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THE IMPACT OF THE DIRECTION OF PRODUCTION OF THE EUROPEAN UNION AGRICULTURAL ENTERPRISES AT THE LEVEL OF TOTAL FARMING OVERHEADS

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Purpose: The main aim of the study is to analyse the relationship between the production direction of the European Union agricultural enterprises and the different types of total farming overheads incurred by these agricultural enterprises. Additionally, the achieved results are to present how the direction of production of the European Union agricultural enterprises influences on the incurred total farming overheads relating to the functioning of the agricultural enterprises.
Design/methodology/approach: The one-way analysis of variance ANOVA was used to realise the aim of the study. To present the production directions the data relating to the eight agricultural types listed in the FADN base were used. The conducted studies have been focused on the four types of total farming overheads relating to the performed production activities. The study covers all European Union member countries from the period from 2005 to 2017.
Findings: The most frequent differences in bearing the different types of total farming overheads are evident between the type of horticulture, wine and permanent crops and the types of agricultural enterprises focused on livestock production. The several differences may be observed in case of the agricultural enterprises oriented on the same food sources
Originality/value: There are significant differences in the level of the incurred total farming overheads between the agricultural enterprises oriented on crop production and livestock production. The much higher costs may be observed in the agricultural enterprises oriented on crop production, in particular in case of horticulture, wine and permanent crops.

Keywords: agriculture, FADN, costs, analysis of variance.

Category of the paper: Research paper.

1. Introduction

The incurred costs are one of the essential factors determining the competitive advantage of agricultural enterprises. They constitute an element contributing to the financial profit in the future. As presented by W.F. Samuelson and S.G. Marks (2006) the accurate knowledge of

costs is a condition to define the actual level of profitability of an organization. Thus, the costs may be considered as a measure of development of the future competitive potential of agricultural enterprises.

The measure frequently used to assess the achieved effects is the difference between the production value and total costs (Józwiak, 2014). According to the criterion of place of costs generation, it is possible to select direct and indirect costs from the total amount of costs, which are divided into farming overheads and total production costs. As E. Kołoszycz and M. Świtłyk (2004) remarked, the agricultural enterprises aim at the best adjustment of the costs level to the prices they acquire from selling their products. However, there are significant differences between the cost level in the individual types of agricultural enterprises. As A. Skarżyńska (2011) emphasizes it is, among others, due to the effectiveness of the farmers' activities. Additionally, A. Skarżyńska adds that running an agricultural enterprise is a very complicated process and achieving good results depends on knowledge, entrepreneurship and innovation of undertaken activities.

There is a necessity to determine the level of agricultural enterprises costs and to analyse their diversity. The appropriateness of conducting this kind of studies is connected with performing the analysis of empirical data from the point of view of meso- or macroeconomics. It is possible to carry out the studies, among others, due to implementation of Polish FADN (The Farm Accountancy Data Network) in 2004 (Goraj et al., 2004). This system allows to select a representative sample based on farming type criterion, which indicates the focus on production of agricultural enterprises (Goraj, Osuch and Sierański, 2006). The studies based on this agricultural enterprises sample enable to draw conclusions relating to the whole population of agricultural enterprises.

The issue of analysing the costs connected with functioning of agricultural enterprises is frequently taken into consideration. It was addressed, among others, by J. Sharples (1990), who emphasised that when analysing competitiveness, it is necessary to add marketing costs to the production costs, E.M. Tegtmeier and M.D. Duffy (2004) who referred to the analysis of the external costs of the agricultural production in the USA, V. Bašek and J. Kraus (2011) who analysed the total costs of agricultural production, D. Czakowski and A. Czyżewski (2017) who analysed costs as one of the determinants of the effectiveness of agricultural enterprises functioning on the major markets of agricultural products, and K. Firlej (2017) proving in his studies that the costs level is one of the most important conditions limiting the use of organization resources.

However, these studies do not contain the analysis of the existing correlation between the type of production of the agricultural enterprises in the European Union and the level of total farming overheads. Addressing the total farming overheads in the research derives from their relative importance in the costs incurred by the agricultural enterprises. The studies performed by M. Chmielowska and M. Madra (2008) emphasise that total farming overheads represent 20% of total production costs. Due to the fact that the studies based on the use of tools for the

analysis of variance have also not been carried out, the main aim of this study is to analyse the relationship between the direction of production of the agricultural enterprises in the European Union and the individual types of total farming overheads incurred by these enterprises. Additionally, the achieved results are to present how the direction of production of the European Union agricultural enterprises affects the total farming overheads incurred on the functioning of the agricultural enterprises. The implementation of the aims is based on the analysis of variance.

