBT.... net operating profit before taxes
TA..... total assets.

Return on Assets expresses the profitability of all funding sources involved and is the essential indicator of financial analysis. Operating profit

was used for its calculation, which is not affected by secondary activities the company and reflects success on the market. Relating this value to the amount of assets gives vital indicators their relative shape, which allows the comparison of different-sized businesses. The selected total assets in the denominator are related to the concept of a stakeholder owned company and also exclude the influence of a respondent chosen capital structure, which is not the subject of our research. Operating profit is produced throughout the year, while the indicator of total assets relates to the point in time at the end of the year. Therefore, we express the denominator in the value of the assets involved in a given year as the average amount of assets at the beginning and end of the year.

Financial performance achieved using a strategy of growth has been measured using the rate of Assets Growth:

$$Assets\ Growth_t = \left(\frac{TA_t}{TA_{t-1}} - 1 \right) \times 100 . \quad (2)$$

Increase the value of total assets while involving a greater amount of resources is due to the higher production of a company. During long-term growth in business demand, an enterprise must invest into the expansion of production capacity and thus increase the overall amount of assets. An alternative was to choose a direct indicator of growth in sales, but this was not possible to calculate from the database used (due to the different procedures used in the database to determine indicators of total sales – replacing total sales with revenues from sales of goods, more precisely, products and services, total revenues or performance indicators).

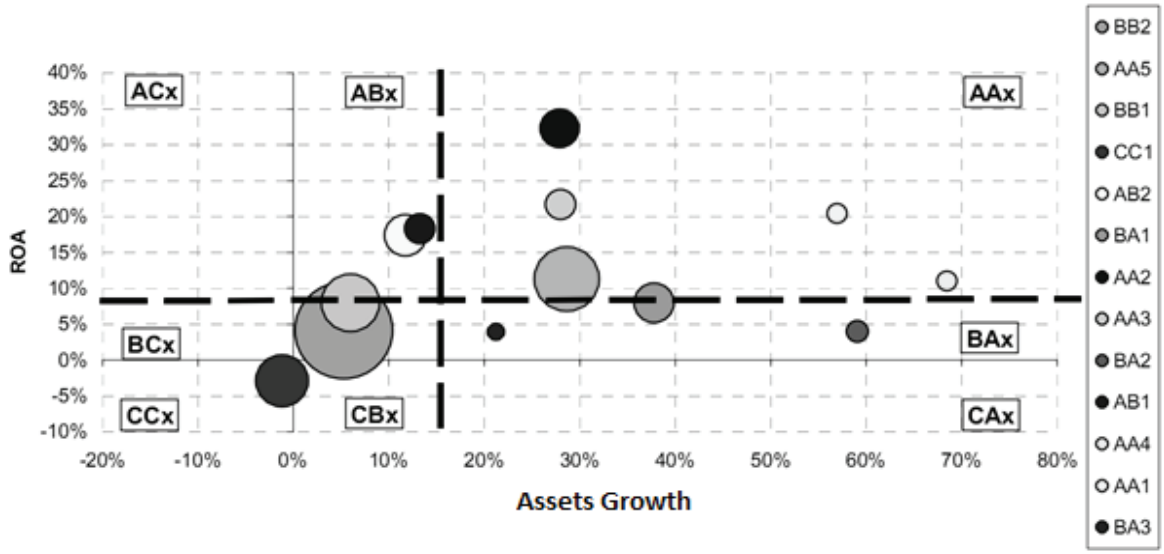
For both indicators, we have worked with a series of data from six years (2003–2008). Using any longer time period would have meant a large amount of data would be missing, and the result would be too distorted due to the need to replace this missing data with, for example, average values.

Distribution of firms according to financial performance

For further evaluation, it was necessary to group or sort studied companies by financial performance. We paid a lot of attention to finding the most appropriate way of assessing the financial performance, because it significantly affects the results of other experiments. Over time, we have revised the model several times so that the selected indicator expressed the actual financial performance of the company best.

In the first stage of evaluation of financial performance within the research of the RCCCE, L. Šiška (2008) used a method of **cluster analysis**, whereby companies have been divided into 13 relatively homogeneous groups (clusters) according to the minimum distance of individual members within the cluster (Fig. 1). Two indicators: ROA and Assets Growth were assessed on the basis of their development in five consecutive years, 2002–2006. L. Šiška attempted to assess the financial performance on the basis of the most recent financial data possible. To reinforce the importance of financial data for the years closer to empirical investigation (2007), he applied to both indicators analysed for 2002–2006, and 1-2-3-4-5 weight. The most recent data thus had the greatest weight.

