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The farming costs (including insurance) of the agricultural holdings in the European Union

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Abstract. The paper is devoted to exploring the farming costs (including insurance) indicators of the agricultural enterprises in the European Union. The analysis employs the box plot methodology that provides a five-number summary for a set of data. In this paper, we analyse the evidence of interconnection between the indicators of efficiency and competitiveness and insurance costs regarding food market security. This research discusses the dynamic changes of the absolute value of farming costs (including insurance) indicators and different relative indicators derived from the original one for the agricultural enterprise holdings

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in the European Union for the period of 2004-2019. The results show that farming costs (including insurance) indicators of the agricultural holdings should be considered as an instrument for providing food market security. Based on these research results, we are going to further explore the impact of insurance on the food market security. In addition, these research results could help to clarify the difference between EU countries and dynamic changes in farming costs (including insurance) indicators of agricultural holdings.

Keywords: agricultural holdings, farming costs, insurance, competitiveness, European Union.

JEL Classification: G22, L66, Q12, Q14, Q18

1. INTRODUCTION

At present, the efficiency and profitability of agricultural enterprises are challenged in many ways, however, there are also many different opportunities for increasing them. Nevertheless, one of the most important elements here is defining and correctly interpreting every possible economic indicator. This paper presents the estimation of the role that cost (including insurance) indicators play in ensuring the effectiveness of agricultural holdings.

The aim of the study is to conduct data analysis of farming costs (including insurance) indicators of agricultural enterprises in the EU and to define indicators of box plot analysis.

The empirical results indicate that for agricultural holdings in the European Union, the absolute values of farming costs (including insurance) indicators of EU countries are symmetrical, illustrating how tightly this data is grouped, and if and how our data is skewed. In addition, agricultural enterprises in the EU show almost the same amount of farming costs (including insurance) indicators without any substantial changes. But, as an exception, in regards to Slovakia, the research indicators show that the values of farming costs (including insurance) indicator of agricultural holdings has changed dramatically.

The research paper is organized as follows. The first section outlines the literature review and the international experience of the efficiency estimation of agricultural enterprises based on the different approaches and methods. Also, this part of the research it was analyzed the shreds evidence of interconnection between indicators of efficiency or competitiveness and insurance costs regarding food market security. Section 2 shows the dataset and research methods (including indicators for a box plot analysis. The next part presents the analysis of the statistical data of the farming costs (including insurance) indicators' (six indicators: the first one is absolute; all others are relative and derived from the first one) of the agricultural enterprises in the European Union based on the boxplot method. Section 4 provides the theoretical generalization and estimation of the EU countries depending on where is median at boxplot graphs for farming costs (including insurance) indicators of the agricultural holdings. Lastly, the final section summarizes the key findings of the research, as well as theoretical empirical results. In addition, it was justified as the main suggestion for future research directions.

Thus, the research study provides a comprehensive analysis of the farming costs (including insurance) indicators of the agricultural holdings in the European Union based on the box plot methodology regarding the five-number summary of a set of data.

2. LITERATURE REVIEW

There are many different types of agricultural enterprises in the European Union. The character of individual enterprises is determined by their size, business orientation, ownership structure, local legislation, subsidies, and many other determinants (Hornowski et al., 2020; Naglova et al., 2017). The driver of individual enterprises is their efficiency and competitiveness.

The efficiency of agricultural enterprises in the European Union (next – EU) has a substantial influence on European food market security (Dos Santos & Ahmad, 2020; D'Amico et al., 2013; Guth et al., 2020; Csaki & Jambor, 2009; Volkov et al., 2020). In general, the assessment of efficiency or competitiveness could be done via different instruments, methods, or indicators (Slavickiene & Savickiene, 2014; Perisa, Kurnoga & Sopta, 2017). For example, a list of methods for multifactorial assessment of multifunctional procedure as follows (Laurinavičius & Rimkuvienė, 2017): production frontier model or Stochastic Frontier Approach (SFA), FDH model (Free Disposal Hull), DEA method (Data Envelopment Analysis). The study of the capacity and profitability of different size agricultural enterprises (large and small crop farms) and mixed farms of the old and new European Union regions indicates that the top level of profitability is achieved by the biggest agricultural holdings (Błażejczyk-Majka, Kala & Maciejewski, 2012). Furthermore, Wrzaszcz & Zegar (2016) have adopted the productivity and profitability indicators of economic sustainability of agricultural holdings (a case study of Poland): land productivity and labor efficiency; land efficiency and labor output. The research results of this paper show an interaction between the economic and environmental sustainability of agricultural enterprises (Wrzaszcz & Zegar, 2016). Notably, Dos-Santos and Diz (2019) explored the sustainability in EU agricultural firms, defining four groups of indicators as follows: economic, social, environmental, and institutional. In addition, the most detailed description of efficiency indicators is provided by Nábrádi, Pető & Orbán (2009), which defines four types of economic indicators following below: 1) liquidity (current and quick); 2) leverage (debt to capital, debt to equity capital, non-current liabilities to equity, and interest coverage ratio); 3) activity (inventory turnover ratio, ratio of sales to the value of fixed assets, revenue to average assets, receivable turnover ratio, and an average number of days it takes a farm to convert its accounts receivable into cash); 4) profitability (gross margin ratio, operating margin, profit margin, and the ratio between net income and total average assets (ROA), and price earning) (Nábrádi, Pető & Orbán, 2009).

Following up on exploring the evidence of interconnection between indicators of efficiency or competitiveness and insurance costs regarding food market security, we should note that at present this problem has been explored by a lot of scientists. Thus, Akinrinola & Okunola (2014) argued that there may be a growth in the degree of investment of agricultural holdings that have insurance policies as a consequence of the suitability of agricultural loans covered by insurance; Juan et al. (2016) explored a model for forecasting the insurance influence on the enterprise efficiency indicators of resources; Spörri et al. (2012) discovered the influence of crop insurance on the farms' productivity (a case study of Hungary): negative impact of insurance on economic indicators. Furthermore, there are other different research papers regarding exploring the insurance influence on the efficiency and productivity of agricultural holdings that summarized valuable results relating to the outcome of crop insurance on the income of agricultural enterprises (Zhao & Preckel, 2016) or on the company disinvestment and decisions regarding market exit strategy (Kim, Pendell & Yu, 2018; Dankiewicz, 2020).

