doi: 10.17221/237/2015-AGRICECON

The land use structure of agricultural holdings in the Central and East European Countries and its evolution

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Strojny J., Piecuch J. (2017): **The land use structure of agricultural holdings in the Central and East European Countries and its evolution**. Agric. Econ. – Czech, 63: 13–23.

Abstract: The taxonomy of agricultural holdings' land use structure of the CEEC countries that are the EU members aims to investigate the diversity of this phenomenon and its evolution in 2005–2010. In order to establish homogenous clusters of land use, a structural taxonomy technique called the vectors elimination method was employed. The research outcome was the split of the entire data set into 5 subgroups characterizing more homogenous land use structures. Migrations of countries between the taxonomic subgroups over time were determined by the character of the transformation of the land use structure.

Keywords: agricultural land, vectors elimination method, CEEC countries

The enlargements of the European Union to the East in 2004, 2007, and 2013 generated a situation when approximately 90% of the European Union territory is covered by rural areas and over a half of the EU population lives there. It means that even today, in the second decade of the 21st century, agriculture is still an important sector of the economy, and rural development amplified by the Common Agriculture Policy still plays an important role in every European country, especially in its Central and Eastern part. The majority of countries located in the Central and Eastern part of Europe can be described as less developed economies with a strong dependence on agricultural production. The position of those countries is somehow underprivileged due to their peripheral location and the distance to the main European markets.

Despite all the funding and efforts which have been undertaken in the recent years, small-scale and low-tech agriculture still prevails in this part of Europe and suffers from a lack of many natural resources, capital, and knowledge. As a result, the dominant traditional agriculture is still not adapted to market conditions imposed by the common market. Nonetheless, many positive changes can be observed in the agriculture of New Member States. In the recent years, we have witnessed, among others, a spectacular decrease in the contribution of the agricultural sector to the total employment. Along with the decrease of employment, the contribution of the primary sector to the total value added has changed significantly over the last decade. Both changes led to a major improvement of the agricultural production in terms of efficiency.

The amount of the EU workers employed in agriculture rose to over 12 million in 2010 (5.4% of labour force in the EU-27). The increase in the figures for 2010 was due to the accession of Bulgaria, the Czech Republic, Estonia, Latvia, Lithuania, Hungary, Poland, Romania, Slovenia, and Slovakia. But if we only take into account changes in the situation of the New Member States, the number of jobs in the agricultural sector is declining progressively. This is the most important and ongoing trend, related to the global economic developments and previously observable in all advanced economies. The decrease in agricultural employment influences all Member States but in particular the countries with the highest participation of workplaces in farming.

One of the crucial structural changes observed in the primary sector is the growing size of agricultural holdings in the Central and Eastern part of the European Union as an effect of the land consolidation process

doi: 10.17221/237/2015-AGRICECON

(Pašakarnis et al. 2010). During the last decade, a steady increase in the number of farms with a large utilized agricultural area (UAA) can be observed. But still there were evident differences in the structure of agriculture across the EU. There were 12 million agricultural holdings across the European Union in 2010 working 175.8 million haof land (40.0% of the total land area of the EU). The average size of one farm in the EU28 was almost 14.4 ha in comparison to 7.3 when analysing the 11 Central and Eastern countries (approximately 6.8 million farms). On the one hand, in 2010 in all EU countries, there was a large number (5.8 million) of very small farms with less than 2 ha in size and less than 2.5% of the total land area that was used for farming (Martins et al. 2010). On the other hand, there was a small number (2.7% of all holdings) of very large farms with over 100 ha of UAA that farmed half of the farmland. These differences are even larger among the EU 11 countries, where very large agricultural holdings (0.8% of the total number of farms) used approximately 49% of UAA.

Almost 57% (6.8 million) of all agricultural holdings were located in the analysed eleven countries and more than 58% of them were smaller than 2 ha of UAA. The worst situation can be observed in Bulgaria and Romania, where the ownership of agricultural land is highly fragmented (Popesku et al. 2011; hartvigsen 2014). Approximately three quarters of holdings in both countries were under 2 ha in size in 2010. At the other end of the size scale was the Czech Republic, with only 8.8% of agricultural holding less than 2 ha of UAA. Positive changes in the Czech Republic were connected with the gradual adaptation to the system of market regulation in the EU (Štolbová and Míčová 2012; Lososová and Zdeněk 2013).

