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# Changes in agrarian structure in the EU during the period 2010–2016 in terms of typological groups of countries

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**Abstract:** The paper presents the changes in the spatial structure of agricultural holdings in the European Union between 2010 and 2016 from the perspective of typological groups of countries. The research was conducted based on Eurostat data. The holdings were divided into the following groups: up to 5 ha of agricultural land (AL), 5–20 ha, 20–50 ha, and over 50 ha. Based on the fuzzy classification method, 4 typological groups of countries with a similar spatial structure of holdings were distinguished. The intergroup diversity is high. The dynamics of changes in the number of holdings in particular countries per typological group was presented. A downward trend in the total number of holdings and smallholdings was observed, in particular in countries characterised by a fragmented structure of holdings. In these countries, an upward trend in the number of holdings of 20–50 ha and over 50 ha was noted. Between 2010 and 2016, the structure and composition of typological groups changed. There were also slight changes (in different directions) in the structural distance between the groups.

**Keywords:** dynamics; EU countries; spatial structure of holdings; typological groups

The spatial structure of agricultural holdings in EU countries is highly diversified. According to the General Agricultural Census conducted in 2010, in countries with the highest rate of fragmentation of holdings, such as Romania, Bulgaria, Hungary, and Portugal, the smallest holdings [up to 5 ha of agricultural land (AL)] constituted over 70% of all holdings in a given country, whereas the largest holdings (at least 50 ha AL) constituted less than 5%. In the countries with the best holdings structure, such as Denmark, Germany, and the United Kingdom, the share of the smallest holdings did not exceed 10% (they took up no more than 1% of AL area in a given country), while the biggest holdings constituted over 30% of all holdings in a given country (ca. 80% AL area).

Significant changes took place between 2010 and 2016: the total number of holdings in the EU dropped by 13%, which was mostly due to the decrease in the number of holdings up to 5 ha. In other groups, the changes were smaller. These changes are constantly monitored, in particular in the context of CAP, but also in terms of the competitiveness of larger holdings in particular, thus the numerous studies on the subject (Smutka et al. 2019; Bożek et al. 2018; Szabo et al. 2018; Czyżewski and Smędzik-Ambroży 2017; Janovska et al. 2017; Popescu et al. 2016). The changes in the number of holdings also affected the spatial structure in particular countries, but to a highly varied extent. The problem of diversity of the studied countries is important in terms of research, as well as in terms of the objectives of development policy, cohesion policy, and the increase in the international competitiveness of the EU agriculture (Hampl 2020; Smutka 2018), meeting the sustainable development requirements as well (Savickienė and Miceikienė 2018). Therefore, conducting analysis of the phenomenon is reasonable. The aim of the paper is to determine the scale and direction of changes

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and the level of diversification of spatial structure in the European Union between 2010 and 2016, using the typological groups approach. Based on the fuzzy classification method, 4 typological groups of countries with a similar spatial structure of holdings and high intergroup diversity were distinguished. The dynamics of changes in the number of holdings in particular countries per typological group was presented. The changes in the composition and structure of typological groups in the studied period were compared. It was examined whether the distance between groups decreased or, to the contrary, the disproportions grew.

## MATERIAL AND METHODS

The analysis was conducted based on Eurostat data presenting the results of structure analysis of agricultural holdings in EU countries in 2010 and 2016. The 2010 data were gathered during the General Agricultural Census (Eurostat 2013)[1], while the 2016 data were gathered during the last sample survey (Eurostat 2019)[2]. The holdings were divided into the following groups: up to 5 ha of agricultural land (AL), 5–20 ha, 20–50 ha, and over 50 ha. The advantage of the size criterion is the ease of use and universality all over the world. However, for example, in addition to farmland sizes, another factors, such as type of farm employment (full time and/or part time), farm income and sales value, degree of specialization may also be included (Guiomar et al. 2018).

Countries were grouped using fuzzy classification, which was then transformed into classic classification. In classic classification, the inclusion of a given object in a given class is determined using a zero-one variable, whereas in fuzzy classification, a continuous variable is used. They are the so-called membership functions that take the values from the [0,1] interval (Zadeh 1965).

The problem of fuzzy classification can be formulated as follows.

One assumes that there is a set $\Omega$ consisting of $n$ objects (countries, in this case): $P_1, P_2, ..., P_n$. These objects are described by $r$ values of the variables: $X_1, X_2, ..., X_r$ (in the paper, $X_l$ means the share of the number of holdings from the $l^{\text{th}}$ spatial group in the total number of holdings in a given country). On the $\Omega$ set, one has to determine the family of fuzzy classes: $S_1, S_2, ..., S_K \ (1 < K < n)$, so that the following conditions are met:

**1.** $0 \le f_{S_j}(P_i) \le 1 \quad (i = 1, ..., n; j = 1, ..., K)$;

where: $f_{S_j}(P_i)$ is the degree of membership of the $P_i$ object in class $S_j$.

**2.** $\sum_{j=1}^{K} f_{S_j}(P_i) = 1 \quad (i = 1, ..., n)$;

**3.** Objects for which the degrees of membership in the same class are high are very similar, whereas the objects for which the degrees of membership in different classes are high are not similar.

