Multivariate statistical methods as a tool of financial analysis of farm businesses

Vícerozměrné statistické metody jako nástroj finanční analýzy zemědělských podniků

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Abstract: The paper is focused on the evaluation of the possibilities of analysing the relations between economic and financial indicators of farm businesses by the application of multivariate statistical methods. It also indicates the possibilities of the construction of a general economic indicator of business effectiveness.

Key words: financial analysis, financial ratios, multivariate statistical methods, correlation analysis, discriminant analysis, cluster analysis

Abstrakt: Práce je zaměřena na posouzení možnosti využití vícerozměrných statistických metod při rozboru ukazatelů používaných pro finanční analýzu k hodnocení podnikatelské činnosti a pro konstrukci souhrnných ukazatelů hodnotících ekonomickou efektivnost. Optimální výběr ukazatelů pro možnou tvorbu komplexních ukazatelů efektivnosti značně závisí na objektivnosti třídění podniků do skupin, které by měly být nezávislé na vypočtených ukazatelích. K třídění podniků jsme využili jednak hledisko úrovně hospodářského výsledku (kladný – záporný), jednak úrovně přírůstku investic oproti předchozímu roku (kladný – záporný). Pro statistickou analýzu byla využita neparametrická korelační analýza, metoda shlukové analýzy, regresní analýza a lineární diskriminační analýza. Využití uvedených metodických přístupů vedlo k závěru, že hodnocení podniků 25 ukazateli finanční analýzy je stejně efektivní jako hodnocení podniků založené jen na počtu pracovníků, výši výkonů, výši přidané hodnoty a úrovni hospodářského výsledku. Z toho vyplývá, že optimální poměrové ukazatele pro hodnocení podniků je možno konstruovat na základě výše uvedených absolutních ukazatelů. Uvedené závěry budou ověřeny v dalším pokračování úkolu. Práce je součástí řešení grantu EP 9358 „Finanční hodnocení českých zemědělských podniků, řešeného v rámci NAZV (Národní agentury pro zemědělský výzkum).

Klíčová slova: finanční analýza, finanční poměrové ukazatele, vícerozměrné statistické metody, korelační analýza, diskriminační analýza, shluková analýza

INTRODUCTION

There are a lot of financial indicators that can be easily derived from accounting (and other information systems) and can be easily interpreted independently.

In some cases, their predicability can be contradictory. In the view of one indicator, a business may seem to be excellent, in the view of another one, a business may be at an average or a low level.

We believe that even large systems of indicators do not bring new information and, moreover, the manipulation with them is difficult. Therefore, various general indices started to be used, including the systems of optimally selected indicators derived by the mathematical statistical methods.

In this paper, we concentrate on the application of multivariate methods to reduce the number of suitable indicators as a base for construction of a synthetic general index.

METHODOLOGY

Various financial ratios and indicators are used for the assessment of a business financial situation. The ratios are derived from absolute measures (indicators). We took these absolute measures from business balance sheets and income statements and we also included other basic characteristics (e. g. acrage and number of employees):

G	number of employees
H	acreage (ha)
I	total assets
J	fixed assets
K	current assets
J+K	fixed + current assets
L	inventory
M	equity
O	short-term liabilities
N+P	long-term liabilities + long-term bank credits
Q+R	short-term bank credits

P bank credits
S turnover
T sales of products and services
U value added
V depreciation
W earnings after taxes

The data were available for 120 farm businesses for the years 1997, 1998 and 1999.

The businesses were primarily divided into groups according to two economic criteria:
– earnings after taxes in the previous year,
– the increment of investments in comparison to the previous year.

For further analysis, some of the businesses had to be excluded because of their negative equity (13 business in 1998 and 12 business in 1999) that represents an unusual economic situation.

There may be created 4 groups of businesses based on the classification according to the two criteria mentioned above (Table 1).