The distribution of the UAA between large and small agricultural holdings in this part of Europe varies significantly among countries, but in general, a relatively small number of holdings occupies a high percentage of the agricultural area. The best example is Slovakia, the Czech Republic and Bulgaria where more than 80% of UAA belongs to the largest holdings (100 ha of UAA and more).

In 2010, more than 1.5 million agricultural holdings were recorded in Poland. The number of holdings has decreased significantly in comparison to 2005 (by almost 1 million) and in the analysed year, less than 1% had the size of at least 100 ha of UAA (approximately 10 thousand). All agricultural holdings in Poland occupied a little less than 14.5 million ha of the utilized agricultural area, while holdings larger than 100 ha of UAA occupied almost 3.2 million ha of UAA (21.6%, 4.2 percentage growth compared to 2005). The average physical body farm size in Poland amounted to 9.6 ha of UAA (compared to 6 ha in 2005). In 2010, less than 24% farms had less than 5 ha of UAA.

The agrarian structure depends not only on the character of agricultural development but on the access to different recourses, as well. Land use structures may vary substantially over time. To expand on this point, the land use structures of the Central and Eastern European counties and its evolvement in the period of 2005-2010 were examined.

THEORETICAL BACKGROUND

The theory of structures and its different aspects could be find in many research areas. In the broad sense, the theory of structures is a field of applied engineering that deals with the methods of analysis of different types of structures subjected to various external exposures. The analysis of a structure characteristics in engineering implies its examination from the perspective of its strength, stability, stiffness, and vibration. Some general and abstract ideas of the structural analysis performed in the field of engineering could be extended (not directly) into area of economic research. An examination of literature discloses that the concept of structure in the discipline of economics is recognized in a variety of ways. Economic structure is the elementary set of interaction among market operators forming the basic framework for economic activities. One may conclude that most economic processes are the result of the underlying economic structure – which case relates both to their outcome as well as to the cause. Interdependence among economic magnitudes brings about the after-effects adequate for a particular type of structure and produces the outcome which is to be expected for a specific underlying network of relationship. Generally, within a certain scheme of relationships which is appropriate for a structure in question, interactions among economic units tend to impose a specific pattern of the aggregate behaviour.

The concept of economic structure has been used to shape and verify the theory in a number of ways. Theories based on the exchange model focused on the resources allocation and the problem of the individual's decisions' rationality. This perception of economic structures focuses on the role of the struc-

doi: 10.17221/237/2015-AGRICECON

tural framework in providing congruous restrictions on the individuals' behaviour that lead to specific social effects and it refers to the identification of the interaction and communication scheme among economic units (Kirman 1989). On the other hand, theories invoking the production model (theories based on the technical relation of magnitudes) dealt principally with the relationship of the objective stock-flow. The role of the structural construction in these terms is to endow with a framework in which the mutual compatibility of objective conditions shaping action are perceived to be independent of the individual objective functions.

The structural economic analysis could be linked to the conceptual foundations of economic theory. On the other hand, that issue may be a subject of the factual analysis of a particular economic system. However, it has to be noted that the analysis of certain economic systems significantly depends on the type of the structural specification assumed. An immanent attribute of the economic change is its impact on evolution of the corresponding economic structure. So, the patterns of economic structure transformation, the mutual interdependence within economic structure and the attempts of their assessment are an important aspect of the economic systems research. The identification of the economic structure is very important for establishing a connection between the economic theory and the analysis based on real facts. Economists are concerned with the issue of the structural change to capture economic fundamentals by the search for readily interpretable models that enable to tackle the issue of shocks occurring to the economic system. Usually, the variability of structures is influential and causes difficulties of the economic planning process.

Some authors perceive structure as the network of interpersonal interactions on which a particular economic system is based (Baranzini and Scazzieri 1986). An economic analysis of so defined structure is focused on the description of the social rules and believes within the considered sphere of social life. An instance of the interaction between interpersonal reactions provides the emergence of market laws. Furthermore, a specialized set of legal arrangements substituted the general rules. This process led to the institutionalized system of rules that created the framework for economic action. However, following the Keynes' view that one may substitute market laws by the direct economic policy (in some circumstances), the economic structure does not provide a system of ruling that entirely regulates the economic activity. Defining the concept of economic structure, the authors suggest a reconsideration of the role of models called as 'pure-exchange' and 'pure-production' in the construction of economic theory.