Thus, creating a fuzzy classification involves assigning to each object $P_i \in \Omega$ such as:
$f(P_i) = \left(f_{S_1}(P_i), f_{S_2}(P_i), ..., f_{S_K}(P_i)\right)$ vector that Conditions (1–3) are met.

There are several methods of creating a fuzzy classification (Jajuga 1984). In this paper, the iterative method using the notion of a fuzzy centre of gravity was used. In this method, the values of degrees of membership of particular objects in particular classes is changed in subsequent iterations. The procedure is continued until the values stop changing significantly.

The fuzzy classification obtained this way was then transformed into classic classification, assuming that the object $P_i$ belongs to the class (typological group) $S_j$, when:

$$f_{S_j}(P_i) = \max_l f_{S_l}(P_i) \tag{1}$$

The presented method of classification of multidimensional objects is useful in spatial-temporal analysis of the spatial structure of agricultural holdings (Bożek 2016). It allows for the objective separation of groups of countries similar in terms of analysed structure, as well as synthetic and accurate presentation of a given phenomenon in time (with relatively small input information loss).

For each typological group, the mean values of indicators (elements) of the spatial structure of holdings, i.e. the centre of gravity of the group ($l^{\text{th}}$ element of the centre of gravity of $i$ group is the arithmetic aver-

[1]In 2010, the General Agricultural Census was conducted in all EU countries. The definition of agricultural holding was unified, which allows for data comparison.

[2]The farm structure survey was carried out in 2016 throughout the EU, and its primary purpose was to obtain the data necessary to evaluate and shape the tools of the Common Agricultural Policy (Eurostat 2019), Farm Structure Survey 2016 – Main Results. It should be noted that the results of the sample survey may be subject to error.

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age of $l$ elements of the objects belonging to $i$ group) were designated. To evaluate the differences between the structures of the distinguished groups, intergroup distances were set. The intergroup distance measure was taken to be the distance between the centres of gravity of the groups, calculated using the following formula:

$$v_{ij} = \frac{1}{2}\sum_{l=1}^{r}\left|a_{il}^{*} - a_{jl}^{*}\right| \quad (2)$$

where: $v_{ij}$ – distance between the $i^{th}$ and $j^{th}$ groups $a_{il}^{*}$; $a_{jl}^{*}$ – the $l^{th}$ element of the centre of gravity of the $i^{th}$ and $j^{th}$ groups, respectively.

It takes its values from the [0,1] interval. The higher its value, the more group structures differ. Determining the distance between the groups at the beginning and end of the studied period allows for the observation of the trends of changes – an increase or decrease in differences between groups.

To determine the degree of changes in the structure in a certain period, the following measure was used (Kukuła 1989): if α is a share structure analysed in $t = 0, 1, ..., n$ time, consisting of $r$ elements,
i.e. a matrix $\left[\alpha_{tk}\right]_{(t = 0, 1, ..., n;\ k = 1, ..., r)}$ is given,
where:

$$\sum_{i=1}^{r}\alpha_{ti} = 1 \text{ and } 0 \le \alpha_{ti} \le 1;\ t = 0,1,...,n;\ k = 1,2,...,r,$$

then:

$$v_{t,t-\tau} = \frac{\sum_{k=1}^{r}\left|\alpha_{tk} - \alpha_{(t-\tau)k}\right|}{2} \quad (3)$$

defines the degree of structure changes in the period from $t-\tau$ to $t$. This measure takes its values from the [0,1] interval. Its high value indicates significant changes in the structure. In particular, $v_{n0}$ allows for comparison of the initial structure $t = 0$ to the final structure $t = n$.

## RESEARCH RESULTS

In 2016, the spatial structure of agricultural holdings in EU countries is highly diversified, as shown in Table 1, presenting the structure of agricultural holdings (EU-15 and EU-12 countries were grouped separately). The biggest difference is 87.8 percentage points (pp.) and concerns the share of the smallest holdings: from 4% in Finland to 91.8% in Romania, while the mean share of these holdings in the EU is 42.9%. Holdings of 5–20 ha constitute between 7.1% in Romania and 45.5% in Sweden, while the average is 28%. High disproportions are visible also in the share of holdings of 20–50 ha (from 0.5% in Romania to 38.6% in Ireland) and over 50 ha (from 0.5% in Romania to 41.3% in France) (Table 1). These numbers are far from the average values for EU countries, which are 14.3% and 14.8%, respectively.

This is why it is necessary to distinguish typological groups composed of countries with a similar structure of holdings.

Countries were grouped based on the fuzzy classification method (two countries were excluded: Malta and Luxembourg). This was due to their small number of holdings, deviating significantly from the remaining countries). Calculations were made using an original computer program that establishes the centres of gravity of clusters for a given set of multidimensional objects and calculates the values of function of membership of particular objects in these clusters[3].

Based on these calculations, 4 groups of countries were distinguished. For each group of countries, the average shares of farms from particular area groups were calculated, as well as measures of intra-group diversity: standard deviation (Std.) and coefficient of variation ($V$). Their composition and characteristics are presented in Table 2. The highest fragmentation of holdings is characteristic of group I, which encompasses 6 countries, where the smallest holdings (up to 5 ha) are dominant and constitute on average 82.4% of the total number of holdings in these countries. The biggest holdings, the area of which is at least 50 ha, are scarce – only 2.5%.

