

**ECONOMICS**

*Sociology*

Jencova, S., Vasanicova, P., Gavurova, B., & Bacik, R. (2022). Financial position of companies operating in food processing industry of Slovakia by using multidimensional scaling. *Economics and Sociology*, 15(2), 253-273.  
doi:10.14254/2071-789X.2022/15-2/16

## FINANCIAL POSITION OF COMPANIES OPERATING IN FOOD PROCESSING INDUSTRY OF SLOVAKIA BY USING MULTIDIMENSIONAL SCALING

**Sylvia Jencova**

*University of Prešov,  
Prešov, Slovakia*

*E-mail:* [sylvia.jencova@unipo.sk](mailto:sylvia.jencova@unipo.sk)

ORCID 0000-0002-0736-0880

**Petra Vasanicova**

*University of Prešov,  
Prešov, Slovakia*

*E-mail:*

[petra.vasanicova@unipo.sk](mailto:petra.vasanicova@unipo.sk)

ORCID 0000-0001-7353-2057

**Beata Gavurova\***

*Technical University of Košice,  
Košice, Slovakia*

*E-mail:* [beata.gavurova@tuke.sk](mailto:beata.gavurova@tuke.sk)

ORCID 0000-0002-0606-879X

*\*Corresponding Author*

**Radovan Bacik**

*University of Prešov,  
Prešov, Slovakia*

*E-mail:* [radovan.bacik@unipo.sk](mailto:radovan.bacik@unipo.sk)

ORCID 0000-0002-5780-3838

*Received:* August, 2021

*1st Revision:* March, 2022

*Accepted:* June, 2022

DOI: 10.14254/2071-  
789X.2022/15-2/16

**JEL Classification:** L66,  
O14, G30

**ABSTRACT.** The food processing industry (FPI) is an integral part of the Slovak economy. This paper aims to compare the financial position of the largest companies operating in the Slovak FPI at the NUTS II level (Western, Central, and Eastern Slovakia Region) by using the multidimensional scaling (MDS) method. The second aim is to provide an intercompany comparison of these companies using methods of multi-criteria evaluation. The research sample consists of 60 largest companies whose ranking was obtained through the Register of the Financial Statements of the Slovak Republic according to the amount of generated revenues in 2019. The MDS method found out dissimilarity between the elements (eight financial ratios calculated for 2018 and 2020) of a set of objects (60 companies from FPI). The MDS resulted in two-dimensional matching configuration plots for the mentioned regions and years. Moreover, statistically significant values of Spearman's rank correlation coefficients show that most companies from the Slovak FPI reached a similar rank within all methods of multi-criteria evaluation. There are described the financial ratios (return on assets and return on equity) of the whole Slovak FPI in 2007-2020, separately for the Manufacture of food products (Division 10 of NACE Rev. 2), and for the Manufacture of beverages (Division 11). Partially, this paper also deals with the Manufacture of tobacco products (Division 12). The results of this study point to the importance of innovation in the FPI in the context of Industry 4.0.

**Keywords:** food processing industry, financial ratios, multidimensional scaling, Slovakia

## Introduction

The food processing industry (FPI) is closely connected with agriculture; it is the basis of food self-sufficiency. In Slovakia, the FPI has a long tradition and is an integral part of the industry as well as industrial production. The FPI must be understood as a strategic industry that ensures the food sovereignty of Slovakia and which has the potential for development to ensure the food self-sufficiency of the country at a sufficient level (Slaný and Tancošová, 2004).

Technological innovation is a key driver of economic growth (Kogan *et al.*, 2017; Hombert and Matray, 2018), while investment plays an irreplaceable role in any economy (Timková and Košíková, 2018). The Fourth Industrial Revolution, the digitization of processes, the sharing economy, the shrinking economy, and greening are already leading to the transformation of traditional production systems and a change in the understanding of production, services, and consumption (Pauhofová and Stehlíková, 2017; Krajčík, 2021, 2022; Ivanov *et al.*, 2021, Kavčáková & Kočíšová, 2020). Automation is associated with technological unemployment, with structural changes in the economy, which are quantified by the application of the Lilien indicator, the values of which indicate that this is not a significant shift. There are no structural changes in the direction of the reallocation of employees between industries, which would have the character of moving towards stabilizing employment. There are certain driving moments for automation that are very important to capture and expose (Urbancová *et al.* 2020; Pietrzak & Balcerzak, 2021). They are related to the controlled company formation, to the continuation of the trend of globalization, to the increase of the efficiency of work processes, the profit of corporations, and competitiveness at the corporate level (Hudáková *et al.* 2019; Cihelková *et al.* 2020, Hudáková-Stašová, 2021). This is also connected with the wide issue of offshoring when automation enables the transfer of some work tasks to countries with lower wages (Pauhofová and Stehlíková, 2017). The importance of the introduction of Industry 4.0 in Slovakia is highlighted in (Grejčíková and Krajčo, 2019).

The continuing decline in food and agricultural production, limited production efficiency, and inadequate innovative activity are eminent consequence of the weakening of Slovak agriculture, despite the measures of the Ministry of Agriculture and Rural Development of the Slovak Republic. The current situation associated with COVID-19 has affected the Slovak economy in all areas. Although the change is reflected in both retail chains and the food processing industry, this industry is one of the least affected by the corona crisis.

The aim of this paper is to compare the financial position of the largest companies operating in the Slovak FPI at the NUTS II level by using the multidimensional scaling (MDS) method. The second aim is to provide the intercompany comparison of these companies using multi-criteria methods.

## 1. Literature review

At present, the FPI has the equipment to process increasing agricultural production, but, in the context of Industry 4.0, it necessarily needs investment in modernization, innovation, and green manufacturing while respecting environmental protection requirements and maintaining the principles of sustainable development. With competition in the FPI rising, acquiring a competency in supply chain management has been a key to the success (Marcus and Anderson, 2006) of the companies operating in this industry. Industry 4.0 and technological adoption in the food supply chain was studied in (Kayikci *et al.*, 2022; Lezoche *et al.*, 2020); the state of the FPI in the context of Industry 4.0 was analyzed in (Luque *et al.*, 2017). Attention should be paid particularly to four major technologies: the Internet of things, the blockchain, big data, and

artificial intelligence (Lezoche *et al.*, 2020). Production performance indicators for FPI were measured by Soltanali *et al.* (by 2020).

Draganac (2016) applied financial indicators of the Du Pont model on a sample of food producers in Serbia. Financial indicators of the Du Pont model were also used by Firlej and Kubala (2019). The authors examined the profitability of selected food companies operating in Poland, specifically listed on the Warsaw Stock Exchange (WIG-Food). Arimany *et al.* (2014) studied the economic and financial situation of the major wine producing companies in Catalonia using data of their equity and cash flow. Kedžo and Lukač (2021) used a sample of the food and drink producing companies from 18 European countries and studied financial efficiency by using data enveloped analysis approach. They identified efficient producers according to liquidity, efficiency, leverage, and profitability indicators. Fenyves *et al.* (2020) examined the capital structure of agricultural and food companies of the Visegrad group countries. Their results showed that companies having large profitability are less likely to rely on debt. Isakson (2014) provided a literature review on the rise of finance in food provisioning, specifically, he dealt with the financial transformation of agro-food supply chains. Vukadinović *et al.* (2018) determined the financial position of three companies operating in the agricultural sector in Serbia by using the Altman Z-score and Kralicek Quick test. They pointed out the privatization processes. Notta and Oustapassidis (2001) studied the impact of consumer behavior on the profitability of food companies in Greece. Czerwińska-Kayzer *et al.* (2021) pointed out the existence of the multidirectional relationship between liquidity and profitability on a sample of companies from the food industry by using canonical variate analysis. Levine *et al.* (2003) analysed the relationship between food and beverage industry funding and published opinions about the safety and efficacy of olestra. Tong and Saladríguez (2022) investigated factors affecting the profit of the companies operating in the Spanish food industry. They used logistic model to suggest that indebtedness, profitability, and accounts payable can help to gain profit.

The studies (Adamišin *et al.*, 2017; Kravčáková *et al.*, 2019) deal with the economic analysis of non-financial corporations in the FPI. Predictive analysis for assessing the financial situation of companies in this industry in Slovakia is performed in (Chrastinová, 2013; Tóth, 2013; Gurčík, 2002). Jenčová and Jusková (2013) point to the specifics and uniqueness of agricultural companies, their impact on the structural development of agrarian entities, and the assessment of the financial situation.

Chrastinová *et al.* (2019) describe the macroeconomic situation of agriculture and food processing industries in terms of the social and the economic aspect by the share of these industries in the national economy during the years 2008-2017. They studied the development of the share of agriculture and food processing industries indicators in the indicators of the Slovak national economy, gross value added, employment, and average wage. Matošková and Uhrinčat'ová (2015) deal with the evaluation of the Slovak FPI economic situation concerning its economic and social aspects as well as the identification of economic indicators with an effect on employment in agriculture and the food processing industry. Misečka *et al.* (2019) devote to the food commodities market.

However, there is a research gap in modeling the financial position of companies operating in the Slovak FPI in space by applying the MDS method.

## 2. Food processing industry in Slovakia

In general, the FPI is defined as a sum of three divisions of the Statistical classification of economic activities in the European Community (NACE Rev. 2), specifically  
- Division 10–Manufacture of food products,

- Division 11–Manufacture of beverages,
- Division 12–Manufacture of tobacco products.

Division 10 include nine groups, namely 10.1–Processing and preserving of meat and production of meat products; 10.2–Processing and preserving of fish, crustaceans and molluscs; 10.3–Processing and preserving of fruit and vegetables; 10.4–Manufacture of vegetable and animal oils and fats; 10.5–Manufacture of dairy products; 10.6–Manufacture of grain mill products, starches and starch products; 10.7–Manufacture of bakery and farinaceous products; 10.8–Manufacture of other food products; 10.9–Manufacture of prepared animal feeds.

In 2021, the Slovak FPI employed 56,700 employees where operated more than 3,800 companies. According to the Statistical Office of the Slovak Republic, in 2021, average number of employees in the Slovak FPI was 39,145. In 2021, total of 5,789 economic entities operated in the Slovak FPI. In 2020, it was 5,336. In 2021, revenues from own outputs and merchandise were €5,035 billion. This is an increase of 5% (from 2020 to 2021). From 2019 to 2020, revenues decreased by 9.8%.