2. Research methodology

The study covers all European Union member countries. The analysed period was limited to the years 2005-2017 due to restrictions for access to statistical data. To present the directions of production the data related to eight agricultural types listed in the FADN (The Farm Accountancy Data Network) database were used. The following types of agricultural enterprises were identified: fieldcrops (1), horticulture (2), wine (3), permanent crops (4), milk (5), other grazing livestock (6), granivores (7), mixed (8).

The conducted studies are focused on the four types of total farming overheads connected with production activities that are part of the FADN system variable of SE336 symbol. They include: machinery and building current costs (A), energy (B), contracts work (C), other costs (D).

One-factor analysis of variance ANOVA was used to achieve the research aim. In accordance with the definition, ANOVA shall be understood as a method that determines the differences between means in several populations (Aczel and Sounderpandian, 2018). Therefore, it is used to analyse measurable observations, that depend on one or several factors, and at the same time it explains if they may be a reason of differences between group means. ANOVA tests the hypothesis of equal means, i.e.:

$H_0: m_1 = m_2 = \ ... = \ m_k$

$H_1: m_i \neq \ m_j \ for \ definite \ i \ \neq$ j

The test statistics gives answer to the question how much proportion of the total variability results from a factor and random nature of phenomenon. The distribution of statistics is F with $k-1$ and $n-k$ degrees of freedom, where k means the number of degrees of an analysed factor, and n the size of the sample. To verify the hypothesis of equal means the table of variance analyses should be completed (table 1).

Table 1.
Variance analysis table (single classification)

Source of variation	Degrees of freedom	Sum of squares	Mean square	Test statistics
between groups (objects)	k - 1	$SSA = \sum_{i=1}^{k} (\bar{X}_i - \bar{X})^2 n_i$	$MSA = \frac{SSA}{k-1}$	$F = \frac{MSA}{MSE}$
within groups (error)	n - k	$SSE = \sum_{i=1}^{k} \sum_{j=1}^{n_i} (X_{ij} - \bar{X}_i)^2$	$MSE = \frac{SSE}{n-k}$	
total	n - 1	$SSA = SSA + SSE$	$MST = \frac{SST}{n-1}$	

Adapted from: own study based on: Górecki, T. (2011). *Podstawy statystyki z przykładami w R*. Legionowo: Wydawnictwo BTC, p. 255.

The important aspect of performing research with the use of ANOVA method is taking into account a number of assumptions (Rabiej, 2012):

1. independency of random variables in the analysed populations (groups),
2. measurability of analysed variables,
3. normal distribution of variables in every population (group),
4. uniformity of variables in all populations (groups).

The assumption of normal distribution of variables in every population (group) was carried out with the use of Anderson-Darling test that includes two opposite statistical hypotheses (Anderson and Darling, 1952):

H_0: the distribution of data is consistent with normal distribution,

H_1: the distribution of data is not consistent with normal distribution.

In order to determine if there are premises to reject the null hypothesis, the p value is used. If the p value is lower than the accepted level of test significance 0,05, there are no grounds to reject the null hypothesis of normal distribution of the analysed characteristic.

The study of uniformity of variables in all populations (groups) was conducted with the use of Bartlett test. The test focuses on a comparison of weighted arithmetic mean of variance with the weighted geometric mean of variance (Stanisz, 2007). It is based on statistics with the asymptotic distribution chi-square.

If any of the conditions are not fulfilled, it is appropriate to use nonparametric Kruskal-Wallis test. The way the test is interpreted is similar to the one-factor parametric ANOVA, with the exception that the test shows the equality of average ranks, not average values.

3. The study results

The following hypotheses were formulated to determine the dependencies between the direction of production of the European Union agricultural enterprises and the types of costs incurred by these agricultural enterprises:

- $H_{0(i)}$: the distribution of value of the reached value of i- total economic cost by the agricultural enterprises of the European Union is the same in every direction of production of these enterprises (the direction of production of the European Union agricultural enterprises does not significantly influence on the achieved value of i- total economic cost of these enterprises),
- $H_{1(i)}$: at least two directions of production of the European Union agricultural enterprises differ in terms of the value of i- total economic cost of these agricultural enterprises from the others (the direction of production of the EU agricultural enterprises significantly affects the reached value of i- total economic cost of these enterprises).

When reviewing dependent variables (table 2), it should be concluded that in the case of machinery and building current costs the lowest mean was observed for the agricultural enterprises oriented on granivores, then milk and other grazing livestock. The wine had highest level of costs and the similar level was also recorded in horticulture.