In group II (7 countries), holdings up to 5 ha are less popular than in group I – 57.5% on average. Holdings of 5–20 ha constitute almost 30% of all holdings, and big and very big holdings constitute 7.3% and 6%, respectively.

Group III is the smallest. It is composed of 3 countries, the structure of which is more favourable than that of the former two groups. The percentage of holdings up to 5 ha is 32.6% and the share of big and very big holdings is 16.4% and 11.6%, respectively.

Group IV is the biggest and includes 10 countries with the best spatial structure (9 EU-15 countries and the Czech Republic), where holdings over 20 ha dominate. In 2016, 64% of holdings on average had an area of 20–50 ha and over 50 ha: 25.3% and 29%,

[3]The C$^{++}$ program calculates the values of the function of objects belonging to fuzzy classes, according to the algorithm presented in the paper Bożek and Bożek (2011).

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Table. 1. Structure of agricultural holdings in EU countries in 2016

| Country | Total number of holdings (thousands) | Area of holdings in agricultural land (AL; %) | | | |
|---|---|---|---|---|---|
| | | up to 5 ha | 5–20 ha | 20–50 ha | ≥ 50 ha |
| EU (26) | 10 467.8 | 65.6 | 20.4 | 7.1 | 6.9 |
| Austria | 132.5 | 31.0 | 37.4 | 23.1 | 8.5 |
| Belgium | 36.9 | 13.9 | 30.6 | 30.2 | 25.3 |
| Denmark | 35.1 | 4.4 | 39.3 | 20.9 | 35.3 |
| Finland | 49.7 | 4.0 | 33.0 | 33.0 | 30.0 |
| France | 456.5 | 24.3 | 18.2 | 16.3 | 41.3 |
| Germany | 276.1 | 8.6 | 36.7 | 24.1 | 30.6 |
| Greece | 685.0 | 77.3 | 18.4 | 3.4 | 0.9 |
| Ireland | 137.6 | 7.4 | 36.0 | 38.6 | 18.0 |
| Italy | 1 145.7 | 61.9 | 26.1 | 7.8 | 4.1 |
| Netherlands | 55.7 | 20.2 | 28.7 | 29.7 | 21.5 |
| Portugal | 259.0 | 71.5 | 19.3 | 5.0 | 4.2 |
| Spain | 945.0 | 51.6 | 26.8 | 10.8 | 10.8 |
| Sweden | 62.9 | 10.5 | 45.5 | 19.3 | 24.7 |
| United Kingdom | 185.1 | 10.2 | 29.3 | 21.9 | 38.6 |
| Bulgaria | 202.7 | 82.6 | 8.5 | 4.1 | 4.8 |
| Croatia | 134.5 | 69.5 | 22.0 | 4.7 | 3.8 |
| Cyprus | 34.9 | 89.6 | 7.7 | 1.7 | 1.0 |
| Czech Republic | 26.5 | 18.7 | 36.4 | 17.9 | 27.0 |
| Estonia | 16.7 | 31.6 | 37.1 | 13.7 | 17.7 |
| Hungary | 430.0 | 81.4 | 11.1 | 3.8 | 3.7 |
| Latvia | 69.9 | 35.2 | 43.5 | 12.5 | 8.8 |
| Lithuania | 150.3 | 50.0 | 34.7 | 8.1 | 7.2 |
| Poland | 1 410.7 | 54.3 | 36.1 | 7.2 | 2.4 |
| Romania | 3 422.0 | 91.8 | 7.1 | 0.5 | 0.5 |
| Slovakia | 25.7 | 55.7 | 23.8 | 7.5 | 13.0 |
| Slovenia | 69.9 | 59.5 | 34.7 | 4.9 | 0.9 |
| Mean shares | – | 42.9 | 28.0 | 14.3 | 14.8 |

Source: Own calculations, based on Farm Structure Survey 2016 – Main Results (Eurostat 2019)

respectively. The percentage of holdings up to 5 ha is the lowest at 12.3%. It should be noted that in this group only the Czech Republic is a post-socialist state. Ludek Homolac and Karel Tomsik (Homolac and Tomsik 2016) presented the description and course of the adopted reprivatisation model in Czech agriculture from 1990 to 2015.

A graphic of the structure of the groups is shown in Figure 1.

Groups I and II are the most diversified internally in terms of percentage of holdings of at least 50 ha ($V$ = 0.69), while group IV is the most diversified in terms of the share of holdings up to 5 ha ($V$ = 0.53). The main factor determining the division into groups is the percentage of holdings up to 5 ha.

Between 2010 and 2016 the number of agricultural holdings in the EU changed drastically, as shown in Table 3. Analysing these changes, one may notice the high pace of decrease in the number of all holdings. The total number of holdings in the entire EU dropped by 1 547.2 thousand, i.e. by 13%. This is mostly due to the decline in the smallest holdings, up to 5 ha AL, the number of which decreased in the entire EU by 1 455.8 thousand (17%). The changes in the remaining groups of holdings were relatively small, so in Table 3 changes in absolute terms are presented only for the smallest holdings.