This method divided enterprises into clusters in relative detail, according to their typical performance in the reporting period. This method was abandoned for its low usability. The resulting 13 clusters represented values of a nominal variable, which complicated or eliminated the use of most of the statistical methods.



1: *Cluster analysis: Weighted means of ROA and Assets Growth for each cluster (bubbles area indicates the number of respondents)*
Source: L. Šiška, 2008

From this perspective, it was desirable to divide the companies into a few classes, which would produce nominal variable with just a few categories, divide them into classes which could be considered ordinal, or express the financial performance with a single continuous number.

Upon further investigation in 2009 (Blažek *et al.*, 2009), L. Šiška based his method on Kaplan and Norton's (2004) thesis of the incompatibility of the financial strategy to increase productivity and growth. The easiest expression of this fact is the inverse proportion between the observed measures of ROA and Assets Growth. The best solution, therefore, appeared to be the crossing of the coordinates of each point, which, as a coefficient, indicated financial performance. The value of indicators in the calculation of the coefficient of financial performance were, for the purpose of the research, assigned weights, taking into considerations the declining significance of variables from the past.

The method (for future reference in this article entitled as "**hyperbole with weights**") is graphically shown in Fig. 2, where successful companies (Group A) are identified as those, whose financial performance coefficient is higher than the multiple of medians of the two financial performance indicators of surveyed companies. Financially inefficient companies (Group C) are companies that exhibit for one or both indicators a negative value. Identified as financially inefficient companies were also those located in the first quadrant, but below the borderline (group B). Sharp division of companies by borderline was mitigated by creating a "border zone" in the area of hyperbola that represents +/– 10% of the median of the financial performance coefficient (Group AB).

A similar methodology followed with minor changes – due to excessive distortion, using weights reflecting the declining significance of older financial results was abandoned, meaning, indicators of each year were given equal weight (to this method is here referred as to "**hyperbole without weights**").

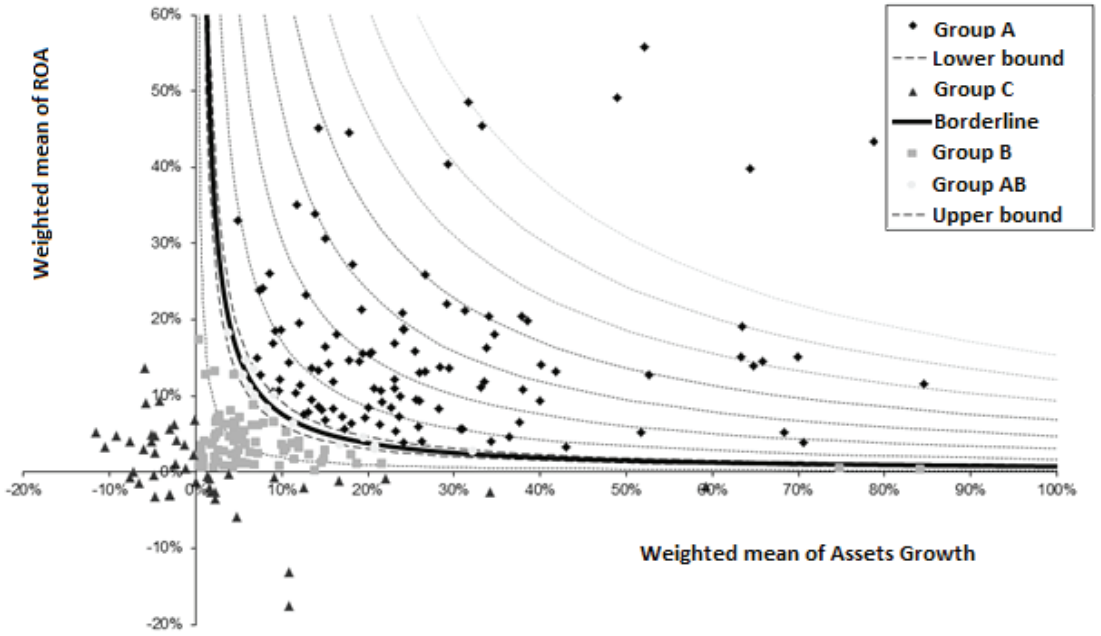
In the next phase, we also tried to take into account the variability vs. stability of results and perform risk data adjustment (the method was denoted as the "**risk-purged hyperbole**"). We based it on the assumption that a) an enterprise with financial indicator values stable over long term are probably better able to compete than the company with the same average performance, but strong fluctuations in financial indicator values over long term, and b) a stable company with lower risk and therefore stable indicators is more attractive to owners and other stakeholders. We calculated the values of financial indicators for the six-year period as:

$$X_{risk-purged} = \frac{\bar{X}_i}{1+\sigma(X_i)}, \tag{3}$$

where $i = (1, 2, 3, 4, 5, 6)$.

