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Determinanty čistého príjmu poľnohospodárskych podnikov a zhlukovanie regiónov Slovenskej republiky

Determinants of agricultural enterprises net income and regions clustering: The case of Slovakia

Abstract *The economic situation of agricultural holdings is influenced by various factors at national and international level. The aim of this paper is to identify and quantify the impact of determinants on the economic situation of the Slovakia farms, which is expressed through the net profit item. The database of Slovakia Farm Accountancy Data Network (FADN), the accounting year 2016 was examined through a multiple regression analysis. Two hypotheses were defined in the paper. The results of the analysis confirmed the statistical significance of agricultural subsidies and tax rates. If the volume of M3 subsidies increased by 1 EUR , net income would inceased by 0.3034 EUR. Income tax was identified as the most significant variable. If it's value would by 1 EUR higher, net income would decreased by 2.695 EUR. The second part of the analysis dealed with the hierarchical clustering and defined 3 clusters.*

Key words *dendrogram - net income - micro level - subsidies - tax rates - Ward's method*

Abstrakt Ekonomická situácia poľnohospodárskych podnikov je ovplyvnená rôznymi faktormi, na národnej i medzinárodnej úrovni. Cieľom tohto príspevku je identifikovať a kvantifikovať vplyv determinantov na ekonomickú situáciu slovenských fariem, ktorá je vyjadrená prostredníctvom čistého príjmu. Databáza Slovak Farm Accountancy Data Network (FADN), účtovný rok 2016, bola skúmaná pomocou viacnásobnej regresnej analýzy. V príspevku boli definované dve hypotézy. Výsledky analýzy potvrdili štatistickú významnosť poľnohospodárskych dotácií a daňových sadzieb. Ak by sa objem dotácií M3 zvýšil o 1 EUR, čistý príjem by narástol o 0,3034 EUR. Daň z príjmu bola identifikovaná ako najvýznamnejšia premenná. Ak by jej objem bol o 1 EUR vyšší, čistý príjem by sa znížil o 2,695 EUR. Druhá časť analýzy sa venovala hierarchickému zoskupovaniu a definovala 3 klastre.

Kľúčové slová dendrogram - čistý príjem - mikroúroveň - dotácie - daňové sadzby - Wardova metóda

Entrepreneurial income has a number of economic functions which make it a very important concept in the context of farmers and agriculture. Profits from agriculture are generally suffering from long-term downward pressure and shorter-term instability. The Common Agricultural Policy of the European Union forms conditions and defines targets for agricultural entities operating on its territory. Through the support system created by the I. and II. pillar of

the Common Agricultural Policy subsidizes agricultural entities. The subsidy policy affects the pension situation, business efficiency and rural development.

While a large number of studies focuses on price and revenue instability, there are not many analyses specifically focused on the stability of the whole farm income. This seems an important knowledge gap, according MISHRA, A. and ANDRETTO, G. (2002), farmers are ultimately concerned more about their net incomes than about prices and costs". To fulfill this gap these studies were realized. SEVERINI, S. at al. (2016) focused on the FADN variable Farm Net Income, that is the remuneration to fixed factors of production of the family (work, land and capital) and remuneration to the entrepreneur's risk. GALLUZZO, N. (2016) used a multiple regression model aimed at estimating by the method of Ordinary Least Square in all Romanian farms belonging to the FADN dataset from 2007 to 2015 the main relationships and correlations between the dependent variable of farm net income and others independent variables such as total payments and financial support allocated by the CAP. ŚREDZIŃSKA, J. (2018) identified determinants of the income of farms in the EU-15 as well as in Central and Eastern European countries and to assess how these determinants varied over time.

Methodology

The main research question was addressed to investigate, using a quantitative approach, in Slovakia farms FADN 2016 dataset, the role and function of taxation system and financial subsidies allocated by the CAP in the first and second pillar and other variables such as farm area, labour, debts, liabilities, receivables, total costs, revenues and assets on the level of farm net income. In order to identify and quantify the impact of variables was selected multiple regression analysis as the most suitable method.

