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CANONICAL VARIATE ANALYSIS APPLIED TO DETERMINE FACTORS INFLUENCING THE FINANCIAL SITUATION OF FEED ENTERPRISES

ABSTRACT. The purpose of this study was to present the factors that determine the financial situation of feed enterprises under different economic conditions. In the pursuit of its main objective, this paper also identifies enterprises which share similar financial characteristics. The goals defined above were sought with the use of canonical analysis. The variables used in the analysis were calculated based on the financial performance figures of feed enterprises carrying out economic activity in 2008-2013 on a continuous basis and delivering complete financial statements throughout that period. Their financial standing was assessed with indicators that allow to describe corporate operations in all areas of economic activity, i.e. liquidity, financial support, managerial efficiency and financial efficiency. This research found that while the group of feed enterprises is relatively homogeneous in terms of financial standing, it includes outliers exhibiting clearly different characteristics of the cash conversion cycle. The conclusion from this study is that operators who stand apart in terms of their different financial situation are engaged in animal production in addition to their core business (which is animal feed production). This suggests they follow a multi-modal activity pattern. The study also confirmed that during the economic downturn (in 2009), the operators surveyed saw their financial performance deteriorate. Conversely, they recorded an improvement in the years of economic upturn (2012). Another conclusion is that liquidity ratios exhibited greater variation.

INTRODUCTION

In an era of continuously increasing risks, primarily driven by competition and globalization and the growing complexity of economic processes in both a domestic and international environment [Czerny 2011], one of the major issues of corporate management is to make sure the company's status, position and operational efficiency allow it to continue its activity and deliver value to its owners [Czerwińska-Kayzer 2018]. The above is all the more important since it is difficult to establish the right diagnosis, i.e. to clearly identify the areas that threaten the company's financial situation. This is primarily due to multiple factors which often cannot easily be foreseen. Also, it is difficult to quantify the direction and strength of their financial impact on the enterprise [Dziura 1995]. Financial indicators are widely used in generalizing considerable amounts of financial information

and in "condensing a complicated reality" [Weber 2002]. Despite their being widespread, the theory of finance has so far failed to identify a specific set of indicators that present the financial standing of an enterprise in a precise and unbiased manner [Bieniasz et al. 2008]. It is generally assumed that the assessment of the financial situation of a company should cover all areas of its economic activity (i.e. liquidity, financial support, managerial efficiency and financial efficiency), and that the indicators should match the purpose of the analysis [Birgham 1996, Kowalak 2003, Waśniewski 2004, Bednarski 2007, Sierpińska, Jachna 2007, Nowak 2007, Gabrusewicz 2014, Gołębiowski et al. 2014]. This means that despite generating broad interest, the identification of factors that enable an enterprise to maintain its financial standing continues to be an open and current problem. However, as noted by Joanna Stanisławska and Joanna Florek [2013], the search for the determinants of the financial condition (based on financial ratios) should be supported with econometric methods.

The main purpose of this paper is to present the factors that determine the financial situation of feed enterprises under different economic conditions. In the pursuit of its main objective, this paper also identifies enterprises which exhibit similar or different economic and financial characteristics. In finding the determinants of the financial situation, this paper relied on canonical analysis. The relevant variables were calculated based on financial performance figures of feed enterprises. This group of enterprises was selected to address the requirements of research carried out under the Multi-annual Programme of the Ministry of Agriculture and Rural Development[1].

The proposed approach to the financial analysis of enterprises is a valuable source of information for corporate benchmarking, and will make it easier to assess the outcomes of measures taken and find out what the impact of different factors on economic performance is.