At the same time, to address the defining nature of interconnection between insurance and food market security, in the outline of the finale conference report regarding agricultural insurance (Czymoch, 2014) it was argued that this type of insurance should be considered as an element relating to food security. On the other hand, Mârzaa et al. (2015) suggested that insurance as a unique instrument has not have the possibility for providing food security, however, it could have a subnational influence in raising awareness and

encouraging investments. Besides, Isaboke et al. (2016) regarding the agriculture industry have explored the outcome of microinsurance, where payments are made based on an index, on food security status, and have found a positive influence of insurance on food market security.

Previous research paper (Arych et al., 2020a) on studying the impact of insurance on food security market indicators' (for example, food exports in % (as a part of merchandise exports and food import in % (as a part of merchandise import) regarding foreign countries indicate that for France and Turkey, insurance is effective in regulating only the share of food exports; however, for Italy and the United Kingdom – food imports (Arych et al., 2020b)

However, results from the literature show that, currently, there are only a few of the most valuable research papers regarding exploring the influence of insurance spending on agricultural enterprises' competitiveness in the context of food market security in Ukraine. For example, according to Shirinyan & Arych (2019), enterprises in the food item production industry with higher market efficiency are more predisposed to buy an insurance policy. In addition, Arych et al. (2020b) state that for the Ukrainian market, firstly, insurance is a statistically significant tool for influencing the food market security, but only for the share of food exports – not for food import (Vološin, Smutka & Selby, 2011; Svatoš & Smutka, 2012).

Therefore, given the insufficient study of this issue regarding the European Union, and its relevance to ensuring food market security, with this article we begin a series of scientific publications to assess the influence of insurance spending on the market efficiency of agricultural holdings in the European Union.

3. METHODOLOGY

All data were collected from the official site of the Farm Accountancy Data Network (Floriańczyk, Osuch, & Plonka, 2017; FADN, 2022). The research purpose it was analyzed statistical data of the agricultural enterprises in the EU by countries for the 2004-2019 study period.

In this research we have made the exploration of farming costs (including insurance) of the agricultural holdings based on the following indicators (FADN, 2022):

1) farming costs (including insurance) – is a type of farming costs which also linked to insurance spending (except for buildings and accidents at work), water and other farming overheads; in EURO, SE356 (indicated as "other direct inputs") in FADN standard results indicators. The farming costs (including insurance) is a part of the total farming overheads as well as supply costs (FADN, 2022);

2) share of farming costs (including insurance) in total farming overheads (S_{TFO}), calculates in % and shows how much of farming costs (including insurance) (in EURO) per 1 EURO of total farming overheads:

$$S_{TFO} = \frac{\text{Farming costs (including insurance)}}{\text{Total farming overheads}} \times 100\% , \quad (1)$$

where, total farming overheads (*SE336*) – supply costs linked to production (except for specific lines of production) (FADN, 2022);

3) share of farming costs (including insurance) in total costs (S_{TC}), calculates in % and shows how much of farming costs (including insurance) (in EURO) per 1 EURO of total costs:

$$S_{TC} = \frac{\text{Farming costs (including insurance)}}{\text{Total costs}} \times 100\% , \quad (2)$$

where, total costs (*SE270*) – a sum of costs, overheads, depreciation, etc. (FADN, 2022);

4) share of farming costs (including insurance) in total output (S_{TO}), calculates in % and shows how much of farming costs (including insurance) (in EURO) per 1 EURO of total output:

$$S_{TO} = \frac{\text{Farming costs (including insurance)}}{\text{Total output}} \times 100\% , \quad (3)$$

where, total output (*SE131*) – contains the total output of crops and crop products, livestock and livestock products, and of other output (FADN, 2022);

5) share of farming costs (including insurance) in gross farm income (S_{GFI}), calculates in % and shows how much of farming costs (including insurance) (in EURO) per 1 EURO of gross farm income:

$$S_{GFI} = \frac{\text{Farming costs (including insurance)}}{\text{Gross farm income}} \times 100\% , \quad (4)$$

where, gross farm income (*SE410*) includes the output (except for the intermediate consumption) and the balance of current subsidies and taxes (FADN, 2022);

6) share of farming costs (including insurance) in total assets (S_{TA}), calculates in % and shows how much of farming costs (including insurance) (in EURO) per 1 EURO of total assets:

$$S_{TA} = \frac{\text{Farming costs (including insurance)}}{\text{Total assets}} \times 100\% , \quad (5)$$

where, total assets (*SE436*) – include assets in ownership (FADN, 2022).

Regarding the descriptive statistics, we have used *Python* (programming language) for box plot analysis. This study methodology provides a graphical image of the concentration of the data, and also shows how far the extreme values are from most of the data. The main part of the box plot analysis requires to defining the five-number summary of a set of values: minimum score, first (lower) quartile, median, third (upper) quartile, and maximum score.

4. EMPIRICAL RESULTS AND DISCUSSION

Our paper has investigated the statistical data of the farming costs (including insurance) indicators (six indicators: the first one is absolute; all others are relative and derived from the first one) of the agricultural enterprises in the EU. For this purpose, we have used a boxplot method for arranging the data in increasing order, determining the median, and displaying the distribution of data quartiles (or percentiles) and averages.

Consequently, at the beginning of this research, we are going to explore the box plot summary of a set of data for the absolute value of farming costs (including insurance) indicators of EU countries for the period of 2004-2019 (Table 1).

Table 1

The box plot summary of a set of data for farming costs (including insurance) indicator of the agricultural holdings in EU countries

