Agris on-line Papers in Economics and Informatics

Volume VIII Number 4, 2016

Categorization of the EU Countries in the Context of Agricultural Production

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Abstract

Paper provides synthesis of knowledge and empirical research on selected determinants of agricultural production and verifies the applicability of the methods of hierarchical and non-hierarchical clustering in the agricultural sector. It identifies and categorizes the EU Member States in order to their clustering based on the similarity of common features in the context of direct (gross value added, support for agriculture, agriculturally utilized land) and indirect factors (employment, gross fixed capital) affecting the total agricultural production. The aim of the paper is creation of the economically meaningful groups of the EU countries that would confirm or reject the classification of old and new member states. The results of cluster analysis divided countries into three clusters, and confirmed that second cluster was represented by the new member states, and third by the old member states. Clusters were mutually different in the indicators of labour force in agriculture, support for agriculture, and agriculturally utilized land.

Keywords

Agricultural production, employment, agricultural policy, fixed capital creation, gross value added, support of agriculture.

Andrejovská, A., Buleca, J. and Hudáková, M. (2016) "Categorization of the EU Countries in the Context of Agricultural Production", *AGRIS on-line Papers in Economics and Informatics*, Vol. 8, No. 4, pp. 3-14. ISSN 1804-1930. DOI 10.7160/aol.2016.080401.

Introduction

The agrarian system of the individual EU countries significantly differs from the other sectors of the national economy due to its specifics. From the global aspect, the agricultural production represents the primary sector of the biological character and the areal spread of production. The share of the agriculture on the total EU budget has significantly decreased, from the maximum of 70% in the 70's, down to around 38% nowadays. This decline reflects both, the increase of the EU's powers in other areas, as well as the savings brought by the reforms. The main objective of the reforms was to improve the agricultural productivity, which would provide consumers with a stable supply of affordable food and the agricultural producers with the appropriate income. The efficiency of the agriculture and also the changes that are currently occurring in all EU Member States, are significant. The agro-food economy is affected by several factors, but a crucial role in this process is played by the Common Agricultural Policy, which significantly influences the situation of the agricultural businesses through individual forms of support. The European agricultural decision makers must deal with many components described in the Common Agricultural Policy in order to optimize data integration and achieve transparency (Toth and Kucas, 2016). Recent CAP reforms, including the last reform implemented in 2015, have been designed to reallocate expenditure, reduce inequality and ensure higher territorial balance. Despite the initial funding allocation, this expenditure re-distributes its effects towards richer and urban regions. This redistributive pattern depends on the magnitude and direction of intersectoral and interregional linkages (Bonfiglio et al., 2016). The key question in the context of the Common Agricultural Policy is mainly the regionalization of the EU, which creates opportunities and challenges for individual countries (Alexiadis et al., 2013). On the other side there is a risk that this regionalization may aggravate the inequalities between regions (Trouvé and Berriet-Solliec, 2010). Since each EU country

is geographically, economically and climate-specific, it is difficult to unite this heterogeneous agricultural potential.

Enlargement of the EU have amplified the diversity of European agriculture, resulting in the intensification of agricultural activities in some regions, together with marginalization of agriculture in others. For some transient economies the EU membership caused the delay in the restructuring process and some substandard businesses, thanks to the support policy, get a chance for the continued existence (Doucha, 2011). There are large differences across transition countries with respect to agricultural-sector performance and corresponding scope of farm restructuring. The territorial structure of the foreign agrarian trace is continuously concentrating on the EU-Single Market, both in terms of exports and imports (Smutka et al., 2016). Potential implications of Brexit for the EU's Common Agricultural Policy and agri-food sector will have broadly negative effects for the EU farm and food sector (Matthews, 2016).

In the investigation of the impact of gross-value-added to farm, land and labour productivity indicators significant differences between the Northern-Central counties and the continental peripheries (Mediterranean, Eastern, Northern Scandinavian) were found, and the factors behind this different performance were specified (age and training of farm population, investments to agriculture, environmental conditions and technical efficiency, utilization of agricultural land) (Giannakis and Bruggeman, 2015).