MATERIAL AND METHODS OF STUDIES

The financial condition is measured and assessed with the use of different synthetic financial indicators [Sierpińska, Jachna 2007]. On the one hand, this study takes account of information needs of the greatest possible group of stakeholders. On the other hand, the authors realize that the operators surveyed must be described in the context of different financial aspects [Gabrusewicz 2014]. Therefore, this study uses indicators that address four operating areas of an enterprise, i.e. liquidity, financial support, managerial efficiency and financial efficiency. Research by Tomasz Maślanka [2008], Ross Kirkham [2012], Sulayman H. Atieh [2014] and Dorota Czerwińska-Kayzer [2018] suggests that in order to be complete, the assessment of liquidity and cost-efficiency should be based on both accrual- and cash-based indicators. Hence, this analysis uses the following ratios describing the operators' economic efficiency and capacity to timely repay liabilities:
- ratio of cash from operating activities to net sales [x_1] which is the surplus cash derived from one-zloty worth of sales;

- ratio of cash from operating activities to total assets $[x_2]$ which illustrates the capacity of assets engaged to generate cash from operations;
- current ratio $[x_3]$ which is the most synthetic way of assessing the operator's capacity to meet its short-term liabilities, and is expressed as the proportion between current assets and current liabilities;
- quick ratio $[x_4]$ which is calculated as the ratio of current assets less stocks and deferred charges to current liabilities, and shows whether the payment of short-term liabilities is secured with the most liquid current assets;
- cash conversion cycle (in days) $[x_5]$, which is calculated as the difference between the operating cycle and days payable outstanding, and shows the number of days it takes for cash to return to the enterprise (and, thus, reflects the transformation of working capital);
- the sufficiency of operating cash to repay short-term liabilities $[x_6]$, calculated as the ratio between operating cash flow and current liabilities,
- return on sales $[x_7]$ which presents the margin on sales revenue and is expressed as the ratio between profit from sales and sales value;
- return on assets $[x_8]$ which is the ratio between net profit and total assets, and shows the amount of profit per unit of assets engaged;
- return on equity $[x_9]$ which measures the benefits earned by capital providers and is expressed as the ratio of net profit to equity.

In addition to the ratios listed above, this analysis uses two indicators of financial support, i.e. the debt ratio $[x_{10}]$ and self-financing ratio $[x_{11}]$. The first one is the ratio between total liabilities and total corporate assets, and therefore shows the contribution of external capital to asset financing. In turn, the second one is the ratio between equity and total liabilities, and measures the company's self-financing capacity and financial security. The last indicator covered by this study is the assets turnover ratio $[x_{12}]$ which shows how fast assets are converted into sales revenue and is expressed as the proportion between the sales value and total assets.

The study relied on data from individual annual financial statements of 17 feed enterprises. The study sample was selected purposefully. The analysis covered feedingstuffs companies which underwent a direct interview in 2018 for the purposes of the Multi-annual Programme of the Ministry of Agriculture[1]; were engaged in continuous economic activity in 2008-2013; and prepared and published their financial statements throughout that period.

This study used multidimensional analytic tools to identify the key factors that determine the financial situation of feed enterprises. Let us assume the structure of a model for k-th financial ratios coming from the i-th feed enterprises producer ($i = 1,.., I$; here $I = 17$) and the j-th year ($j = 1,…, J$; here $J = 6$):

$$x_k(i,j) = \mu_k + \alpha_k(i) + \beta_k(j) + e_k(i,j) \tag{1}$$

where for the k-th indicator ($k = 1,…,K$; here $K = 12$):
μ_k presents general mean values, $\alpha_k(i)$ is the effect of the i-th feed enterprises producer, $\beta_k(j)$ is the effect of the j-th year, $e_k(i,j)$ is the error related with the combination of the i-th producer in the j-th year.