The number of holdings decreased in all EU countries apart from the Czech Republic and Slovakia, where it increased slightly, by 3.6 thousand (16%) and 1.2 thou-

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Table 2. Composition of typological groups of EU countries; mean values and dispersion of spatial structure indicators in the groups

| Specification | Spatial groups in agricultural land (AL) | | | |
|---|---|---|---|---|
| | up to 5 ha | 5–20 ha | 20–50 ha | ≥ 50 ha |
| **Group I** | | | | |
| Mean (%) | 82.4 | 12.0 | 3.1 | 2.5 |
| Std. | 6.9 | 5.0 | 1.5 | 1.7 |
| *V* | 0.08 | 0.42 | 0.49 | 0.69 |
| **Group II** | | | | |
| Mean (%) | 57.5 | 29.2 | 7.3 | 6.0 |
| Std. | 6.2 | 5.4 | 1.9 | 4.2 |
| *V* | 0.11 | 0.19 | 0.26 | 0.69 |
| **Group III** | | | | |
| Mean (%) | 32.6 | 39.3 | 16.4 | 11.6 |
| Std. | 1.9 | 3.0 | 4.7 | 4.3 |
| *V* | 0.06 | 0.08 | 0.29 | 0.37 |
| **Group IV** | | | | |
| Mean (%) | 12.3 | 33.4 | 25.3 | 29.0 |
| Std. | 6.5 | 7.0 | 7.0 | 7.2 |
| *V* | 0.53 | 0.21 | 0.28 | 0.25 |

Group I – Bulgaria, Cyprus, Greece, Portugal, Romania, Hungary; group II – Croatia, Spain, Lithuania, Poland, Slovakia, Slovenia, Italy; group III – Austria, Estonia, Latvia; group IV – Belgium, Czech Republic, Denmark, Finland, France, Ireland, Netherlands, Germany, Sweden, United Kingdom; Std. – standard deviation; *V* – coefficient of variation
Source: Own calculations

sand (5%), respectively. The biggest changes took place in countries where holdings are the most fragmented. In absolute terms, the biggest decrease was observed in Italy (475.3 thousand), Romania (437 thousand), Bulgaria (167.3 thousand), Hungary (147 thousand), Croatia (98.8 thousand), and Poland (96.3 thousand). In line with the rest of the EU, it was due to the decline in the smallest holdings (up to 5 ha). The dynamics of the decrease in the number of the smallest holdings (up to 5 ha) were diverse: the greatest was observed in Bulgaria (51%), Croatia (48%), Hungary (30%), and Lithuania (36%), whereas in Romania their number decreased by 13% and in Poland by 8%. These dynamics indicators show not only the rate of decline, but also that the percentage of the smallest holdings was left in the aforementioned countries, which may suggest the future direction of changes.

As a result of the decrease in the number of holdings, the structure indicators in particular countries also changed, as shown in Table 4. The direction of changes

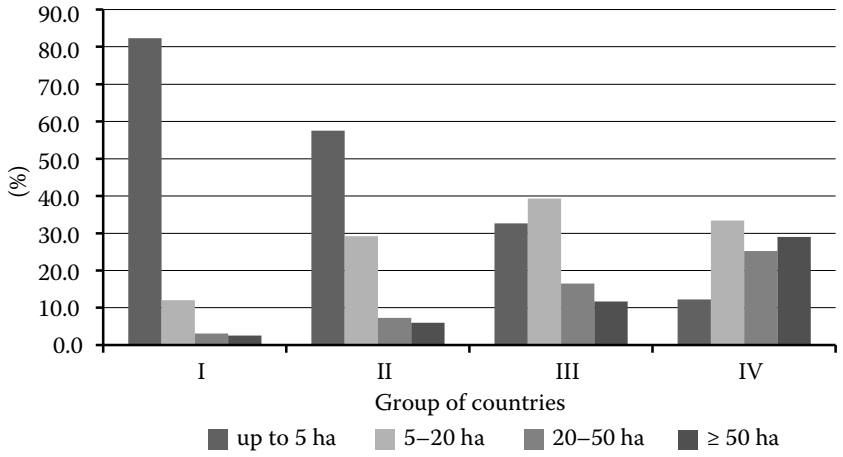


Figure 1. Spatial structure of agricultural holdings in typological groups of EU countries in 2016

Source: Own research, based on Eurostat (2019), Farm Structure Survey 2016 – Main Results

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Table 3. Dynamics of changes in the number of holdings in EU countries between 2010 and 2016 per typological group

