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## **MULTIDIMENSIONAL COMPARATIVE ANALYSIS OF OTHER GAINFUL ACTIVITIES OF AGRICULTURAL HOLDINGS IN EU COUNTRIES**

### **Summary**

Over the past few years, diversification and pluriactivity of farmers and farming households has been increasing in EU-27 countries. But the type of diversification activity encouraged, as well as their scale, appears to be very different across the EU.

Therefore the analysis of spatial diversification of other gainful activity of farm households in EU countries is the main purpose of this paper. 27 UE countries described with 9 variables relating to the non-agricultural activity of farms are the analysed objects.

The carried survey helps to show spatial disparities and to discriminate groups of countries with a similar farmer's non-agricultural activity.

There were used chosen methods of multidimensional comparative analysis which enable clustering the multicriterial objects: Czekanowski's diagram, Ward's method, and *k*-mean algorithm.

As a final result there were formed 5 clusters with countries about similar level of farm diversification. It may be stated, that a development of diversification of agricultural holdings is correlated with a spatial arrangement. Neighbouring countries belong to the same clusters of other gainful activity kinds.

**Key words:** Multidimensional comparative analysis, other gainful activity (OGA), diversification of farm activities

### **INTRODUCTION**

Diversification, pluriactivity and multifunctionality are promoted by agricultural policies as possible survival strategies for farmers. In the literature, diversification has been extensively studied and presented as a possible solution for extending the farming income basis [Meert *et al*, 2005].

One option to generate a non-agricultural income for farming household is to set up diversification activities on the farm. Diversity of agricultural production patterns should be understood as the outcome of external as well as internal to the farm family forces [Whatmore *et al.* 1987, Daskalopoulou and Petrou, 2002].

It can be defined as the creation of any gainful activities that do not comprise any farm work but are directly related to the holding. This concerns i.a. tourism, accommodation and other leisure activities, handicraft, processing of farm products, wood processing, aquaculture, production of renewable energy for the market, and contractual work using equipment of the holding. These activities are chosen as variables for cluster analysis in this paper.

The share of farms with a diversification activity ranges from 1% in Lithuania to 29% in Finland. Farm diversification is more widespread in Western and Northern Europe - in Finland (29%), France (25%), the United Kingdom (24%), Germany (22.5%), the Netherlands (22.5%), Austria (21.4%), and Denmark (18.4%) - and seems less developed in Eastern and Southern Member States as well as in Ireland [European Commission, 2008].

Other gainful activities are defined (following European Commission) as every activity other than activity relating to farm work, carried out for remuneration. This includes non-agricultural gainful activities carried out on the holding itself (i.e. farm diversification activities such as camping sites, accommodation for tourists, etc that will be analyzed at a later stage) or on another agricultural holding, as well as activity on non-agricultural enterprise.

## METHODS

27 UE countries described with 9 variables relating to the non-agricultural activity of farms (2008 year) are objects analysed in this paper. In the Table 1 are specified all variables.

The Czekanowski's diagram, Ward's Amalgamation (Tree Clustering) and *k*-means algorithm were methods used for objects' clustering.

The Czekanowski's diagram belongs to the linear ordering methods. It is mainly used to isolate typological groups of homogeneous objects. In this method numbers in similarity or distance matrix are substituted by properly selected graphic symbols.

In the ordered diagram symbols displaying smallest distance between objects indicate groups of similar objects. Each unit of such symbols concentrated along the main diagram's diagonal indicates a typological group. It includes least diversified units concerning describing values.

Emphasizing the most important relations and similarities between researched objects is the main advantage of Czekanowski's method. Simultane-

ously it includes all detailed connections between spatial units, the whole distance matrix [Bywalec and Rudnicki, 2002].

Furthermore there were used also hierarchical and non-hierarchical classification methods for correct grouping of EU countries regarding scale and types of other gainful activity.

Ward's method was chose as a hierarchical procedure. It is designed to optimize the minimum variance within clusters. A Euclidean squared distance was chose as a clustering criterion in this paper.

Ward's method looks for small clusters and in this is regard very effective [Grabiński and Sokołowski, 1984]. This method indicated the number of clusters for further analysis.