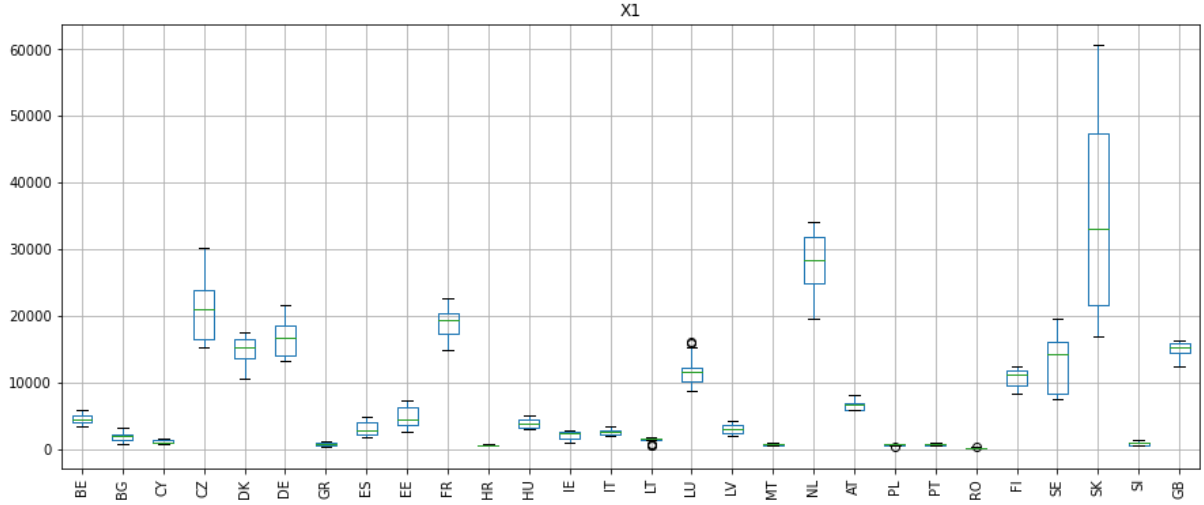
№	Country	Country Codes ISO 3166-2	*Min.*	*1st Qu*	*Median*	*Mean*	*3rd Qu*	*Max.*
1	Belgium	BE	3410	3988.25	4467.0	4526.69	5007.50	5744
2	Bulgaria	BG	676	1360.00	1943.0	1869.85	2142.00	3241
3	Cyprus	CY	788	861.50	948.5	1067.94	1311.25	1491
4	Czech Republic	CZ	15278	16389.00	21055.5	20649.94	23819.00	30135
5	Denmark	DK	10520	13538.25	15214.0	14808.38	16409.75	17574
6	Germany	DE	13280	13941.25	16751.5	16655.44	18478.50	21680
7	Greece	GR	389	453.50	703.0	729.38	1028.25	1153
8	Spain	ES	1724	2260.75	2770.0	3024.19	4052.50	4830
9	Estonia	EE	2597	3544.00	4460.5	4773.88	6165.25	7363
10	France	FR	14774	17209.50	19334.5	18900.88	20308.50	22543

11	Croatia	HR	499	504.00	558.0	573.00	627.00	692
12	Hungary	HU	3046	3278.25	3899.5	3862.69	4442.00	4959
13	Ireland	IE	1036	1559.50	2409.0	2133.44	2581.50	2846
14	Italy	IT	1926	2078.00	2554.0	2518.12	2864.75	3324
15	Lithuania	LT	459	1322.75	1457.0	1359.75	1649.75	1807
16	Luxembourg	LU	8788	10089.00	11467.0	11717.12	12257.75	16047
17	Latvia	LV	1903	2285.25	2950.0	2974.38	3567.00	4107
18	Malta	MT	475	550.75	649.0	681.75	804.00	977
19	Netherlands	NL	19444	24872.75	28251.0	27757.06	31814.25	33975
20	Austria	AT	5768	5898.25	6590.0	6560.75	6798.75	8131
21	Poland	PL	375	629.00	681.0	661.38	725.00	823
22	Portugal	PT	486	608.25	698.5	714.25	789.50	938
23	Romania	RO	99	133.00	167.0	172.15	200.00	331
24	Finland	FI	8225	9447.00	11221.0	10626.50	11676.00	12470
25	Sweden	SE	7394	8370.00	14218.5	12885.94	16006.75	19586
26	Slovakia	SK	16945	21585.00	33128.5	35691.56	47383.25	60711
27	Slovenia	SI	458	585.25	875.0	779.94	936.50	1248
28	United Kingdom	GB	12441	14408.25	15277.0	14989.81	15885.00	16365

Source: authors' own calculations based on FADN, 2022

Table 1 describes the results of the box plot summary of the farming costs (including insurance) indicator of European Union countries as follows: minimum score (*Min.*); first or lower quartile (*1st Qu*) – 25 % of scores fall below the first quartile value; median (*Median*) – is the mid-point of the data; mean (*Mean*) – is the average number of the data set; third or upper quartile (*3rd Qu*) – 75 % of the scores fall below the third quartile value; maximum Score (*Max.*) – it is the highest score.

Furthermore, our results show if absolute values of farming costs (including insurance) indicators of EU countries are symmetrical, how tightly this data is grouped, and if and how our data is skewed (Graph 1).

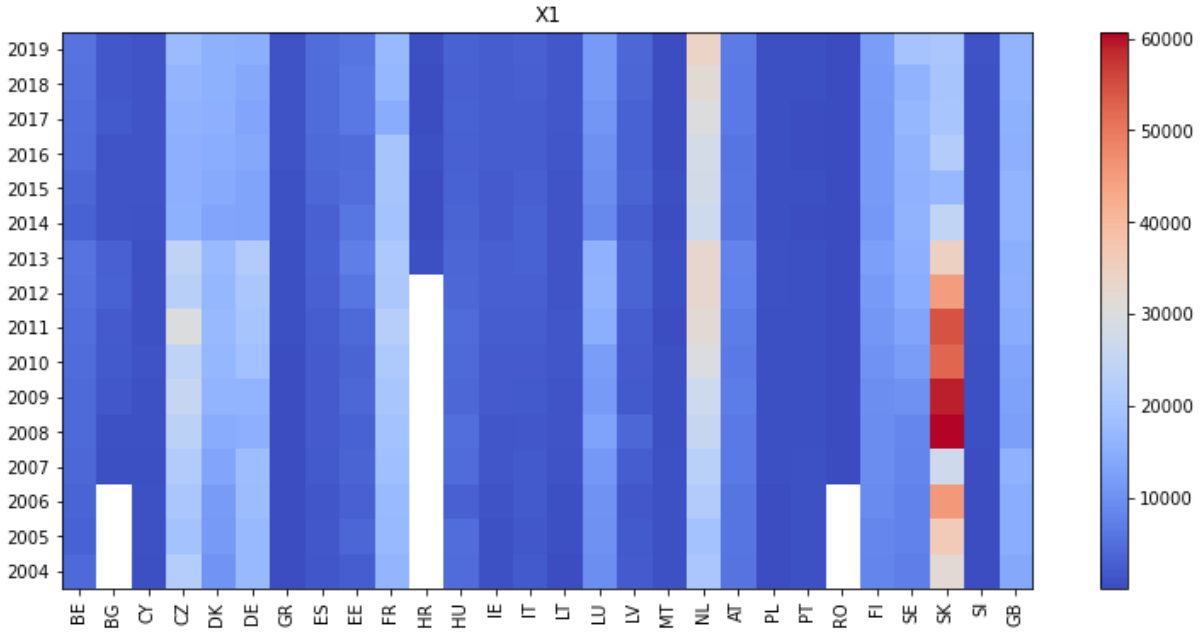


Graph 1. The box plot analysis for farming costs (including insurance) indicators of the agricultural holdings in EU countries, 2004-2019

Source: authors' own calculations based on FADN, 2022.