Table 1. Classification of business to the groups

Earning after taxes	Investments	Resulting group
Negative	negative	A
Negative	positive	B1
Positive	negative	B2
Positive	positive	C

The numbers of businesses assigned to the groups A, B1, B2, C in the years 1998 and 1999 are given in the Table 2.

The group C is the best, the group A is the worst.

Table 2. The numbers of businesses in the groups

Group	Number of businesses 1998	Number of businesses 1998
A	27	41
B1	7	9
B2	47	28
C	17	19
Total	98	97

Our aim was to optimise the selection of indicators that would enable to classify the businesses into the predefined groups (A, B1,B2, C) in the best way. In order to reduce the number of indicators and to select optimal indicators, we used the following statistical methods.
– Non-parametric methods: because the variables are not normally distributed we used as a measure of dependency of absolute indicators Spearman's correlation coefficient.
– Cluster analysis: was used for creating clusters (groups) of variables in such a way that variables (indicators) within the same cluster are correlated as much as possible while the correlation of variables from different groups has to be the lowest.
– Regression analysis: linear regression was used for the description of the relations between the above mentioned variables (absolute indicators). These input variables are not normally distributed and, moreover, it appeared in the course of regression analysis that frequently with the growth of an indicator increases the variability of dependant indicator. Therefore we used logarithmic transformation of variables to homogenise variability.

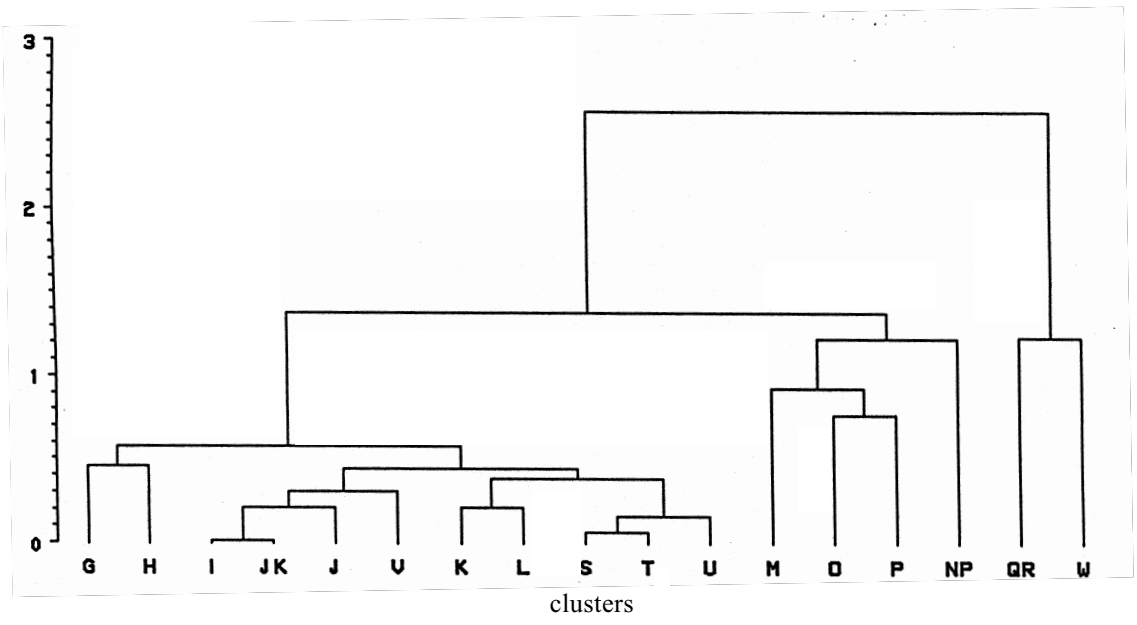

Figure 1. Hierarchical clustering of absolute indices – complete linkage method

– Linear discriminant analysis: was used to construct a discriminant function which enables to classify businesses into the groups (A, B1, B2, C). The method enabled to select the set of optimally discriminating absolute indicators that were transformed by a logarithmic transformation (For this transformation, the values of absolute indicators were suitably shifted into the area of positive values).