Relative macroeconomic performance and international competitiveness of the agro-food sectors differ considerably among the EU member state countries. It seems that as far as international competitiveness is concerned the CAP should be more oriented towards improving economic efficiency of the agro-food sectors, especially in the countries where the revealed competitiveness index is low (Figiel and Kufel, 2013). The agricultural sector has significantly changed its structure and position within the national economy of individual new EU member states in the 20 years since the early 1990s. The size of the agricultural sector reduced, resulting in a reduction in the value of the agricultural sector performance, but agricultural sector performance of several countries became more efficient (Svatoš et al., 2014). In other works, the workforce was defined as one of the most important factor contributing to the increase in the level of agricultural production, due to its ability to compensate for physical and material limitations and shortcomings of other factors (Davijani et al., 2016). Investigation of the impact of an ageing agricultural labour population on agricultural production showed, that in context of ageing, changes in the working-age households have a significant impact on agricultural output (Guo et al., 2015). Other authors indicated that productivity (value added and its growth) in the agricultural sector, significantly depends on relative prices of agricultural goods, quantity and quality of resources, and technical progress on production methods, especially management styles (Besharat and Amirahmadi, 2011). Income distributional effects of three main instruments of the Common Agricultural Policy (CAP) in the EU: Coupled Direct Payments (CDP), the Rural Development Programme (RDP) and the Single Payment Scheme (SPS) showed that farmers gained 66–72%, 77–82% and 93–109% from the CDP, SPS and RDP respectively. These results suggest that the initiated shift in CAP expenditure from the support of farm production activities towards supporting rural development and the provision of public goods and externalities is also in line with supporting farmers' income (Ciaian et al., 2015). Changes in production can partly be related to climatic variability and change, but also subsidies and other developments (e. g. technology, markets) are important. The initial purpose and objectives of the agricultural subsidies was to improve the income of agricultural producers with regard to the general interests of society (Foltýn, 2008).

The aim of submitted paper is, based on the methods of quantitative economics, creation of economically transparent and meaningful categorization of the EU member countries, which would confirm or reject the classification of the countries into old and new Member States according to common characteristics affecting the total agricultural production. Direct (gross value added, support for agriculture, and agriculturally utilized land), and indirect factors (employment, gross fixed capital) were included among the common determinants. The analysis was performed on the 28 EU Member States and is based on a combination of six direct and indirect variables representing the economic performance of agriculture:

1. total agricultural production (expressed in mil. €)
2. gross value added (expressed in mil. €)

3. labour force in agriculture–expressed in 1000 AWU (annual work unit, which measures the number of people working as full-timers throughout the entire monitored year)
4. support of the agricultural production (expressed in mil. €)
5. agriculturally utilized land (expressed in 1000 ha)
6. formation of gross fixed capital (expressed in mil. €)

Material and methods

The analysis was performed, and is also presented in two steps. In the first step of the research, similar clusters of countries based on variables connected to economic performance of agriculture have been identified by the applied methods of cluster analysis (Ward method, median method, k-means, and fuzzy cluster analysis) (Estivill-Castro, 2000; Suzuki and Shimodaira, 2006). The final groups of these multidimensional objects with characteristic features were compared to each other and subjected to economic verification to identify the appropriate economic categorization. In the second step of the research, final categorization of countries, confirming or rejecting the classification of EU member states to old and new ones was discussed and similarities and differences were evaluated.

The selection of indicators was performed based on the theoretical knowledge of the authors who investigated similarities or dissimilarities (distances) of examined objects using the multidimensional scaling in their studies and examined the relations and activity of the selected economic variables affecting the total agricultural production (Rimarčík, 2000; Hair et al., 1992; Pecáková, 1998; Meloun et al., 2005; Buday and Vilček, 2013; Dubravska et al., 2015; Ionescu, 2015; Mura et al., 2013; Gazda et al. 2014; Gavurová et al.,2016). As mentioned above, the categorization has been performed using several methodological approaches to the data study. The methods are mentioned mainly in the context of the problem of so-called manifold learning (Rosman et al., 2010). It is known that the concept of metrics is the common denominator of mentioned methods which are substantially different by its historical origin, objectives and procedures. For applying the methods, we used implementation in R environment. Within the methodology of the cluster analysis, it has been applied the traditional hierarchical cluster analysis which is well known within the scientific community with application of the Ward's linkage (which is the most frequently used method on this field) and the median method, both using the standard tool hclust () (R-Core Team, 2013; Řezanková, 2015). Out of non-hierarchical methods the k-means () routine and its widening by fuzzy c-means, implemented by cmeans() routine were used (Brauksa, 2013). Fuzzy c-means is specific compared to other methods, as it enables to detect so-called classification fuzzy objects by using tools k-means and fann () (Charrad et al., 2012). In all methods the Euclidean distance was used (Halkidi et al., 2001; Everitt et al., 2001). The obtained information on the structure of clusters was complemented with the dimensional scaling (called the principal coordinates analysis), which was realized using cmdscale () routine (Venables and Ripley, 2002).