A boxplot on Graph 1 provides exploration results of descriptive statistics for the first research indicator – farming costs (including insurance). Thus, for most of the EU countries (for instance: BE, BG, CY, GR, HR, HU, IE, IT, LT, LV, MT, AT, PL, PT, RO, and SI) the dispersion of the data set is very density; for some EU member (CZ, DK, DE, ES, EE, FR, LU, NL, FI, SE, and GB) – is average density; and, only for SK (Slovakia) – is sparsity, and the distribution is positively skewed (most values are clustered around the left tail of the distribution). Meanwhile, with the aim of more detailed data assessment of farming costs (including insurance) indicators of EU countries, we have made the heatmaps for all our research indexes. In general, a heatmap is a graphical representation of data.

In particular, the heatmap of matrix visualization of the data of farming costs (including insurance) indicator of the European Union is presented in Graph 2.



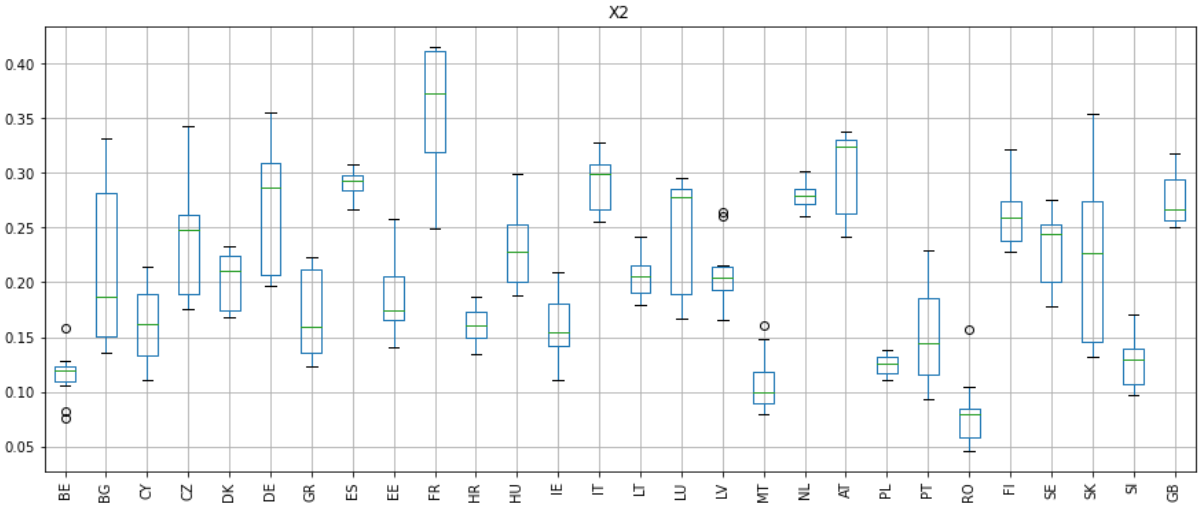
Graph 2. The heatmap of matrix visualization for farming costs (including insurance) indicator of the agricultural enterprises in EU countries, 2004-2019.

Source: authors' own calculations based on FADN, 2022.

Overall, the line and color of the graphs represent how farming costs (including insurance) data have changed over the research time period. Comparing countries by the absolute values of mentioned above indicator, we should state that for most EU members (for instance: BE, CY, GR, CZ, DK, DE, ES, EE, FR, HU, IE, IT, LT, LU, LV, MT, AT, PL, PT, SI, etc.) the agricultural holdings show almost the same amount of farming costs (including insurance) indicator without any substantial changes. However, the bar of colored segments for Slovakia (SK) illustrates that the values of farming costs (including insurance) indicators of the agricultural holdings have changed dramatically: for example, minimum in 2014 and maximum values in 2008. Furthermore, for some EU countries (BG, HR, and RO) there is no full data of the above research indicator at the official site of the Farm Accountancy Data Network. These bar segments are colored in white.

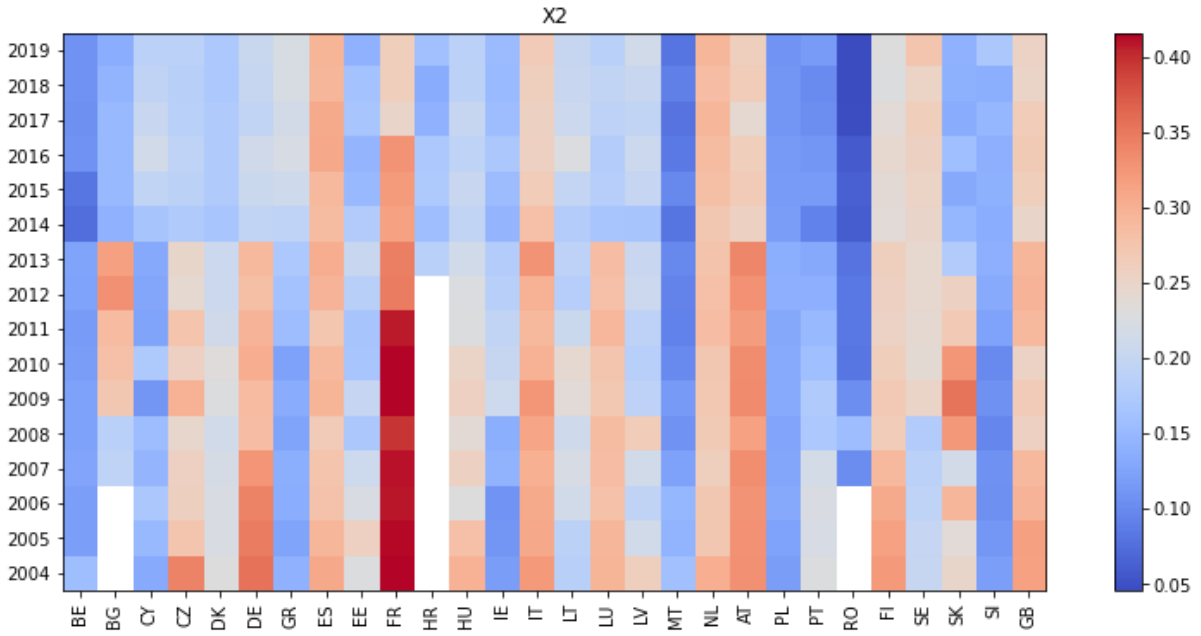
Additionally, we have also defined the other derivative from farming costs (including insurance) indicators, which describes the shares of mentioned above value in different indicators (total farming overheads, total inputs, total output, gross farm income, and total assets). Thus, the research results of its