| Country | Total number of holdings | | Area of holdings in agricultural land (AL) | | | | |
|---|---|---|---|---|---|---|---|
| | | | up to 5 ha | up to 5 ha | 5–20 ha | 20–50 ha | ≥ 50 ha |
| | 2016–2010 (thousands) | 2010 = 1 | 2016–2010 (thousands)* | 2010 = 1 | | | |
| **EU (26)** | –1 547.2 | 0.87 | –1 455.8 | 0.83 | 0.96 | 0.96 | 1.01 |
| **Group I** | | | | | | | |
| Bulgaria | –167.3 | 0.55 | –171.5 | 0.49 | 0.98 | 1.39 | 1.16 |
| Cyprus | –4.0 | 0.90 | –3.5 | 0.90 | 0.90 | 0.84 | 1.20 |
| Greece | –38.1 | 0.95 | –27.4 | 0.95 | 0.95 | 0.92 | 0.86 |
| Portugal | –46.0 | 0.85 | –45.9 | 0.80 | 0.96 | 1.11 | 1.04 |
| Romania | –437.0 | 0.89 | –453.2 | 0.87 | 1.08 | 1.03 | 0.86 |
| Hungary | –147.0 | 0.75 | –151.9 | 0.70 | 1.04 | 1.05 | 1.15 |
| **Group II** | | | | | | | |
| Croatia | –98.8 | 0.58 | –84.8 | 0.52 | 0.67 | 0.81 | 1.64 |
| Spain | –45.0 | 0.95 | –38.6 | 0.93 | 1.00 | 0.95 | 0.98 |
| Lithuania | –49.6 | 0.75 | –41.8 | 0.64 | 0.85 | 0.98 | 1.25 |
| Poland | –96.3 | 0.94 | –64.5 | 0.92 | 0.92 | 1.06 | 1.30 |
| Slovakia | 1.2 | 1.05 | –1.5 | 0.90 | 1.42 | 1.37 | 1.11 |
| Slovenia | –4.8 | 0.94 | –3.8 | 0.92 | 0.94 | 1.14 | 1.24 |
| Italy | –475.3 | 0.71 | –472.4 | 0.60 | 0.98 | 1.03 | 1.05 |
| **Group III** | | | | | | | |
| Austria | –17.5 | 0.88 | –6.4 | 0.87 | 0.84 | 0.95 | 1.00 |
| Estonia | –2.9 | 0.85 | –1.3 | 0.80 | 0.83 | 0.85 | 1.05 |
| Latvia | –13.5 | 0.84 | –3.7 | 0.87 | 0.76 | 0.91 | 1.16 |
| **Group IV** | | | | | | | |
| Belgium | –6.0 | 0.86 | –4.6 | 0.53 | 0.94 | 0.91 | 1.04 |
| Czech Republic | 3.6 | 1.16 | 1.5 | 1.42 | 1.19 | 1.08 | 1.05 |
| Denmark | –7.1 | 0.83 | –1.6 | 0.50 | 0.87 | 0.80 | 0.89 |
| Finland | –14.2 | 0.78 | –4.2 | 0.32 | 0.77 | 0.76 | 1.01 |
| France | –59.5 | 0.88 | –28.2 | 0.80 | 0.86 | 0.84 | 0.98 |
| Germany | –22.9 | 0.92 | –3.8 | 0.86 | 0.92 | 0.87 | 0.99 |
| Ireland | –2.4 | 0.98 | 0.5 | 1.05 | 1.01 | 0.96 | 0.97 |
| Netherlands | –16.6 | 0.77 | –9.5 | 0.54 | 0.76 | 0.86 | 1.06 |
| Sweden | –8.2 | 0.89 | –2.3 | 0.74 | 0.95 | 0.80 | 0.92 |
| United Kingdom | –1.9 | 0.99 | 2.1 | 1.13 | 0.98 | 0.95 | 0.99 |

*Number of holdings

Source: Own calculations, based on Agriculture Census 2010 – Main Results (Eurostat 2013), Farm Structure Survey 2016 – Main Results (Eurostat 2019)

in the absolute number of holdings and their percentage (share) are not always consistent with one another. For example, in Greece the number of holdings up to 5 ha decreased by 5% (Table 3) and their share increased by 0.3 pp. (Table 4). A similar situation occurred in the United Kingdom, Latvia and Cyprus. In the majority of countries (20), the share of holdings up to 5 ha decreased, to the greatest extent in countries where their absolute number also decreased the most: in Italy (11 pp.), Bulgaria (9 pp.), Croatia (6.9 pp.), and Hungary (5.6 pp.).

A significant decrease in the share of holdings up to 5 ha was observed also in countries where the changes in absolute number were not big: Belgium and Slovakia (decrease of 8.8 pp.), the Netherlands and Lithuania (8.5 pp.). This can be explained by the relatively

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Table 4. Change in shares of the number of holdings by area groups in EU countries between 2010 and 2016; degree of structural changes