Due to correlations between financial ratios, it was sufficient to use tools of multivariate analysis for the determination of differences between feed enterprises and years. Hence, the considered model (1) for one producer and one year can be presented in the form:

$$\mathbf{x}(i,j) = \boldsymbol{\mu} + \boldsymbol{\alpha}(i) + \boldsymbol{\beta}(j) + \mathbf{e}(i,j) \tag{2}$$

where: $\mathbf{x}(i,j) = [x_1(i,j), \dots, x_K(i,j)]'$; $\boldsymbol{\mu} = [\mu_1, \dots, \mu_K]'$; $\boldsymbol{\alpha}(i) = [\alpha_1(i), \dots, \alpha_K(i)]'$

$\quad\quad \boldsymbol{\beta}(j) = [\beta_1(j), \dots, \beta_K(j)]'$; $\quad \mathbf{e}(i,j) = [e_1(i,j), \dots, e_K(i,j)]'$

The model (2) can be described in the matrix form:

$$\mathbf{X} = \mathbf{1}_N \boldsymbol{\mu}' + \mathbf{P}_1 \boldsymbol{\alpha} + \mathbf{P}_2 \boldsymbol{\beta} + \mathbf{U} \tag{3}$$

where: $\mathbf{X} = [\mathbf{x}(1,1), \dots, \mathbf{x}(1,J), \mathbf{x}(2,1), \dots, \mathbf{x}(I,J)]'$; $\boldsymbol{\alpha} = [\boldsymbol{\alpha}(1), \dots, \boldsymbol{\alpha}(I)]'$; $\boldsymbol{\beta} = [\boldsymbol{\beta}_1, \dots, \boldsymbol{\beta}_J]'$

$\quad\quad \mathbf{U} = [\mathbf{e}(1,1), \dots, \mathbf{e}(1,J), \mathbf{e}(2,1), \dots, \mathbf{e}(I,J)]'$

$\quad\quad \mathbf{P}_1 = \mathbf{I}_I \otimes \mathbf{1}_J; \quad\quad \mathbf{P}_2 = \mathbf{1}_I \otimes \mathbf{I}_J$

(the symbol $\otimes$ denotes the Kronecker product of matrices).

Finally the considered model (3) can be presented in the form:

$$\mathbf{X} = \mathbf{P}\boldsymbol{\Xi} + \mathbf{U} \tag{4}$$

where: $\mathbf{P} = [\mathbf{1}_N \vdots \mathbf{P}_1 \vdots \mathbf{P}_2]$ and $\boldsymbol{\Xi}' = [\boldsymbol{\mu} \vdots \boldsymbol{\alpha}' \vdots \boldsymbol{\beta}']$

Two matrices were analyzed:

$\mathbf{C}_1\boldsymbol{\Xi}_1$, $\mathbf{C}_2\boldsymbol{\Xi}_2$ where $\mathbf{C}_1 = \mathbf{I}_I - \frac{1}{I}\mathbf{1}_I\mathbf{1}_I'$, $\mathbf{C}_2 = \mathbf{I}_J - \frac{1}{J}\mathbf{1}_J\mathbf{1}_J'$ and the matrix $\boldsymbol{\Xi}_1$ and $\boldsymbol{\Xi}_2$ can be written as follows $\boldsymbol{\Xi}_1 = (\mathbf{Y}_1'\mathbf{Y}_1)^{-1}\mathbf{Y}_1'\mathbf{X}$ and $\boldsymbol{\Xi}_2 = (\mathbf{Y}_2'\mathbf{Y}_2)^{-1}\mathbf{Y}_2'\mathbf{X}$. The elements of the matrix $\mathbf{C}_1\boldsymbol{\Xi}_1$ are differences in financial ratios between the means of an individual feedingstuffs producer and the mean values of all producers. Similarly, the elements of the matrix $\mathbf{C}_2\boldsymbol{\Xi}_2$ are differences in financial indicators between a particular year and the mean value of all years.