exploration were made by box plot analysis (Graph 3; Graph 5; Graph 5; Graph 7; Graph 9; Graph 11) and heatmaps of matrix visualization for these indicators (Graph 4; Graph 6; Graph 8; Graph 10; Graph 12).



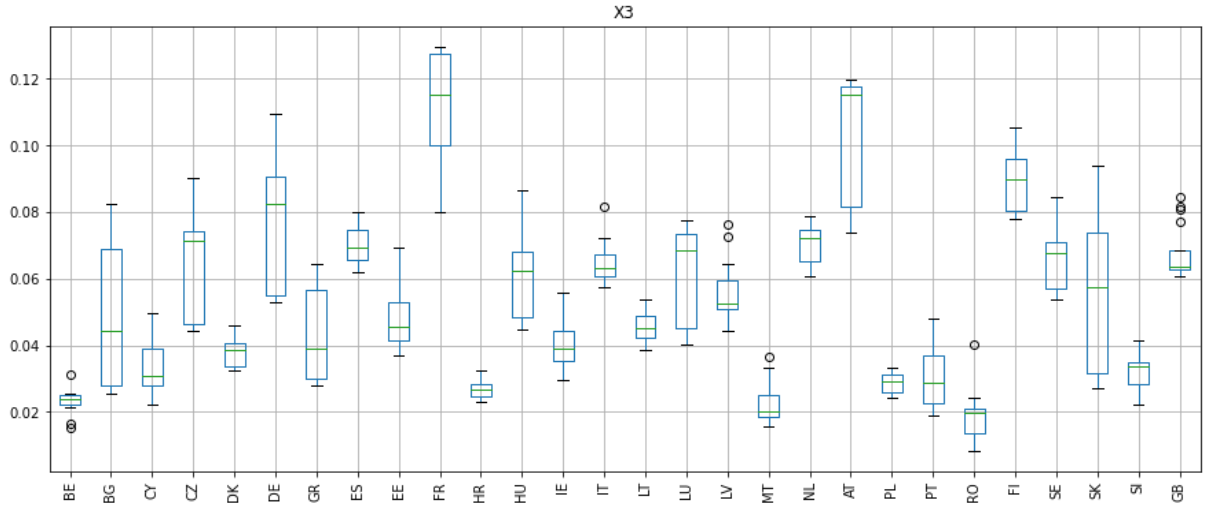
Graph 3. Box plot analysis for a share of farming costs in total farming overheads of the agricultural enterprises in EU countries, 2004-2019.

Source: authors' own calculations based on FADN, 2022.



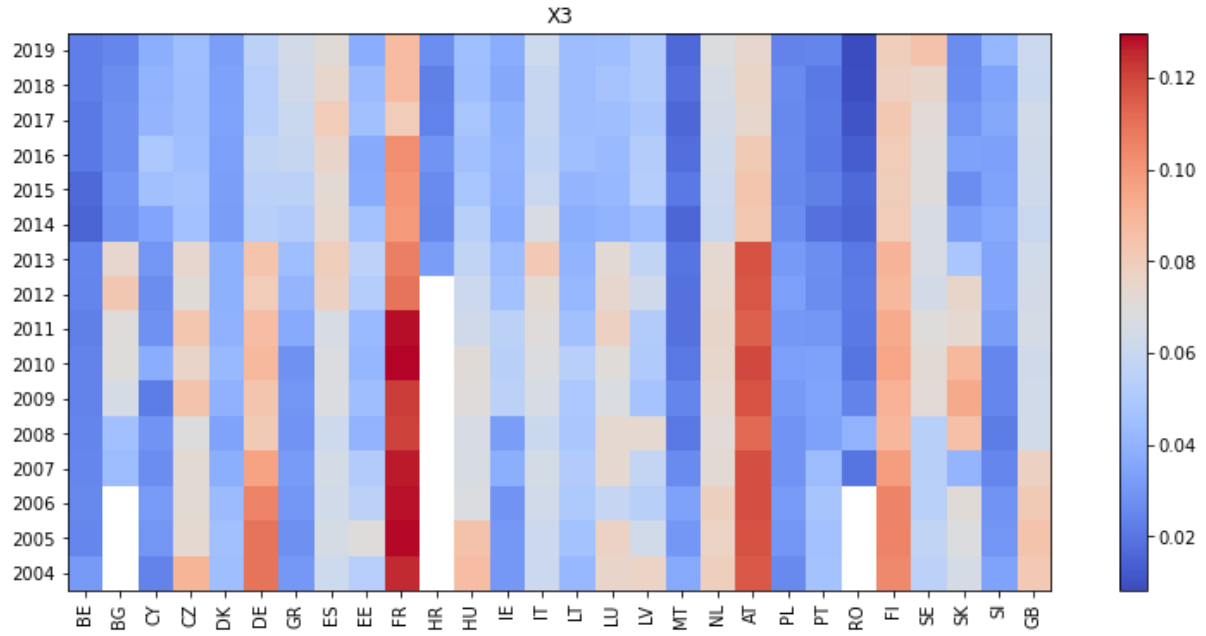
Graph 4. Heatmap of matrix visualization for a share of farming costs in total farming overheads of the agricultural enterprises in EU countries, 2004-2019.

Source: authors' own calculations based on FADN, 2022.