According to the Statistical Office of the Slovak Republic, in 2017, the Slovak FPI registered 3,900 companies, from which 3,152 companies belonged to Division 10 (Manufacture of food products). In 2017, the registered number of persons employed in the manufacture of food products was 37,021, and in the manufacture of beverages was 5,250. The amount of revenues in Division 10 was €3,772,349 thous., in Division 11 was €715,901 thous. The share of the FPI revenues (expected Division 12) on industrial production was 5.78%. In 2019, the revenues of 116 non-financial corporations entering our analysis reached €3,284,024 thous. The total revenues of the Slovak FPI were €4.4 bill. The negative international trade balance of the food products, in 2019, was €1.8 bill. Added value in the manufacture of food products was €674,171 thous., in the manufacture of beverages was €175,655 thous., i.e., 6.04% on the total added value of industrial production. The FPI reached positive earnings before interests and taxes (EBIT) in all Divisions. The personal costs in Division 10 were €464,670 thous., in Division 11 €85 307 thous. (i.e., 6.94% of industrial production) (Slovak Credit Bureau, 2022; SARIO, 2022).

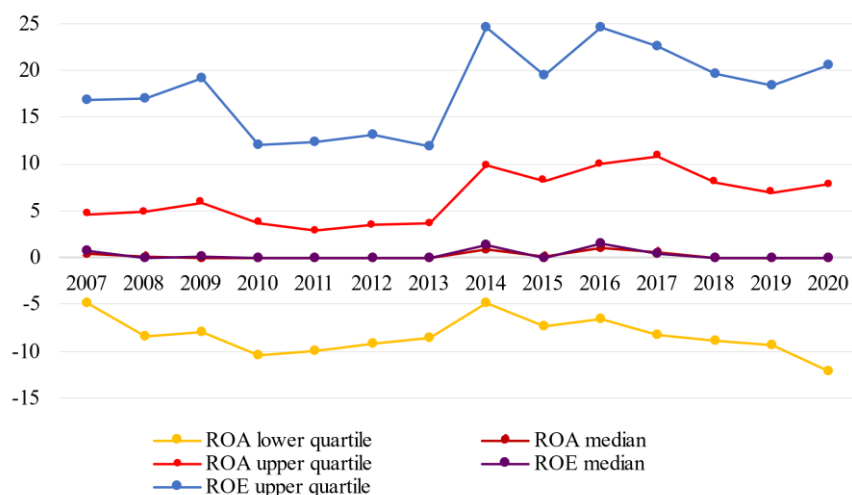
In most seasonal companies from the FPI, the inequality in the asset turnover cycle results from the seasonal nature of agricultural production. In industrial enterprises and industries processing perishable agricultural raw materials, the seasonal nature of agricultural production is reflected not only in the seasonal accumulation of raw materials but also in the seasonal accumulation of finished products (in FPI: sugar factories, meat industry, dairies, canneries, etc.). In these cases, the seasonal nature of agricultural production is reflected in the unbalanced asset turnover cycle of the particular industrial companies, in all three stages. This impact on the seasonal nature of the production can be gradually reduced by creating technological storage conditions that allow raw materials to be stored for a longer period (until a new crop is harvested) without deteriorating their quality. This group of industrial seasonal enterprises also includes those in which production is interrupted for a certain period each year (sugar factories, some canneries, distilleries, etc.).

In Graph 1 and 2, we present the development of median, lower, and upper quartile of financial ratios, namely return on equity (ROE) and return on assets (ROA), for two divisions of the Slovak FPI (the manufacture of food products and the manufacture of beverages). In the following part, we describe several financial ratios of the Slovak FPI obtained using own calculations according to data from Slovak Credit Bureau (2022).

The median of the current ratio, in Division 10, grew from 0.86 (in 2007) to 1.25 (in 2018). In Division 11, it reached values from 1.3 to 2.03. The median of the current ratio, in the manufacture of tobacco products, reached 2.03 in 2018. The worst results were in 2008 and 2009 caused by the financial crisis (Slovak Credit Bureau, 2022).

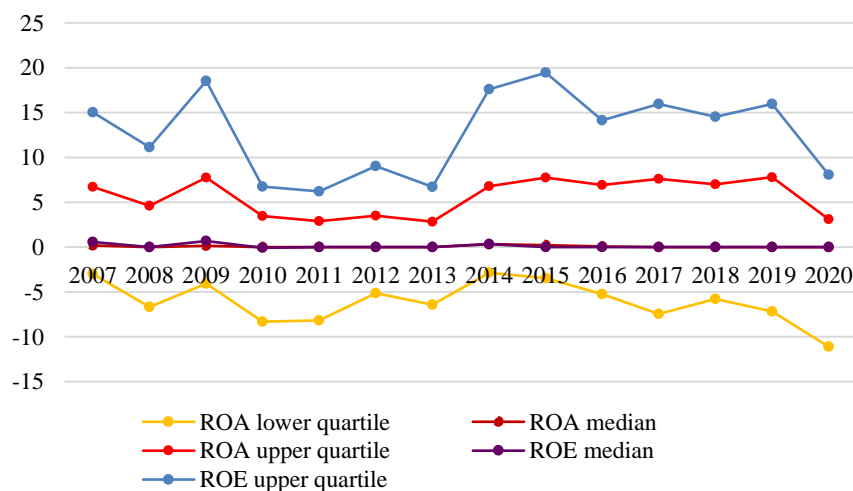
In general, the analysis of activity ratios points to a favorable financial situation within the entire industry, which has caused that the efficiency of the food companies processes has an immediate reflection on the EBIT and the basic earning power ratio of the company. On the other hand, it is necessary continually monitor average collection period ratios, while the median for Division 10 reached a positive decline from 43.72 days (in 2007) to 23.28 days (in 2018), for Division 11 from 52.87 days (in 2007) to 20.19 days (in 2018), and for Division 12 from 448.46 days (in 2007) to 45.14 days (in 2017). In contrast, food companies pay their liabilities much sooner before they collect them (Slovak Credit Bureau, 2022).

While non-financial corporations in Divisions 10 and 11 reach the recommended limits of the total debt to total assets ratio, non-financial corporations in the manufacture of tobacco products achieve high indebtedness (the median of total debt to total assets ratio is 146.6%). The earnings before interest, taxes, depreciation, and amortization (EBITDA) to sales ratio decreased by 0.8% year-on-year in the manufacture of food products, by 4% in the manufacture of beverages, and by 80% in the manufacture of tobacco products (Slovak Credit Bureau, 2022).



Graph 1. Development of quartiles of ROA (%) and ROE (%) in the NACE Division 10 - Manufacture of food products

Source: own processing according to data from Slovak Credit Bureau



Graph 2. Development of quartiles of ROA (%) and ROE (%) in the NACE Division 11 - Manufacture of beverages

Source: own processing according to data from Slovak Credit Bureau

### 3. Data and methodology

#### 3.1. Data

This paper aims to compare the financial position of the largest companies operating in the Slovak FPI at the NUTS II level by using the multidimensional scaling (MDS) method. The second aim is to provide intercompany comparison using multi-criteria methods (i.e., ranking method, scoring method, method of normed shape, and method of distance from a fictitious object - TOPSIS), while the procedure and formulas for used methods are according to Jenčová (2018).

The research sample consists of a set of 60 largest companies of the Slovak FPI, whose ranking was obtained through the Register of the Financial Statements of the Slovak Republic according to the amount of generated revenues in 2020. We analyse 36 companies from Western Slovak Region, 10 Central Slovak Region, and 14 from Eastern Slovak Region. The data from which the financial indicators were calculated were obtained from the Register of the Financial Statements of the Slovak Republic. In Appendix, Table 5, 6, and 7 shows the list of the companies that make up the research sample. Moreover, in this table, we present the codes of companies that are used in the resulting graphs and the NUTS II region, to which the company belongs to. In these tables, we use the exact names of the companies and the legal form of the company in the Slovak language, where “a. s.” denotes incorporated company (Inc.), “s.r.o.” denotes limited liability company (Ltd.).

Financial ratios have traditionally been indicators of the overall performance of the company (Kliestik *et al.*, 2020). Therefore, the financial indicators used in the MDS to fulfil the first aim of this paper are the following: return on assets (ROA), return on sales (ROS), return on investment (ROI), financial leverage (FL), added value to personal costs ratio (AVPC), added value to sales ratio (AVS), personal costs to sales ratio (PCS), assets turnover (sales to assets ratio, AT). MDS is provided for the financial ratios in 2018 and 2020. Table 1 shows descriptive statistics of mentioned financial ratios for 60 analysed companies.

Table 1. Descriptive statistics of financial ratios of 60 companies analysed in MDS

Indicator	2018					2020				
	Mean	Median	Min	Max	Std. dev.	Mean	Median	Min	Max	Std. dev.
<b>ROA</b>	0.091	0.030	-0.149	1.826	0.254	0.063	0.024	-0.247	0.573	0.130
<b>ROS</b>	0.041	0.023	-0.131	0.297	0.068	0.037	0.015	-0.136	0.297	0.080
<b>ROI</b>	0.063	0.025	-0.160	1.429	0.196	0.043	0.018	-0.228	0.358	0.105
<b>FL</b>	2.999	2.522	-3.508	14.481	2.765	2.669	2.808	-66.697	26.359	9.920
<b>AVPC</b>	0.198	0.199	-0.011	0.634	0.120	1.820	1.661	-0.135	6.922	1.017
<b>AVS</b>	0.198	0.199	-0.011	0.634	0.120	0.184	0.168	-0.009	0.622	0.118
<b>PCS</b>	0.126	0.113	0.009	0.406	0.073	0.112	0.102	0.006	0.393	0.064
<b>AT</b>	2.019	1.470	0.398	17.318	2.275	1.849	1.507	0.356	9.771	1.386

Source: *own compilation*

The intercompany comparison is provided using productivity financial ratios (ROA, ROS, added value to sales ratio) and the intensity financial ratios (personal costs to sales ratio). The ranking of companies is compiled for each year from 2015 to 2020.