THE ANALYSIS OF THE RELATIONS BETWEEN ABSOLUTE INDICATORS

The relations between absolute indicators were characterised by the Spearman correlation coefficients, which are presented in the Table 3. There is a high correlation of assets I, J, K. The variable I is practically a sum of variables J+K. On the other hand, there are very low correlations of indicators with earnings after taxes (W). W therefore appears to be only very weakly linked with other indicators in contradiction to usual economic expectation. There is a weak negative correlation of W with M, N+P, O that should be mentioned. A weak correlation of Q+R with other variables indicates that bank credits are extended according to other criteria than financial indicators (e. g. long-term relationship, the role of credit risk mitigation etc.). The role of bank credit in the financial structure of farm businesses does not seem to be important.

The correlations of indicators are illustrated in the Figure 1 by dendrogram that represents the result of clustering of absolute indicators by the method of complete linkage. As a measure of similarity of variables, we chose the square of the Spearman correlation coefficient.

We can see in the dendrogram that variables M, O, P, NP, QR, W form relatively isolated one-point clusters and are dissimilar to other variables. The other remaining variables can be grouped into 4 clusters: (G, H), (I, JK, J, V), (K, L), (S, T, U).

These clusters are in accordance with the economic interpretation:
– cluster I, JK, J, V – represents assets and their items,
– cluster K, L – includes current assets and their important item: inventories,
– cluster S, T, U – represents the income statement indicators,
– cluster G, H – represents productive assets.

The isolated variables (M, O, P, NP, QR, W) which represent the individual items (liabilities, equity, earnings after taxes) give an evidence of big differences and instability in the present farm businesses financial structure.

Generally, in the process of construction of ratio indicators the dependencies of variables used in nominator with those used in denominator should be analysed. Regression and correlation statistical methods form a useful tool for such analysis.

Table 3. Matrix of Spearman correlation coeffients

	G	H	I	J	K	JK	L	M	NP	O	QR	P	S	T	U	V	W
G	1.00	0.79	0.85	0.80	0.84	0.84	0.82	0.71	0.51	0.67	0.30	0.66	0.87	0.86	0.85	0.79	0.04
H	0.79	1.00	0.83	0.79	0.82	0.82	0.82	0.66	0.53	0.65	0.31	0.71	0.84	0.84	0.84	0.83	0.16
I	0.85	0.83	1.00	0.98	0.94	1.00	0.90	0.80	0.65	0.70	0.30	0.76	0.92	0.92	0.90	0.93	0.08
J	0.80	0.79	0.98	1.00	0.86	0.98	0.85	0.79	0.64	0.68	0.29	0.75	0.87	0.87	0.86	0.92	0.05
K	0.84	0.82	0.94	0.86	1.00	0.94	0.94	0.73	0.64	0.65	0.31	0.74	0.94	0.93	0.92	0.85	0.16
JK	0.84	0.82	1.00	0.98	0.94	1.00	0.91	0.80	0.65	0.69	0.30	0.76	0.92	0.92	0.90	0.92	0.08
L	0.82	0.82	0.90	0.85	0.94	0.91	1.00	0.74	0.59	0.62	0.36	0.72	0.89	0.87	0.89	0.81	0.14
M	0.71	0.66	0.80	0.79	0.73	0.80	0.74	1.00	0.15	0.50	0.22	0.56	0.70	0.70	0.68	0.72	-0.02
NP	0.51	0.53	0.65	0.64	0.64	0.65	0.59	0.15	1.00	0.42	0.27	0.61	0.69	0.68	0.70	0.65	0.30
O	0.67	0.65	0.70	0.68	0.65	0.69	0.62	0.50	0.42	1.00	0.34	0.57	0.68	0.67	0.63	0.65	-0.03
QR	0.30	0.31	0.30	0.29	0.31	0.30	0.36	0.22	0.27	0.33	1.00	0.42	0.33	0.33	0.31	0.30	-0.05
P	0.66	0.71	0.76	0.75	0.74	0.76	0.72	0.56	0.61	0.57	0.42	1.00	0.78	0.78	0.75	0.76	0.15
S	0.87	0.84	0.92	0.87	0.94	0.92	0.89	0.70	0.69	0.68	0.33	0.78	1.00	0.99	0.96	0.88	0.22
T	0.86	0.84	0.92	0.87	0.93	0.92	0.87	0.70	0.68	0.67	0.33	0.78	0.99	1.00	0.95	0.88	0.20
U	0.85	0.84	0.90	0.86	0.92	0.90	0.89	0.68	0.70	0.63	0.31	0.75	0.96	0.95	1.00	0.88	0.31
V	0.79	0.83	0.93	0.92	0.85	0.92	0.81	0.72	0.65	0.65	0.30	0.76	0.88	0.88	0.88	1.00	0.08
W	0.04	0.16	0.08	0.05	0.16	0.08	0.14	–0.02	0.30	–0.03	-0.05	0.15	0.22	0.20	0.31	0.08	1.00