The analyses performed to determine the relationship between financial ratios made it possible to present the position of selected feed enterprises in the space of the two first canonical variates [Lejeune, Caliński 2000, Kayzer 2019]. The method of canonical variate analysis, similar to principal component analysis, was chosen as it considers data sets coming from the multidimensional experimental linear model classified according to two sources of variability. In the case of our investigations on the differences between feedingstuffs producers, this method consists in transforming the matrix $\mathbf{C}_1\boldsymbol{\Xi}_1$ into a set of new variables, which carry similar information, but are distributed in multivariate Euclidean space [Lejeune, Caliński 2000]. Following the transformation, the matrix $\mathbf{C}_1\boldsymbol{\Xi}_1$ is presented in the form:

$$\mathbf{C}_1 \Xi_1 = \sum_{h=1}^{a} \lambda_{1h}^{-1/2} \, \boldsymbol{\psi}_{1h} \boldsymbol{\varphi}_{1h}' \tag{5}$$

where: $\alpha = min\ (K,\ I-1)$ and the vectors $\boldsymbol{\Psi}_{1h}$, $\boldsymbol{\varphi}_{1h}$ and scalars λ_{1h} are determined from equations of the form:

$$\mathbf{C}_1 \Xi_1 \mathbf{S}^{-1} (\mathbf{C}_1 \Xi_1)' [\mathbf{C}_1 (\mathbf{Y}_1' \mathbf{Y}_1)^{-1} \mathbf{C}_1']^{-} \boldsymbol{\psi}_{1h} = \lambda_{1h} \boldsymbol{\psi}_{1h} \tag{6}$$

$$(\mathbf{C}_1 \Xi_1)' [\mathbf{C}_1 (\mathbf{Y}_1' \mathbf{Y}_1)^{-1} \mathbf{C}_1']^{-} \mathbf{C}_1 \Xi_1 \mathbf{S}^{-1} \boldsymbol{\varphi}_{1h} = \lambda_{1h} \boldsymbol{\varphi}_{1h} \tag{7}$$

where: $\mathbf{S} = \frac{1}{N-r} \mathbf{X}' (\mathbf{I}_N - \mathbf{Y}(\mathbf{Y}'\mathbf{Y})^{-} \mathbf{Y}') \mathbf{X}$ ($r = I + J - 1$ is the order of matrix $\mathbf{Y}$).

The vectors $\boldsymbol{\psi}_{1h}$ are called the *h*-th canonical coordinate, and the vectors $\lambda_{1h}^{-1/2} \boldsymbol{\varphi}_{1h}$ are called the *h*-th dual canonical coordinate [Lejeune, Caliński 2000, Kayzer et al. 2018].

RESULTS AND DISCUSSION

The results of canonical analysis based on a comparison of selected characteristics of the financial standing of feed enterprises are shown in Figure 1. Based on the analysis, it was found that two operators, designated as M15 and M11 in Figure 1, were the furthest from the group of other companies covered by this study. This was largely caused by four variables, i.e. the cash conversion cycle (x_5), the extent of self-financing (x_{11}), the current ratio (x_3) and the quick ratio (x_{10}) (Table 1). Compared to other companies surveyed, these operators recorded relatively high values of variables referred to above. Their average cash conversion cycle was 77 and 70 days (vs. 40 days as the average duration in the study population). Also, these operators relied on self-financing to a relatively great extent (11.5% and 26.9% vs. 3.1% as the average value for the whole group). In turn, the average current ratios calculated for these operators were 6.8 and 19.3 (vs. 2.7 as the average for the study population), and the quick ratios were 4.4 and 17.2 (compared to the average level of 2.1).

Note that the greatest difference between the two outliers and the rest of the population is that they had a cash conversion cycle (x_5) longer by 30 days, on average. A similar trend was also true for the sufficiency of operating cash to repay short-term liabilities (x_6). In the two outliers, the average values of these ratios were 2.5 and 2.4, compared to 0.5 as the general average. In turn, it was the opposite for the assets turnover ratio: the average levels recorded in the two outliers were 0.7 and 1.1, whereas 50% of the study population had a ratio of no less than 2.2.