For the final clustering was chose a non-hierarchical algorithm which is a  $k$ -means method. It is a method of cluster analysis which aims to partition  $n$  observations into  $k$  clusters ( $k < n$ ) in which each observation belongs to the cluster with the nearest mean.

## RESULTS

Before proceeding to the appropriate cluster method a formal and substance valuation of variables characterizing each country was made.

There was analyzed the relative dispersion between variables using the variation coefficient  $V_x$ .

**Table 1.** Correlation ( $r_{xy}$ ) matrix of 9 chosen variables

| Variables<br>[% of all holdings] | Another gainful<br>activity | Tourism | Handicraft | Processing<br>of farm products | Wood processing | Aquaculture | Renewable<br>energy production | Contractual work | Other gainful<br>activities n.a.e. |
|----------------------------------|-----------------------------|---------|------------|--------------------------------|-----------------|-------------|--------------------------------|------------------|------------------------------------|
| Another gainful activity         | 1.00                        | 0.36    | -0.06      | -0.21                          | -0.08           | -0.19       | 0.35                           | 0.13             | 0.15                               |
| Tourism                          | 0.36                        | 1.00    | 0.08       | -0.36                          | 0.32            | 0.00        | 0.18                           | 0.09             | 0.06                               |
| Handicraft                       | -0.06                       | 0.08    | 1.00       | -0.49                          | 0.51            | 0.08        | 0.01                           | 0.37             | 0.14                               |
| Processing of farm products      | -0.21                       | -0.36   | -0.49      | 1.00                           | -0.37           | -0.35       | -0.17                          | -0.60            | -0.63                              |
| Wood processing                  | -0.08                       | 0.32    | 0.51       | -0.37                          | 1.00            | 0.21        | 0.09                           | 0.05             | 0.03                               |
| Aquaculture                      | -0.19                       | 0.00    | 0.08       | -0.35                          | 0.21            | 1.00        | -0.13                          | 0.19             | 0.19                               |
| Renewable energy production      | 0.35                        | 0.18    | 0.01       | -0.17                          | 0.09            | -0.13       | 1.00                           | -0.10            | -0.11                              |
| Contractual work                 | 0.13                        | 0.09    | 0.37       | -0.60                          | 0.05            | 0.19        | -0.10                          | 1.00             | 0.04                               |
| Other gainful activities n.a.e.  | 0.15                        | 0.06    | 0.14       | -0.63                          | 0.03            | 0.19        | -0.11                          | 0.04             | 1.00                               |

Source: Eurostat – Farm Structure Survey

For all variables  $V_x$  values were higher than 0.7. It proves about the great diversity inside EU (27 countries). Then correlation between variables was verified. The limit value is set as  $r_{xy} = 0.7$  (Table1.). Five classes of similarities of researched objects were determined in the Czekanowski's diagram:

| Classes | Ranges         |
|---------|----------------|
| 1       | 0 – 0.384      |
| 2       | 0.384 – 0.516  |
| 3       | 0.516 – 0.657  |
| 4       | 0.657 – 0.867  |
| 5       | 0.867 and more |

This method allowed to isolate six typological groups of EU-countries.

