GROUPING OF AGRICULTURAL HOLDINGS IN THE EUROPEAN UNION

Marie Šimpachová Pechrová – Ondřej Šimpach

Abstract

Possible (dis)similarity of agricultural holdings in NUTS II regions in the EU can be considered during the formulation of regulations on the supra-national level. The aim of the paper is to group 276 NUTS II regions in the EU and Norway (also influenced by EU's policy) based on the farms' characteristics (type and size of production, economic and demography criteria). Data were obtained from Farm structure survey 2013 and normalized by Z transformation. We used hierarchical cluster analysis – Ward's method with Canberra distance to create 5 clusters.

Only in few countries all regions belonged to one cluster (e.g. in Norway to cluster 3 characterized by middle values of all indicators). The smallest cluster 4 was characterized by the highest share of small farms and of farms with female manager. All Czech regions were in cluster 1 with the highest share of large farms. UK's and Netherland's regions were in cluster 2 typical for high share livestock production and old managers. Cluster 5 included regions (mainly from Poland and Hungary) with the most farms and the most natural persons and the highest self-consumption. The results can be used for setting the support for the farms in the regions.

Key words: agricultural holdings, cluster analysis, European Union

JEL Code: Q18, Q13, C38

Introduction

Common Agricultural Policy (CAP) of the European Union (EU) is undergoing continuous reforms and changes in order to adjust to changing conditions on the agricultural markets and policy and economic environment in the member states. Since the MacSharry reform in 1993 CAP "continued to provide substantial payments to farmers, but shifted in emphasis towards food quality, supporting farm diversification and environmental maintenance," (Barnes et al., 2016). The reforms are more and more highlighting the subsidiarity principle, when the measures shall be taken at the lowest possible level, and the directives are providing to the member states gradually bigger flexibility in adoption and adjustment of the regulations.

Practically the subsidiarity principle means that the "decisions should be taken, whenever possible, as close as possible to citizens, thus reducing the emergence of veto players and boycott strategies and enhancing shared responsibility and stakeholders' participation," (Galiana et al., 2013). Hence, the CAP shall be also flexible as the structure of agricultural holdings in the EU vary and it is hard to find one solution that would suit all of them. However, the level of subsidiarity must not disturb the principles of the common market.

Knowledge about possible (dis)similarity of agricultural holdings in NUTS II regions in the EU can be considered during the formulation of regulations on the supra-national level. For example, Uthes, Li and Kally, (2017) used statistical and multivariate analysis of CMEF baseline (regional characteristics) and input (expenditure) indicator data at the NUTS II level to compare four expenditure patterns of allocation from CAP (Competitiveness, Environment, Rural Viability, Equal Spending) in terms of regional characteristics and development trends. Šimpach and Pechrová (2016a) searched for suitable linkage method and distance measure of cluster analysis in order to group EU NUTS II regions according to their agricultural characteristics. Besides, Šimpach (2013) and Šimpach and Pechrová (2016b) also clustered the regions according to demographic criteria.

1 Data and Methods

The aim of the paper is to group 276 NUTS II regions in the EU and Norway (as it is also influenced by EU's policy) based on the farms' characteristics (type and size of production, economic and demography criteria). First, we describe the data and variables, then the method of cluster analysis. Calculations were done in software Stata 11.2.

1.1 Data

Data were obtained from Eurostat from Farm structure survey (FSS) for the latest available year 2013 (as of February 2018). Particularly we utilized tables ef_m_farmleg and ef_m_farmang (Eurostat, 2018), where are included characteristics of agricultural holdings from about type of production and size of production, and from economic and demography area for NUTS II regions. Regions where there were no agricultural holdings (e.g. big cities) were omitted.

First indicator was the *total number of farms* in the region. Then the **type of farm and production** was described by following indicators: (1) *share of natural persons*, (2) *share of farms whose household consumes more than 50% of the final production* and (3) *share of farms with livestock production*. Family farms are usually supposed to be related with the ownership

by natural persons (and smaller size). We are using the indicator "share of natural persons" as an indirect measure that indicates the presence of family farming. However, it is not a rule as for example in the Czech Republic there are many agricultural firms owned and managed by families. In general, the size of the agricultural holdings is much higher than in other countries of the EU. Share of farms whose household consumes more than 50% of the final production can also point on the fact that family farms usually consume their own production in the household. According to the share of farms with livestock production, we can deduce the importance of the meat production in the region.

Indicators from the area of **size of agricultural holding** are (1) *average size of holding in hectares of Utilized agricultural area* (UAA), (2) *average size of 1 holding in livestock units (LU),* (3) *share of large farms with standard output (SO) over 500 000 EUR* and (4) s*hare of small farms with SO lower than 2000 EUR*. Size of business is expressed by two indicators (the average agricultural holding in hectares and LU) in order to reflect the type of production (crop/livestock). Despite that in many countries prevails farms with mixed type of production, the share of farms with crop production only can indicate, how important is this type of production in particular region. Importance of crop production is also indirectly represented by the average number of hectares per one holding.