Another characteristic that made them stand apart from their peers is the scope of economic activity. In addition to animal feed production, the outliers carried out agricultural activity in the livestock sector. Hence, they can be regarded as operators who diversify their business.
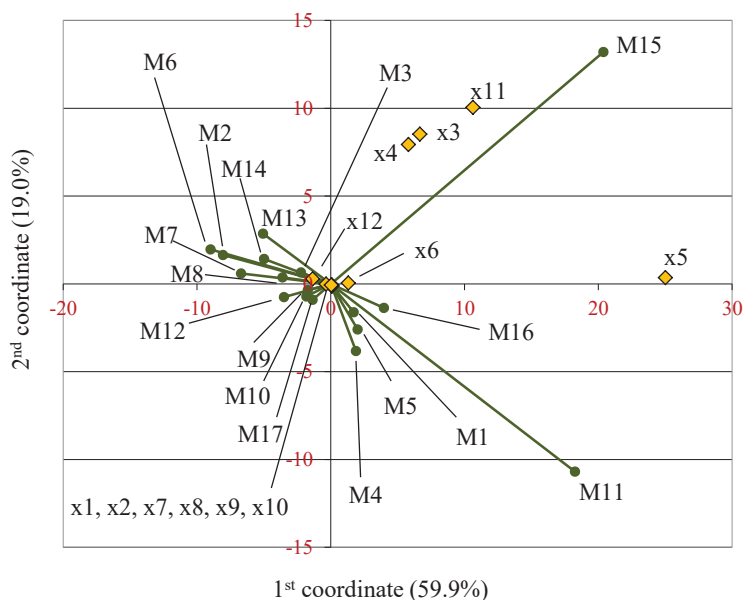
Figure 1. Position of feed enterprises determined by financial ratios in the space of the two first canonical variates and spacing of these indicators in dual space
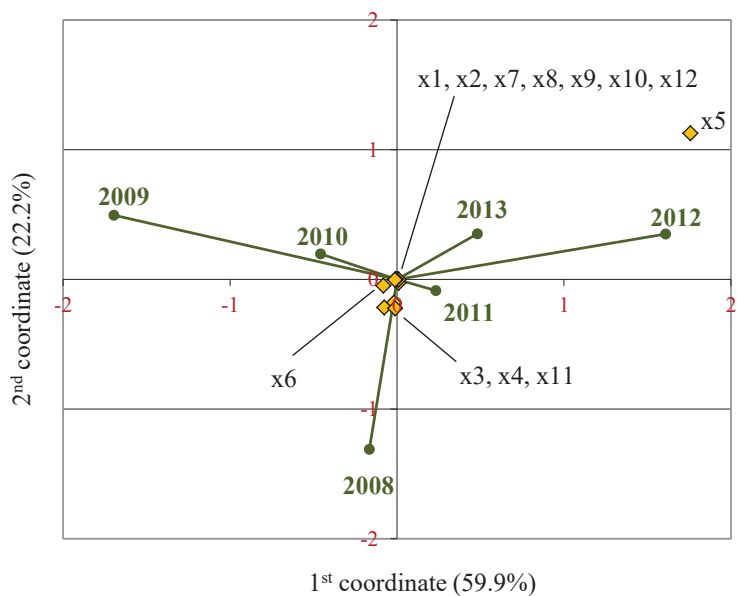
Source: own study

Figure 2. Position of particular years by financial ratios in the space of the two first canonical variates and the spacing of these indicators in dual space

Source: own study

Table 1. Differences of financial ratios between the mean value in individual feed enterprises and the general mean