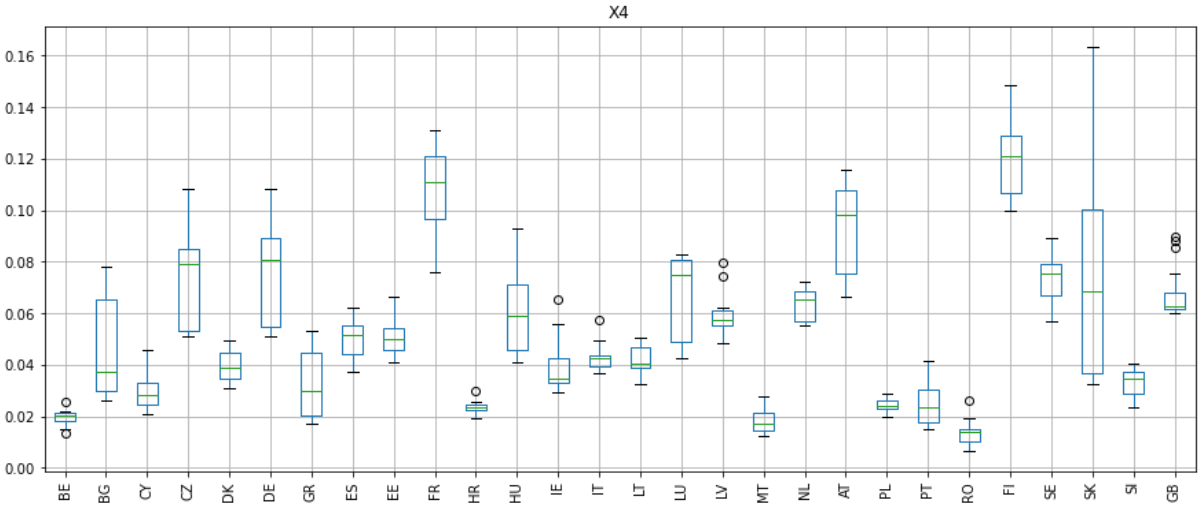
Graph 5. Box plot analysis for a share of farming costs in total costs of the agricultural enterprises in EU countries, 2004-2019.

Source: authors' own calculations based on FADN, 2022.



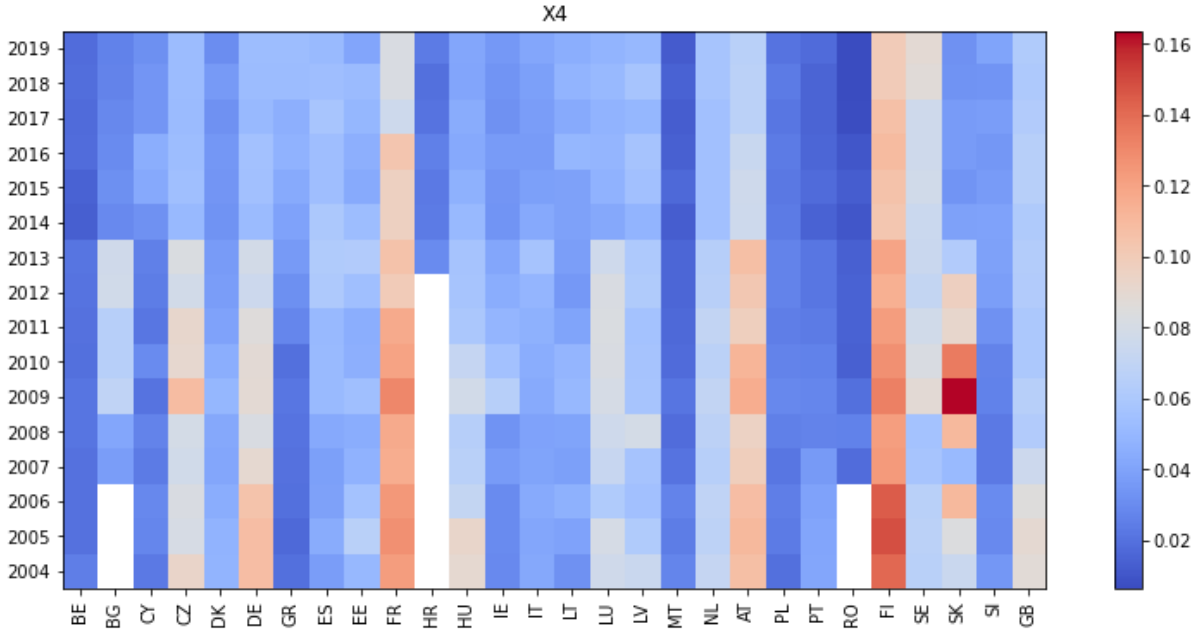
Graph 6. Heatmap of matrix visualization for a share of farming costs in total costs of the agricultural enterprises in EU countries, 2004-2019.

Source: authors' own calculations based on FADN, 2022.



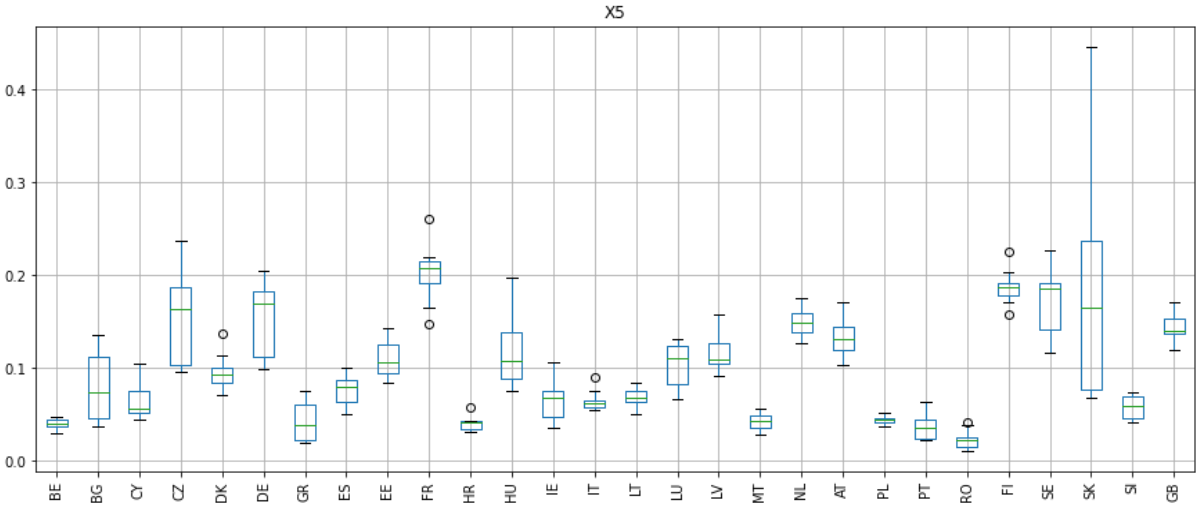
Graph 7. Box plot analysis for a share of farming costs in total output of the agricultural holdings in EU countries, 2004-2019.