THE SELECTION OF OPTIMALLY DISCRIMINATING INDICATORS

By means of the discriminant analysis, we studied the effectiveness of classification of the businesses into the predefined groups A, B1, B2, C. As we pointed above ,the discrimination was based on logarithms of absolute indicators.

It came forward that it was not possible to distinguish between groups A and B1. Therefore, in further analysis we joined these two groups into one. Similarly, it was not possible to distinguish between groups B2 and C and these groups were also merged. According to this, finding the criterion of increment of fixed assets is not suitable for definition of basic groups. The reason is generally low investment activity of businesses.

Therefore we applied the discriminant analysis to classify the businesses into two groups A+B1 and B2+C. The linear discriminant analysis leads to the conclusion that classification based on all absolute variables is as effective as the classification based on the four following variables only:

G number of employees
S turnover,
U value added,
W earnings after taxes.

This conclusion follows from stepwise (as well as from forward and also backward) method for selection of variables in the discriminant analysis.

The optimal financial ratios for the classification of businesses could be therefore built on the base of absolute measures G, S, U and W only.

The following table represents the results of discriminant analysis based on the data from the years 1998 and 1999. The table shows that the classification of businesses belonging to the group B2+C is very accurate (Table 4).

Table 4. The results of the discriminant analysis of businesses in the years 1998 and 1999

From class		To class		
		B2 + C	A + B1	Total
B2 + C	number	107	3	110
	%	97.27	2.73	100.00
A + B1	number	21	61	82
	%	25.61	74.29	100.00
Total	number	128	64	192
	%	66.67	33.33	100.00

CONCLUSION

The results of the analysis show that multivariate statistical methods may be an effective tool of:

– the analysis of the relations between economic indicators
– the reduction of the number of indicators that are used for the assessment of a business financial and economic situation.

The optimal selection of indicators to form a general indicator or score depends strongly on the objectiveness of the basic classification of businesses into predefined groups. The definition of these basic groups of businesses should not depend on the indicators used in discriminant analysis. For this basic classification, expert opinion and expert classification could be used.

The hitherto research confirmed that the classification of businesses into groups without an intimate acquaintance of the classified businesses is very difficult and provides only a rough classification into bigger groups. We believe that for further refinement of classification we would be able to complement the inputs by the qualitative non-financial data, e. g.:

– whether the business has any general problems of financial management
– whether the business has a clear strategy
– what is the relation between the receivables and liabilities past due
– what is the production specialisation.

The above mentioned analyses showed that the interpretation of financial indicators cannot be done without previous formal mathematical analysing of the whole system of indicators. It also indicated that the interrelationships between generally used indicators have to be taken into account when constructing the system of indicators to be used for the financial analysis.

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