In an effort to improve the accuracy and explanatory ability of performance measures, we also considered and tested alternative evaluation of financial performance by creating a "hyperbole" for each sector of economic activity and for comparison of companies within their industry (the method was labelled "**sector hyperbole**").

A set of methods with "hyperbole" clearly achieved dividing companies into two or three



2: *Hyperbole with weights*
Source: Modified from Blažek *et al.*, 2009

groups, but for some statistical methods, this was still not sufficient and could also mean a substantial loss of information about the performance of companies. Therefore however this division met the requirement of a small number of groups, because we are looking for a relationship difficult to statistically model, between financial performance and its many potential factors, such information loss could significantly complicate the search for a relationship.

For this reason, the next stage of the project focused on finding methods for evaluating financial performance, the output of which at best would be a continuous variable or ordinal variable with larger scale.

To fulfil the requirement of these methods, it was necessary to convert the values of both financial indicators to the same scale. We decided to use standardization, which is particularly advantageous compared to normalization because there is no need to determine the minimum and maximum, but also to preserve the explanatory ability of the resulting z-score, which for the average company is zero. The following formula was used for standardization:

$$Z_i = \frac{X_i - \tilde{X}_s}{\sigma(X_s)}, \tag{4}$$

where $i = (1, 2, 3, 4, 5, 6)$ and the median value in the given formula is the median of the whole population derived from the CreditInfo database for each year separately, the standard deviation is the deviation of the whole population for each year separately. By performing standardization for every year, we have eliminated the influence of various economic developments in individual years. The resulting value of indicator ROA (or Assets Growth), is for a company the average of six standardized values.

While designing the single-number indicator, we have also drawn on the above assumption that growth strategy and strategy to increase productivity are equivalent and a company can choose between one of them or apply their combination. Standardized indicators of ROA and Assets Growth therefore have the same weight and it is possible to add them up without risk of distortion. This method was, for ease of reference, labelled "**Summation**" further in this article.

While using standardized indicator values, we have also considered another method of evaluating financial performance (the method is further labelled as "**Exponent**"). Its aim was to stress the differences between companies using the power relationship between the variables:

$$X = \frac{a^{ROA} + a^{AssetsGrowth}}{2}, \tag{5}$$

where $a > 1$.

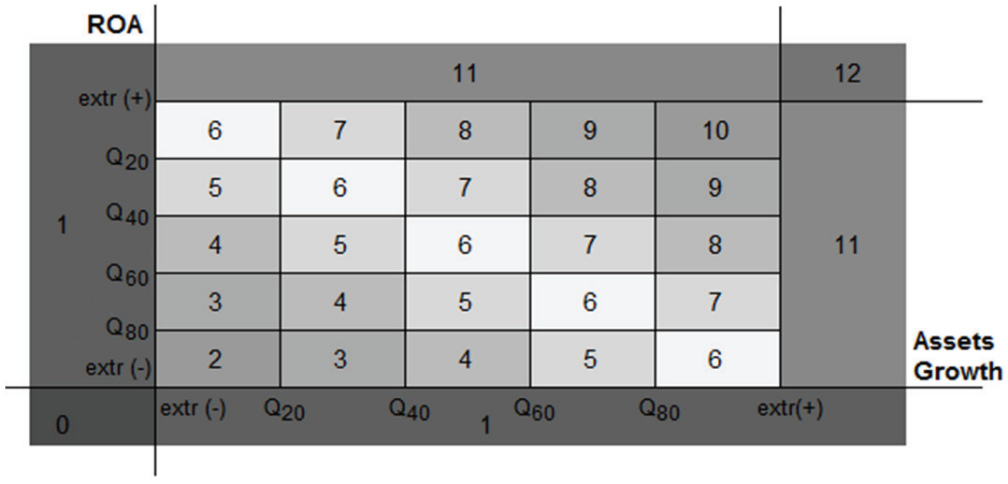
The disadvantage of this method is the difficulty in determining the value of variable *a*, which affects the coefficient diffusion rate of financial performance. For the purposes of the experiments carried out, we used the value $a = 2$.