The relationship between fundamental properties concerning the structure and its institutional assumptions was elucidated by Pasinetti (1965, 1983). The author in the formulation of the economic structure theory and structural evolution denoted the fact that relationships within the system under consideration may be stated in the terms of objective efficiency (for example, the relationship between the productivity rise, investment, price level, wage rate) or in the natural terms (for example, the interdependences among industry branches). Pasinetti defined as well the determinants of the natural dynamic path in the context of structural changes as full employment and full capacity utilization. These postulates could be applied only if there are satisfied the conditions of the new sectorial investment reflecting the evolving structure of the capital accumulation and effective macroeconomic demand.

Additionally, there is an approach to structural analysis going beyond the proportional dynamics proposed by Pasinetti (1993). In the authors' opinion, this involves remaining with a model which is in contrast with the long-run evolution of industrial systems. According to the idea, to achieve the reality of economic systems requires to abandon the 'artificial hypothesis of proportional dynamics'. On the other hand, the consistency of the methodology entails the necessity to introduce into economic analysis the phenomenon of the individual and social learning which is labelled with the term 'technical progress'. The Japans' network structures and their impact on the economy chronic travails were assessed by Lincoln and Gerlach (2004). The authors pointed out that the network structures playing previously a useful role in economic development have outlived their usefulness as the rules of the economic play have changed fundamentally. A kind of dynamic analysis of the structure of Korean economy was performed by España (1991). A different conception of the economic structure emerges from the research paper of the authors who stress the importance of portraying economic systems in a quantitative way by measuring their crucial characteristics. magnitudes. In the economics, the concept structure and its analysis has been widely employed as the study of the main factors constituting an economic system. In the economic

doi: 10.17221/237/2015-AGRICECON

literature, there was extensively presented the issue of the portrayal and evolution of economic sectors, according to the contribution to GDP and impact on employment.

A prominent place in the economic literature occupies the kind of structural analysis extensively used in the empirical countrywide studies which is known as the input-output research. The concept is based on the assumption that the exchange relations among economy sectors are mirrored in an input-output table. The input-output model enabled a descriptive analysis of the final macroeconomic variables, for example consumption, imports and employment. Additionally, the analysis allowed to quantify the effects of the changes in production on the stated above macroeconomic factors. Leontief, describing American economy at the national level with regard to a flow of the inter-industry applied this kind of the economic structure conceptualization (Leontief 1951). The essence of the Leontief Input-Output analysis is the estimation of the quantities of commodities that each economy sector receives from other sectors and in turn the amount of commodities that are provided for the other sectors. Kantorovich (1965) pointed out that although the inter-sectoral relation represents the technology characteristics, it is suitable for featuring the economic structure properties when describing it in the value form. The scope of the Leontief concept of the economic structure was widened by the subsequent authors and in particular by Stone's (Stone 1956) final consumption structure tie-in with income levels. As an example of modelling used to identify the crucial structural change in economy, there could be quoted the case of the Philips curve concept, as well.

An innovative aspect structural analysis points out the study of Baranzini et al. (2015). The research is directed towards the role of resources as the cause of structural change. The book suggests to reconsider the problem of the scarcity of resources and to evaluate it in terms of bottlenecks and opportunities characterizing the production systems. The assessment of the different aspects of the concept of the economic structure, especially the economic structure as a frame for the existing institutional arrangements and their pattern of transformation was the subject of Baranzini and Scazzieri (2012) study. Furthermore, the authors point out that the specification of the economic structure is a critical phase in building and verifying the economic theory. The structural analysis approach to the study of the structure and evolution of regional productive systems was presented by Garcia (2006). The research method corresponds to the social network analysis, to examine the productive systems to highlight its relational aspect proposing specific measures to value the relationships taking place in a particular system. With the main characteristic of the data, the input-output analysis was joined. Cooper et al. (2007) the raised issues of regional policy which need to be addressed in the increasingly progressive globalization. The research suggested a major shift from the geographically identifiable regions to the coordinated policy in the overlapping regional structures.

In order to achieve more complete understanding of economic systems, the researchers employ models that can approximate the processes under investigation. The intention of such modelling process is capturing of the crucial dimensions of structural relationships with the constant structure. Models based on the unstable, frequently evolving structure are inadequate in description of the economic systems. An analysis of the structural variability requires a quantitative methodology adjusted to the presuppositions of the structural analysis. Regardless of the evolutionary or fierce character of the change, it is intended to accommodate adjustments in the model. On one hand, the models appealing to the non- stationary data tend to fail in the predictive capacity but on the other hand, these models failures may reveal the essential structural changes within the economy. The assumption of invariance in the analysis of an economic structure usually entails unacceptable oversimplifications. Generally, structural studies employ econometric methods and descriptive statistics without using a specific method for the analysis of structural relationships.