Methodology of data collection

The National Agricultural and Food Centre has the position of Liaison Agency in Slovakia and responsibility for the collection of FADN data. The minimum economic size class for the Slovak Republic from the Farm Structure Survey 2013 for the accounting year 2016 was set at 25 000 EUR, which represents the economic size class number 6. The surveyed enterprises reached 95 % of the total standard production of the Slovak Republic and managed 93.2 % agricultural land, thus fulfilling the FADN conditions for the definition of the survey area. In the field of research, the sample size of 563 entities – 194 self-employed farmers and 369 agricultural companies, were approved by the European Commission, were determined by statistical methods, according VÚEPP (2018).

Multiple regression analysis definition and description of variables

Researchers have used this multiple regression analysis as a powerful tool because it allows to model statistically the relationship between dependent variable and a set of independent variable.

The multiple regression equation is as follows:

$$\hat{Y} = b_0 + b_1X_1 + b_2X_2 + \cdots b_pX_p + \varepsilon_t \quad (1)$$

where $\hat{Y}$ is the dependent variable, X_1through X_p are p distinct independent variables, b_0 is the value of Y when all of the independent variables (X_1 through X_p) are equal to zero, and b_1 through b_p are the estimated regression coefficients. Each regression coefficient represents the change in Y relative to a one unit change in the respective independent variable and ε_t is random component.

In the case of Slovakia FADN multiple regression analysis were selected these variables:

- dependent variable= net income (NI)
- independent variables= total farm area (HECTARES), labour input - awerage working units (AWU), subsidies - according FADN tables structure (M1,M2,M3,M4), land rent+tax (LRT), shortdebt (STD), longdent (LTD), liabilities (LIAB), receivables (REC), other taxes (OT), income tax (INCT), total costs (TC), revenues (REV), current assets (CA), long term assets (LTA)
- b_0 through b_{17}= regression coefficients
- ε_t = random component

units: farm area- hectares, AWU- hours per worker, dependent variable and independent variables 3-17 in EUR

Using these variables, the following model of agricultural enterprise net income was defined as:

$$NI=b_0 + b_1\,HECTARES + b_2AWU + b_3M1 + b_4M2 + b_5M3 + b_6M4 + b_7LRT + b_8STD + b_9LTD + b_{10}\,LIAB + b_{11}REC + b_{12}OT + b_{13}INCT + b_{14}TC + b_{15}\,REV + b_{16}CA + b_{17}LTA + \varepsilon_t \quad (2)$$

The selection of these variables was influenced by following reasons:

The business environment of enterprises depends on the tax system that affects the profitability. Through direct and indirect taxation is affected the value of costs. According the database of Slovakia FADN was analysed 369 agricultural companies.

The selection of variables was influenced by previous analyzes of the FADN database by other authors. SEVERINI, S. et al. (2016) examined FADN variable Farm Net Income, that is the remuneration to fixed factors of production - work, land and capital. GALLUZZO, N. (2016) used a multiple regression model of wealth of farmers - farm net income and independent variables such as total payments and financial support allocated by the CAP and rural development.

The article defined two hypotheses H1 and H2 :

H1: Net income of the farm was dependent on subsidies.

H2: Net income of the farm was dependent on Slovakia tax rates.

The first step of analysis was to verify the statistical significance of individual variables. The model of net income had the character of linear model. In this case, the statistical significance of each variable was tested via the summary command. As non-significant variables were identified: average working unit, M1, M4, short debts, liabilities, total cost, current assets, long term assets. Then, the statistically significant model was subsequently tested. Statistics Durbin - Watson did not detect the presence of autocorrelation, it's value was DW = 2.0427 and p-value > α (0.6503> 0.05). As the statistic significant model was burdened by the problem of heteroscedasticity and multicollinearity, the next step in the analysis was differentiation of the originally defined model of agricultural net income and the process of identification the statistical significance of individual variables was repeated.

The next part of the analysis was clustering based on the Ward's Hierarchical Agglomerative Clustering Method. Ward's is the only one among the agglomerative clustering methods that is based on a classical sum-of-squares criterion, producing groups that minimize within-group dispersion at each binary fusion. In addition, Ward's method is interesting because it looks for clusters in multivariate Euclidean space, according MURTAGH, F. and LEGENDRE, P. (2014).

Own work

The multiple regression model results

Farmers are ultimately concerned more about their net incomes. Agricultural income is an important indicator as it provides information on the viability of the agricultural sector.

The defined model contained these significant variables: subsidies M2, M3, M4, total rent, long debt, liabilities, receivables and income tax. The regression analysis results are in Tab. 1.