Whereas the indicators acquired vastly different values, in the first step of our analysis, we decided to transform the data by conversion to the z-scores. Each item was subject to standardization/normalization by subtracting the median and dividing by the standard deviation. By this transformation we achieved zero value of median and standard deviation equal to one. Those were depicted in multidimensional scaling by cmdscale () procedure and evaluated whether the data has showed clusterization feature–aggregation. Subsequently, the transformed data were processed by the selected methods mentioned above.

The cluster analysis was conducted in the R statistical software for the EU countries for the year 2014. The quantitative data were used from the Eurostat database and from the reports of the Research Institute of Agriculture and Food Economics. The obtained results are mutually compared and taken into account in further clustering processes, which categorize the EU countries into three separate clusters, based on their similarities. The clusters' indices were re-implemented into the output of multidimensional scaling and were evaluated in terms of the countries' distribution. The paper contains the values of the final models only.

Results and discussions

1. Hierarchical and non-hierarchical cluster analysis of the income tax

The data for meta-analysis was first pre-treated by the multidimensional scaling (Figure 6).

Accordingly, the countries were classifying into three clusters. After visual evaluation we have transformed the data to z-scores and processed it by selected methods of cluster analysis (Ward's method, and single linkage clustering, also the k-means method, and fuzzy clustering). Each of the method has led to three clusters, in line with the preliminary estimate. The clusters' indices were again re-implemented into the output of multidimensional scaling and were evaluated in terms of the countries' distribution.

2. Ward's method of hierarchical clustering

This method is the most used method and also very popular among economists. It generates approximately the equal-sized clusters and reports them in the form of dendrograms (Figure 1), by using the command cutree. The analysed countries were grouped into three clusters. The first clusters consisted of the highest number of countries: Belgium, Bulgaria, the Czech Republic, Denmark, Estonia, Ireland, Greece, Croatia, Cyprus, Latvia, Lithuania, Luxembourg, Hungary, Malta, Netherlands, Austria, Portugal, Slovenia, Slovakia, Finland and Sweden. The second cluster included Germany, Spain, France, Italy and the United Kingdom and the last, third cluster consisted of Poland and Romania.

Figure 2 graphically illustrates the rate of mutual similarity of objects within one cluster and at the same time the rate of dissimilarity of objects from different clusters. The results of the cluster analysis show the satisfactory conclusion, as none of the clusters overlapped the other clusters and they do not have a common intersection. At the same time, the graph sketches the object of the third cluster (Poland and Romania), which is significantly different from other two clusters.

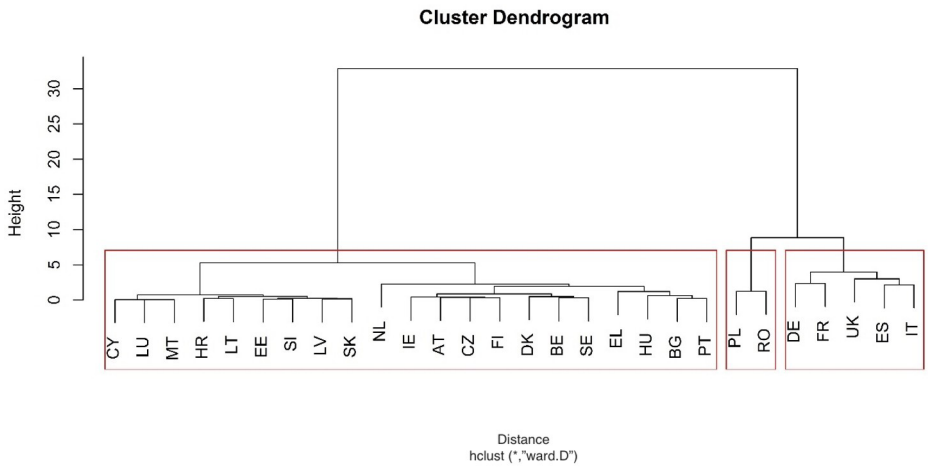

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Figure 1: Dendrogram created through Ward's method of cluster analysis for year 2014.