| Country | Area of holdings in agricultural land (AL; pp.) | | | | Degree of structure changes $v_{2016,2010}$ |
|---|---|---|---|---|---|
| | up to 5 ha | 5–20 ha | 20–50 ha | ≥ 50 ha | |
| **Group I** | | | | | |
| Bulgaria | –9.0 | 3.7 | 2.5 | 2.5 | 0.089 |
| Cyprus | 0.1 | 0.0 | –0.1 | 0.3 | 0.003 |
| Greece | 0.3 | 0.0 | –0.1 | –0.1 | 0.003 |
| Portugal | –4.3 | 2.2 | 1.2 | 0.8 | 0.042 |
| Romania | –1.4 | 1.3 | 0.1 | 0.0 | 0.014 |
| Hungary | –5.6 | 3.1 | 1.1 | 1.3 | 0.056 |
| **Group II** | | | | | |
| Croatia | –6.9 | 3.1 | 1.4 | 2.5 | 0.069 |
| Spain | –1.6 | 1.2 | –0.1 | 0.3 | 0.016 |
| Lithuania | –8.5 | 3.9 | 1.9 | 2.9 | 0.086 |
| Poland | –0.8 | –0.6 | 0.9 | 0.7 | 0.015 |
| Slovakia | –8.8 | 6.3 | 1.8 | 0.8 | 0.088 |
| Slovenia | –1.3 | 0.2 | 0.9 | 0.2 | 0.013 |
| Italy | –11.0 | 7.3 | 2.4 | 1.3 | 0.110 |
| **Group III** | | | | | |
| Austria | –0.6 | –2.1 | 1.6 | 1.0 | 0.026 |
| Estonia | –2.1 | –1.2 | –0.1 | 3.4 | 0.034 |
| Latvia | 1.3 | –4.7 | 1.0 | 2.4 | 0.047 |
| **Group IV** | | | | | |
| Belgium | –8.8 | 2.7 | 1.8 | 4.3 | 0.088 |
| Czech Republic | 3.4 | 1.0 | –1.3 | –2.7 | 0.042 |
| Denmark | –3.0 | 1.8 | –0.9 | 2.1 | 0.039 |
| Finland | –5.7 | –0.3 | –1.0 | 7.0 | 0.070 |
| France | –2.7 | –0.6 | –0.8 | 4.0 | 0.041 |
| Germany | –0.6 | –0.1 | –1.4 | 2.2 | 0.021 |
| Ireland | 0.5 | 0.8 | –1.0 | –0.2 | 0.013 |
| Netherlands | –8.5 | –0.5 | 3.1 | 5.9 | 0.090 |
| Sweden | –2.0 | 3.3 | –2.1 | 0.8 | 0.041 |
| United Kingdom | 1.3 | –0.3 | –0.8 | 0.0 | 0.012 |

Source: Own calculations, based on Agriculture Census 2010 – Main Results (Eurostat 2013), Farm Structure Survey 2016 – Main Results (Eurostat 2019)

small overall number of holdings in these countries, due to which even small changes in absolute number of holdings in spatial groups lead to significant changes of their percentage in the overall number of holdings.

In the next spatial group, 5–20 ha, both in the entire EU and in the majority of countries, a decrease in the number of holdings was observed, with the exception of the Czech Republic, Romania, Hungary, and Slovakia. The decrease in absolute terms was small in comparison to the former spatial group, and the dynamics of decline were lower. In the entire EU, the number of these holdings dropped by 4%. A greater decrease in the number of these holdings was noted in Croatia (33%), Finland (23%), the Netherlands (24%), and Latvia (24%). In the Czech Republic, their number increased by 19%, in Slovakia by 42%, in Romania by 8%, and in Hungary by 4%. In 15 countries, the share of this group of holdings increased (Table 4) by 4 pp. Only in Italy and Slovakia was the increase higher, namely by 7.3 pp. and 6.3 pp., respectively.

In total, the number of holdings of 20–50 ha decreased by 4% in the entire EU. The decrease was

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observed in the "old" EU countries except for Italy and Portugal, where the number of these holdings increased. In 6 (the majority) of "new" EU member states, the number of these holdings increased (Bulgaria, the Czech Republic, Hungary, Poland, Romania, Slovakia, and Slovenia).

The number of holdings of at least 50 ha increased in the majority of countries from groups I and II, i.e. the most fragmented ones. The highest growth dynamic was noted in Croatia, Poland, Lithuania, and Slovenia. In the majority of the countries from group IV, the number of these holdings either slightly decreased or stayed at the same level.

In general, trends are similar in countries from the same typological group, but their pace differs.

In order to compare the extent of structural changes in particular countries, the degree of structural changes was calculated [using Formula (3)]. The values $\nu_{2016,2010}$ are presented in Table 4.

The structure changed the most in countries where big changes in absolute terms occurred: Italy ($\nu_{2016,2010}$ = 0.11), Bulgaria (0.089), Croatia (0.069), and Hungary (0.056), but also in the countries where changes in absolute terms were not so big: the Netherlands (0.09) and Belgium (0.088).

From comparisons of the previous studies, based on the data of the 2010 General Agricultural Census data (Bożek 2016), follows that structural changes in particular countries resulted in changes in both, the structure and composition of typological groups (Tables 5–6). Table 5 presents the composition of typological groups in 2010 and 2016, and Table 6 – the structure of the groups.

One country (Italy), moved from group I to group II due to structural changes. For this very reason, structural changes in group II between 2010 and 2016 are marginal and smaller than the structural changes of particular countries from this group would suggest (e.g. the average decrease in the percentage of holdings up to 5 ha in group II without Italy is: 5.5 pp., and after the inclusion of Italy: only 0.9 pp.). The second case of a change in group membership is the Netherlands, moving from group III to group IV, i.e. the countries with the most favourable farm structure.