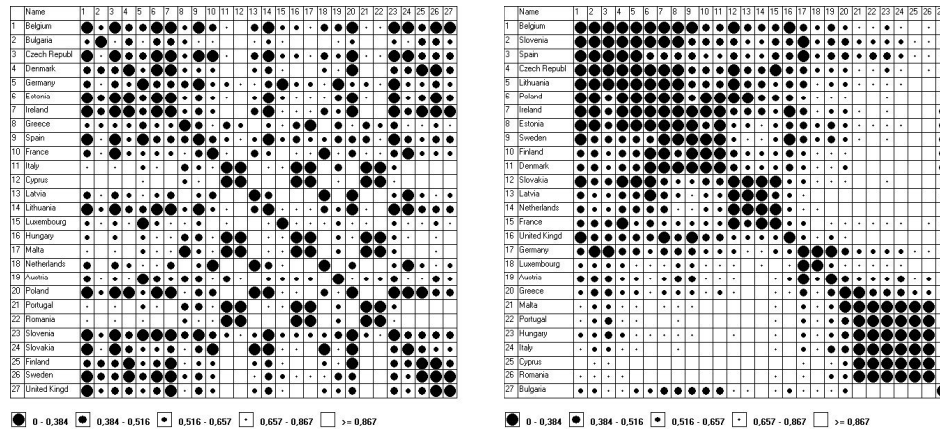


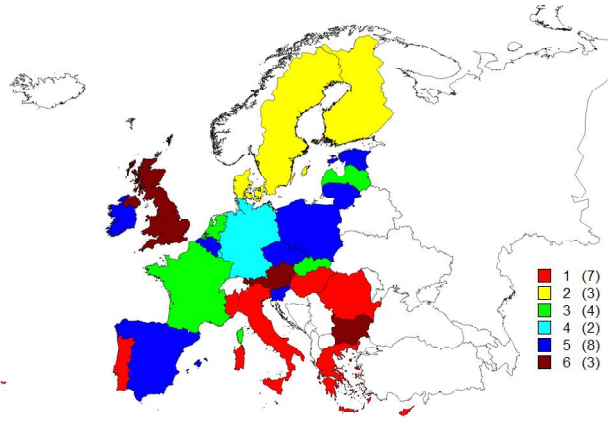
Figure 1. No well-ordered and ordered Czekanowski's diagram

The clustering results according to Czekanowski's diagram are formed as follow:

|   |   |
|---|---|
| 1 | Portugal, Hungary, Italy, Cyprus, Romania, Malta, Greece                      |
| 2 | Sweden, Finland, Denmark  |
| 3 | Slovakia, Latvia, Netherlands, France   |
| 4 | Germany, Luxemburg  |
| 5 | Belgium, Slovenia, Spain, Czech Republic, Lithuania, Poland, Ireland, Estonia |
| 6 | United Kingdom, Austria, Bulgaria   |

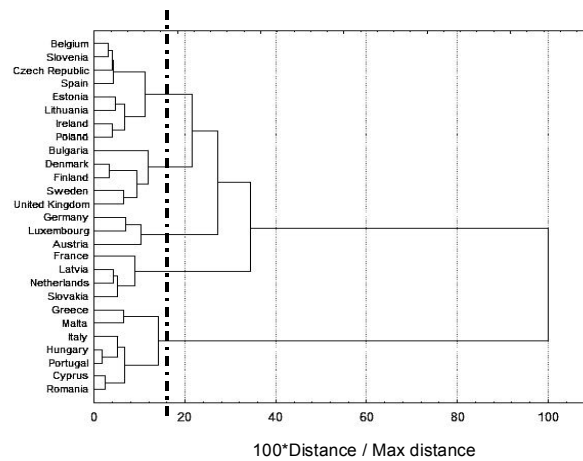
The formed groups are corresponding with a countries spatial arrangement (Fig. 2). Clusters of Scandinavian (cluster 2) and of Mediterranean (cluster 1) countries are particularly marked.

Poland was classified with neighbour countries (Czech Republic and Lithuania) but also with Spain, Ireland, Belgium, Slovenia and Estonia. It means. that the level and forms of non-agricultural activity are in these countries similar.