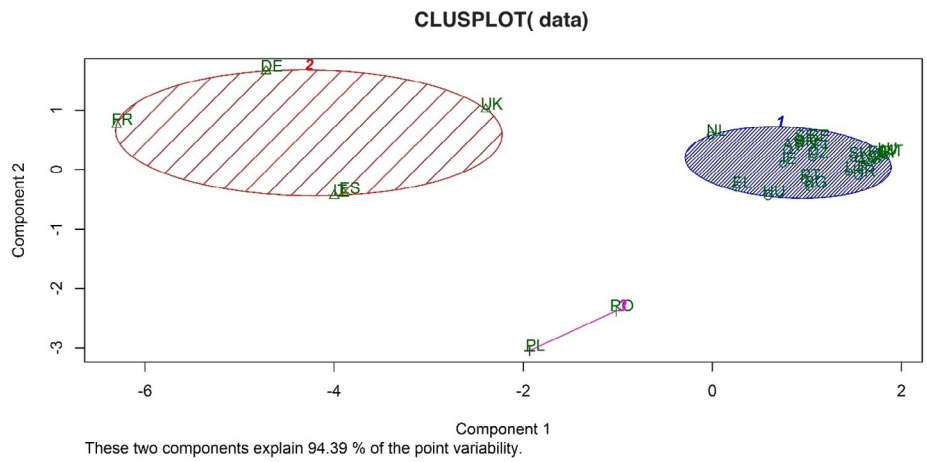

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Figure 2: Graphical representation of cluster analysis of EU member states by Ward's method.

3. Median method of hierarchical clustering

The second analysed method was the median method, which represents another hierarchical method. We determined the optimal number of clusters, which was also three, by applying the tool NbClust, as shown in Figure 3. The classification, as well as the composition of the countries within the clusters was identical to the Ward's method, despite the fact that this method primarily does not concentrate on the number of clusters, but rather focuses on the distribution of the clusters.

4. K-means method of non-hierarchical clustering

When applying k-means method, we have pre-determined the number of centroids that means the number of clusters, which should be formed from the individual objects. We have applied the methods of non-hierarchical clustering, such as k-means method and method of fuzzy clustering, for comparison purposes. The optimal number of clusters was determined visually from the graphical output of Figure 4, from which we concluded that the optimal number of clusters is three clusters, while the testing reported the optimal number of clusters in the range of one to ten clusters.

The curve sharply increased to a value of three, which indicated that this value represents the optimum. Also the value of 5 possibly 7 clusters could be considered as optimal number, since these points reported also the significant increase. This step of selecting the number of clusters is thus affected by a subjective judgment of the analyst, therefore we have decided on three clusters, as it was reported in the hierarchical clustering by the Ward's method and the median method. The number of countries in each cluster was the same 21.5 and 2.

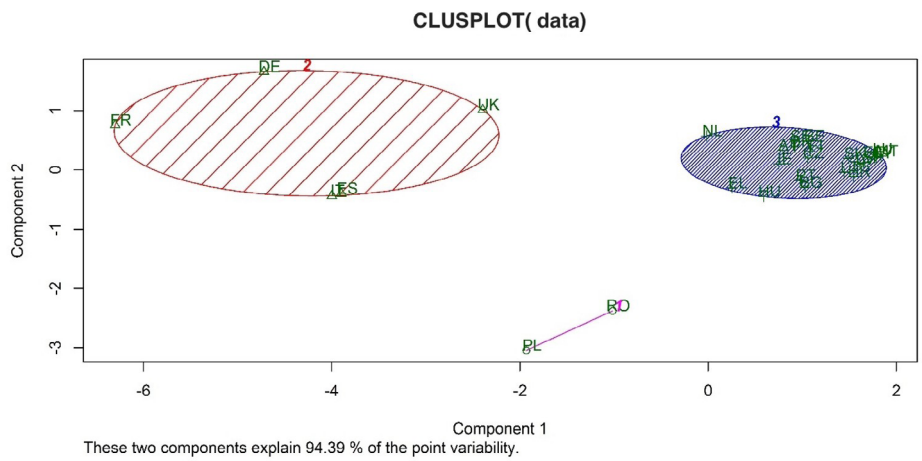

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Figure 3: Graphical representation of cluster analysis of EU member states by median method.

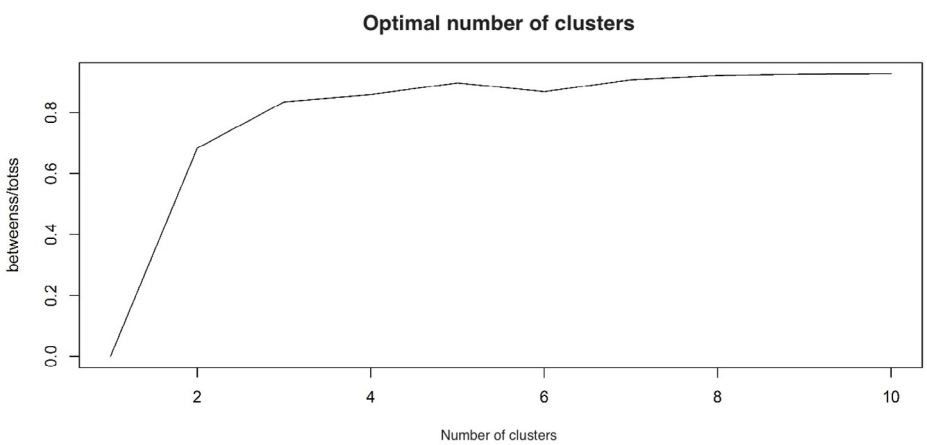

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Figure 4: Determination of optimal number of clusters by k-means method.