The role of statistics in the detection of structural change was analysed by Anderson and Mizon (1989). The authors argued that statistical tests for the hypothesis of structural stability could underline the econometric models evaluation. They considered the discrimination of methods between these models and provided a typology of models incorporating the structural change. According to Gilbert (1986), the process of scientific discovery cannot be automated because of its innovative character. However, the value of a model could be assessed as a result of the evaluation procedure, without regard to the route in its discovery. In the econometric modelling primarily, the economists are trying to build models that are befitted when the data and are trustworthy. The usefulness of an econometric model describing

doi: 10.17221/237/2015-AGRICECON

the structural change is assessed by a scrupulous model evaluation. Such models should be congruent with the theory and rival models (Hendry and Richard 1990). Since the structural change is usually recorded in time series in nature, it was represented in the framework of parametric models for numerous researchers. Westlund and Törnkvist (1989) were incorporating a numerical simulation and the theoretical study demonstrated that the identification of time for structural changes is more labyrinthine in the event of progressive changes, and when the changes occur on the early stage of the time series. They suggest that a way to represent a structural change within the modelled economic system is to enable for the parameter adjustment.

Recent works in the field of economics emphasize the necessity of binding together the observed facts and their theoretical explanation. This involves the theory dependence on the real data and the linkage between the theoretical and descriptive schemes, accommodating the fact that the description is predicated on a certain degree of simplification of the economic system considered. The economic theory may be regarded as the representation of relations among the economic units which are for example the basic technology stages, production practices and consumption behaviours. Production processes and consumption events are linked to each other. In most cases, the consumption acts are the natural prerequisites of the production procedure. Generally, the commodities' production is the forerun for the production of other goods that become inputs in the subsequent stages for other operations. This interdependence introduces a pattern of integration to the economy.

The economic structure framework explanation could particularly contribute for the dynamic analysis. The process of economic change is followed by the transformation of the economic structure as the reaction to structural interrelations among the system magnitudes and may be named as the dynamics of the structure. In line with the Poirier's (1976) designation, the hypothesis of structural change is associated with the structural variability that the frequency is low but the change is of a considerable magnitude. Westlund and Zackrisson (1986) also share the Poirier's opinion of the character of structural variability. Although the concept of the economic structure evolution and its relation to economic change is of a critical importance for the economic dynamic research, this issue has been relatively seldom evaluated in the terms of economic theory. In contradiction to the physical world in the case of economics, the qualitative change of structure magnitudes rather than motion in the sense of the Newtonian dynamics is the determinant of the dynamic pattern of the processes evolution. So, an important feature of the dynamic economic systems is an accompanying pattern of structural change. No theory of economic dynamics should overlook the analytical representation of the production technology known as the input-output model, because the goods are produced from other goods by the accomplished production processes.

The fascination by structural change has a long history in economics. This analytical platform was treated as a device for analysing the ways of introduction and supporting the sustainable growth in the economy. By investigating the stimulants to growth, the economists hope to control the evolution of the structural change. Despite the fact that the major changes in economy were called 'revolutionary', the long-run data analysis portrays them as being gradual evolutions. In order to accommodate structural changes in the economic modelling, the identification of epochs associated with each structure should determine the modelling of alteration between distinguished periods.

Lin (2012) covers probably the most intriguing topic for the economists – the issue of the quest for sustainable growth. The author suggests to explore the nature and determinants of economic growth by learning from the sparse success of development cases and the failed development attempts, as well. This led Lin to bring the concept of the structural change back to the centre of development studies. He presented the 'New Structural Economics' as an attempt of the conceptualization of the interrelationship between the roles of the market and the state in the process of economic growth inducing. Lin's approach assumes that 'the economic structure of an economy is endogenous to its factor endowment structure' and that the growth process is accelerated by the technological innovation and changes over time in factor endowments. According to the theory, the best way to modernize the endowment structure of an economic system is to develop industries based on the comparative advantage derived from the given endowment structure at any specific time. Lin's observations are supported by the Kuznets (1966) conclusions that the sustained economic growth is implicitly linked to structural changes and the countries that were abortive in their development programs have failed to bring about the structural transformation. Basu (1990) provided review of the

doi: 10.17221/237/2015-AGRICECON

impact of the agrarian economic relations on the economic progress. In the monograph, a special attention was given to the structure of the property rights, the agrarian structure and its impact on the economic development.