The first statistically significant determinant were M2 subsidies, which represented the second pillar of the Common Agricultural Policy. The coefficient belonging to this determinant was 0.2217 that represented a positive impact on the agricultural net income. If M2 subsidies would be 1 EUR higher net income would increase by 0.2217 EUR with a probability of 90%.

The second pillar of the Common Agricultural Policy is the EU's rural development policy. A higher degree of flexibility, compared to the first pillar, allows regional, national and local authorities to draw up their individual seven-years rural development programs on the basis of rural development. Unlike the first pillar, which is fully funded by the EU, the second pillar programs are co-financed by EU and regional or national funds. Statistically signicant were also M3 and M4 subsidies, which represented the first pillar of the CAP. Since 2014, the greening component has been introduced into the first pillar, ensuring that all EU farmers, beneficiaries, will operate in an environmentally and climate-friendly way. If the volume of M3 subsidies increased by 1 EUR, net income would inceased by 0.3034 EUR with a probability of 99 %. If the greening components - M4 subsidies would be 1 EUR higher, net income would increased by 0.7214 EUR with a probability of 95%.

Tab. 1 Multiple regression analysis results

Výsledky viacnásobnej regresnej analýzy

	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	-5.139e+02	9.568e+03	-0.054	0.957200	
diff(M2)	2.217e-01	1.142e-01	1.941	0.053063	.
diff(M3)	3.034e-01	9.259e-02	3.277	0.001153	**
diff(M4)	7.214e-01	3.156e-01	2.286	0.022864	*
diff(LRT)	-5.048e-01	1.342e-01	-3.761	0.000198	***
diff(LTD)	-4.318e-02	2.307e-02	-1.872	0.062077	.
diff(LIAB)	2.622e-02	9.561e-03	2.742	0.006417	**
diff(REC)	-1.118e-01	2.371e-02	-4.716	3.47e-06	***
diff(INCT)	-2.695e+00	2.157e-01	-12.493	< 2e-16	***
Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1					

Source: author's own elaboration from R-program based on database of Slovakia FADN 2016[1]

Legend: subsidies (M2, M3, M4), land rent+tax (LRT), longdent (LTD), liabilities (LIAB), receivables (REC), income tax (INCT)[2]

1/ Prameň: vlastné spracovanie autora z R-programu založeného na databáze Slovenska FADN 2016

2/ Legenda: dotácie (M2, M3, M4), prenájom pôdy + daň (LRT), dlhodobý dlh (LTD), záväzky (LIAB), pohľadávky (REC), daň z príjmu (INCT)

The total rents had a negative impact on the variable explained. If total rent rised by 1 EUR, net income of company would decreased by 0.5048 EUR. Long-term debts recorded a slight impact on net profit, wiht a probalitily of 90 %. If long-term debts increased by 1 EUR, net income would declined by 0.043 EUR. Next three model components - liabilities, receivables and income tax had recorded statistical significance with a probability of 99%. If the liabilities would be 1 EUR higher, net income would increase by 0.026 EUR. If receivables rised by 1 EUR, net income would decreased by 0.112 EUR. The last statistically significant variable in the model was income tax, with its impact on net profit being confirmed as the most significant. Income tax data are derived from the balance sheets of individual companies that participated in the FADN database survey. For data collection, The National Agricultural and Food Center requires financial statements of the participating companies as an attachment. If the value charged to income tax account would by 1 EUR higher, net income would decreased by 2.695 EUR. If we looked at F-statistic we would see that p-value < α (2.2e-16<0.05), the model was statistically significant. The statistical significance was also confirmed by the reset test where: p-value>α (0.3862>0.05). According studentized Breusch-Pagan test result p-value>α (0.3075> 0.05) the problem of heteroscedasticity was removed. Vif command confirmed that the model was not burdened with the problem of multicollinearity. One-sample Kolmogorov-Smirnov test with D = 0.14736, p-value = 0.9016 confirmed normality of residues. According to the coefficient of determination R^2 is stated that the model explained 51 % of the total variability. In this case, 51 % correctly explained the explanatory variable agricultural enterprises net income and the rest 49 % was a random component.