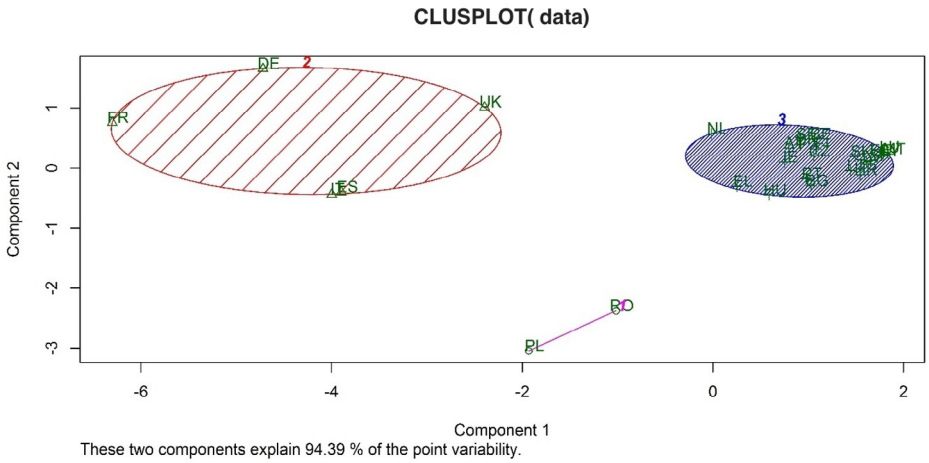

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Figure 5: Graphical illustration of the k-means method.

We have identified the match between the compared results of the k-means method and the Ward's method, which proves the appropriate classification of the Member States into individual clusters. The match was shown in the determination of the optimal number of clusters (3). Although the number of clusters was selected solely on the basis of our decision, the number of clusters in our analysis was not chosen freely, but based on the testing in the R software. The second important match occurred in distribution of Member States in individual clusters. Therefore, we can conclude that the clustering has met the requirements of clear classification, the clusters do not overlap each other and are distributed with a sufficient distance.

5. Non-hierarchical method of fuzzy clustering

The second testing method we used was the method of uncertain aggregation fuzzy k-means, which allows the country to belong simultaneously to all clusters, always with a definite or indefinite probability. Uncertain countries were the countries whose share in individual clusters was similar. Alignment of certain countries to specific cluster was more than 50%. On that basis, each country was assigned a probability value. The analysis was also expressed by multidimensional scaling (Figure 6). Overlapping expressed the percentage rate of a specific country belonging to one of the clusters (Table 1).

Affiliation rate of some objects within the data set was very high. However, some countries showed relevant signs of affiliation to multiple clusters. In classification the highest aggregation rate was showed in Estonia (83%), Slovenia (82.45%), Latvia (81.19%) and Cyprus (80.89%), all of them represent the certain countries with affiliation level higher than 50%. Although in given analysis they showed a strong affiliation to third cluster, in previous methods, these countries were clearly included in the first cluster. This is a group of the new EU member states. The uncertain countries with uniform affiliation rate to all three clusters were Romania (37.58%, 32.82% and 29.60%) and Poland (32.45%, 40.80% and 26.75%). In previous methods they constituted a separated second cluster and from other objects they considerably differ by aggregation distance. They also represent the new Member States. The old Member States showed a strong affiliation to second cluster and we can classify them as the specific countries: Germany (68.69%), Spain (72.71%), France (70.57%), Italy (68.11%) and United Kingdom (52.74%). However, when using other methods, they created the basis of the third cluster.

Results comparison of selected factors by the methods of cluster analysis

The results of the applied methods were satisfactory. The hierarchical Ward's method, as well as the non-hierarchical k-means method and method of fuzzy k-means clustering, classified the EU states into cluster identically. The average value of the original variables for each cluster, represented by the EU Member States, according to the Ward's method of hierarchical cluster analysis is shown in Table 2.