The lowest average energy costs were observed in the same types of agricultural enterprises as in the case of running costs of machinery and construction. On the other hand, the highest average was noticed in agricultural enterprises focused on horticulture, then on permanent crops and wine (the average costs of this type of agricultural enterprises amounted to 9316.62 Euro, 6182.00 Euro and 6048.15 Euro).

In the dependent variable: the lowest level of contracts work costs and the remaining costs is observed in four types of agricultural enterprises: granivores (in both cases the lowest level), milk, other grazing livestock and mixed. On the other hand, the highest costs of contracts work were noticed in wine, however, the highest in the category remaining costs is in the agricultural enterprises oriented on horticulture.

Table 2.
Basic data of dependent variables in individual groups

	Dependent variable: machinery and building current costs							
Types of agricultural enterprises	1	2	3	4	5	6	7	8
Average	16881.77	36847.85	37242.38	22552.08	10555.54	12091.54	6181.85	17581.77
Kurtosis	-1.62	-1.76	-1.39	-0.58	-1.32	0.32	-1.69	-1.73
Skewness	-0.33	-0.07	0.03	-0.87	-0.36	1.17	0.19	-0.03

Cont. table 2.

	Dependent variable: energy costs							
Types of agricultural enterprises	1	2	3	4	5	6	7	8
Average	3995.85	9316.62	6084.15	6182.00	2748.00	3485.54	1320.15	3658.23
Kurtosis	-1.52	-1.35	-1.37	-0.99	-1.61	-1.70	-1.40	-1.40
Skewness	0.61	0.37	0.49	-0.39	-0.08	0.26	0.58	0.59
	Dependent variable: contracts work costs							
Types of agricultural enterprises	1	2	3	4	5	6	7	8
Average	5255.92	12293.38	16367.77	5796.15	3265.85	3014.15	1891.62	2685.00
Kurtosis	-1.55	-1.84	-1.40	-1.17	-1.29	-1.32	-1.75	-1.74
Skewness	-0.09	-0.08	0.60	-0.20	-0.48	-0.42	-0.19	-0.20
	Dependent variable: other costs							
Types of agricultural enterprises	1	2	3	4	5	6	7	8
Average	3565.77	5948.77	3723.77	5020.69	2004.00	2325.15	836.77	2909.38
Kurtosis	-1.56	-1.73	-1.12	-0.96	-1.42	-0.43	-0.14	-0.90
Skewness	-0.31	-0.07	0.42	-0.69	-0.44	0.86	0.97	0.67

Source: own study.

The conducted study of the average levels of particular types of total farming overheads allows initially assume the rejection of the null hypothesis in most cases. Additionally, on the basis of kurtosis and obliquity it may be stated that in some cases of costs there may be problems with normality of distribution. In order to confirm the initial assumptions, box graphs were created (fig. 1).