As mentioned in literature reviewed most of the models available are implemented at an aggregate level. There are not many analyses specifically focused on the whole farm income. The importance and impact of subsidies in agriculture was confirmed by this analysis as well as the following studies. GALLUZZO, N. (2018) analysed Italian family farms income

technical, economic and allocative efficiency using the FADN dataset at micro level. The Italian family farms were influenced in a positive way by the funds. The multiple regression model in the upland rural areas pointed out that the family farmers were very sensitive to the funds disbursed by the Rural Development Program. The independent variables of the usable agricultural area and the total costs acted in an indirect way on the number of farms.

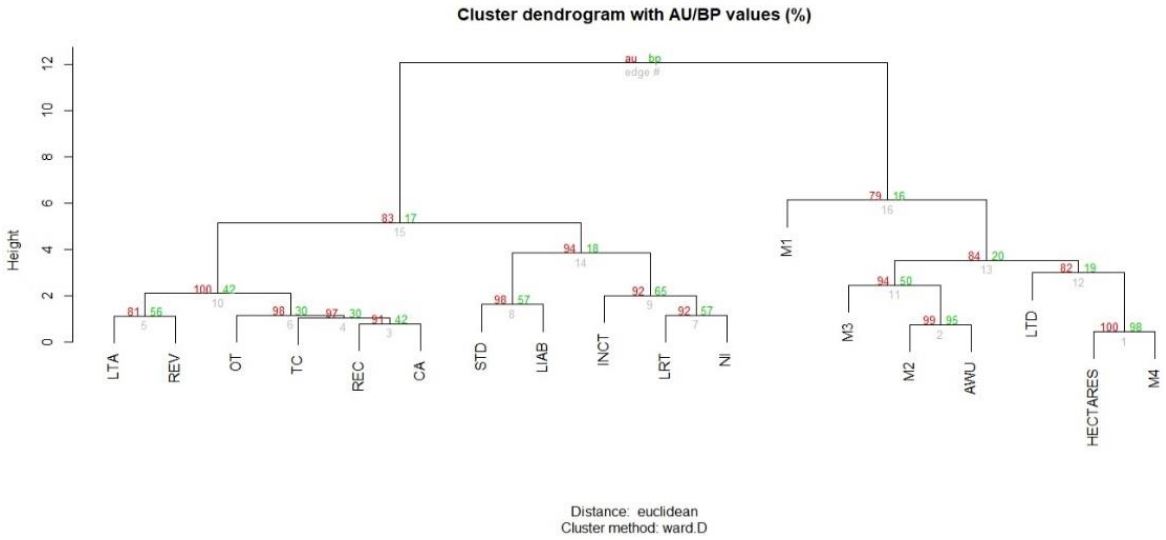
SEVERINI, S. et al. (2016) examined Italian FADN variable Farm Income defined as: farm income= revenues - external costs + direct payments ≡ market income + direct payments. The analysis studied the role of CAP direct payments in stabilising farm income using individual farm data. Small farms were facing a relatively higher level of income variability. As suggested by VROLIJK, H. and POPPE, K. (2019), this could be caused by the fact that income of small farms is in many cases very low, so that small changes in revenue can cause high relative changes in income. On the contrary, ŚREDZIŃSKA, J. (2018) in her study focused on determinants of the income of farms in EU counties, used multiple regression to investigate the influence of selected variables on the income of farms at an aggregate level. Farm income was positively influenced by operating activity subsidies, production intensity and land used for work. Fixed assets had a negative influence on income. Important role of income tax was confirmed by the results of the analysis and evaluated the hypothesis H2 as true. The taxation mechanism significantly affects the size of disposable income of individual entities.

Hierarchical agglomerative cluster analysis

In this method, in the first stage of clustering, each statistical object – enetrprise is considered as individual cluster and subsequently, these objects are grouped to superior cluster-regions which are grouped again based on the distance between them while the objects with the smallest distance between are grouped together. After, on the highest level of clustering, all the statistical objects are joined into one cluster. For measurement of the distance between the objects the metric of euclidian distance was used. The cluster analysis was elaborated for 18 variables of slovak regions, which were the same as the variables used in multiple regression analysis and described the characteristics of region.