Králová and J. Šiška (2012) proposed evaluating the financial performance of companies by assigning points to enterprises according to their location within the created sub-segments in the graph showing the ROA and Assets Growth on the main axes. We have modified this method (labelled here "**Quintile**") with the use of standardized values for both indicators and with creating own segment boundaries (Fig. 3).

The disadvantage of this method is the subjective determination of the boundaries between the segments; the advantage is that the variable is ordinal and sufficiently detailed classification is obtained.

Data used

The experiments were based on data from a relatively extensive empirical investigation. The selected sample of 432 firms represents companies



3: *Quintiles*
Source: Authors according to Králová and J. Šiška (2012)

seated in the Czech Republic, operating in the manufacturing industry and construction, whose legal form is a public limited company or private limited company, employing 50 or more people. The total number of these companies (population) included about 4500 companies at the time of conducting the empirical survey.

A relatively large amount of data was obtained for each company from the CreditInfo database, which collects economic data from financial statements, and the questionnaire that was completed by interviewers during a personal interview with a representative of each company. Data from the questionnaire provided independent variables – potential competitiveness factors. Financial data were used as dependent variables – for assessment of competitiveness.

Means for evaluating the suitability of methods used

Evaluating the suitability of methodologies assessing financial performance is based on the following assumptions:

1. there is a statistically measurable relationship between the studied factors of competitiveness and financial performance,
2. as long as factors and the relationship measurement method used (association, correlation, determination) remain unchanged, the various expressions of financial performance can be accounted for the changes of relationship coefficient value (coefficients of association, correlation, determination) and this value can be the measure indicating the suitability of the expression of financial performance.

For the stated to be true, it is necessary to choose proper method for measuring relationships. It is important that such method in particular:

1. is not affected by the shape of the relationship (such as correlations and the linearity), because this shape can change with a change of expression of financial performance,
2. does not require an a priori model (such as structural modelling), which would be necessary to change when changing the expression of financial performance,
3. should be able to measure the impact of several independent variables with potential interdependencies.

Because of the above mentioned reasons, it is possible to exclude the most commonly used methods: correlation, linear regression, structural modelling, decision trees, some multiple regression analyses and multiple correlations. By contrast, our selected method does not suffer from these shortcomings. It is from the area of statistical pattern recognition, namely, the algorithm of Sequential Floating Forward Selection (SFFS), developed by Salome, which is a joint department of the Institute of Theory Information and Automation Academy of Sciences and the Faculty of Management VŠE. It is a method termed learning method of recognition and selection of the most-informative features. By feature, we mean a characteristic of the displayed object, in our case, the variable describing the enterprise. Informativeness then represents to what extent this characteristic can explain the dependent variable, in our case, the financial performance. For us, the most important attribute of this algorithm is the ability to reduce the number to the most-informative features and express with what success, according to these most-informative features, would financial performance be correctly determined for every other (i.e. "new") company. To evaluate the informativeness of tested sets of variables, we use the classification method *k*-Nearest Neighbours, which sorts the displayed objects (companies) into distinct classes (group of above-average performing companies and group of below-average companies) according to *k* the nearest neighbours. The number of nearest neighbour *k* is an optional parameter. Because it is not possible to categorically determine what size of *k* should be used, we will perform experiments with variable *k* values of 1, 3 and 5. It is common to not use even numbers to suppress indecisive situations (Pudil, 2008) and for higher value than 5; the number of companies in distinct groups of financial performance might be too low. The size of *k*, which will yield the most-informative set of variables, will be chosen as the most suitable after each experiment. The same procedure was used to search for factors of competitiveness (Částek, 2008). In the following text, *k* will be referred to by the individual use of *k* as to the methods 1NN, 3NN and 5NN.

We must not forget to mention one important limitation of th SFFS algorithm, the condition of a minimum ratio of displayed object to features, i. e.the number of companies to the number of input variables. The general consensus is that there should be at least ten times more displayed objects than features entering the experiment. (Jain and Chandrasekar, 1982, cited by Pudil, 2008). More on the method of statistical pattern recognition can be found in the text of Pudil (Pudil *et al.*, 1994).