Source: authors' own calculations based on FADN, 2022.



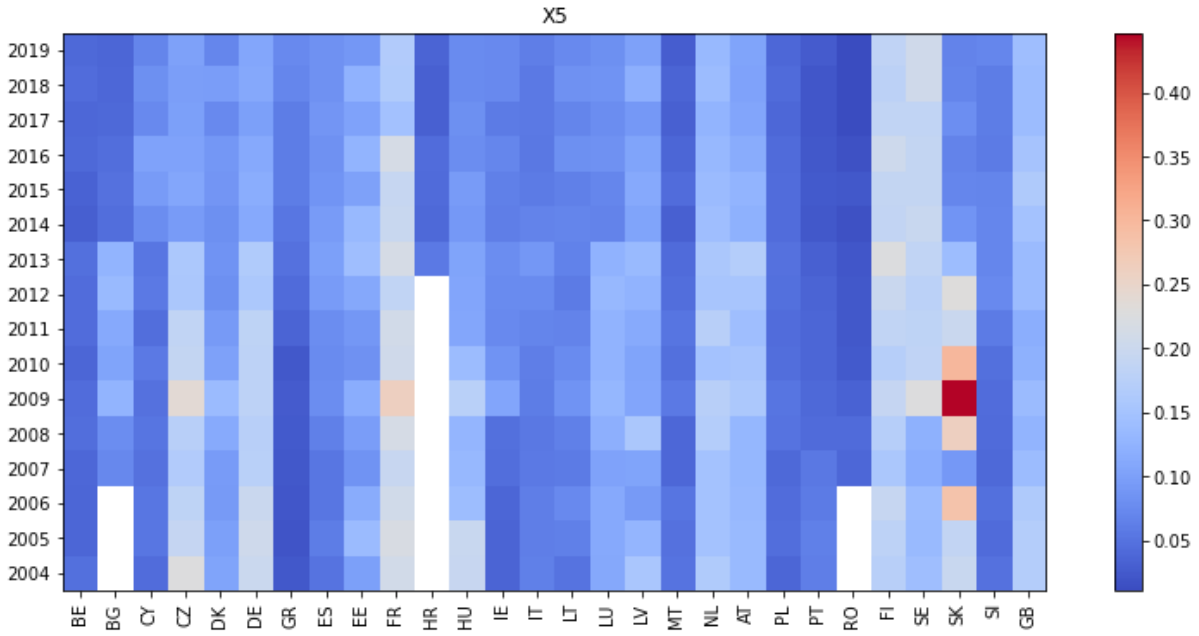
Graph 8. Heatmap of matrix visualization for a share of farming costs in total output of the agricultural holdings in EU countries, 2004-2019.

Source: authors' own calculations based on FADN, 2022.



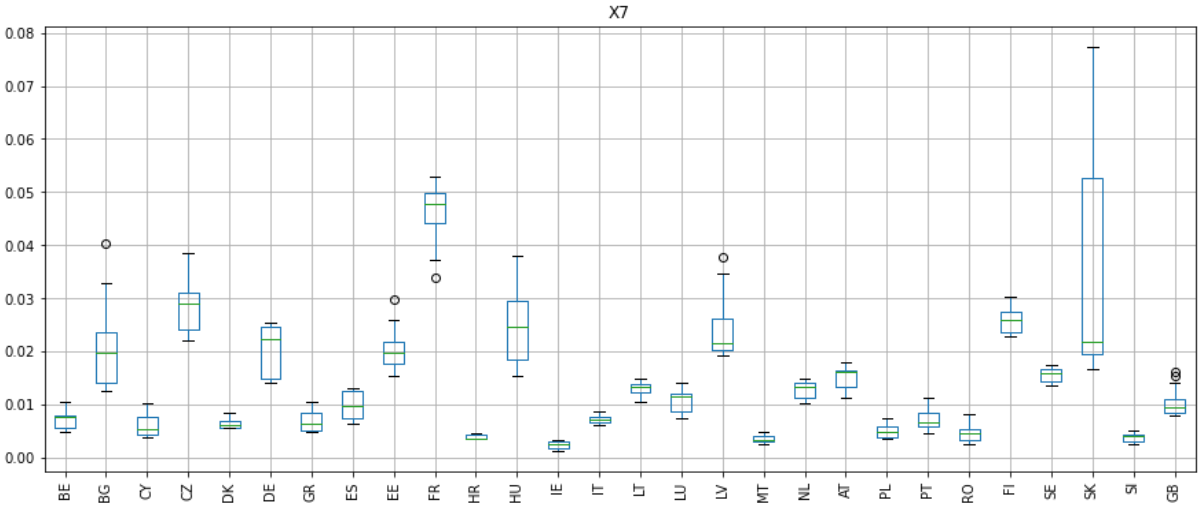
Graph 9. Box plot analysis for a share of farming costs in gross farm income of the agricultural enterprises in EU countries, 2004-2019.

Source: authors' own calculations based on FADN, 2022.