Fig. 1 Dendrogram with Euclidean distance of variables by Ward's method

Dendrogram s euklidovskou vzdialenosťou premenných podľa Wardovej metódy



Source: author's own elaboration from R-program based on database of Slovakia FADN 2016[1]

Legend: total farm area (HECTARES), labour input - average working units (AWU), subsidies - according FADN tables structure (M1,M2,M3,M4), land rent + tax (LRT), shortdebt (STD), longdebt (LTD), liabilities (LIAB), receivables (REC), other taxes (OT), income tax (INCT), total costs (TC), revenues (REV), current assets (CA), long term assets (LTA)[2]

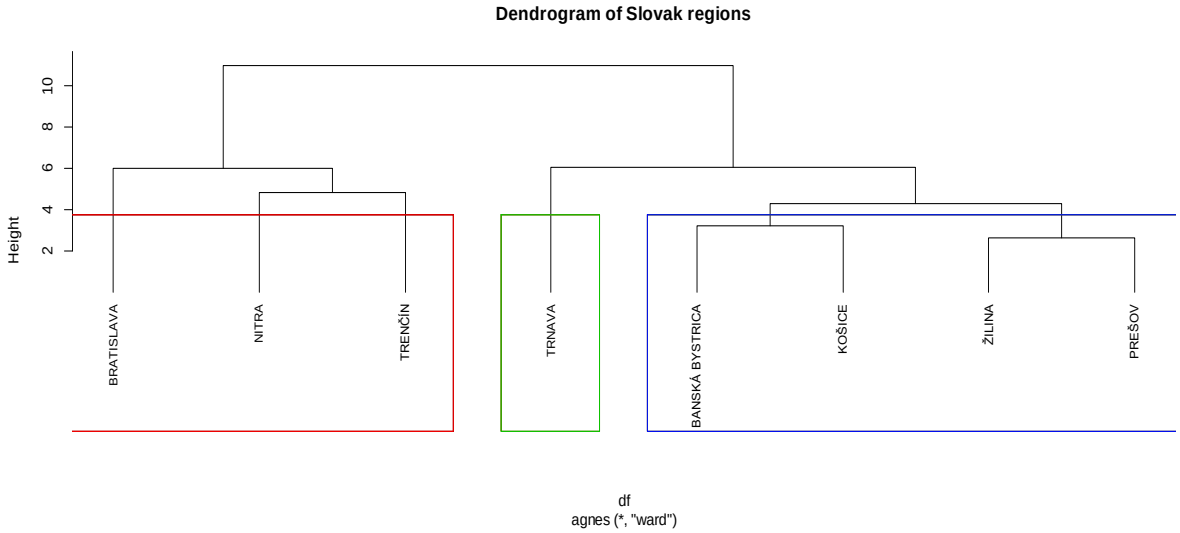
1/ Prameň: vlastné spracovanie autora z R-programu založeného na databáze Slovenska FADN 2016

2/ Legenda: celková výmera farmy (ha), pracovné vstupy - AWU, dotácie podľa štruktúry tabuliek FADN (M1, M2, M3, M4), prenájom pôdy + daň (LRT), krátkodobý dlh (STD), dlhodobý dlh (LTD), záväzky (LIAB), pohľadávky (REC), ostatné dane (OT), daň z príjmu (INCT), celkové náklady (TC), príjmy (REV), obežné aktíva (CA), dlhodobé aktíva (LTA)

Hierarchical agglomerative cluster analysis identified 3 clusters of Slovak regions. The first cluster was formed by three regions - Bratislava, Nitra and Trenčín. In the first cluster, the utilized agricultural area represented 26.4 % of the total area with 88 holdings. In terms of economic indicators, cluster 1 defined an area with above-average profit levels. Nitra region was the most profitable, with an average net profit on the level of 89 203 EUR. Revenues in this area ranged from 140 % to 170 % of the average. The total subsidies per hectare amounted to 300 EUR. On the other hand, this area is characterized by an above-average level of total costs - Bratislava 130 % of the average, Nitra 161 % and Trenčín 130 %. Total rent with tax rates per hectare was 108 EUR in Nitra, 71 EUR in Bratislava and 38 EUR in Trenčín.