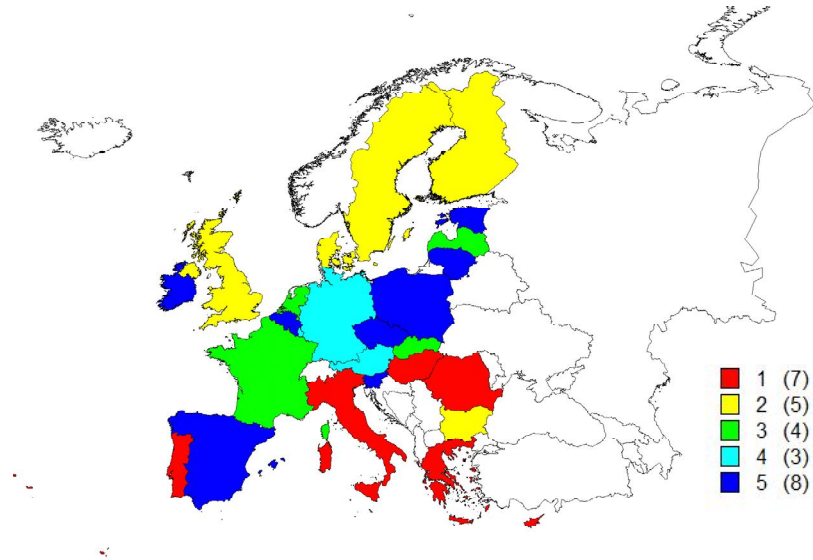


**Figure 2.** Clusters according to Czekanowski's diagram

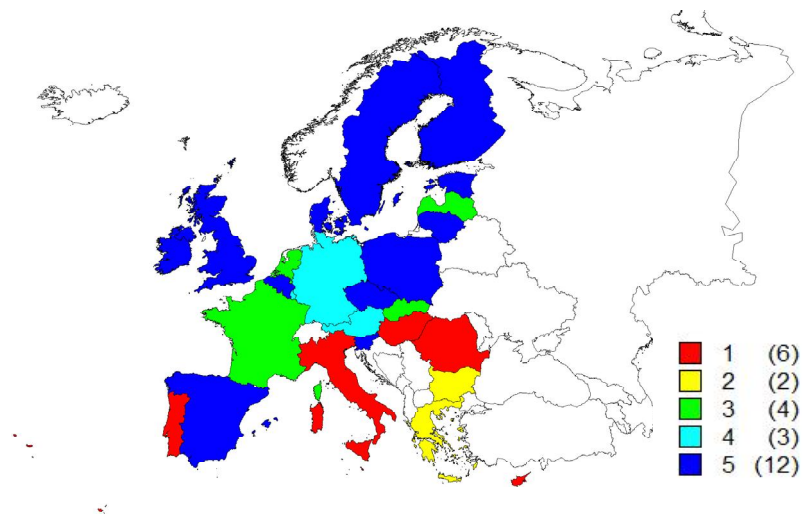
The next stage in the clustering procedure was the Ward's method. The results of analysis are presented as a dendrogram (fig. 3). It is possible to discriminate smaller or large number of concentrations depending on the considered distance between objects. The clustering procedure should distinguish well-separated and coherent subsets.



**Figure 3.** Ward's clustering results (for Euclidean Squared Distance



**Figure 4.** Clusters according to the Ward's diagram



**Figure 5.** Clusters according to the *k*-means method

The limited distance between clusters, which indicates a final group number, was defined at 16 % of maximum distance.

By the assumed limit level European Union was divided into five clusters with a similar characteristic of other gainful activity:

|   |   |
|---|---|
| 1 | Greece, Malta, Italy, Hungary, Portugal, Cyprus, Romania                      |
| 2 | Bulgaria, Denmark, Finland, Sweden, United Kingdom                            |
| 3 | France, Latria, Netherlands, Slovakia   |
| 4 | Germany, Luxemburg, Austria   |
| 5 | Belgium, Slovenia, Czech Republic, Estonia, Spain, Lithuania, Ireland, Poland |

The clustering results are very similar to those according to the Czekanowski's method. Only three countries were classified to the other clusters (Bulgaria, United Kingdom, Austria). Clusters 1, 3 and 5 remain without any changes (Fig. 4).

Finally, there was also used *k*-means method for confirming the clustering accuracy. Following the Ward's findings, five clusters were accepted.

The gotten clusters are slightly differ from those received with Ward's method. Five countries (objects) have changed they clusters. These groups of hierarchical method were regarded ultimate. Final cluster results are presented on the Fig.5.

Table 2 presents the basic cluster's statistics.

The highest percentage of households with another gainful activity is in cluster 4 (Germany, Luxemburg, Austria). Processing of farm products is the major activity. This is also mostly carried out activity in the cluster 1 (Italy, Cyprus, Hungary, Malta, Portugal, Romania).