The structural analysis was basis for the study of the structure and evolution of the land use structure of agricultural holdings in the Central and East European countries and its evolution in the period of 2005–2010. In order to investigate the diversity of the phenomenon and its change, the taxonomy of agricultural holdings' land use structure which is called the vectors elimination method was employed. The research method enabled the split of the entire data into more homogenous subgroups of the structure under consideration. The transformation of the land use structure was detected as migrations of the data records (representing countries' structures) between the taxonomic subgroups. The application of the vectors elimination method in this structural study comes for a limited use in the literature of the relational analysis to study structural relationships and the dynamics of those relationships.

MATERIAL AND METHODS

The statistical assessment of the similarity of structures

The vector elimination method could be used for the partition of the particular groups of objects into sub-groups characterizing similar structures. Such partition makes an analysis of the diversification of various structures possible. The extent of structural diversifications is a criterion of the homogeneity of objects in such reflections (Kukuła 1989). Each of the objects under investigation is described by its structure. The objects subjected the investigation are characterized by the same kind of structural data. The comparisons between objects are executed by the means of "every object with each other". A particular object is defined as the structure of exports of any individual country in a specific year. Initially, the statistical data were gathered in hectares.

The typology of the composition of the CEEC countries land use structure was based on the coefficients of contribution of every considered product group in the country total exports in a particular period. The designation of objects to homogeneous subgroups on the basis of the compared structure was conducted according to the procedure presented in the study by Bogocz et al. (2010). Methods of the taxonomic study of structures are widely discussed in this publication. Moreover, the management on every stage of the taxonomic study was introduced in the theoretical chapter.

In the taxonomic analysis, a measure of the lack of similarity (P_{ij}) takes the form:

$$P_{ij} = 1 - \sum_{k=1}^{r} \min(p_{ik}, p_{jk}) \quad (1)$$

where:

i, j = numbers of objects,

p_{ik} = contribution of the *k-th* component to the *i-th* object structure,

p_{jk} = contribution of the *k-th* component to the *j-th* object structure.

The formula defined above produces a value (P_{ij}) in the interval <0. 1>. If the compared structures were exactly the same, the measure $P_{ij} = 0$; on the other hand, when they were completely different, $P_{ij} = 1$.

The grouping process employing the vector elimination method is decisively determined by the threshold value of the inter-variation of structures $\alpha \in (0.\ 1)$. The most favourable value of a results in the apportionment of the original data set into subgroups that satisfy the condition of an appropriate balance for the internal coherence and the between-groups disparity. In the analysis of the EU countries' agricultural export structure, the α coefficient was set down based on the empirical data – it was estimated as the arithmetical average from the matrix of the structural differentiation. Therefore, the threshold value of the distance between similar groups was estimated as $\alpha = 0.3668056073$. Pairs of objects characterized by the level of diversification below the threshold value were classified into the same subgroup.

The taxonomic analysis of structures

Knowledge is currently recognised as one of the most important factors which accelerate the economic growth. On the other hand, the economic development entails the necessity of in-depth knowledge about correlations between the components of the economic process (Barna 1967).

The process of economic growth is a non-homogeneous phenomenon. Studies of economic growth, focusing on the essence of development, emphasise its complexity. Studies on structural changes that

doi: 10.17221/237/2015-AGRICECON

accompany the growth process enable us to understand it in a greater depth. In part, such knowledge explains why some economies flourish while others lag behind Salvadori et al. 2009). The literature in the growth theory brings out the major impact of structural changes within an economy in the development process. The intensity of structural transformations is the most important attribute of the economic change. The changing role of the economic process components is an attribute of the economic development over time. Subsequently, relentless structural transformations are a succession of anterior changes of a system. This should result in the quantitative growth of a particular structure.

Structural transformation studies were conducted at the macroeconomic level, at the regional conceptualization or as a spatial research. In this context, we should point out such authors as: Linneman (1966), Carter (1970), Nelson and Winler (1982), Pasinetti (1983), Małuszyńska (1993), Nietupski (1996), Głębocki (1998) and Kukuła (2007). The theoretical aspects of the methodology of the structural analysis, especially the degree of the structural differentiation and grouping techniques on the grounds of structural homogeneity, were raised by Chomątowski and Sokołowski (1978), and Kukuła (1996). The characteristics of the dynamics of economic structure analysis methodology were considered by Kukuła (1975) and were reviewed in a piece of scholarship of Kukuła (1996). The review works listed above focus on the specific properties of the particular research techniques.