### 3.2. *Multidimensional scaling*

The requirement for multidimensional scaling of objects is oscillation in the choice of characters, their importance, or oscillation in time. The idea of MDS is closely related to dimensionality reduction of data and their graphical representation. The purpose of MDS is to specify the number of dimensions, location of objects (coordinated of objects). The greater the similarity between the two objects, the closer the points that appear in the model. The main aspect is determining the number of dimensions in the MDS model to adequately capture the structure of similarities (Hendl 2015). The goal is to keep the number of dimensions as small as possible and the best accuracy of the fit.

We obtain results of MDS using Stata, while we use modern MDS that specifies modern scaling. For modern MDS, the optimal transformation to disparities is calculated during the estimation. To measure the accuracy of the fit, we use stress loss function normalized by the squared Euclidean distances. The formula is given by

$$stress = \sqrt{\frac{\sum_{k=1}^m (d_{ij} - \hat{d}_{ij})^2}{\sum_{k=1}^m (d_{ij} - \bar{d})^2}}$$

where  $d_{ij}$  is the Euclidean distance that indicate how remote two objects (in this paper, the objects are companies)  $i$  and  $j$  are, and  $\hat{d}_{ij}$  is the predicted distance achieved by the MDS model, the value of which depends on the number of dimensions achieved and the algorithm used (Kruskal and Carmone, 1967). According to Kaufman and Rousseeuw (1990),  $d_{ij} = 1 - s_{ij}$ , where  $s_{ij}$  is similarity indicates how close (alike) two objects (companies) are.

The stress value around 0.2 indicates poor goodness of fit; 0.1 means fair goodness of fit; 0.05 is good fit; 0.025 is excellent fit, and 0.00 represents perfect goodness of fit. Acceptable values of stress depend on the quality of the distance proximity matrix and the number of objects in that matrix.

## 4. Results and discussion

According to evaluating the competitiveness of industries by modelling the volume of sales (Jenčová, 2018), taking into account the negative coefficient of the competitiveness in 2008 and 2010, we can include the manufacture of food products, beverages, and tobacco products to the group of fewer competitiveness industries. In the following years analysed, the coefficient of competitiveness developed positively, which made it possible to place the FPI in the group of competitive.

The financial indicators of food companies in 2020 were influenced by many determinants, mainly legislative changes, investments in the modernization of production, expansion of capacities, increasing purchase prices, food imports, and many others, whether positive or negative. Due to the high level of automation, modern FPI requires a strong focus on research as well as a close relationship with the natural sciences.

### 4.1. *Results of the multi-criteria evaluation*

The impact of the Covid-19 pandemic did not have a negative impact on the profit of analysed companies. Table 2 presents results of average ranking of companies for the period from 2015 to 2020. Average ranking was calculated as arithmetic mean of all four rankings calculated according to the mentioned methods of multi-criteria evaluation (i.e., ranking

method, scoring method, method of normed shape, and method of distance from a fictitious object - TOPSIS). Table 2 also shows year-on-year change of the country's position in the ranking.

Table 2. Average ranking of companies based on multi-criteria evaluation

Company	2015	2016	2017	2018	2019	2020	Δ 1	Δ 2	Δ 3	Δ 4	Δ 5
Rajo	27.3	31.8	32.5	33.3	26.3	20.5	↓5	↓1	↓1	↑7	↑6
Nestlé Slovensko	12.5	12.1	14.6	13.0	11.9	17.5	0	↓3	↑2	↑1	↓6
Mecom Group	47.3	58.0	56.9	44.0	40.9	24.5	↓11	↑1	↑13	↑3	↑16
Plzeňský Prazdroj Slovesnko	8.0	12.0	10.8	5.5	4.5	11.3	↓4	↑1	↑5	↑1	↓7
Heineken Slovensko	10.0	9.6	14.1	3.8	1.5	9.5	0	↓5	↑10	↑2	↓8
Poľnoservis	2.3	4.0	2.8	8.3	24.3	27.3	↓2	↑1	↓6	↓16	↓3
Hyza	33.5	39.5	44.0	37.8	27.5	31.8	↓6	↓5	↑6	↑10	↓4
Tauris	43.0	47.3	45.0	43.3	33.3	11.5	↓4	↑2	↑2	↑10	↑22
Syráreň Bel Slovensko	21.8	25.3	25.3	27.3	19.5	20.0	↓4	0	↓2	↑8	↓1
Kofola	4.5	2.8	3.8	6.8	8.3	2.0	↑2	↓1	↓3	↓2	↑6
Cloetta Slovakia	22.4	24.3	37.8	24.8	16.5	28.8	↓2	↓14	↑13	↑8	↓12
Tatranská mliekareň	29.6	29.9	19.6	27.3	34.4	35.5	0	↑10	↓8	↓7	↓1
Považský cukor	55.8	25.5	12.8	56.8	54.3	51.5	↑30	↑13	↓44	↑3	↑3
Agro Tami	26.0	29.3	29.3	26.0	38.5	46.8	↓3	0	↑3	↓13	↓8
Hydina Slovensko	41.8	36.9	48.8	21.8	57.8	59.5	↑5	↓12	↑27	↓36	↓2
Savencia Fromage & Dairy SK	25.9	17.0	9.6	18.3	20.5	46.8	↑9	↑7	↓9	↓2	↓26
VVISS	23.9	32.0	23.5	19.0	38.5	19.3	↓8	↑9	↑5	↓20	↑19
Penam Slovakia	58.5	58.0	55.5	56.0	56.0	49.0	↑1	↑3	↓1	0	↑7
Slovenské cukrovary	14.0	12.5	11.9	58.8	42.8	15.3	↑2	↑1	↓47	16	↑28
Ryba Žilina	51.5	46.0	49.0	25.8	35.4	45.8	6	↓3	23	↓10	↓10
JAV - AKC	26.5	24.0	21.0	18.5	31.1	34.3	↑3	↑3	↑3	↓13	↓3
Podtatranská hydina	52.8	59.8	26.0	45.5	58.3	57.0	↓7	34	↓20	↓13	↑1
Slovenské pramene a žriedla	42.3	50.5	48.0	45.8	37.0	25.0	↓8	↑3	↑2	↑9	↑12
Heineken Slovensko Sladovne	9.5	9.0	15.1	35.5	24.8	28.8	↑1	↓6	↓20	↑11	↓4
Zvolenská mliekareň	52.3	51.0	57.9	45.3	50.0	54.8	↑1	↓7	↑13	↓5	↓5
Ryba Košice	20.0	37.9	45.0	48.3	51.3	44.5	↓18	↓7	↓3	↓3	↑7
Fekollini	27.5	25.8	30.6	16.0	11.0	13.3	↑2	↓5	↑15	↑5	↓2
HO&PE Family	37.0	42.6	50.0	37.5	31.3	40.5	↓6	↓7	↑13	↑6	↓9
Koliba	45.1	43.4	40.5	41.3	42.1	44.3	↑2	↑3	↓1	↓1	↓2
Istermeat	50.3	54.3	43.8	48.3	47.3	39.8	↓4	↑11	↓5	1	↑8
St. Nicolaus	17.5	21.6	30.1	32.5	35.8	28.8	↓4	↓9	↓2	↓3	↑7
Mlyn Pohronský Ruskov	41.6	39.5	55.3	54.3	48.5	51.0	↑2	↓16	↑1	↑6	↓3
Púchovský mäsový priemysel	35.3	47.8	59.0	8.5	59.8	5.3	↓13	↓11	↑51	↓51	↑55
Milsy	60.0	52.8	57.8	54.8	38.3	37.3	↑7	↓5	↑3	↑17	↑1
Baliarne obchodu	29.0	20.5	34.9	17.3	10.1	8.0	↑9	↓14	↑18	↑7	↑2
Hubert J.E.	2.0	3.5	1.8	1.8	1.5	4.3	↓2	↑2	0	0	↓3
P.G.Trade	38.0	18.8	18.8	27.0	35.5	39.0	↑19	0	↓8	↓9	↓4
Nourus - Mäso	10.5	18.8	25.0	31.0	36.4	41.5	↓8	↓6	↓6	↓5	↓5
Mondelez SR Production	40.3	46.1	44.8	43.5	30.6	24.5	↓6	↑1	↑1	↑13	↑6
Minit Slovakia	40.9	39.5	41.5	59.8	17.8	29.5	↑1	↓2	↓18	42	↓12
Mlyn Kolárovo	18.0	17.3	23.5	26.0	29.0	33.8	↑1	↓6	↓3	↓3	↓5
Mäspoma	40.9	32.0	33.0	34.3	22.5	26.3	↑9	↓1	↓1	12	↓4
Agrofarma	13.9	16.1	15.0	50.3	51.3	54.0	↓2	↑1	↓35	↓1	↓3
Dr.Oetker	3.8	3.8	8.3	3.0	4.3	3.3	0	↓5	↑5	↓1	↑1
Frost	29.0	10.5	8.3	8.0	5.3	18.3	↑19	↑2	0	↑3	↓13
Lycos - Trnavské sladovne	34.5	22.4	21.8	16.8	21.9	27.8	↑12	↑1	↑5	↓5	↓6
Vinárske závody Topoľčianky	4.3	6.8	4.5	7.0	4.3	3.3	↓3	↑2	↓3	↑3	↑1
McCarter	43.3	38.1	35.4	39.3	29.3	49.3	↑5	↑3	↓4	↑10	↓20
Hydina SK	49.0	48.0	39.3	10.3	51.8	56.0	↑1	↑9	↑29	↓42	↓4



## RECENT ISSUES IN ECONOMIC DEVELOPMENT

Svaman	50.3	53.5	30.8	25.8	54.8	49.3	↓3	↑23	↑5	↓29	↑6
Levické mliekárne	53.6	47.3	43.3	45.3	43.0	42.0	↑6	↑4	↓2	↑2	↑1
Old Herold	13.3	17.0	20.3	23.0	11.9	12.8	↓4	↓3	↓3	↑11	↓1
Vamex	27.5	36.0	44.5	46.3	13.9	13.0	↓9	↓9	↓2	↑32	↑1
Tauris Nitra	36.9	40.8	37.5	10.5	15.4	5.3	↓4	↑3	↑27	↓5	↑10
Thymos	39.8	37.0	31.9	34.8	25.0	34.5	↑3	↑5	↓3	↑10	↓10
Novofruct SK	20.9	23.3	28.9	48.0	36.0	54.5	↓2	↓6	↓19	↑12	↓19
Sladovňa	7.3	7.6	4.8	15.0	13.4	22.3	0	↑3	↓10	↑2	↓9
Euromilk	58.4	56.3	50.3	56.5	56.3	58.5	↑2	↑6	↓6	0	↓2
Progast	7.3	1.9	9.5	10.0	7.0	7.5	↑5	↓8	↓1	↑3	↓1
Mäsokombinát Nord Svit	40.6	54.3	45.8	51.3	43.0	34.0	↓14	↑9	↓6	↑8	↑9

Source: *own compilation*

In the analyzed period, Rajo, Plzenský Prazdroj Slovensko, Syrárreň Bel Slovensko, Ryba Žilina, Heineken Slovensko Sladovne, Hubert J. E., Mondelez SR Production, Dr. Oetker, Vinárske závody Topoľčianky, and Hydina SK achieved the same ranking when we applied multi-criteria methods. One of the largest investment companies in 2019 was Cloetta Slovakia (a chocolate company with an investment of €35,360 thous.) and Tatranská mliekareň, which is in 12th place in the ranking by size in terms of achieved sales (an investment is €16,863 thous.).