**Table 2.** The cluster's basic descriptive statistics

| VARIABLE                        | CLUSTER     |                    |             |                    |             |                    |             |                    |             |                    |
|---------------------------------|-------------|--------------------|-------------|--------------------|-------------|--------------------|-------------|--------------------|-------------|--------------------|
|                                 | 1           |                    | 2           |                    | 3           |                    | 4           |                    | 5           |                    |
|                                 | Mean        | Standard deviation | Mean        | Standard deviation | Mean        | Standard deviation | Mean        | Standard deviation | Mean        | Standard deviation |
| Another gainful activity        | 0.08        | 0.04               | 0.02        | 0.00               | 0.14        | 0.09               | <b>0.20</b> | 0.02               | 0.12        | 0.10               |
| Tourism                         | 0.04        | 0.06               | 0.04        | 0.02               | 0.10        | 0.05               | 0.23        | 0.10               | 0.17        | 0.10               |
| Handicraft                      | 0.01        | 0.01               | 0.03        | 0.03               | 0.02        | 0.02               | 0.01        | 0.01               | 0.05        | 0.04               |
| Processing of farm products     | <b>0.83</b> | 0.08               | 0.28        | 0.32               | 0.14        | 0.16               | <b>0.34</b> | 0.11               | 0.12        | 0.11               |
| Wood processing                 | 0.01        | 0.01               | 0.01        | 0.01               | 0.03        | 0.02               | 0.07        | 0.04               | 0.08        | 0.07               |
| Aquaculture                     | 0.00        | 0.00               | 0.01        | 0.01               | 0.01        | 0.01               | 0.01        | 0.01               | 0.02        | 0.03               |
| Renewable energy production     | 0.01        | 0.01               | 0.00        | 0.00               | 0.06        | 0.07               | 0.29        | 0.23               | 0.03        | 0.03               |
| Contractual work                | 0.09        | 0.09               | <b>0.57</b> | 0.23               | 0.19        | 0.05               | 0.20        | 0.07               | <b>0.32</b> | 0.12               |
| Other gainful activities n.a.e. | 0.06        | 0.08               | 0.09        | 0.09               | <b>0.73</b> | 0.06               | 0.07        | 0.10               | <b>0.34</b> | 0.07               |

Overall 14% of farm households have another gainful activity in cluster 3. This is the most spatial incoherent group: France, Latvia, Netherlands, and Slovakia with predominantly other, not specified gainful activities (inter alia raising fur animals).

Contractual work is mostly carried out in the clusters 2 (Bulgaria, Greece) and 5. Cluster 5 is most numerous (12 countries) with relatively high level of development of diversification activities on farm (12%). It includes Eastern and Northern Europe mainly.

Generally it may be stated that a development of farmers and farming households diversification is correlated with spatial arrangement. Neighbouring countries belong to the same clusters of other gainful activity kinds.

## CONCLUSIONS

Over the past few years, pluriactivity of farmers and farming households has been increasing and more than one third of EU-27 family farmers carry out now another gainful activity.

Though they are mainly small farmers (up to 5 ha) looking for complementary income [Krakowiak-Bal 2009].

Nevertheless, setting up diversification on the holding is not possible on every farm. Elements such as the size of the farm, its specialisation or its location will make it more or less feasible. Individual characteristics of the farmer, in particular age, education level or motivation, are also to be taken into account, not to mention the importance of the local conditions such as a potential market or legal provisions.

The European Union has long been encouraging the development of other gainful activities for farming households. These have been mainly targeted at the development of diversification activities on farm, pluriactivity being indirectly supported by measures encouraging participation in the labour market and creation of new employment opportunities in rural areas.

It may be stated based on carried analysis:

– The clustering procedure allowed to separate 5 typological clusters (groups) of EU-countries regarding level of farm's diversification activities. There were confirmed a big differences of types and scale of other gainful activity across the EU.

– The carried researches have showed also that the development of farmers and farming households diversification is correlated with spatial arrangement.

– The highest percentage of households with another gainful activity characterizes (20%) cluster 4 (Germany, Luxemburg, Austria).

– Poland has been classified with another 11 countries mainly of Eastern and Northern Europe.



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