Table 5. Membership of the EU countries in typological groups

| Groups | Group composition | |
|---|---|---|
| | 2010* | 2016 |
| I | Bulgaria, Cyprus, Greece, Portugal, Romania, Hungary, Italy | Bulgaria, Cyprus, Greece, Portugal, Romania, Hungary |
| II | Spain, Lithuania, Poland, Slovakia, Slovenia | Croatia, Spain, Lithuania, Poland, Slovakia, Slovenia, Italy |
| III | Austria, Estonia, Netherlands, Latvia | Austria, Estonia, Latvia |
| IV | Belgium, Czech Republic, Denmark, Finland, France, Ireland, Germany, Sweden, United Kingdom | Belgium, Czech Republic, Denmark, Finland, France, Ireland, Netherlands, Germany, Sweden, United Kingdom |

*The results for 2010 were compiled based on Bożek (2016)

Source: Own research

Table 6. Spatial structure of holdings in typological groups of EU countries in 2010 and 2016

| Groups | Year | Area of holdings in agricultural land (AL; %) | | | |
|---|---|---|---|---|---|
| | | up to 5 ha | 5–20 ha | 20–50 ha | ≥ 50 ha |
| I | 2010* | 83.8 | 11.5 | 2.8 | 1.9 |
| | 2016 | 82.4 | 12.0 | 3.1 | 2.5 |
| II | 2010 | 58.4 | 29.0 | 6.6 | 5.9 |
| | 2016 | 57.5 | 29.2 | 7.3 | 6.0 |
| III | 2010 | 32.0 | 38.8 | 18.3 | 11.0 |
| | 2016 | 32.6 | 39.3 | 16.4 | 11.6 |
| IV | 2010 | 13.3 | 33.0 | 25.5 | 28.2 |
| | 2016 | 12.3 | 33.4 | 25.3 | 29.0 |

*The results for 2010 were compiled based on Bożek J. (2016)

Source: Own research

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Table 7. Intergroup distances in 2010 and 2016

| Groups | 2010 | | | 2016 | | |
|---|---|---|---|---|---|---|
| | II | III | IV | II | III | IV |
| I | 0.2541 | 0.5189 | 0.7053 | 0.2487 | 0.4978 | 0.7010 |
| II | – | 0.2648 | 0.4512 | – | 0.2491 | 0.4523 |
| III | – | – | 0.2444 | – | – | 0.2620 |

Source: Own calculations

In all typological groups there was a slight increase in the share of farms with an area of 5–20 ha and the largest farms with an area of at least 50 ha. Farm shares of 20–50 ha increased in groups I and II, while in other countries they fell. The percentage of up to 5 ha farms decreased in groups I, II and IV, and slightly increased in group III.

To analyse the direction of changes to the intergroup diversity (whether group structures are getting closer to each other or, to the contrary, the disproportions are growing), intergroup distances in 2010 and 2016 were calculated (Table 7).

In 2016, the structural distance is still large. The biggest difference is between groups I and IV: in 2010, the distance between them was 0.7053, while in 2016 it was 0.7010, which means that the sum of absolute values of differences in shares is as big as 140 pp.

In the studied period, the distances between group I and the remaining groups as well as between groups II and III slightly decreased, while the distances between groups III and IV as well as II and IV increased, which means that the structural differences deepened.

Even though the changes in countries with unfavourable spatial structure of holdings are more extreme, the changes taking place in countries where said structure is better mean that the distance between these two typological groups changes very slowly. This is confirmed by the values of coefficient of structure diversity between groups of countries with different structure, as well as other values, such as the percentage of the smallest holdings.

The analysis presented in the paper allowed for an objective grouping of units (countries) with a similar farm structure, as well as a synthetic picture of the diversity of the examined structure in EU countries, with a relatively minor loss of output information.

The changes presented in the number of farms in absolute and relative terms indicate the scale and direction of changes in countries according to their typological groups, and thus allow for trends in countries with a similar farm structure in the period considered to be captured.

## CONCLUSION

In 2016, the spatial structure in EU countries is very diverse. Four groups of countries can be distinguished: group I – Bulgaria, Cyprus, Greece, Portugal, Romania, and Hungary, with a predominance of holdings up to 5 ha (ca. 80% of all holdings in a given country) and a low percentage of holdings over 50 ha (2.5%); group II – Croatia, Spain, Lithuania, Poland, Slovakia, Slovenia, and Italy, with a lower fragmentation rate: on average, holdings of up to 5 ha constitute 58% of all holdings and all holdings over 20 ha constitute 13%; group III – Austria, Estonia, and Latvia, where 1/3 of all holdings are holdings up to 5 ha, and holdings between 20 and 50 ha and over 50 ha constitute 16.4% and 11.6%, respectively; and group IV with the best structure, including the majority of the "old" EU countries – Belgium, the Czech Republic, Denmark, Finland, France, Ireland, the Netherlands, Germany, Sweden, and the United Kingdom, in which holdings of at least 50 ha constitute 30% of all holdings on average, and holdings up to 5 ha only 12%.

Between 2010 and 2016, the number of holdings decreased in the entire EU due mostly to the disappearance of the smallest ones (up to 5 ha). The greatest decrease in the number of holdings up to 5 ha was observed in the countries from groups I and II, where the agriculture fragmentation is the biggest, which positively affected their structure. In these countries, the share of the smallest holdings (up to 5 ha) decreased and the share of the largest holdings (at least 50 ha) increased.