Table 3 presents Spearman's rank correlation coefficient comparing similarity between ranking of companies compiled by using four methods of multi-criteria evaluation. For each accounting year (from 2015 to 2020), the correlation coefficient between ranking of two methods is calculated. High and statistically significant values of these coefficients show that most companies from the Slovak FPI reaches similar rank within all methods of multi-criteria evaluation.

Table 3. Correlation between rankings using different methods of multi-criteria evaluation

Method	2020				2019				2018			
	RM	SM	MNS	TOPSIS	RM	SM	MNS	TOPSIS	RM	SM	MNS	TOPSIS
RM	1	0.9220	0.9631	0.9128	1	0.9637	0.9649	0.8828	1	0.9112	0.9533	0.9583
SM		1	0.9043	0.8846		1	0.9144	0.8487		1	0.9120	0.9288
MNS			1	0.9155			1	0.8785			1	0.9755
TOPSIS				1				1				1
Method	2017				2016				2015			
	RM	SM	MNS	TOPSIS	RM	SM	MNS	TOPSIS	RM	SM	MNS	TOPSIS
RM	1	0.8930	0.9321	0.9192	1	0.9177	0.9620	0.9632	1	0.8741	0.9374	0.9422
SM		1	0.7899	0.7353		1	0.8814	0.9264		1	0.8090	0.8276
MNS			1	0.9735			1	0.9738			1	0.9647
TOPSIS				1				1				1

Source: *own calculations*

Note: All Spearman's rank correlation coefficients are statistically significant ( $p = 0.0000$ ). RM denotes ranking method, SM denotes scoring method, and MNS denotes method of normal shape.

#### 4.2. Results of the multidimensional scaling

In Graphs 3, 4, and 5, we present the results of the modern MDS method. Those companies that are perceived to be very similar to each other are placed near each other on the plot, and those companies that are perceived to be very different from each other are placed far away from each other on the plot (Jee *et al.*, 2006), specifically, they are more different from

the competitors. The results of MDS are interpreted according to the distances of objects in matching configuration plots (Graphs 3, 4, and 5). The values of these distances are given in Appendix in Tables 8, 9, 10, 11, 12, and 13.

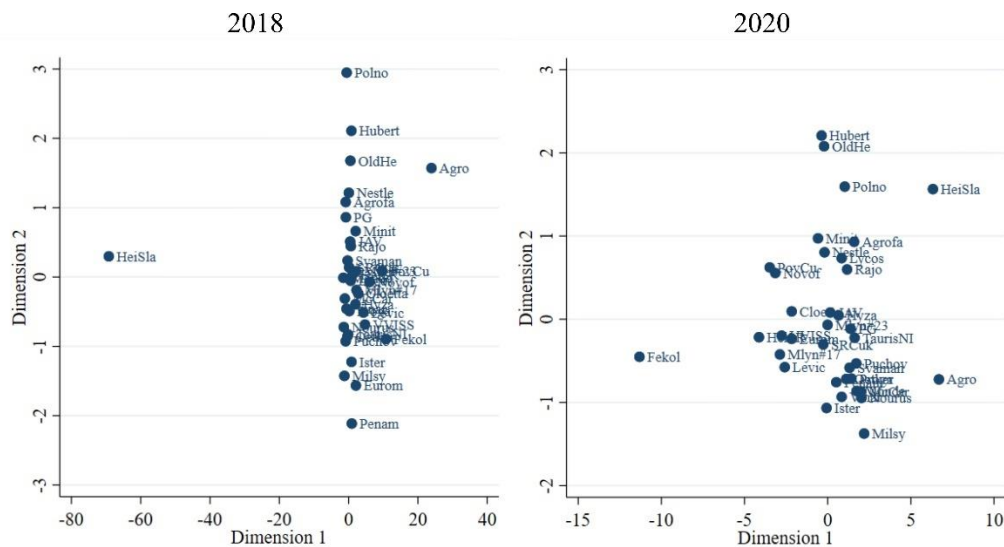
Table 4 presents the goodness of fit and values of stress for analysed NUTS II regions. Results show that the best accuracy was obtained for Western Slovakia Region and Eastern Slovakia Region in 2020.

Table 4. Goodness of fit – stress function

Year	Region		
	Western	Central	Eastern
2018	0.0175	0.0364	0.0430
2020	0.0128	0.0220	0.0046

Source: *own compilation*

Graph 3 presents a two-dimensional matching configuration plot derived after modern MDS, while a set of objects is formed by 36 companies operating in FPI in the Western Slovakia Region.



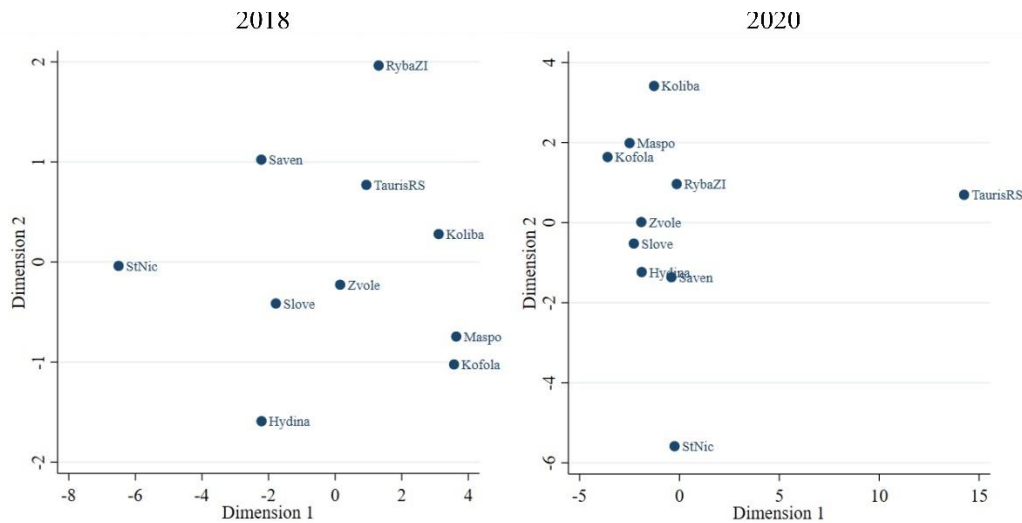
Graph 3. Matching configuration plot – Western Slovakia Region

Source: *own processing in Stata*

In 2018, Rajo, JAV - AKC, and Lycos – Trnavské sladovne had the same position in space because these companies have similar financial ratios. The distance between these companies is the smallest. Dissimilar objects Mlyn Pohronský Ruskov, Heineken Slovensko Sladovne, Polnoservis, Považský cukor, and Púchovský mäsový priemysel are located far apart. The reasons are following: I) Mlyn Pohronský Ruskov and Heineken Slovensko Sladovne: Inventories did not go through their stages of the production cycle even once during the accounting year, and the efficiency with which a company was using its assets to generate revenue was very low. II) Polnoservis: On the one hand, it is in seventh place according to the volume of generated revenues in the Slovak Republic, and one euro of assets generated €0.07 of EBIT. On the other hand, there was a significant decrease in value added, and the company has low efficiency of using its assets to generate revenue. III) Považský cukor: Company's net turnover decreased by 44% year-on-year, EBIT decreased by almost €13 mil., and the company reported a loss. IV) Púchovský mäsový priemysel: Company is in restructuring.

In 2020, the smallest distances ( $d$ ) were between the following companies: Nourus – Mäso (meat production) and McCarter (production of fruit and vegetable juice) ( $d = 0.151$ ); Mondelez SR Production (production of cocoa, chocolate, and confectionery) and McCarter ( $d = 0.262$ ); Nestlé Slovensko and Minit Slovakia ( $d = 0.44$ ), Rajo and Lycos – Trnavské sladovne ( $d = 0.51$ ). One cluster is made up of companies producing alcoholic beverages (Hubert and Old;  $d = 0.37$ ). According to the financial ratios, the company Fekollini, which deals with the production of long-lasting pastries and cakes, differed the most from its competitors. In 2020, the company increased its profit by 19% (to €2.656 million), its revenues increased to €39.93 million. Heineken Slovensko Sladovne, engaged in the production of malt, was the second most different company from competitors. In 2020, the company decreased its profit by 25% (to €646.267), and its revenues decreased by 2% (to €40.19 million).

In Graph 4, we visualize a two-dimensional matching configuration plot derived after modern MDS for a set of 10 objects representing companies from FPI in the Central Slovakia Region.