The essential applications of structural changes measures are typically:
– assessments of the structural dynamics,
– and the appraisal of structural differentiation between objects under investigation.

The actual analysis of the land use structure is based on the coefficients of structure – the percentage shares of categories investigated in the total number of agricultural holdings for every object (a particular country in a considered period). The analysis does not take into consideration the absolute values of this phenomenon. Thus, two hypothetical objects (p_{ik}, p_{jk}) defined as structures can be represented as vectors in k-dimensional space:

$$p_{ik} = \begin{bmatrix} p_{1k} \\ p_{2k} \\ \vdots \\ p_{rk} \end{bmatrix} \text{ and } p_{jk} = \begin{bmatrix} p_{1k} \\ p_{2k} \\ \vdots \\ p_{rk} \end{bmatrix} \quad (2)$$

The vectors constituents that are structural indicators satisfy the given conditions:

$$0 \le p_{ik} \le 1 \text{ and } 0 \le p_{jk} \le 1 \quad (3)$$

and

$$\sum_{i=1}^{r} p_{ik} = 1 \text{ and } \sum_{i=1}^{r} p_{jk} = 1 \quad (4)$$

The outcome of the structures p_{ik} and p_{jk} comparison is a value of the coherence indicator (a measure of similarity or dissimilarity). Both these measures yield identical information but should be interpreted inversely. The study carried out utilizes an idea, proposed by Chomątowski and Sokołowski (1978), to assess the degree of the diversification of the agricultural holdings land use structure and its evolution over time. The measure used in the study is represented by the formula:

$$P_{ij} = 1 - \sum_{k=1}^{r} \min(p_{ik}, p_{jk}) \quad (5)$$

where:
i, j = objects numbers
p_{ik} = contribution of the component k to the structure of the object i
p_{jk} = contribution of the component k to the structure of the object j

The scope of this measure is delimited to the range [0.1]. If the compared structures are identical, $P_{ij} = 0$, and if they are entirely different, $P_{ij} = 1$.

The empirical part of this paper focuses on the changes on the national level. The research was based on the analysis of reports prepared by the European Commission as well as national studies. Data collected or estimated by the National Statistics Institutes, the Directorate-General for Agriculture and the AMECO were used as well. The study of the land use structure of agricultural holdings in the Central and East European Countries and its evolution in 2005–2010 is based on the EUROSTAT statistical data. The EU Member States collect information from the individual agricultural holdings and all data are forwarded subsequently to the EUROSTAT office. The information related to the farm structure survey covers – among others – the land use structure. The basic unit underlying the farm structure survey is the agricultural holding: a technical-economic unit under single management, engaged in agricultural production. Although the thresholds for defining the agricultural holding can be different between the countries, the methodology implemented by the EUROSTAT aims to adjust the

doi: 10.17221/237/2015-AGRICECON

national statistical offices data and covers not less than 98% of the UAA and the livestock of each country. In this context, all data for different years in all EU member states are comparable and may be used in the taxonomic analysis of structures even though in a particular country, the data is used regarding the separate domestic methodology. The original data provided by the source database comprised the number of farms in eight area categories. Farm sizes which were considered are defined as follows: less than 2 ha, 2–4.9 ha, 5–9.9 ha, 10–19.9 ha, 20–29.9 ha, 30–49.9 ha, 50–99.9 ha, and above 100 ha. Three time periods were considered, namely: 2005, 2007, and 2010. The absolute data (the number of farms in a particular area class) were transformed into relative values. For the first period (2005), the number of holdings in Croatia was not published. Consequently, there were 32 (11 countries, 3 time periods, 1 country data unavailable for one period) objects – land use structures – available for the analysis.

RESULTS AND DISCUSSION

The results of the classification of the complete data set are presented in Table 1. The fundamental basic property of the vector elimination method is that the grouping process yields relatively few subgroups containing numerous objects (the significant percentage of the considered dataset), and on the other hand, a fairy prolific number of subgroups including not many observations – occasionally a single object. In order to maintain this proper character of the taxonomic technique, five clusters emerged. The distribution of the objects in subgroups was extremely differentiated (Table 1). The first cluster contained 46.9% observations and the two most numerous groups consisted of 84.4% of the total number of cases under investigation. The third cluster was considerably less numerous (9.4% of all objects) out of the structures classified. The two smallest subgroups contained solely an individual data record.