The results of the methods used were satisfactory. Hierarchical Ward; median; but also non-hierarchical k-means method has classified the EU countries completely identical. Undetermined aggregation fuzzy k-means method

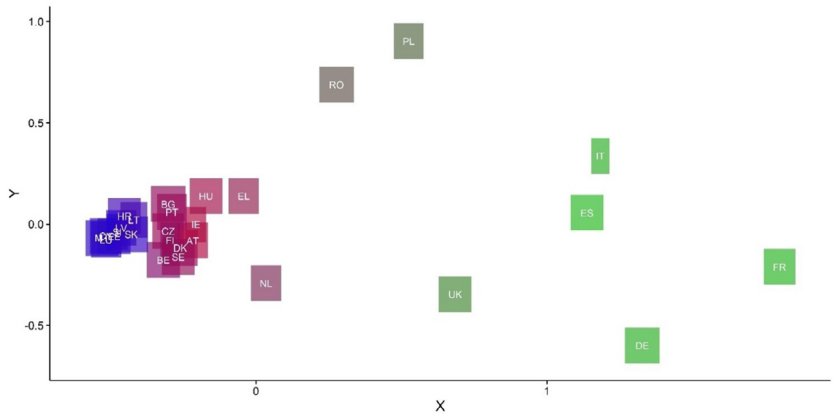

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Figure 6. Multidimensional scaling of the EU member states by fuzzy cluster analysis.

country	cluster 1	cluster 2	cluster 3	country	cluster 1	cluster 2	cluster 3
BE	51.35%	5.32%	43.33%	LT	27.89%	3.13%	68.98%
BG	57.76%	4.87%	37.37%	LU	17.38%	2.78%	79.84%
CZ	61.13%	3.51%	35.36%	HU	63.36%	7.23%	29.41%
DK	60.40%	4.64%	34.96%	MT	18.37%	3.06%	78.57%
DE	16.87%	**68.69%**	14.44%	NL	48.94%	16.86%	34.19%
EE	14.87%	2.13%	**83.00%**	AT	68.93%	4.33%	26.74%
IE	69.83%	4.50%	25.67%	**PL**	**32.45%**	**40.80%**	**26.75%**
EL	57.84%	11.58%	30.58%	PT	60.36%	4.23%	35.41%
ES	14.97%	**72.71%**	12.32%	**RO**	**37.58%**	**32.82%**	**29.60%**
FR	15.71%	**70.57%**	13.72%	**SI**	15.45%	2.09%	**82.45%**
HR	26.11%	3.39%	70.50%	SK	21.10%	2.35%	76.55%
IT	17.35%	**68.11%**	14.54%	FI	58.13%	4.82%	37.05%
CY	16.50%	2.62%	**80.89%**	SE	59.18%	5.21%	35.60%
LV	16.65%	2.16%	**81.19%**	**UK**	26.46%	52.74%	20.80%

Source: own processing

Table 1: The percentage distribution of the EU Member States in the clusters by fuzzy k-means method (in 2014).

cluster	A1	A2	A3	A4	A5	A6
1	1,879	5,540	33,095	135,047	819,666	2,302,714
2	21,619	51,843	379,804	694,400	5,969,800	19,367,200
3	7,614	19,750	58,490	1,683,000	2,240,000	13,876,500

Notes:
A1 = gross value added of the agricultural industry - producer prices
A2 = output of the agricultural industry - producer prices
A3 = gross fixed capital formation (investments)
A4 = labour force in agriculture measured in AWU
A5 = support of agricultural production
A6 = agriculturally utilized land
Source: own processing

Table 2: Quantitative characteristics of clusters formed by Ward's method for year 2014.

classified the countries to the similar structures like the previous methods. In contrast to these, however, Estonia, Slovenia, Latvia and Cyprus belonged to the third (not to the first) cluster; and Germany, Spain, France, Italy and the United Kingdom belonged to the second (not to the third) cluster. The average value of original variables for each cluster represented by the EU Member States according to Ward's method of hierarchical cluster analysis is showed in the Table 2.