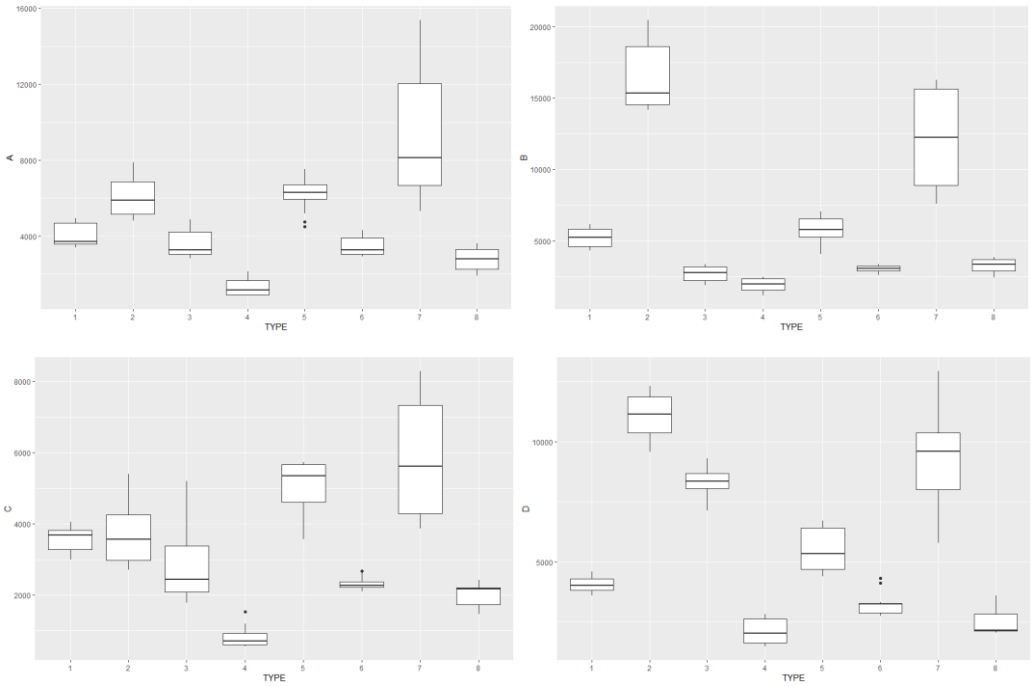

Figure 1. Box-and-whisker plot illustrating the relationship between the direction of production of the European Union agricultural enterprises and individual dependent variables. Source: own study.

The Anderson-Darling test was performed to check the normality of distribution of dependent variable. In each group of total farming overheads of the European Union agricultural enterprises there is a p-value smaller than 5% (table 3). Therefore, it should be assumed that the normal distribution does not exist in any groups.

Table 3.
Results of the Anderson-Darling test for individual dependent variables

	Dependent variable: machinery and building current costs		**Dependent variable: energy costs**	
Types of agricultural enterprises	Test statistics A	p-value	Test statistics A	p-value
1	1.106	0.004	0.302	0.525
2	0.399	0.313	0.680	0.058
3	0.546	0.128	0.877	0.017
4	0.314	0.505	0.211	0.820
5	0.337	0.446	0.452	0.229
6	0.634	0.076	0.423	0.272
7	0.782	0.031	0.612	0.087
8	0.823	0.024	0.565	0.116
	Dependent variable: contracts work costs		**Dependent variable: other costs**	
Types of agricultural enterprises	Test statistics A	p-value	Test statistics A	p-value
1	0.523	0.148	0.387	0.335
2	0.626	0.080	0.172	0.909
3	0.352	0.409	0.366	0.379
4	0.587	0.102	0.785	0.030
5	0.698	0.052	1.054	0.006
6	0.673	0.060	0.948	0.011
7	0.638	0.075	0.403	0.304
8	0.607	0.090	0.146	0.955

Source: own study.

In order to verify uniformity of variance the Bartlett test was carried out. The obtained figures are presented in table 4. The obtained p-value values are at the level of less than accepted level of materiality (0.05). Therefore, it should be concluded that there is no uniformity of variance in any groups of total farming overheads incurred by the European Union agricultural enterprises.

Table 4.
Bartlett test results for individual dependent variables

Dependent variable: machinery and building current costs		**Dependent variable: energy costs**	
K-squared	p-value	K-squared	p-value
91.783	< 2.2e-16	120.53	< 2.2e-16
Dependent variable: contracts work costs		**Dependent variable: other costs**	
K-squared	p-value	K-squared	p-value
82.519	= 4.217e-15	63.91	= 2.489e-11

Source: own study.

The conducted Anderson-Darling and Bartlett tests indicate that in the case of each dependent variable the ANOVA tests assumptions are not met. As a result it is necessary to use non-parametric Kruskall-Wallis test in further studies to analyse relationship between the direction of production of the European Union agricultural enterprises and individual dependent variables. Table 5 presents the results of ANOVA test Kruskall-Wallis ranks for individual dependent variables.

The obtained values allow to observe that at the level of materiality 0,05 the individual null hypotheses should be rejected as they indicate that the distribution of value of incurred total farming overheads by the agricultural enterprises in every production direction is the same for alternative hypothesis, which emphasises that at least two production directions differ in terms of incurred total farming overheads and remaining costs.

The obtained results permit the conclusion that the production directions of the European Union agricultural enterprises cause significant differences in the values of incurred total farming overheads, thus the running costs of machinery and construction, energy, contracts work and the remaining costs.

Table 5.
Results of the Kruskal-Wallis rank ANOVA test for individual dependent variables

Dependent variable: machinery and building current costs		**Dependent variable: energy costs**	
Chi-squared	p-value	Chi-squared	p-value
89.433	< 2.2e-16	94.469	< 2.2e-16
Dependent variable: contracts work costs		**Dependent variable: other costs**	
Chi-squared	p-value	Chi-squared	p-value
85.458	1.056e-15	95.666	< 2.2e-16

Source: own study.

In order to determine the reasons of significant differentiation of the production direction of the European Union agricultural enterprises and the values of individual variables the multiple comparison test was used (table 6).