Table 2 contains the characteristics of agricultural holdings in the subgroups established by the means of the vector elimination method. The data listed in Table 2 show the values in respective subgroups. The most numerous cluster (No. 1) could be named as comprising the most typical land use structure (Table 2). It is characterized by 20.5–27.0% mean percentage of farms below 10 ha. The class 10–19.9 ha makes up 13.7% of the researched structures. In this subgroup, farms above 20 ha hold only 15.0% of agricultural land. Very close parallels occur between cluster one and cluster three. These two structures are approximate except for the category less than 2 ha. Especially in the third cluster, there are relatively more holdings below 2 ha. Generally, in subgroup No. 3 overweight smaller farms than occur in the most numerous cluster No. 1. The sizeable cluster No. 2 is dominated by small farms – below 2 ha (75.5%). The category 2–4.9 ha makes up the only remaining significant share (13.6%). Farms bigger than 5 ha add up to 10.8% of the total agricultural land in this subgroup. Cluster No. 4 stands out from the population under investigation with regard to 40.8% of agricultural holdings with the area of 2–4.9 ha. The specificity of the fifth subgroup is determined by the two-thirds participation of farms above 10 ha.

The highest variation of structural indicators occurs in the most numerous clusters (Table 2). However,

Table 1. Countries' taxonomic group affiliation and its evolution

Group number	Group frequency	Taxonomic group affiliation			
1	15	CZ'05, CZ'07 EE'05, EE'07 EE'10	LT'10 LV'05, LV'07 LV'10	PL'07, PL'10 SI'05, SI'07 SI'10	SK'10
2	12	BG'05, BG'07 BG'10	HR'10 HU'05, HU'07	HU'10 RO'05, RO'07,	RO'10 SK'05, SK'07
3	3	HR'07	LT'07	PL'05	
4	1	LT'05			
5	1	CZ'10			

Symbol indicates a particular country; 'number indicates a respective year

Countries' symbols: Bulgaria – BG, Czech Republic – CZ, Estonia – EE, Croatia – HR, Latvia – LV, Lithuania – LT, Hungary – HU, Poland – PL, Romania – RO, Slovenia – SI, Slovakia – SK

Source: own calculations based on the EUROSTAT 2014 data

doi: 10.17221/237/2015-AGRICECON

Table 2. Characteristics of taxonomic groups of the CEES countries – the mean land use structure of agricultural holdings in the emerged groups (Mean, *V* – coefficient of variation)

Agricultural holding area (ha)	Group										Total	
	1		2		3		4		5			
	mean	*V*	mean	*V*	mean	*V*	mean	*V*	mean	*V*	mean	*V*
Less than 2	0.2369	41.5	0.7556	13.5	0.3761	54.9	0.1046	.	0.0877	.	0.4357	63.8
2–4.9	0.2704	26.7	0.1364	53.5	0.3159	42.2	0.4089	.	0.0558	.	0.2220	49.8
5–9.9	0.2045	26.3	0.0506	60.3	0.1622	21.5	0.2605	.	0.1851	.	0.1440	59.7
10–19.9	0.1378	30.3	0.0236	59.3	0.0881	27.8	0.1433	.	0.1749	.	0.0917	69.2
20–29.9	0.0467	39.6	0.0081	66.7	0.0255	28.6	0.0357	.	0.0912	.	0.0313	78.9
30–49.9	0.0355	51.8	0.0073	67.1	0.0161	41.0	0.0236	.	0.1023	.	0.0248	93.5
50–99.9	0.0276	70.7	0.0067	61.2	0.0098	64.3	0.0136	.	0.1072	.	0.0201	114.9
Above 100	0.0406	100.7	0.0117	86.3	0.0064	89.1	0.0098	.	0.1957	.	0.0304	144.7

Source: own calculations based on the EUROSTAT 2014 data

factoring in variation within the area categories, the percentages of farms greater than 30 ha are the most differentiated. On the other hand, the lowest variation of the measure mentioned above was noticed in the holdings of the agricultural area in the range of 2–10 ha.

The land use structure classification has two different aspects: static and dynamic. The static analysis encompasses the cross-sectional character of the phenomenon. Such clustering is conducted within one period of time. Grouping objects at different time periods introduces a dynamic perspective to the study. A particular country's taxonomic group membership tracing enables us to uncover this country land use structure evolution.