RESULTS AND DISCUSSION

Experiments were carried out with the following settings. Within each of the two financial performance indicators (Assets Growth, ROA) have been accepted up to two missing values in the six-year time periods. By each method of evaluation of financial performance, companies were divided into two groups, between which were, for better differentiation of less competitive and more competitive, gaps created by an omission of about 10% of border enterprises (according to particular methods of evaluation).

Each enterprise has been described by 37 variables that represented potential factors of competitiveness, in terminology of statistical pattern recognition 'features'. More about work with these

variables prior to the application of statistical methods and about the SFFS algorithm can be found in the article on the benefits of this algorithm in the search for factors of competitiveness (Špalek and Částek, 2010).

The Tab. I shows the descriptive statistics of attained informativeness values using each method of evaluating financial performance. The methods in the table are ordered according to average values of informativeness attained. It should be noted that the performance of the first three is within four per mille, while the fourth method is almost two percentage points behind the best one. The most accurate method thus appears to be the method of summation, followed by hyperbola without weights and with a minimum distance the method of exponent.

Besides the informativeness value, however, the performance of methods can be assessed with the help of other criteria. One of them is the degree of fluctuation in the selected variables. In the next table we can see how the algorithm SFFS output can be summarized. For classifiers 1NN, 3NN and 5NN are stated values of informativeness, the number of variables in a set of variables with the highest informativeness and codes of variables contained in this most-informative set.

Ideally, there should not only be the high value of informativeness but different classifiers should agree on the same variables. In the case of an exponent method, however, we see that all three classifiers agreed on one variable only, and that is the number 14, with three variables having been selected twice (numbers 9, 31, 34), while seventeen variables were selected only once. For comparison with other methods, we can construct this evaluation of fluctuation of variables in the most-informative in the set:

$$\frac{\text{Number of different variables}}{\left(\frac{\text{Number of places}}{3}\right)} - 1,$$

I: *Descriptive statistics for values of attained informativeness values achieved by individual methods*

Financial performance measurement method	Minimum	Maximum	Mean	Std. Deviation
Summation	0.739	0.782	0.765	0.022
Hyperbole without weights	0.747	0.787	0.762	0.022
Exponent	0.751	0.773	0.761	0.011
Quintiles	0.745	0.751	0.749	0.003
Hyperbole with weights	0.73	0.755	0.744	0.012
Sector hyperbole	0.709	0.725	0.717	0.008
Risk-purged	0.701	0.715	0.706	0.008

Source: Authors

II: *Output summary for algorithm SFFS for exponent method*

Classifier	Properties of most-informative subsets of variables		
	Informativeness	Number of variables	Variables
1NN	0.750685	9	**3 7** 9 14 **18** *31* **32 33** *34*
3NN	0.772603	13	**4 5 12** 14 **19 24 25 26 27** *31 34* **35 36**
5NN	0.758904	4	**8** 9 14 **17**

Note: **Bold** – variables selected only once
Italic – variables selected twice
Underlined – variables selected every time

Source: Authors

III: *Fluctuation evaluation*

Fin. perf. measurement method	Average values		
	Informativeness	Fluctuation	Number of variables in most-informative subset
Summation	0.765	1.25	4.00
Hyperbole without weights	0.762	1.54	8.67
Exponent	0.761	1.42	8.67
Quintiles	0.749	1.18	16.00
Hyperbole with weights	0.744	1.02	15.33
Sector hyperbole	0.717	1.36	4.67
Risk-purged	0.706	0.80	3.33

Source: Authors

where the number of different variables is the sum of selected variables, so for the above case it would be a number of different variables: 1 (No. 14) + 3 (numbers 9, 31 and 34) + 17 (rest of variables) divided by the number of places, i.e. 9 + 13 + 4 and divided by three (because each experiment ran for 1NN, 3NN and 5NN). The formula would look like this:

$$\frac{21}{\left(\frac{26}{3}\right)}-1,$$

i.e. the result is equal to 1.42. The result can range in interval from zero to two, with zero being the lowest fluctuation (each *k*NN selects the same variables) and 2 meaning the maximum fluctuation (each *k*NN selects a completely different variable). A fluctuation in this case is actually similar to generalizability, and if low, same result of repeated experiments can be expected with higher probability. The Tab. III shows the available data on the average most-informative sets of variables.