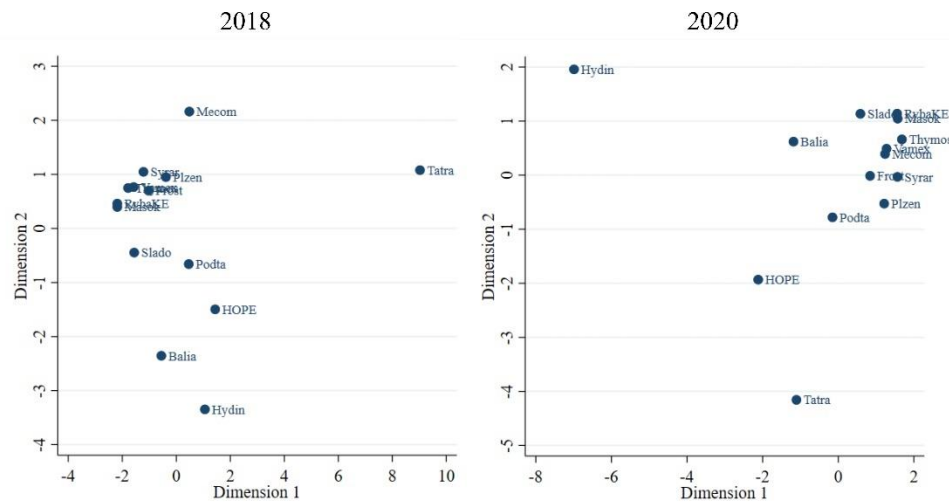
Graph 4. Matching configuration plot – Central Slovakia Region

Source: *own processing in Stata*

In 2018, Slovenské pramene a žriedla and Zvolenská mliekareň represent the cluster of companies with similar indebtedness and activity indicators (components of Du Pont model, financial leverage, and total assets turnover ratio). St. Nicolaus is different in all financial ratios. This company produces distillation, treatment and blending of alcohol in the FPI. In 2018, the profit of this company decreased on €617 thous., despite revenue growth.

In 2020, the smallest distance was between Kofola and Mäspoma ( $d = 1.81$ ). The companies have similar results of indebtedness, added value to sales ratio, and intensity financial ratios. These companies had the smallest distance in 2018, too ( $d = 0.376$ ). On the other hand, Tauris has the highest distance from its competitors. One cluster is created by Hydina Slovensko and Savencia Fromage & Dairy SK ( $d = 1.537$ ). The second cluster is made up by Zvolenská mliekareň, engaged in milk and cheese production, and Slovenské pramene a žriedla, focused on the production of soft drinks, mineral water production ( $d = 0.681$ ). According to the volume of sales of 60 analyzed companies, Slovenské pramene a žriedla ranked 24th, Zvolenská mliekareň ranked 26th. Unfortunately, companies do not achieve the required profitability.

Finally, we display a two-dimensional matching configuration plot (Graph 5) derived after modern MDS for a set of 14 companies operating in FPI in the Eastern Slovakia Region.



Graph 5. Matching configuration plot – Eastern Slovakia Region

Source: *own processing in Stata*

In 2018, the smallest distance between Ryba Košice and Mäsokombinát Nord Svit ( $d = 0.18$ ), and Vamex and Thymos ( $d = 0.306$ ) is caused by similar financial ratios of these companies. The most different were four food companies (i.e., Mecom Group, Plzeňský Prazdroj Slovensko, Ryba Košice, Tatranská mlékareň). I) Mecom Group: The company is the third largest company in the Slovak FPI in terms of assets turnover. At the same time, the company generated a loss until 2018, but in 2019, the company achieved EAT of €223 thous. due to the measures to increase efficiency, increased export growth. In connection with industry 4.0, the most significant investment of this company was the purchase of an automatic packaging line and investments in new technologies, thus reducing the company's conversion costs in production. II) Tatra engaged in the milk processing and cheese production reached, in 2018, revenues of €74.9 million, net income (EAT) was €0.55 million. In 2020, the profit of this company increased by 70% (to €1.220 million) and revenues increased by 8% (to €90.36 million). III) Plzeňský Prazdroj Slovensko: Compared to the competition, in this company that engaged in the production of beer, one euro of assets generated €0.37 of EBIT. The coefficient of assets turnover reached the value of 3.15, and the profit margin was 12%. IV) Ryba Košice, s. r. o. Košice: This company is the most different from all and has negative profitability. In relation to the Du Pont equation, the total asset turnover ratio has the most positive effect on the change in profitability.

In 2020, the smallest distances were between Mecom Group and Vamex ( $d = 0.194$ ). One cluster is made up by Ryba Košice, Sladovňa, Mäsokombinát. All financial ratios of these companies have similar values. Hydina SK, oriented to meat production, and Tatra, engaged in milk production, were the furthest from other companies. It was caused by negative ROA and profitability. When comparing 2018 and 2020, the biggest change is in companies engaged in the production of meat and meat products. Interestingly, clusters are made up of companies with a different focus on food production.

## Conclusion

The multidimensional scaling aimed to map the relative location of the largest companies operating in the Slovak FPI on the NUTS II level. The analysis resulted in two-dimensional matching configuration plots that show clusters of most similar non-financial corporations according to selected financial ratios, as well as show which objects differ. Moreover, we provided intercompany comparison in space using multi-criteria methods (i.e., ranking method, scoring method, method of normed shape, and method of distance from a fictitious object - TOPSIS). Spearman's rank correlation coefficient showed a high correlation between these methods. The sense of using these methods was a comparison of methods of multi-criteria evaluation of objects (MDS, TOPSIS). As the Slovak FPI has the largest representation in the Nitra Region, in future research, it should be appropriate to do MDS at the NUTS III level.

The results of the multi-criteria evaluation of the Slovak food companies have shown that the competitiveness of the meat production companies has improved the most (Mecom Group, Tauris). The Slovak Republic is sufficiently competitive in sugar production, nevertheless, imports sugar, especially from the Czech Republic. The position of Považský cukor increased by 30 places in 2016. On the other hand, in 2018, it decreased by 44 places and then followed only by a slight rise. In 2020, 37 companies decreased (mostly, Savencia Fromage & Dairy SK). On the contrary, Púchovský mäsový priemysel and Slovenské cukrovary increased the most year-on-year.

Production efficiency in the context of Industry 4.0 is only possible by introducing the production of new products, new technologies, improving the quality of products, their marketing, and sales in new markets. Attention must be paid to the technological deficiency in food companies, due to which the Slovak FPI is less competitive compared to foreign competition.

It is necessary to analyze the reasons for the implementation of the above-mentioned concept of Industry 4.0 in Slovak companies. Thanks to innovations and increased efficiency in production processes, the costs of total production will decrease, which will have a positive impact on the environment that can significantly affect sustainable development and still resonate with one of the key priorities of the food industry. At the same time, food self-sufficiency will continue to resonate as one of the key priorities of the FPI.

## Acknowledgement

This paper was supported by research grant KEGA No. 001PU-4/2022: “Application of Modern Trends in Quantitative Methods in the Teaching of Financial and Managerial Subjects”, and APVV-21-0188: “Development of concepts of strategic investment and development packages for regions of Slovakia with a causal link to the creation of methodology for quantifying their effectiveness and efficiency”.

## References

- Adamišin, P., Kotulič R., Kravčáková, & Vozárová, I. (2017). Legal form of agricultural entities as a factor in ensuring the sustainability of the economic performance of agriculture. *Agricultural Economics*, 63(2), 80-82. <https://doi.org/10.17221/208/2015-AGRICECON>
- Arimany, N., Farreras, M. A., & Rabaseda, J. (2014). Economic analysis financial catalan wine sector. *Intangible Capital*, 10(4), 741-765. <https://doi.org/10.3926/ic.546>
- Cihelková, E., Nguyen, H. P., Fabuš, M. (2020). The EU concept of the “Strategic Partnership”: Identifying the “unifying” criteria for the differentiation of Strategic Partners. *Entrepreneurship and Sustainability Issues*, 7(3), 1723-1739. [https://doi.org/10.9770/jesi.2020.7.3\(19\)](https://doi.org/10.9770/jesi.2020.7.3(19))
- Chrastinová, Z., et al. (2013). *Ekonomické parametre slovenského poľnohospodárstva a potravinárstva v kontexte štátov EÚ*. Bratislava: VÚEPP.
- Chrastinová, Z., Belešová, S., & Jenčíková, J. (2019). Economic and social aspects of agri-food sector. *Economics of Agriculture*, 9(1), 5-29.
- Czerwińska-Kayzer, D., Florek, J., Staniszewski, R., & Kayzer, D. (2021). Application of canonical variate analysis to compare different groups of food industry companies in terms of financial liquidity and profitability. *Energies*, 14(15), 4701. <https://doi.org/10.3390/en14154701>
- Draganac, D. (2016). Comparative Analysis of Functional Food Producers’ Profitability in Serbia - A Leader-Follower Relation. *Economics of Agriculture*, 63(2), 547-566.
- Fenyves, V., Pető, K., Szenderák, J., & Harangi-Rákos, M. (2020). The capital structure of agricultural enterprises in the Visegrad countries. *Agricultural Economics*, 66(4), 160-167. <https://doi.org/10.17221/285/2019-AGRICECON>
- Firlej, Ch., & Kubala, S. (2019, February). *Profitability Conditions of The Selected Companies from the Wig Food Industry Index in 2011-2018*. 17th International Scientific Conference on Hradec Economic Days, Hradec Kralove, Czech Republic, pp. 194-202.
- Grejčíková, A., & Krajčo, K. (2019, November). *Reasons for Introducing Industry 4.0 in the Slovak Republic*. Conference proceedings: The Impact of Industry 4.0 on job creation 2019, Trenčianske Teplice, Slovak Republic, pp. 117-122.
- Gurčík, Ľ. (2002). G-index - the financial situation prognosis method of agricultural enterprises. *Agricultural Economics*, 48(2), 373-378.
- Hendl, J. (2015). *Přehled statistických metod*. Praha: Portál.
- Hombert, J., & Matray, A. (2018). Can innovation help US manufacturing firms escape import competition from China?. *The Journal of Finance*, 73(5), 2003-2039. <https://doi.org/10.1111/jofi.12691>
- Hudáková, M., Urbancová, H., & Vnoučková, L. (2019). Key Criteria and Competences Defining the Sustainability of Start-Up Teams and Projects in the Incubation and Acceleration Phase. *Sustainability*, 11(23), 6720. <https://doi.org/10.3390/su11236720>
- Hudáková Stašová, L. (2021) Analysis of Calculation Methods Currently Practised at V4 Agricultural Holdings, *AGRIS on-line Papers in Economics and Informatics*, 13(4), 19-32. ISSN 1804-1930. DOI 10.7160/aol.2021.130403.
- Ivanov, V., Shevchenko, O., Marynin, A., Stabnikov, V., Gubenia, O., Stabnikova, O., Shevchenko, A., Gavva, O. & Saliuk, A. (2021). Trends and expected benefits of the breaking edge food technologies in 2021-2030. *Ukrainian Food Journal*, 10(1), 7-36. <https://doi.org/10.24263/2304-974X-2021-10-1-3>