The first, most populous cluster was created by countries: Belgium, Bulgaria, Czech Republic, Denmark, Estonia, Ireland, Greece Croatia, Cyprus, Latvia, Lithuania, Luxembourg, Hungary, Malta, the Netherlands, Austria, Portugal, Slovenia, Slovakia, Finland and Sweden. This cluster reported the lowest values of all monitored indicators. The agriculturally utilized land was at 2,302,714.29 ha, with the highest share by Ireland (2.8%), Hungary and Bulgaria (2.7%). Slovakia and Netherlands have a share of 1.1%, a little higher percentage was reported by Finland (1.3%), Denmark (1.5%), Lithuania (1.6%), Austria (1.7%) and all other countries from this cluster reported a share higher than 2%. Chrastinová et al. (2014) monitored the Slovak agriculture through the method of multidimensional scaling and found out that from the view of the indicator "Agriculturally utilized land (in thousands ha)", Slovakia is associated with geographically similar countries or partially with countries with similar political and economic development, which are Bulgaria, Germany, Hungary, Austria, Poland and Romania. The highest share of agriculturally utilized land on the total area of the country was reported for Denmark (61.4 %), Luxembourg (50.7 %), Hungary (50.4 %) and the Netherlands (50.1 %). The lowest share was in Finland (6.8 %), Sweden (6.9 %) and Cyprus (12.8%). A critical indicator of the cluster was the gross value added, which reached a value of 1,879.61 mils €. The highest value, although only (6.2 %), was in Netherlands. The share of Slovakia represented 0.4 % and on a year over year basis stayed almost unchanged. It was the lowest share among the V4 countries, right after Hungary (1.7 %) and the Czech Republic (0.9 %), which related mainly to the extent of the land usage and the achieved production. The average value of the cluster (819,666.67 mils €) was reached in the support of agriculture, which is still the decisive item of incomes for farmers in all EU countries. Slovakia received a 0.9 % of total EU–28 supports, representing 246.8 €/ha of agriculturally utilized land, which was below the average of the EU-28 countries (17.4 %), representing on average 298.8 €/ha of agriculturally utilized land. The highest amount of support, calculated per hectare of utilized land, was in Malta (1,545.5 €), Greece (820.6 €) and Finland (781.8 €). The smallest amount of support, calculated per hectare of utilized land, was received by Croatia (22.8 €), Lithuania (70.1 €) and Latvia (109.1 €). The share of persons employed in agriculture ranged from 0.2 % in Estonia and Cyprus to 4.7 % in Greece. The highest number of persons employed per 100 hectares of agriculturally utilized land (in AWU) was in Malta (45.5), Cyprus (21.2), Slovenia (17.3) and Croatia (14.7). The employment in Slovakia reached the value of 2.83 persons per 100 hectare of agriculturally utilized land, which was by 0.2 less than in the previous year. It is important to realize, that not only the number of employed persons, but also their education is important, as it is known that in agriculture employees with basic education are predominant. The crucial role of education was confirmed (Giannakis and Bruggeman, 2015). Chances to achieve a high economic performance are almost 9 times higher in the countries with the highly schooled stuff. Their analyses led to results that in the Netherlands it is 72 % and in Germany 69 %.

Similar conclusions in regards of education are stated by other authors (e.g. Stachová et al., 2015). The last monitored indicator was the agricultural production, which was in this cluster reported at the lowest level of 5,540.40 mils €. Slovakia's share on the European production represented 0.6 % with the volume of 2,284 mils. €. The highest intensity of production per hectare of agriculturally utilized land was reached in the Netherlands (14,611.4 €), Malta (11, 218.2 €), Belgium (6,280 €) and Cyprus (5,851.2 €). The lowest production per hectare of agriculturally utilized land was reported in Latvia (666.1 €), Estonia (926.4 €), Lithuania (890.2 €) and Bulgaria (890 €). Slovakia reached the production per hectare of agriculturally utilized land at 1,204.6 €, which ranks it between the countries with the lowest production and the lowest among the V4 countries.

The second cluster was represented by the group of developed EU countries with high values of monitored indicators and a highly developed agricultural market. Based on the similarity of these countries, the cluster was formed by the old Member States such as Germany, Spain, France, Italy and the United Kingdom. The agriculturally utilized land amounted to 19.367 mils ha. The highest share of the total agriculturally utilized land in the EU-28 countries was reached by France (16.2 %), Spain (13.8 %), Germany (9.7 %) and Italy (7.5 %). The above-average values were reported for the indicator of gross value added, which had the highest value among all cluster, at 21,619.98 mils €. Its major share (83.6 %) was formed by the original EU-15, mainly Italy (17.7 %), France (15.4 %), Spain (14.0 %) and Germany (11.4 %). Also the largest part of the total support (81.7 %) was allocated into the original Member States (42.2 billion €) and that was by 8.2 % lower

volume than in previous year. The largest portion of total EU-28 support was allocated into production countries, which are France (15.8 %), Germany (14.1 %), Spain (11.9 %), Italy (8.6 %) and the United Kingdom (7.4 %).