Units	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}	x_{11}	x_{12}
M1	0.0175	0.1102	-0.631	-0.555	-9.716	0.262	0.016	0.084	0.108	-0.205	-0.562	0.668
M2	-0.0091	0.0752	-1.292	-1.149	-24.85	-0.129	-0.009	0.068	0.172	0.017	-2.153	2.313
M3	-0.0247	-0.0276	-0.932	-0.835	13.46	-0.309	-0.025	-0.013	-0.011	-0.040	-1.852	0.372
M4	0.0435	0.0406	-1.297	-1.052	-53.33	-0.099	0.044	0.021	0.221	0.170	-2.709	-1.027
M5	0.0023	0.0091	-1.107	-1.262	13.39	-0.128	-0.029	-0.012	-0.001	-0.193	-1.279	-0.335
M6	-0.0172	0.0017	-1.656	-1.440	-27.78	-0.358	-0.044	-0.078	-0.241	0.270	-2.790	0.945
M7	-0.0352	-0.0573	-2.112	-1.897	-64.94	-0.429	-0.039	-0.101	-0.199	0.219	-2.676	0.913
M8	-0.0240	-0.0401	-1.754	-1.404	-8.598	-0.406	-0.026	-0.068	-0.316	0.212	-2.777	-0.277
M9	-0.0551	-0.0998	-1.206	-1.071	61.95	-0.498	-0.008	-0.015	0.000	0.068	-2.281	-0.538
M10	-0.0179	-0.0345	-1.481	-1.309	22.46	-0.369	-0.011	-0.027	-0.019	0.105	-2.437	-0.496
M11	0.1480	0.1187	3.195	2.394	34.61	2.071	0.175	0.130	0.114	-0.406	8.437	-1.297
M12	-0.0210	-0.0302	-1.464	-1.319	2.919	-0.371	-0.007	-0.006	0.058	0.152	-2.578	-0.089
M13	-0.0257	-0.0204	-1.388	-0.967	-9.939	-0.337	-0.019	0.011	0.064	0.103	-2.397	0.888
M14	-0.0117	-0.0119	-1.600	-1.279	15.95	-0.35	-0.019	-0.036	-0.029	0.211	-2.669	-0.056
M15	0.0607	0.0022	16.98	15.22	27.92	1.885	0.037	0.017	-0.014	-0.454	23.85	-1.603
M16	-0.0132	-0.0139	-1.231	-1.078	-8.289	-0.138	-0.020	0.025	0.081	-0.191	-1.171	-0.493
M17	-0.0172	-0.0220	-1.022	-1.001	14.78	-0.296	-0.014	0.000	0.012	-0.037	-1.955	0.111
Mean	0.0413	0.0762	2.657	2.048	42.61	0.465	0.044	0.054	0.088	0.493	3.088	2.349

Source: own study

Table 2. Differences of financial ratios between the mean value for a particular year and the general mean

Year	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}	x_{11}	x_{12}
2008	0.0066	0.0222	0.906	0.733	-4.449	0.280	0.000	-0.013	-0.003	-0.001	0.973	0.086
2009	0.0345	0.0602	-0.053	-0.009	-6.273	0.412	0.004	0.021	0.050	-0.048	0.285	-0.026
2010	-0.0056	-0.0137	-0.358	-0.269	-2.962	-0.193	0.000	-0.004	-0.010	-0.001	-0.352	-0.146
2011	-0.0159	-0.0244	-0.456	-0.388	1.369	-0.245	0.002	0.007	0.025	0.005	-0.675	0.049
2012	-0.0288	-0.0572	-0.132	-0.153	6.508	-0.340	-0.008	-0.011	-0.047	0.040	-0.350	0.024
2013	0.0090	0.0130	0.093	0.084	5.808	0.086	0.002	0.001	-0.014	0.005	0.120	0.013

Source: own study

The analysis suggests that three other operators (M6, M2 and M7) also faced a different situation. They had short cash conversion cycles, relied on self-financing to a small extent and were affected by a lack of liquidity measured both with the current ratio and quick ratio. Conversely, they had a faster assets turnover. Note that two of them even had negative cycles which means that their entire current assets could be financed with short-term liabilities. A large share of liabilities is also confirmed by small values of the self-financing ratio which signifies a small proportion of equity in the capital mix. It should be emphasized that their activity consisted solely in manufacturing and selling feed for farm animals.

Based on these analyses, it was concluded that the profitability ratios (x_7, x_8, x_9), the debt ratio (x_{10}) and the cash generation ratios (x_1 and x_2) differed only slightly between the feedingstuffs producers covered by this study.

The second part of the study consisted of comparing the indicators of the financial situation recorded in the six-year period of 2008 through 2013, which included both an economic downturn and a rebound. The results of this part of the analysis are shown in Figure 2.