- Jee, T. C., Lee, H., & Lee, Y. (2006). *Shrinking Number of Clusters by Multi-Dimensional Scaling*. Proceedings of the 3rd Italian Semantic Web Workshop SWAP 2006, Pisa: Scuola Normale Superiore, pp. 1-6.
- Jenčová, S., & Jusková, M. (2013). *Špecifická poľnohospodárskych subjektov a ich konzekvence*. *Financie, účtovníctvo a controlling v kontexte globálnych a regionálnych zmien*. Prešov: Bookman, pp- 53-58.
- Jenčová, S. (2018). *Aplikácia pokročilých metód vo finančno-ekonomickej analýze elektrotechnického odvetvia Slovenskej republiky*. Ostrava: SAEI, VSB-TU Ostrava.
- Isakson, S. R. (2014). Food and finance: The financial transformation of agro-food supply chains. *The Journal of Peasant Studies*, 41(5), 749-775. <https://doi.org/10.1080/03066150.2013.874340>
- Kavčáková, M. and Kočišová, K. (2020) Using Data Envelopment Analysis in Credit Risk Evaluation of ICT Companies, *AGRIS on-line Papers in Economics and Informatics*, 12(4), 47-60. ISSN 1804-1930. <https://doi.org/10.7160/aol.2020.120404>
- Kayikci, Y., Subramanian, N., Dora, M., & Bhatia, M. S. (2022). Food supply chain in the era of Industry 4.0: Blockchain technology implementation opportunities and impediments from the perspective of people, process, performance, and technology. *Production Planning & Control*, 33(2-3), 301-321. <https://doi.org/10.1080/09537287.2020.1810757>
- Kaufman, L., & Rousseeuw, P. J. (1990). *Finding Groups in Data: An Introduction to Cluster Analysis*. New York: Wiley.
- Kedžo, M. G., & Lukač, Z. (2021). The financial efficiency of small food and drink producers across selected European Union countries using data envelopment analysis. *European Journal of Operational Research*, 291(2), 586-600. <https://doi.org/10.1016/j.ejor.2020.01.066>
- Kliestik, T., Valaskova, K., Lazaroiu, G., Kovacova, M., & Vrbka, J. (2020). Remaining financially healthy and competitive: The role of financial predictors. *Journal of Competitiveness*, 12(1), 74-92. <https://doi.org/10.7441/joc.2020.01.05>
- Kogan, L., Papanikolaou, D., Seru, A., & Stoffman, N. (2017). Technological innovation, resource allocation, and growth. *The Quarterly Journal of Economics*, 132(2), 665-712. <https://doi.org/10.1093/qje/qjw040>
- Krajčík, V. (2021). The readiness of Small and Medium-sized Enterprises (SMEs) for the digitalization of industry: Evidence from the Czech Republic. *Acta Montanistica Slovaca*, 26(4), 761-772. <https://doi.org/10.46544/AMS.v26i4.13>
- Krajčík, V. (2022). Digitalization of SMEs and their perceptions regarding public interventions and supports of digitalization: Evidence from mining and iron industries. *Acta Montanistica Slovaca*, 27(1), 100-116. <https://doi.org/10.46544/AMS.v27i1.08>
- Kravčáková Vozárová, I., Kotulič, R., & Vavrek, R. (2019). Disparities in the financial performance of agricultural entities according to the legal form: the case of Slovakia. *Applied Economics*, 51(56), 5999-6008. <https://doi.org/10.1080/00036846.2019.1645285>
- Kruskal, J. B., & Carmone, F. J. (1967). *How to use MDSCAL (version 5M) and other useful information*. Bell Laboratories, Unpublished manuscript.
- Levine, J., Gussow, J. D., Hastings, D., & Eccher, A. (2003). Authors' financial relationships with the food and beverage industry and their published positions on the fat substitute olestra. *American Journal of Public Health*, 93(4), 664-669. <https://doi.org/10.2105/AJPH.93.4.664>
- Lezoche, M., Hernandez, J. E., Díaz, M. D. M. E. A., Panetto, H., & Kacprzyk, J. (2020). Agri-food 4.0: A survey of the supply chains and technologies for the future agriculture. *Computers in Industry*, 117, 103187. <https://doi.org/10.1016/j.compind.2020.103187>

- Luque, A., Peralta, M. E., De Las Heras, A., & Córdoba, A. (2017). State of the Industry 4.0 in the Andalusian food sector. *Procedia Manufacturing*, 13, 1199-1205. <https://doi.org/10.1016/j.promfg.2017.09.195>
- Marcus, A. A., & Anderson, M. H. (2006). A general dynamic capability: does it propagate business and social competencies in the retail food industry?. *Journal of Management Studies*, 43(1), 19-46. <https://doi.org/10.1111/j.1467-6486.2006.00581.x>
- Matošková, D., & Uhrinčat'ová, E. (2015). Economic and social aspects of food industry. *Ekonomika poľnohospodárstva*, 15(1), 27-41.
- Mišečka, T., Ciaian, P., Rajčániová, M., & Pokrivčák, J. (2019). In search of attention in agricultural commodity markets. *Economics Letters*, 184, 108668.
- Notta, O., & Oustapassidis, K. (2001). Profitability and media advertising in Greek food manufacturing industries. *Review of Industrial Organization*, 18(1), 115-126. <https://doi.org/10.1023/A:1026549424670>
- Pauhofová, I., & Stehlíková, B. (2017). *Kvalitatívna zmena v zamestnanosti Slovenskej republiky*. Praha: Wolters Kluwer.
- Pietrzak, M. B., & Balcerzak, A. B. (2021). Selection of the set of areal units for economic regional research on the land use: a proposal for Aggregation Problem solution. *Acta Montanistica Slovaca*, 26(2), 222-234. <https://doi.org/10.46544/AMS.v26i2.04>
- SARIO. (2022). *Food Processing Industry in Slovakia*. Bratislava: Slovak Investment and Trade Development Agency.
- Slaný, A., & Táncošová, J. (2004). Teoretické aspekty priamych zahraničných investícií. *Ekonomický časopis*, 52(1), 62-73.
- Slovak Credit Bureau (2022). *CRIF - Slovak Credit Bureau*. Retrieved January 15, 2022, from: <https://www.crif.sk/>
- Soltanali, H., Khojastehpour, M., & Farinha, J. T. (2021). Measuring the production performance indicators for food processing industry. *Measurement*, 173, 108394. <https://doi.org/10.1016/j.measurement.2020.108394>
- Timková, V., & Košíková, M. (2018). *Súčasný stav a analýza možností financovania strategických investičných projektov s dôrazom na ich význam pre ekonomiku. Manažment podnikateľskej výkonnosti a investovania na zvyšovanie efektívnosti manažérskeho rozhodovania v eú v teórii a praxi: nekonferenčný zborník vedeckých prác*. Prešov: Bookman, pp. 214-226.
- Tong, Y., & Saladrigues, R. (2022). An analysis of factors affecting the profits of new firms in Spain: Evidence from the food industry. *Agricultural Economics*, 68, 28-38. <https://doi.org/10.17221/235/2021-AGRICECON>
- Tóth, M., Bojňanský, J., & Klieštík, T. (2013). Finančný benchmarking a účtovné aspekty ukazovateľov likvidity v podnikoch poľnohospodárskej prvovýroby na Slovensku. *Ekonomika poľnohospodárstva*, 13(3), 36-45.
- Urbancová H, Hudáková M, & Fajčíková A. (2020). Diversity Management as a Tool of Sustainability of Competitive Advantage. *Sustainability*, 12(12), 5020. <https://doi.org/10.3390/su12125020>
- Vukadinović, P., Vujović, S., & Vojnović, B. (2018). Analysis of the financial position of enterprises in privatization in the agricultural sector in Serbia. *Economics of Agriculture*, 65(3), 955-970. <https://doi.org/10.5937/ekoPolj1803955V>



## Appendix

Table 5. Companies from Western Slovakia Region

Code	ID	Company	Code	ID	Company
Agro	9	Agro Tami, a. s., Nitra	Monde	20	Mondelez SR Production, s. r. o., Bratislava
Agrofa	26	Agrofarma, s. r. o., Červený Kameň	Nestle	2	Nestlé Slovensko, s. r. o., Prievidza
Cloetta	8	Cloetta Slovakia, s. r. o., Levice	Nourus	19	Nourus - Mäso, s. r. o., Tešedíkovo
Eurom	35	Euromilk, a. s., Veľký Meder	Novof	32	Novofruct SK, s. r. o., Nové Zámky
Fekol	18	Fekollini, s. r. o., Sládkovičovo	Oetker	25	Dr.Oetker, s. r. o., Bratislava
HeiSla	13	Heineken Slovensko Sladovne, a. s., Hurbanovo	OldHe	31	Old Herold, s. r. o., Trenčín
HeiSR	4	Heineken Slovensko, a. s., Hurbanovo	Penam	11	Penam Slovakia, a. s., Nitra
Hubert	21	Hubert J.E., s. r. o., Sereď	PG	15	P.G.Trade, s. r. o., Komárno
Hyza	6	Hyza a. s., Topoľčany	Polno	5	Polnoservis, a. s., Leopoldov
Ister	24	Istermeat, a. s., Dunajská Streda	PovCu	3	Považský cukor, a. s., Trenčianska Teplá
JAV	12	JAV - AKC, s. r. o., Vlčany	Proga	36	Progast, s. r. o., Bratislava
Levic	30	Levické mliekárne, a. s., Levice	Puchov	14	Púchovský mäsový priemysel, a. s. (in restructuring), Púchov
Lycos	33	Lycos - Trnavské sladovne, s. r. o., Trnava	Rajo	1	Rajo, a. s. Bratislava
McCar	29	McCarter, a. s., Bratislava	SRCuk	7	Slovenské cukrovary, s. r. o., Sereď
Milsy	22	Milsy, a. s., Bánovce nad Bebravou	Svaman	27	Svaman s. r. o., Myjava
Minit	16	Minit Slovakia, s. r. o., Dunajská Streda	Tauris NI	34	Tauris Nitra, s. r. o., Mojmírovce
MlynKO	23	Mlyn Kolárovo, a. s., Kolárovo	Vinar	28	Vinárske závody Topoľčianky, s. r. o., Topoľčianky
MlynPR	17	Mlyn Pohronský Ruskov, a. s., Pohronský Ruskov	VVISS	10	VVISS, s. r. o., Madunice