The indicator of employment in agriculture was in this case the second highest one (694,40 persons in AWU). The agricultural employment was the highest in Italy (11.0 %), Spain (8.5 %) and France (8.0 %), which was related to the extent of the agricultural production and to a larger number of smaller individual farms in these countries. Similar results were confirmed also by other authors (Raisová, 2011; Michalski, 2008; Litavcová, 2015; Zachar et al., 2011; Šoltes et al., 2014; Hakalová et al., 2014; Grancay et al., 2015). The agricultural output was at the value of 51,843.91 mils €. The largest producers in the EU-28 were France (17.7 %), Germany (13.1 %), Italy (12.8 %) and Spain (10.6 %). In the structure of the total EU-28 production, the largest agricultural output was in cereals including rice (305.5 mils tons), where the biggest producers of wheat were France (27.1 %) and Germany (18.4 %). The third cluster was formed of the lowest number of countries, only Poland and Romania. The monitored indicators were in this cluster at the average values. The agriculturally utilized land represented in Poland 8.4 % of the EU countries area and in Romania 7.8 %. The share of the agriculturally utilized land of the total area of a given country was in Romania reported at over 50% (55.8 %) and in Poland it reached 46.2%. The gross value added was in Poland at 5.7 % and in Romania at 4.6 % of the EU countries share. Compared to the other countries, these are average indicators, since these two countries accesses the EU only in 2004, or in 2007 respectively. The agricultural support was in this cluster at the value of 2.240 mils €. When calculated to the hectares of agriculturally utilized land, the average of the EU-28 was at 298.8 € and the average of the EU-15 reported 342.5 €, while Romania reported 125.1 € and Poland 195.5 €. Overall, the number of persons working in agriculture has decreased by 1,504 thousand persons during the last 5 years (2009–2013). The agricultural employment of the EU-28 countries was in Poland at 19.9 % and in Romania at 14.9 %. Per 100 hectares of agriculturally utilized land, the number of persons employed in agriculture (in AWU) was in Poland 13.4 and in Romania 10.9. The EU-15 countries produced almost 83.4 % of the EU-28 production, which was 71.7 % in plant commodities and 84.5 % in animal commodities. The agricultural production in Romania was within the EU countries below average and reached 4.1 % and in Poland 5.7 %. Calculated per hectare of agriculturally utilized land, Poland reached the value of 1,582.5 € and Romania 1,222.1 €. The quantitative characteristics of the analysed clusters differed mainly in the indicators of labour force in agriculture, support to agriculture and agriculturally utilized land. Similar observations were concluded by Chrastinová et al. (2012). In their work they have divided countries into two groups, based on the amount of received support per hectare of agriculturally utilized land: the states reaching the EU-27 average, which are Belgium, the Czech Republic, Denmark, Germany, Ireland, Greece, France, Italy, Cyprus, Luxembourg, Malta, the Netherlands, Austria, Slovenia, Finland, Sweden and the states below the EU-27 average: Bulgaria, Estonia, Spain, Latvia, Lithuania, Hungary, Poland, Portugal, Romania, Slovakia and the United Kingdom. Dos Santos (2013) classified in his analysis 23 EU countries into four groups, according to their performance in agriculture. Slovakia and the Czech Republic formed the third cluster, characterized by the largest agricultural area. Giannakis and Bruggeman (2015) in their analysis of economic performance used similar methods (Ward's, k-means and two-step clustering methods) to classify European agriculture based on gross-value-added farm, land and labour productivity indicators. Their results revealed significant differences between the Northern-Central counties and the continental peripheries (Mediterranean, Eastern and Northern Scandinavian).

Conclusion

The analysis has confirmed that despite the continued integration within the EU, there are still differences in the agrarian policies of individual national governments. Provided cluster analysis confirmed the degree of divergence of different agricultural policies and considerable scope for the implementation of harmonization measures. Our analysis verified that EU countries could be classified into the group of the old member states (cluster 3) and the new Member States (cluster 2). The first cluster consists of both, new and old Member States, while clusplots confirmed that within this cluster there is a clear mutual proximity of clustering to overlap of the new Member States and the old Member States. Clustering similarity was achieved by all methods except the fuzzy k-means, using which the different affiliation was found (Estonia, Slovenia, Latvia and Cyprus

(the new Member countries) belong to the third (not the first) cluster; and Germany, Spain, France, Italy and United Kingdom (the old Member States) belong to the second (not third) cluster, as it was in all previous methods). Provided analysis has clearly confirmed that the EU countries and their agricultural policies, as well as the total amount of agricultural production and other agricultural determinants we studied, were classified into the new and old EU Member States. It was confirmed, that the process of integration and harmonization of agricultural policies is long-term and dynamic, and it is up to agrarian policies of individual governments, how they will manage this process and whether the agricultural market will be unified despite the specific conditions that exist in each country.

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