Let's assume, similarly to informativeness, that if the experiment settings are the same and differ only in the method used for the evaluation of companies` performance, then lower fluctuation of selected variables means that the method used to divide the companies is better. Then we can better distinguish between the successes of the top three assessed methods for evaluating financial performance, for which the values of informativeness are very close to each other. The summation method, which had the highest value of informativeness, is among the best three in terms of fluctuation criteria and the difference between it and the hyperbole without weights method and the exponent method is also much larger now than it was only with informativeness. The average number of selected variables in most-informative set can further validate the selection of the summation method, since in the summation method is in average less than half chosen variables than in the hyperbola method without weights and the exponent method. While the *k*NN classifiers selected with summation method once six and twice three variables (9 different variables), with hyperbola without weights method it was six, sixteen and four variables (22 different variables) and with exponent method, nine, thirteen and four variables (21 different variables). In the latter two cases, more than half of the input variables were selected as most informative.

CONCLUSION

Research of corporate performance is the subject of many articles in economic journals; performance is often used as a dependent variable on a number of factors. Various authors approach its expression differently, and so expressions become numerous. Here we compare these approaches, raise arguments which direction to take, and offer options specific to work with the selected indicators so as to best express the level of performance of organizations, or to divide them into a high-performing or low-performing groups, respectively.

It is obvious that the search for the most appropriate method of expressing the performance of enterprises by one mean has undergone long development during our research; we therefore hope that this article may help facilitate the search of other researchers with similar problem.

Of the options offered for performance measurement, we have chosen, based on the literature research, traditional financial indicators because of their clarity, accessibility and relatively large objectivity. In order to express a company's performance from multiple angles, we worked with two indicators, each of which expresses one of two possible ways to improve company's financial performance. From a number of ways that can combine two indicators into one, we finally recommend for further use the method "Summation." We can say that this method has the highest discriminatory power for division of enterprises into two classes, and at the same time, with its help, the results have achieved relatively good generalizability. Additional advantages are that its output is a cardinal variable, thus widening the range of possible uses and, last but not least, ease of understanding and interpretation. Unlike the nature of nominal variable (the above-mentioned 13 clusters) we can draw conclusions such as 'the larger is the company, the greater is its success' and in arithmetic operations, necessary to obtain such variable, are not hidden processes that would eliminate some uses.

Other methods offering a very similar performance were the hyperbola without weights, and the exponent method. For both of them, however, fluctuation increased by approximately 25% compared to the summation method. In addition to this, for all methods using hyperbole, either the formation of ordinal dichotomous variables or nominal trichotomic variables is necessary, which, as we have previously stated, limits the possibilities of use. With the exponent method, although this disadvantage disappears, higher fluctuation of results and lower informativeness is probably caused by overly emphasizing the differences in financial results.

The other methods analysed are unsuitable in terms of the main criteria: informativeness. We can also add that one method, quintile, has potential to increase its success when used with other means of testing the relationship between factors of financial performance and the financial performance. Its 13-point ordinal scale was converted into a dichotomous division of more-successful vs. less-successful enterprises for the needs of SFFS algorithm and thus part of the information about the financial performance was lost. This, however, to an even greater extent applies to methods of Summation and Exponent.

SUMMARY

The aim of this paper is to find an appropriate method of expressing a company's performance in order to conduct a subsequent search for factors affecting its competitiveness.

While looking for expression of the company performance we have compared approaches of various authors, considered advantages and limitations of offered indicators to best express the level of performance of organizations, or to divide them into high-performing or low-performing groups, respectively. Based on this part of research we have chosen six-years time series of two indicators of financial performance: Return on Assets and Assets Growth, for they represent two basic different strategies a company can take to increase its financial performance.

Furthermore, it was necessary to group or sort studied companies by the values of these indicators. It is necessary, for most statistical methods, to express the dependent variable as a single number. To achieve this, we employed cluster analysis on a first place. Other means of combining the two chosen indicators followed. Eventually, we have developed a set of methods with "hyperbole", "Summation", "Exponent", and "Quintiles".

To evaluate the suitability of proposed methods assessing financial performance we have used methods from the area of statistical pattern recognition, namely, the algorithm of Sequential Floating Forward Selection (SFFS) with the main criteria informativeness. To evaluate the informativeness of tested sets of variables, we have used the classification method *k*-Nearest Neighbours.

Based on experiments we recommend the method "Summation", for its highest discriminatory power to sort companies into two classes (value of informativeness 0.765), and, for its results have achieved relatively good generalizability at the same time.

All experiments were based on data from relatively extensive empirical survey, which had produced around 700 variables describing more than 430 companies.

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