- If a country cluster memberships are constant over time, there is no structure evolution.
- If a country cluster memberships over time do not point to a continued structure transformation, there is no structure evolution and the share changes are activated by changing reasons.
- If a country cluster memberships over time portrays the same direction of the structure transformation, unchangeable inducements cause the structure evolution.

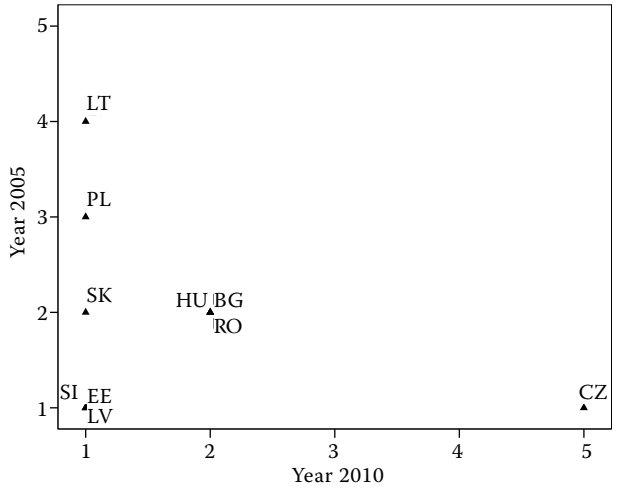

Figure 1. Dynamics of land use structure of agricultural holdings (groups' membership shift in the period of 2005–2010)

Countries' symbols: Bulgaria – BG, Czech Republic – CZ, Estonia – EE, Croatia – HR, Latvia – LV, Lithuania – LT, Hungary – HU, Poland – PL, Romania – RO, Slovenia – SI, Slovakia – SK

Source: own calculations based on EUROSTAT 2014 data

The problem of the land use structure evolution is outlined in Figure 1. Cluster memberships of the countries under investigation in 2005 and 2010 (the first and last year of the study) are shown there. The vertical axis provides information regarding the membership in the first period. On the other hand, the result of a structure transformation is bounded to the horizontal axis. The countries as follows: Slovenia, Estonia, Latvia (cluster Nr 1) as well as Hungary, Bulgaria, and Romania (cluster No. 2) are placed on the main diagonal because of the stable land use structure. Structures of the remaining countries have changed. This is reflected in the location along one of the main axis.

Additionally, Table 1 gives us the insight into the intermediate state of the respective structures. For example, the Lithuania's shift from cluster No. 4 to cluster No. 1 is attributable to the declining share of farms with the area of 2–4.9 ha. The reallocation of Slovakia from cluster No. 2 to cluster No. 1 should

doi: 10.17221/237/2015-AGRICECON

be assigned to a reduced number of agricultural holdings below 2 ha over the period of the study. The rearrangement of the Polish position from cluster No 3 to cluster No 1 arises from a reduction of the percentage of farms below 5 ha. The shift of the Czech Republic to cluster No. 5 occurred because of the significant growth of the share of farms with more than 20 ha (from 25.5 to 49.1 of the total number of holdings) in the period of 2005–2010. However, due to change of the definition of the farm for the statistical purposes in the Czech Republic (in 2005 and 2007 the threshold of 1 ha; in 2010 the threshold of 5 ha UAA or less for holdings with animal or some special crop production), the number of agricultural holdings decreased from 42 250 farms in 2005 to 22 860 holdings in the year 2010. In this context, the statistical detection of the significant change of the land use structure in the Czech Republic could be perceived mostly as the outcome of the statistical data redefinition, whereas the real processes evolved relatively slowly and otherwise.

CONCLUSIONS

The study aimed to investigate the diversification and dynamics of the CEEC countries' agricultural holdings land use structure. The statistical technique employed, the vector elimination method, tends to produce clusters with differentiated numbers of objects. The statistical analysis outcome was the split of the data set into 5 subgroups characterizing more homogenous land use structures. The most numerous clusters lumped the most typical structures. Distinct structures went to single subgroups.

The classification of agricultural land use structure allows to keep track of two aspects of the phenomenon: the state of the observable facts at a particular point in time, and its transformation over time. Grouping objects at the consecutive, subsequent time points enables us to trace the dynamics of the structures under investigation. The land use structure evolution of a particular country is reflected in the migrations between the taxonomic subgroups over time.

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Received on August 5, 2015
Accepted on November 18, 2015
Published online on October 11. 2016