Source: *own compilation*

Table 6. Companies from Central Slovakia Region

Code	Company
Hydina	Hydina Slovensko, s. r. o., Lieskovec
Koliba	Koliba, a. s., Hriňová
Kofola	Kofola, a. s., Rajecká Lesná
Maspo	Mäspoma, s. r. o., Zvolen
Saven	Savencia Fromage & Dairy SK, a. s., Liptovský Mikuláš
Slove	Slovenské pramene a žriedla, a. s., Budiš
StNic	St. Nicolaus, a. s., Liptovský Mikuláš
RybaZI	Ryba Žilina, s. r. o., Žilina
TaurisRS	Tauris, a. s., Rimavská Sobota
Zvole	Zvolenská mliekareň, s. r. o., Zvolen

Source: *own compilation*

Table 7. Companies from Eastern Slovakia Region

<b>Code</b>	<b>Company</b>
Balia	Baliarne obchodu, a. s., Poprad
Frost	Frost, a. s., Prešov
HOPE	HO&PE Family, s. r. o., Poprad, Hossa Family
Hydin	Hydina SK, s. r. o., Kežmarok
Masok	Mäsokombinát Nord Svit, s. r. o., Svit
Mecom	Mecom Group, s. r. o. Humenné
Plzen	Plzeňský Prazdroj Slovesnko, a. s., Veľký Šariš
Podta	Podtatranská hydina, a. s., Kežmarok
RybaKE	Ryba Košice, s. r. o., Košice
Slado	Sladovňa, a. s., Michalovce
Syrar	Syráreň Bel Slovensko, a. s., Michalovce
Tatra	Tatranská mliekareň, a. s., Kežmarok
Thymos	Thymos, s. r. o., Veľká Lomnica
Vamex	Vamex, a. s., Košice

Source: *own compilation*

Table 8. Distances between analysed companies – Western European Region (2018)

ID	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36				
1	0.0																																							
2	1.0	0.0																																						
3	9.1	9.8	0.0																																					
4	1.5	2.0	8.5	0.0																																				
5	3.0	2.3	10.4	3.0	0.0																																			
6	1.5	2.4	7.8	1.6	4.1	0.0																																		
7	0.6	1.2	9.6	1.6	3.0	1.9	0.0																																	
8	2.4	3.2	7.0	1.7	4.3	1.2	2.7	0.0																																
9	23.4	24.0	14.3	22.7	24.3	22.1	23.9	21.2	0.0																															
10	4.3	5.1	5.0	3.9	6.3	2.8	4.7	2.2	19.4	0.0																														
11	2.0	2.7	9.2	3.0	5.0	2.0	2.1	3.1	23.5	4.3	0.0																													
12	0.3	0.8	9.3	1.4	2.8	1.7	0.6	2.5	23.5	4.5	2.2	0.0																												
13	69.7	69.1	78.8	70.4	69.0	71.0	69.3	71.9	93.1	73.8	69.8	69.6	0.0																											
14	1.8	1.9	10.6	2.5	3.7	2.8	1.4	3.7	24.9	5.6	2.3	1.7	68.3	0.0																										
15	1.5	1.0	10.5	2.5	2.7	2.9	1.2	3.7	24.8	5.7	2.8	1.3	68.3	1.4	0.0																									
16	1.5	2.1	7.7	1.7	3.5	1.0	2.0	1.4	22.0	3.0	2.6	1.6	71.1	3.2	2.8	0.0																								
17	1.7	2.6	7.5	1.9	4.2	0.4	2.2	1.1	21.8	2.6	2.2	1.9	71.3	3.2	3.2	0.8	0.0																							
18	10.3	11.0	1.5	9.7	11.7	8.9	10.7	8.1	13.4	6.1	10.2	10.5	79.9	11.6	11.7	9.0	8.6	0.0																						
19	2.2	2.3	11.0	2.7	3.6	3.3	1.7	4.0	25.3	6.0	2.9	2.1	67.9	1.0	1.6	3.6	3.6	12.1	0.0																					
20	2.4	2.5	10.7	2.3	3.0	3.4	2.0	3.9	24.9	6.0	3.7	2.3	68.3	1.9	2.0	3.6	3.8	11.9	1.3	0.0																				
21	1.7	1.2	9.4	2.7	2.7	2.7	2.1	3.4	23.5	4.9	3.1	1.7	69.6	3.0	2.0	2.1	2.7	10.6	3.5	3.6	0.0																			
22	2.5	2.7	10.9	2.9	4.3	3.2	1.9	4.1	25.2	5.9	2.6	2.4	68.1	1.2	2.0	3.7	3.6	11.9	0.8	1.8	3.8	0.0																		
23	1.6	2.4	7.7	2.0	4.2	0.6	2.1	1.5	22.0	2.8	2.0	1.8	71.1	3.1	3.0	0.8	0.5	8.9	3.6	3.8	2.4	3.5	0.0																	
24	2.0	2.7	8.8	1.1	3.7	2.0	1.9	2.0	23.0	4.1	3.0	2.0	70.3	2.5	2.8	2.4	2.3	9.9	2.5	2.1	3.6	2.6	2.5	0.0																
25	1.4	1.8	10.0	2.1	3.7	2.3	1.1	3.2	24.4	5.1	1.9	1.4	68.8	0.6	1.5	2.7	2.6	11.1	1.2	1.9	2.8	1.2	2.5	2.1	0.0															
26	1.6	1.0	10.5	2.3	2.1	3.1	1.4	3.8	24.7	5.8	3.2	1.4	68.4	1.8	0.6	2.9	3.3	11.8	1.8	1.8	2.1	2.3	3.2	2.8	1.8	0.0														
27	1.6	1.9	9.6	1.1	2.6	2.5	1.4	2.8	23.8	4.9	3.3	1.5	69.4	2.0	1.9	2.5	2.8	10.8	1.9	1.2	2.9	2.3	2.8	1.3	1.8	1.6	0.0													
28	1.8	2.2	10.0	1.7	3.3	2.6	1.4	3.1	24.3	5.2	2.8	1.7	68.9	1.3	1.9	2.9	2.9	11.1	1.2	1.0	3.3	1.5	3.0	1.4	1.2	1.9	1.0	0.0												
29	2.0	2.2	10.5	2.1	3.2	3.0	1.5	3.6	24.7	5.6	3.1	1.9	68.5	1.4	1.7	3.3	3.3	11.6	0.8	0.6	3.4	1.3	3.3	1.8	1.4	1.7	1.2	0.6	0.0											
30	3.8	4.6	5.4	3.3	5.8	2.4	4.2	1.6	19.8	0.7	4.0	4.0	73.4	5.2	5.2	2.6	2.2	6.5	5.5	5.4	4.6	5.5	2.5	3.5	4.6	5.3	4.4	4.7	5.1	0.0										
31	1.3	0.7	9.5	2.4	2.6	2.5	1.6	3.2	23.7	4.9	2.8	1.2	69.4	2.5	1.5	1.9	2.5	10.8	3.0	3.2	0.6	3.3	2.3	3.2	2.3	1.6	2.5	2.8	2.9	4.5	0.0									
32	5.5	6.2	3.7	5.0	7.1	4.1	5.9	3.4	18.0	1.5	5.6	5.6	75.2	6.9	6.9	4.1	3.8	4.8	7.3	7.2	5.9	7.3	4.1	5.3	6.4	6.9	6.1	6.5	6.9	1.9	5.9	0.0								
33	0.5	1.4	9.1	1.3	3.2	1.4	0.6	2.3	23.4	4.2	1.9	0.6	69.7	1.6	1.6	1.7	1.7	10.3	2.0	2.2	2.2	2.1	1.6	1.7	1.1	1.8	1.4	1.5	1.7	3.8	1.8	5.5	0.0							
34	1.3	1.7	9.9	2.1	3.7	2.1	1.0	3.1	24.2	4.9	1.7	1.3	69.0	0.8	1.5	2.5	2.5	11.0	1.4	2.1	2.7	1.3	2.3	2.1	0.3	1.9	1.9	1.4	1.5	4.5	2.2	6.2	1.0	0.0						
35	2.2	3.2	7.9	2.7	5.1	1.2	2.5	2.1	22.3	3.0	1.3	2.5	71.0	3.1	3.5	2.0	1.3	8.9	3.6	4.1	3.4	3.4	1.3	2.7	2.6	3.8	3.4	3.2	3.5	2.7	3.1	4.4	2.1	2.4	0.0					
36	1.4	1.9	9.4	1.1	3.3	2.0	1.1	2.4	23.6	4.5	2.6	1.3	69.6	1.6	1.9	2.3	2.3	10.5	1.7	1.5	2.9	1.9	2.4	1.0	1.2	1.9	0.8	0.7	1.1	4.0	2.5	5.8	1.0	1.3	2.7	0.0				

Source: own calculations in Stata

Table 9. Distances between analysed companies – Western European Region (2020)