Fig. 2 **Dendrogram of Slovak regions**

Dendrogram slovenských regiónov



Source: author's own elaboration from R-program based on database of Slovakia FADN 2016[1]

1/ Prameň: vlastné spracovanie autora z R-programu založeného na databáze Slovenska FADN 2016

Second cluster was identified as region Trnava. The utilized agricultural area represented 12.4 % of total area with 62 enterprises. The average company from the Trnava region managed 765 hectares, which was the smallest area per enterprise. Total rent with tax rates per hectare was 77 EUR. The total subsidies per hectare amounted to 301 EUR, which was identical to the average value of first cluster. Total revenue accounted for 96 % of the average and total costs reached 81% of the average. In terms of receivables and liabilities, this region was different from the first cluster as the values of these indicators were at the same level as the third cluster. A specific position in this region was identified by M1 subsidies with an average value of EUR 3 736 for livestock support and short - term debts reached the minimum amounts. The labour input defined as average working units was minimal in this region.

The third cluster was the largest and consisted of 4 regions – Banská Bystrica, Žilina, Prešov and Košice with a total utilized agricultural area of 234 787.7 hectares, which represented 61.2 % of the total agricultural area, with 219 enterprises. Key indicators identified third cluster were indicators of the overall economic situation as: total revenue (59 % - 79 % of the average), total cost (69 % -78 % of the average), long term assets (76 % - 87 % of the average). Different situation was in the net income indicator. Regions Žilina and Prešov were at a loss, in contrast, Košice and Banská Bystrica were profitable. Total rent with tax rates per hectare was 46 EUR in Banská Bystrica, 23 EUR in Žilina, 28 EUR in Prešov and 42 EUR in Košice. The third cluster was characterized by different total subsidies per hectare. The highest value of 416 EUR per hectare was in the Žilina region, with significant position of subsidies for less favoured areas. The second position subsidies per hectare with 333 EUR reached Banská Bystrica, third place Prešov 331 EUR and Košice 312 EUR. The results of this analysis were also confirmed by previous studies that focused on identifying determinants of financial performance of

agricultural enterprises and to define their influences on the overall financial performance of these business entities of different economic characteristics. BERANOVÁ, M. et al. (2013) identified determinants of financial performance of agricultural enterprises of one hundred agricultural enterprises farming in the South Moravian Region and the Region of Zlín. ETUMNU, CH. and GRAY, A. (2018) realised the study titled: A Clustering Approach to Understanding Farmers Success Strategies, based on agglomerative hierarchical cluster analysis of 991 farmers in USA. This paper grouped farmers according their prioritized management success strategies.

Conclusion

Results of the analysis pointed to the statistically significant determinants of net income and by multiple regression analysis of agricultural holdings on the basis of Slovakia FADN database, was quantified impact of independent variables on the dependent variable. The National Agricultural and Food Centre collects the data. The database of Slovakia FADN 2016 consists of 563 entities – 194 self-employed farmers and 369 agricultural companies, which were analysed. The article confirmed two defined hypotheses. The first hypothesis dealt with the impact of subsidies on net profit. If the volume of M3 subsidies increased by 1 EUR , net income would inceased by 0.3034 EUR with a probability of 99 %. If the greening components - M4 subsidies would be 1 EUR higher, net income would increased by 0.7214 EUR with a probability of 95 %. The second hypothesis examined the impact of tax rates on Slovakia agricultural enterprises. If total rent, defined as land rent+ tax, rised by 1 EUR, net income of company would decreased by 0.5048 EUR. The final defined model contained these significant variables: subsidies M2, M3, M4, land rent + tax, long debt, liabilities, receivables and income tax. Next part of the analysis was hierarchical cluster analysis. According the Ward's Hierarchical Agglomerative Clustering Method were defined 3 clusters. The first cluster was formed by three regions - Bratislava, Nitra and Trenčín. Second cluster was identified as region Trnava. The third cluster was the largest and consisted of 4 regions – Banská Bystrica, Žilina, Prešov and Košice. The results of the cluster analysis were influenced by the following facts, which can be divided into three groups. The first group represents the management decisions-business activities in plant and animal production, and financial situations of company- debts, receivables and liabilities. The second group consists of a system of subsidies provided under the first and second pillars of the Common Agricultural Policy. Under the II. pillar, M2 subsidies were allocated to 161 enterprises, which represents 43.6 % of the total number of enterprises. Subsidies from the first pillars M3 and M4 were allocated to 366 enterprises, representing 99 % of the total number of enterprises. The third group represents the Slovakia tax rates, mainly income tax and real estate tax.

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