When analyzing the location of points corresponding to each year, the greatest differences were observed between 2009 and 2012. This was mostly due to changes in the cash conversion cycle which was relatively long in 2012 (an average of 49 days) and short in 2009 (an average of 36 days). Note that the sufficiency of operating cash to repay short-term liabilities followed an opposite trend. The average levels for 2009 and 2012 were 0.88 and 0.12, respectively (Table 2). This means that during the economic downturn, feed enterprises locked up their capital in stocks and receivables and raised greater amounts of funds needed to repay their liabilities. At the same time, conducting less efficient operations.

The study also suggests that in 2008 the current ratio (x_3), the quick ratio (x_4) and the extent of self-financing (x_{11}) were relatively high whereas other indicators, i.e. the assets turnover ratio (x_{12}), return on sales (x_7), return on assets (x_8), return on equity (x_9), the ratio of cash from operating activities to net sales (x_1) and the ratio of cash from operating activities to total assets (x_2) were much less volatile than other indicators.

SUMMARY

The following conclusions could be drawn from this study:

1. The values of indicators show that the outliers (in this case, M1 and M12) were different in their financial situation ratios, especially with regard to their capital structure and liquidity. What also made these operators stand apart from others was the scope of their economic activity. In addition to animal feed production, they carried out agricultural activity in the livestock sector. Hence, they were regarded as diversified businesses.
2. The variables used allowed to identify the differences in results between 2009 and 2012, i.e. between periods affected by different economic conditions. The former was marked by economic downturn while the latter saw a clear improvement in the economic and financial situation of the animal feed market.
3. There was a clear difference in the cash conversion cycle between the two analyses.
4. This study gives grounds for concluding that canonical analysis is the right method for capturing and presenting the differences between sets of variables (in this case, economic operators and study periods), and that the cash conversion cycle proved to be the best indicator of changes.

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ZASTOSOWANIE ANALIZY ZMIENNYCH KANONICZNYCH DO OKREŚLENIA DERERMINANT KONDYCJI FINANSOWEJ PRZEDSIĘBIORSTW PRODUKUJĄCYCH PASZE DLA ZWIERZĄT

ABSTRAKT

Celem badań było określenie czynników kształtujących kondycję finansową w przedsiębiorstwach produkujących pasze dla zwierząt w różnych uwarunkowaniach gospodarczych. Dodatkowo wskazano przedsiębiorstwa o podobnych cechach finansowych. Do realizacji tak sformułowanych celów wykorzystano analizę zmiennych kanonicznych. Zmienne wykorzystane w analizie obliczono na podstawie wyników finansowych przedsiębiorstw produkujących pasze, które w sposób nieprzerwany w latach 2008-2013 prowadziły działalność gospodarczą i sporządzały za ten okres pełne sprawozdanie finansowe. Do oceny kondycji finansowej wykorzystano wskaźniki, pozwalające scharakteryzować funkcjonowanie przedsiębiorstwa we wszystkich obszarach jego działalności gospodarczej, tj. płynności finansowej, wspomagania finansowego, sprawności gospodarowania i efektywności finansowej. Na podstawie przeprowadzonych badań stwierdzono, że w stosunkowo jednorodnej, pod względem kondycji finansowej, grupie podmiotów produkujących pasze występowały jednostki różniące się. Cechą wyraźnie wskazującą na odmienność podmiotów był cykl konwersji gotówki. W wyniku badań stwierdzono, że podmioty odróżniające się pod względem kondycji finansowej, obok podstawowej produkcji pasz, prowadziły także produkcję zwierzęcą, co wskazywało na działalność wielokierunkową. Badania potwierdziły, że w okresach spowolnienia gospodarczego (2009 rok) jednostki prowadziły mniej efektywną działalność, natomiast w latach poprawy uwarunkowań gospodarczych (2012 rok) jednostki gospodarcze gospodarowały lepiej posiadanym majątkiem. Ponadto z badań wynika, że większa zmiennością cechowały się wskaźniki płynności finansowej.

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