The observed division into four groups is well established – between 2010 and 2016, only two countries moved from one group to another, which means that the direction and pace of changes is similar in countries belonging to the same group. In the studied period, the composition of the group characterised by the highest degree of household fragmentation changed: in 2016, Italy had already moved to a group with a lesser degree of fragmentation due to structural changes.

The structural distance between the typological groups is very large, as it did not change much between

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2010 and 2016 in several directions. Even though the changes in countries with unfavourable spatial structure of holdings are more extreme, the changes taking place in countries where said structure is better mean that the distance between these two typological groups did not change significantly.

The observed changes in the number of holdings in the EU between 2010 and 2016 were quite big, but they did not result in a significant reduction in distance between the most fragmented countries and the leading EU countries.

This type of research, based on data analysis of EU farms, farmland, and structural trends, can be useful for: *i*) future comparative studies; and *ii*) decision makers on the EU policy level, and national authorities as well, increasing the chances for needed Common Agricultural Policy amendments. All decisions regarding Common Agricultural Policy (CAP), considering the 9.7 million people employed in agriculture, have long-lasting implications, both economic and social, for all EU communities.

## REFERENCES

Bożek J. (2016): Transformation of agrarian structure of EU countries within the period of 2010–2013. Acta Scientiarum Polonorum. Oeconomia, 15: 15–25.

Bożek J., Bożek B. (2011): Typology of agrarian structure of voivodships in dynamic aspect according to fuzzy classification (Typologia struktury agrarnej województw w ujęciu dynamicznym z zastosowaniem klasyfikacji rozmytej). Metody Ilościowe w Badaniach Ekonomicznych, XII : 91–100. (in Polish)

Bożek J., Sin A., Nowak Cz., Kukuła K. (2018): Types of EU countries agrarian structure, based on fuzzy structure classification. Romanian Agricultural Research Journal, 35: 1–9.

Czyżewski B., Smędzik-Ambroży K. (2017): The regional structure of the CAP subsidies and the factor productivity in agriculture in the EU 28. Agricultural Economics – Czech, 63: 149–163.

Eurostat (2013): Agricultural Census 2010 – Main Results. Available at https://ec.europa.eu/eurostat/ (accessed May 22, 2019).

Eurostat (2019): Farm Structure Survey 2016 – Main Results. Available at https://ec.europa.eu/eurostat/ (accessed May 22, 2019).

Guiomar N., Godinho S., Pinto-Correia T., Almeida M., Bartolini F., Bezák P., Biró M., Bjørkhaug H., Bojnec Š., Brunori G., Corazzin M., Czekaj M., Davidova S., Kania J., Kristensen S., Marraccini E., Molnár Zs., Niedermayr J., O'Rourke E., Ortiz-Miranda D., Redman M., Sipiläinenq T., Soovälil-Seppingr H., Šūmanes S., Surová D., Sutherland L.A., Tcherkezova E., Tisenkopfs T., Tsiligiridis T., Tudor M.M., Wagner K., Wästfelt A. (2018): Typology and Distribution of Small Farms in Europe: Towards a Better Picture. Amsterdam, the Netherlands, Elsevier Ltd., 75: 784–798.

Hampl F. (2020): A statistical analysis of the financial performance of organic and conventional farms in the Czech Republic with respect to their size. Agricultural Economics – Czech, 66: 1–9.

Homolac L., Tomsik K. (2016): Historical development of land ownership in the Czech Republic since the foundation of the Czechoslovakia until present. Agricultural Economics – Czech, 62: 528–536.

Jajuga K. (1984): Fuzzy sets in the issue of classification (Zbiory rozmyte w zagadnieniu klasyfikacji). Przegląd Statystyczny, 3: 237–290. (in Polish)

Janovska V., Simova P., Vlasak J., Sklenicka P. (2017): Factors affecting farm size on the European level and the national level of the Czech Republic. Agricultural Economics – Czech, 63: 1–12.

Kukuła K. (1989): Statistical structural analysis and its application in the sphere of production services for agriculture (Statystyczna analiza strukturalna i jej zastosowanie w sferze usług produkcyjnych dla rolnictwa). Zeszyty Naukowe AE w Krakowie, special series "Monografie": 89. (in Polish)

Popescu A., Alecu I.N., Dinu T.A., Stoian E., Condei R., Ciocan H. (2016): Farm structure and land concentration in Romania and the European Union's agriculture. Agriculture and Agricultural Science Procedia, 10: 566–577.

Savickienė J., Miceikienė A. (2018): Sustainable economic development assessment model for family farms. Agricultural Economics – Czech, 64: 527–535.

Smutka L., Maitah M., Svatoš M. (2018): Changes in the Czech agrarian foreign trade competitiveness – different groups of partners' specifics. Agricultural Economics – Czech, 64: 399–411.

Smutka L., Maitah M., Svatos M. (2019): The Czech agrarian trade comparative advantages distribution based on value and volume approach. Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis, 67: 1613–1625.

Szabo L., Grznar M., Zelina M. (2018): Agricultural performance in the V4 countries and its position in the European Union. Agricultural Economics – Czech, 64: 337–346.

Zadeh L.A. (1965): Fuzzy sets. Information and Control, 8: 338–353.

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