Table 6.
Dunn test results with Bonferroni correction

	Dependent variable: machinery and building current costs						
Types of agricultural enterprises	1	2	3	4	5	6	7
2	0,006*[1]	-	-	-	-	-	-
3	0,247	1,000	-	-	-	-	-
4	0,182	1,000	1,000	-	-	-	-
5	0,361	0,000*	0,000*	0,000*	-	-	-
6	1,000	0,000*	0,011*	0,007*	1,000	-	-
7	0,003*	0,000*	0,000*	0,000*	1,000	0,085	-
8	1,000	0,000*	0,021*	0,014*	1,000	1,000	0,049

Cont. table 6.

	Dependent variable: energy costs						
Types of agricultural enterprises	1	2	3	4	5	6	7
2	0,525	-	-	-	-	-	-
3	0,094	1,000	-	-	-	-	-
4	1,000	1,000	0,289	-	-	-	-
5	0,595	0,001*	0,000*	0,214	-	-	-
6	0,126	0,000*	0,000*	0,037	1,000	-	-
7	0,000*	0,000*	0,000*	0,000*	0,163	0,738	-
8	0,019*	0,000*	0,000*	0,005*	1,000	1,000	1,000
	Dependent variable: contracts work costs						
Types of agricultural enterprises	1	2	3	4	5	6	7
2	0,226	-	-	-	-	-	-
3	1,000	0,462	-	-	-	-	-
4	0,550	1,000	1,000	-	-	-	-
5	0,027	0,000*	0,010*	0,000*	-	-	-
6	0,465	0,000*	0,228	0,000*	1,000	-	-
7	0,000*	0,000*	0,000*	0,000*	1,000	0,156	-
8	1,000	0,002*	1,000	0,006*	1,000	1,000	1,000
	Dependent variable: other costs						
Types of agricultural enterprises	1	2	3	4	5	6	7
2	0,018*	-	-	-	-	-	-
3	0,000*	1,000	-	-	-	-	-
4	1,000	0,663	0,038	-	-	-	-
5	0,373	0,000*	0,000*	0,008*	-	-	-
6	1,000	0,000*	0,000*	0,270	1,000	-	-
7	0,060	0,000*	0,000*	0,001*	1,000	1,000	-
8	0,108	1,000	1,000	1,000	0,000*	0,002*	0,000*

*1 – statistically significant differences.

Source: own study.

The results of Dunn's test with Bonferroni's adjustments reveal that significant differences in all types of total farming overheads are visible in the case of horticultural type agricultural enterprises with the enterprises with the production direction: milk, other grazing livestock and granivores, vineyard type with enterprises oriented on milk and granivores and permanent crops type with granivores. In the case of running costs of machinery and construction, energy and contracts work costs significant differences are observed in agricultural enterprises specialising in fieldcrops and granivores type, as well as mixed crops with horticulture and permanent crops type.

In summarising the significant differences of individual types of total farming overheads, it should be concluded that they are not observed in every type of agricultural production. This occurs in the case of agricultural enterprises directed at fieldcrops with a type permanent crops, milk, other grazing livestock, directed at horticulture with a type wine and permanent crops, directed at wine with a type permanent crops and mixed enterprises, other grazing livestock type with the enterprises oriented on permanent crops and milk type as well as granivores type with a type of milk and other grazing livestock.

4. The final conclusions

The conducted studies revealed that the most frequent differences in incurring individual types of total farming overheads are observed between the type of horticulture, wine and permanent crops and permanent crops with a type of agricultural enterprises directed at livestock production. Several differences can be observed in the case of agricultural enterprises directed at the same source of food.

In such a way the diversification of these two types of production is demonstrated, which results from different specifications of production. The main objective of crop production is to obtain high, good quality and full-value crop yields. Their subsequent purpose may be directed at food products for people, feed for animals or resources for industry. It can therefore be considered that crop production affects the development of livestock production. At the same time, it results in significant diversification of the level of incurred costs. Greatly increased costs may be observed in agricultural enterprises directed at crop production, in particular in the case of horticulture, wine and permanent crops.

In the cost structure of agricultural enterprises directed at crop production as well as livestock production the highest level of costs is observed in the case of machinery and building current costs and contracts work costs. On the other hand, in mixed production the highest costs, apart from running costs of machinery and construction, include energy costs.

At the same time it should be emphasised that the studies on the addressed topic need to be further developed. Indicating the main determinants of the existing diversification, and conducting similar studies on the other costs relating to production process in agricultural enterprises, would be particularly recommended. This would allow to present a comprehensive comparative study of different types of costs incurred by individual types of agricultural enterprises.

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