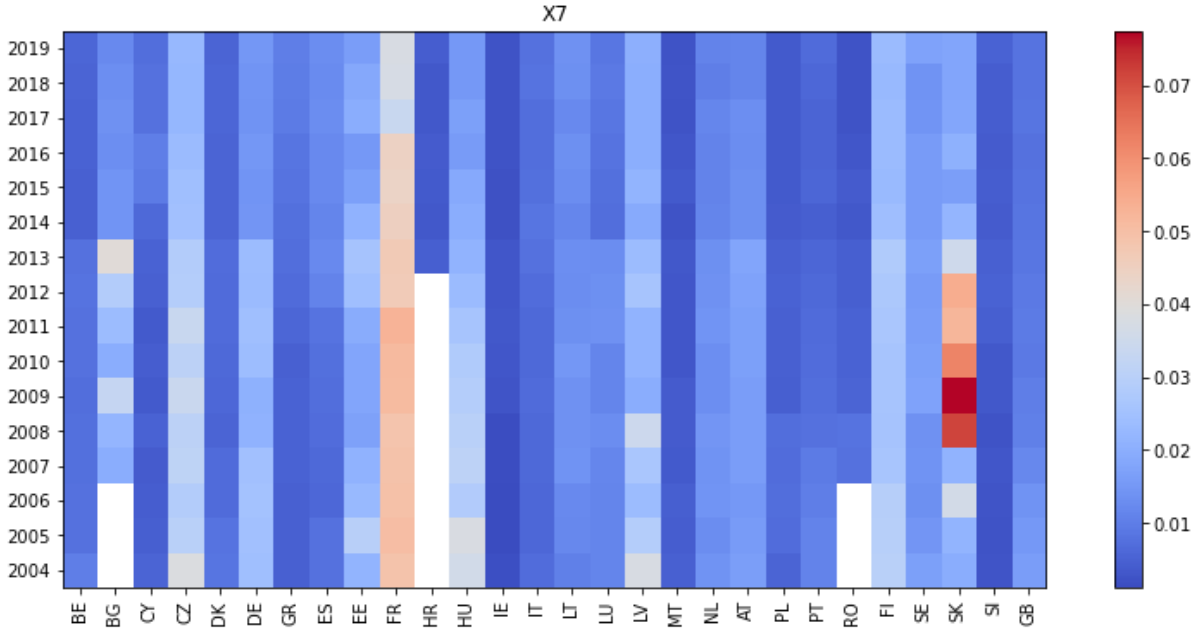
Graph 10. Heatmap of matrix visualization for a share of farming costs in gross farm income of the agricultural enterprises in EU countries, 2004-2019.

Source: authors' own calculations based on FADN, 2022.



Graph 11. The box plot analysis for a share of farming costs in total assets of the agricultural enterprises in EU, 2004-2019.

Source: authors' own calculations based on FADN, 2022.



Graph 12. The heatmap of matrix visualization for a share of farming costs in total assets of the agricultural enterprises in EU, 2004-2019.

Source: authors' own calculations based on FADN, 2022.

Therefore, based on where is median at the boxplot graphs, we can divide all EU countries into three groups: *in the first group* – the median is the closest to the middle of the box, which means the distribution is/isn't symmetric; *the second group* – the median is closer to the bottom of the box; *the third group* – the median is closer to the top of the box - distribution is/isn't negatively skewed (Simply Psychology, 2022). Research results for the following groups are presented in Table 2.

Table 2

EU countries depending where is median at the box plot graphs for farming costs (including insurance) indicators of the agricultural holdings

Research indicators	**European Union members' groups**		
	First group	***Second group***	***Third group***
Share of farming costs (including insurance) in total farming overheads	CY, HR, LV	**BG**, **GR**, **EE**, IE, **MT**, **PT**, **GB**	BE, CZ, **DK**, DE, **ES**, **HU**, **FR**, **IT**, LT, LU, **AT**, **PL**, RO, FI, **SE**, SK, SI, NL
Share of farming costs (including insurance) in total costs	–	**BG**, **CY**, **GR**, **ES**, **EE**, **IE**, **IT**, **LT**, LV, **MT**, **PT**, GB	**BE**, CZ, DK, DE, **FR**, HR, HU, **LU**, **NL**, **AT**, **PL**, **RO**, FI, SE, SK, SI
Share of farming costs (including insurance) in total output	EE, HR, PT, SK	**BG**, **CY**, **DK**, **GR**, **IE**, LT, LV, **MT**, PL, **GB**	**BE**, CZ, DE, **ES**, **FR**, HU, IT, **LU**, **NL**, **AT**, **RO**, FI, SE, **SI**
Share of farming costs (including insurance) in gross farm income	NL, AT	BE, **BG**, **CY**, **GR**, **EE**, **HU**, LT, **LV**, GB	CZ, DK, DE, ES, **FR**, **HR**, IE, IT, **LU**, **MT**, PL, PT, RO, FI, SE, SK, **SI**
Share of farming costs (including insurance) in total assets	EE, IT, PL	**CY**, **DK**, GR, ES, **LV**, **MT**, **PT**, **SK**, **GB**	BE, BG, CZ, **DE**, **FR**, **HR**, HU, IE, **LT**, **LU**, **NL**, **AT**, RO, FI, **SE**, SI

Source: authors' own compilation

Table 2 indicates groups of EU countries where the distribution of farming costs (including insurance) indicators of the agricultural holdings is/isn't symmetric, or positively skewed (most values are clustered around the left tail of the distribution), negatively skewed (more values are concentrated on the right side). These research results could help to understand the difference between EU countries and their dynamic changes of farming costs (including insurance) indicators of the agricultural holdings. In addition, it can be assumed that only for the share of farming costs (including insurance) in total farming overheads (in CY, HR), and for the share of farming costs (including insurance) in gross farm income (in NL), the distribution is almost symmetric because this box plot has equal proportions around the median, and for other indicators, the distribution is not symmetric.

Furthermore, based on the group's identification only for some countries it is confirmed the terms and conditions for positively skewed – the second group; and for negatively skewed – the third group. Its EU countries' codes are highlighted in bold in Table 2.

5. CONCLUSION

This paper discusses the importance of farming costs (including insurance) indicators of the agricultural enterprises in the EU as an instrument for providing food market security. Notably, we have explored exactly farming costs (including insurance) indicators because it includes insurance cost, and we do not have a separate indicator of the insurance cost of the agricultural enterprises in the EU by countries based on the statistical data of the Farm Accountancy Data Network.

The research presented in this article seeks to evaluate the dynamic changes of the absolute value of farming costs (including insurance) results in indicators and different relative and derived from the first indicators of the agricultural enterprises in the EU for the period of 2004-2019.

The results show that in most cases there is a big difference between EU countries based on the values of such indicators, as farming costs (including insurance); and based on the ratios between farming costs

(including insurance) and indicators as follows: total farming overheads; total costs; total output; gross farm income; total assets. Furthermore, according to the interquartile ranges at the box plot graphs for our research indicator of the agricultural enterprises in the EU, we can argue that in most cases data results are dispersed significantly because of the box lengths.

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