From the point of view of **demography** it is examined: (1) *labour force directly employed in Annual work units* (AWU), (2) *share of farms with female managers* and (3) *number of old farmers per 1 young farmer*. This number of AWU can indicate the size of the holding and is somehow related to the type of production as livestock production is much more labour intensive than crop production or than mixed production. Share of farms with female managers can show some specifics of farms, however, the gender issue is not that pronounced in EU as in the developing states mainly in Africa, where the role of women is crucial (see study of Pechrová and Šimpach, 2015). Future development of the agricultural holdings can be ensured when they are younger farmers in the leadership of the holding. Therefore, we included also ration of the young farmers to old farmers as an indicator of generational renewal on the holdings. On one young farmer (less than 35 years) there are on average 5.46 farmers in retirement age (over 65 years old). There were even regions with no farmer younger than 35 years. In this case, the indicator took value as if there was at least one young farmer (Région de Bruxelles-Capitale, Prague, Berlin, Greater Manchester, West Midlands, Outer London).

Finally, *average economic size of the agricultural holding* calculated as the division of total SO of all farms in the region by the number of farms was included into the model.
Characteristics of the regions in below stated indicators are displayed in Tab. 1.

Tab. 1: Characteristics of the farms in NUTS II regions in the sample

Variable	Mean	Std. Dev.	Min	Max
Total no. of farms	39426.16	90048.94	40.00	754530.00
Share of natural persons (%)	91.31%	10.69%	48.00%	100.00%
Share of farms whose household consumes more than 50% of the final production (%)	12.66%	21.90%	0.00%	94.00%
Share of farms with livestock production (%)	58.16%	22.39%	3.00%	97.00%
Average size of holding (ha)	47.05	48.07	0.44	284.10
Average size of holding (LU)	38.34	39.71	0.44	199.49
Share of large farms – SO over 500 000 EUR (%)	3.97%	5.55%	0.00%	29.00%
Share of small farms – SO below 2000 EUR (%)	15.83%	19.35%	0.00%	81.00%
Labour force directly employed (AWU)	34603.19	51321.30	50.00	325690.00
Share of farms with female managers (%)	19.47%	9.79%	0.00%	53.00%
No. of old farmers per 1 young farmer	7.08	16.16	0.31	240.00
Average economic size (EUR)	55102.26	73985.77	290.00	389502.40

Source: own elaboration based on data from Eurostat (2017)

1.2 Methods

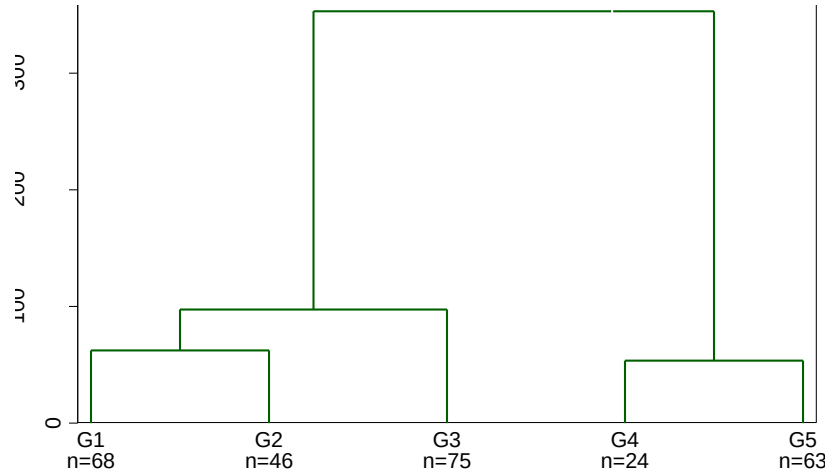
We used hierarchical cluster analysis, but clustering itself can be achieved by several methods. "There is no manual and rule which would clearly identify the appropriate combination method and distance measures during clustering". (Löster, 2017). Hence, we choose Ward's linkage method with Canberra distance as it was recommended by Šimpach and Pechrová (2016a). Ward's linkage method (Ward, 1963) is preferred since it performs well when data contains clusters with the same number of points (Everitt et al., 2011). It tends to find same-size, spherical clusters, so it can create group of students with balanced number of members. However, it is sensitive to outliers. As the variables were in different units, they were firstly normalized by Z-transformation as recommended by Löster (2017). Hierarchical clustering created 5 clusters. Each cluster is described separately according to their characteristics.

2 Results and Discussion

First, the variables were included into correlation matrix to analyse if there is not multicollinearity present. The correlation was not higher than 90 % in any case (only in 2 cases was higher than 80% - between labour force directly employed AWU and total no. of farms and between share of small farms with SO lower than 2000 EUR and share of farms whose household consumes more than 50% of the final production – number), so all variables were included into the analysis.