ID	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36			
1	0.0																																						
2	1.4	0.0																																					
3	4.7	3.3	0.0																																				
4	5.4	4.1	1.1	0.0																																			
5	1.0	1.5	4.6	5.5	0.0																																		
6	0.8	1.1	4.2	4.8	1.6	0.0																																	
7	1.7	1.1	3.4	3.9	2.3	1.0	0.0																																
8	3.4	2.1	1.4	2.0	3.5	2.8	2.0	0.0																															
9	5.7	7.0	10.3	10.8	6.1	6.1	6.9	8.9	0.0																														
10	4.0	2.8	1.1	1.4	4.2	3.4	2.5	0.7	9.4	0.0																													
11	1.5	1.7	4.3	4.7	2.4	0.8	0.9	2.8	6.1	3.3	0.0																												
12	1.1	0.8	3.7	4.3	1.7	0.5	0.6	2.3	6.6	2.9	0.9	0.0																											
13	5.3	6.6	9.9	10.6	5.3	5.9	6.8	8.6	2.3	9.3	6.2	6.3	0.0																										
14	1.4	2.4	5.3	5.8	2.3	1.3	2.0	3.9	5.1	4.4	1.3	1.7	5.2	0.0																									
15	0.8	1.8	4.9	5.5	1.8	0.8	1.7	3.6	5.3	4.1	1.1	1.3	5.2	0.9	0.0																								
16	1.8	0.4	2.9	3.7	1.7	1.6	1.3	1.8	7.5	2.5	2.1	1.2	6.9	2.8	2.3	0.0																							
17	4.2	2.9	1.2	1.3	4.4	3.6	2.6	0.9	9.6	0.4	3.4	3.1	9.4	4.6	4.3	2.7	0.0																						
18	12.5	11.2	7.9	7.2	12.5	12.0	11.1	9.2	18.0	8.6	11.9	11.5	17.8	13.0	12.7	10.8	8.4	0.0																					
19	1.7	2.8	5.7	6.2	2.7	1.7	2.4	4.3	4.7	4.8	1.5	2.1	5.0	0.9	1.0	3.2	4.9	13.3	0.0																				
20	1.5	2.5	5.4	5.9	2.5	1.4	2.1	4.0	5.0	4.5	1.2	1.8	5.2	0.7	0.8	2.9	4.6	13.1	0.3	0.0																			
21	2.2	1.4	3.5	4.5	1.5	2.4	2.5	2.8	7.6	3.4	3.1	2.2	6.7	3.5	2.9	1.3	3.6	11.3	3.9	3.7	0.0																		
22	2.2	3.2	6.0	6.4	3.1	2.0	2.7	4.6	4.6	5.0	1.8	2.5	5.0	1.3	1.4	3.6	5.1	13.5	0.5	0.8	4.3	0.0																	
23	1.4	0.9	3.6	4.1	2.0	0.7	0.6	2.2	6.7	2.8	0.9	0.4	6.5	1.9	1.4	1.2	2.9	11.3	2.2	1.9	2.3	2.5	0.0																
24	2.1	1.9	3.8	4.2	2.8	1.3	0.8	2.4	6.7	2.9	0.7	1.1	6.9	1.8	1.7	2.1	2.9	11.3	2.1	1.8	3.3	2.3	1.1	0.0															
25	1.3	2.0	4.8	5.3	2.3	1.0	1.5	3.4	5.6	3.9	0.8	1.3	5.7	0.6	0.8	2.4	4.0	12.4	1.1	0.8	3.2	1.4	1.4	1.3	0.0														
26	0.6	1.8	5.1	5.8	1.0	1.3	2.2	3.8	5.4	4.5	2.0	1.7	4.8	1.7	1.1	2.2	4.6	13.0	1.9	1.7	2.4	2.3	1.9	2.6	1.7	0.0													
27	1.2	2.1	4.9	5.4	2.2	0.9	1.6	3.6	5.4	4.1	0.8	1.3	5.5	0.7	0.5	2.5	4.2	12.6	0.8	0.5	3.3	1.2	1.4	1.5	0.5	1.5	0.0												
28	1.5	2.0	4.6	5.1	2.5	1.0	1.3	3.2	5.8	3.7	0.5	1.2	6.0	0.9	1.0	2.4	3.8	12.2	1.3	1.0	3.3	1.6	1.3	1.0	0.5	2.0	0.7	0.0											
29	1.7	2.7	5.7	6.1	2.6	1.6	2.3	4.3	4.7	4.8	1.5	2.1	5.0	0.9	0.9	3.1	4.9	13.3	0.2	0.3	3.9	0.6	2.1	2.1	1.0	1.8	0.7	1.2	0.0										
30	3.9	2.8	1.5	1.6	4.2	3.3	2.4	0.8	9.3	0.4	3.1	2.8	9.2	4.3	4.0	2.5	0.4	8.7	4.6	4.3	3.6	4.8	2.6	2.6	3.7	4.4	3.9	3.5	4.6	0.0									
31	2.0	1.3	3.6	4.5	1.4	2.2	2.4	2.8	7.5	3.4	2.9	2.0	6.6	3.3	2.7	1.2	3.6	11.4	3.7	3.5	0.4	4.2	2.2	3.1	3.1	2.2	3.1	3.2	3.7	3.5	0.0								
32	4.3	3.0	0.4	1.2	4.3	3.8	3.0	1.1	9.9	0.9	3.9	3.3	9.5	4.9	4.6	2.6	1.0	8.2	5.4	5.1	3.2	5.6	3.2	3.5	4.5	4.7	4.6	4.3	5.3	1.3	3.3	0.0							
33	0.5	1.1	4.3	5.0	1.0	0.7	1.6	3.1	6.0	3.7	1.5	1.0	5.6	1.7	1.0	1.5	3.9	12.2	2.0	1.8	2.0	2.4	1.2	2.0	1.5	0.8	1.4	1.7	1.9	3.7	1.8	4.0	0.0						
34	1.0	2.1	5.2	5.7	1.9	1.0	1.9	3.8	5.1	4.4	1.2	1.5	5.1	0.5	0.5	2.5	4.5	12.9	0.9	0.7	3.1	1.3	1.7	1.9	0.7	1.3	0.6	1.0	0.8	4.2	3.0	4.8	1.3	0.0					
35	3.4	2.3	1.6	2.0	3.7	2.9	1.9	0.4	8.9	0.8	2.8	2.3	8.7	3.9	3.6	2.0	0.8	9.2	4.3	4.0	3.0	4.5	2.2	2.3	3.4	3.9	3.5	3.1	4.2	0.6	3.0	1.3	3.2	3.8	0.0				
36	1.3	2.2	5.1	5.6	2.3	1.1	1.7	3.7	5.3	4.2	0.9	1.5	5.4	0.6	0.6	2.6	4.3	12.7	0.7	0.4	3.4	1.1	1.6	1.6	0.4	1.6	0.2	0.7	0.6	4.0	3.2	4.7	1.6	0.5	3.7	0.0			

Source: own calculations in Stata

Table 10. Distances between analysed companies – Central European Region (2018)

Company	TaurisRS	Kofola	Hydina	Saven	RybaZI	Slove	Zvole	Koliba	StNic	Maspo
TaurisRS	0.0									
Kofola	3.2	0.0								
Hydina	4.1	5.9	0.0							
Saven	3.3	6.1	2.4	0.0						
RybaZI	1.6	3.6	4.7	3.6	0.0					
Slove	3.1	5.4	1.6	1.7	4.0	0.0				
Zvole	1.4	3.5	2.9	2.7	2.5	2.0	0.0			
Koliba	2.8	1.5	5.2	5.3	2.6	4.9	3.1	0.0		
StNic	7.6	10.1	4.5	4.4	8.0	4.8	6.7	9.4	0.0	
Maspo	3.0	0.4	6.0	6.0	3.4	5.4	3.5	1.4	10.1	0.0

Source: own calculations in Stata

Table 11. Distances between analysed companies – Central European Region (2020)

Company	TaurisRS	Kofola	Hydina	Saven	RybaZI	Slove	Zvole	Koliba	StNic	Maspo
TaurisRS	0.0									
Kofola	17.2	0.0								
Hydina	16.3	3.5	0.0							
Saven	14.8	4.2	1.5	0.0						
RybaZI	14.4	3.3	2.8	2.4	0.0					
Slove	16.6	2.8	0.9	2.1	2.6	0.0				
Zvole	16.3	2.6	1.2	2.1	2.1	0.7	0.0			
Koliba	15.9	3.0	4.6	4.8	2.7	4.0	3.4	0.0		
StNic	15.8	7.8	4.7	4.2	6.6	5.5	5.9	9.0	0.0	
Maspo	17.1	1.8	3.2	4.0	2.8	2.4	2.0	2.1	7.9	0.0

Source: own calculations in Stata

Table 12. Distances between analysed companies – Eastern European Region (2018)

Company	Mecom	Plzen	Syrar	Tatra	Podta	HOPE	RybaKE	Balia	Frost	Hydin	Thymos	Vamex	Slado	Masok
Mecom	0.0													
Plzen	1.8	0.0												
Syrar	2.0	0.9	0.0											
Tatra	8.6	9.7	10.2	0.0										
Podta	2.8	1.9	2.4	8.8	0.0									
HOPE	4.0	3.1	3.7	8.6	1.4	0.0								
RybaKE	3.1	1.9	1.2	11.1	2.8	4.1	0.0							
Balia	4.6	3.2	3.4	10.2	1.9	2.0	3.2	0.0						
Frost	2.3	0.7	0.6	10.3	2.1	3.3	1.2	3.0	0.0					
Hydin	5.3	4.6	4.8	8.8	2.8	2.6	4.8	2.3	4.6	0.0				
Thymos	2.6	1.5	0.7	10.7	2.6	4.0	0.6	3.3	0.9	4.8	0.0			
Vamex	2.5	1.3	0.5	10.5	2.5	3.8	0.7	3.3	0.7	4.7	0.3	0.0		
Slado	2.9	2.0	1.5	10.1	2.2	3.6	1.3	2.8	1.6	3.8	1.2	1.3	0.0	
Masok	3.2	1.9	1.2	11.1	2.8	4.1	0.2	3.2	1.2	4.8	0.6	0.7	1.4	0.0

Source: own calculations in Stata

Table 13. Distances between analysed companies – Eastern European Region (2020)

Company	Mecom	Plzen	Syrar	Tatra	Podta	HOPE	RybaKE	Balia	Frost	Hydin	Thymos	Vamex	Slado	Masok
Mecom	0.0													
Plzen	0.9	0.0												
Syrar	0.6	0.6	0.0											
Tatra	5.1	4.3	4.9	0.0										
Podta	1.8	1.4	1.9	3.5	0.0									
HOPE	4.1	3.6	4.1	2.4	2.3	0.0								
RybaKE	0.8	1.7	1.1	5.9	2.5	4.8	0.0							
Balia	2.4	2.6	2.8	4.8	1.8	2.7	2.8	0.0						
Frost	0.6	0.6	0.7	4.6	1.3	3.5	1.3	2.1	0.0					
Hydin	8.4	8.6	8.8	8.5	7.4	6.2	8.6	6.0	8.1	0.0				
Thymos	0.5	1.3	0.7	5.6	2.3	4.6	0.5	2.9	1.1	8.8	0.0			
Vamex	0.2	1.0	0.6	5.2	1.9	4.2	0.7	2.5	0.7	8.4	0.5	0.0		
Slado	1.0	1.8	1.5	5.6	2.0	4.1	1.0	1.9	1.2	7.6	1.2	1.0	0.0	
Masok	0.7	1.6	1.1	5.9	2.5	4.7	0.2	2.8	1.3	8.6	0.4	0.7	1.0	0.0

Source: own calculations in Stata