Then the data for all regions (276) were included into hierarchical cluster analysis and grouped using Wards' method and Canberra dissimilarity measure into 5 clusters. The grouping process is displayed in dendrogram in Fig. 1.

Fig. 1: Average characteristic of the farms in clusters



Source: own elaboration in Stata 11.2 based on data from Eurostat (2017)

In some countries, all regions belonged to one cluster only. For example, regions in Norway and Austria belonged to **cluster 3** that was characterized by middle values in all indicators, only number of old farmers per 1 young farmer was relatively significantly lower than in other clusters. Besides, there were also regions from Germany and Spain.

All Czech regions were grouped to **cluster 1** for which was typical the highest share of economically large farms (SO over 500 000 EUR) as the regions in the Czech Republic had over two times higher share than is the average. Also average acreage is the biggest, as on farm has on average 83.91 hectares. There were also almost regions from Belgium, then many regions from Germany and France and Netherland.

Majority of UK's and Netherland's regions were in **cluster 2** typical for high share livestock production and average size of the holding in terms of number of hectares and livestock units. Also, the population of farm managers was the oldest (there were 15 "old" farmers per 1 "young"). The share of holdings with agricultural production achieves 72.22%. Almost all regions from United Kingdom and several from Netherlands belonged here.

Mostly countries' regions fell in many clusters. The smallest **cluster** number **4** was characterized by the highest share of economically small farms (with SO lower than 2000 EUR) and of farms with the highest share of female manager. This cluster mostly contained regions from Italy and Greece, then from Malta and Cyprus.

Cluster 5 included regions with the most farms. It is due to the fact that there are mostly natural persons in those regions as same as the share of farms whose household consumes more than 50% of the final production was the highest. This may indicate that possibly family farms are present. As expected there were almost all regions from Poland and Hungary, then some from Romania and Italy. Average characteristics of the farms in clusters are displayed at Tab. 2.

Tab. 2: Average characteristic of the farms in clusters

No. of cluster	1 (n = 68)	2 (n = 46)	3 (n = 75)	4 (n = 24)	5 (n = 63)
Total no. of farms	10 498.00	5 141.00	11 866.00	26 487.00	133 422.00
Share of natural persons (%)	78.99%	96.15%	91.51%	98.71%	98.02%
Share of farms whose household consumes more than 50% of the final production (%)	2.88%	0.00%	5.12%	29.42%	35.06%
Share of farms with livestock production (%)	62.84%	72.22%	59.23%	40.38%	48.33%
Average size of holding (ha)	80.36	83.91	33.73	12.56	13.17
Average size of holding (LU)	68.95	76.85	23.33	4.89	7.81
Share of large farms – SO over 500 000 EUR (%)	8.90%	7.83%	1.24%	0.46%	0.43%
Share of small farms – SO below 2000 EUR (%)	3.06%	5.70%	9.49%	37.92%	36.14%
Labour force directly employed (AWU)	18864.85	8043.48	13387.20	20628.75	101564.10
Share of farms with female managers (%)	15.10%	13.67%	17.55%	29.29%	26.98%
No. of old farmers per 1 young farmer	3.65	15.09	3.92	11.46	7.02
Average economic size (EUR)	76034.81	31817.30	25437.37	18458.25	98785.10

Source: own elaboration based on data from Eurostat (2017)

Conclusion

The aim of the paper was to group 276 NUTS II regions in the EU and Norway based on the character of agricultural production. Agricultural holdings were described according to the criteria that characterize their type of farm and production and size of production, economic and demography criteria. Data were obtained from Eurostat from Farm structure survey (FSS) in year 2013 (tables ef_m_farmleg and ef_m_farmang) and grouped by hierarchical cluster analysis, particularly Ward's linkage method with Canberra distance to create 5 clusters. As the variables were in different units, they were firstly normalized by Z transformation.

Each cluster was described separately according to its average characteristics. In some countries, all regions belonged to one cluster only. For example, in Norway's and Austria's regions were grouped to cluster 3 for which was characterized by middle values in all indicators, only number of old farmers per 1 young farmer was relatively lower in comparison with other clusters.

Mostly countries' regions fell in many clusters. All Czech regions were groped to cluster 1 for which was typical the highest share of economically large farms. UK's and Netherland' s regions were included in cluster 2 typical for high share livestock production and average size of the holding in terms of number of hectares and livestock units. Also, the population of farm managers was the oldest. The smallest group number 4 was characterized by economically the highest share of economically small farms and of farms with higher share of female manager and mostly contained regions from Italy and Greece, than from Malta and Cyprus. Cluster 5 included regions with the highest number of farms as there are mostly natural persons in those regions as same as the share of farms whose household consumes more than 50% of the final production was the highest. As expected there were almost all regions from Poland and Hungary, then some from Romania and Italy. The results can be used for the policy making while setting the support for regions.

Acknowledgment

The research was funded from Internal Research Grant No. 1113/2018 of Institute of Agricultural Economics and Information and from Czech Science Foundation Project No. P402/12/G097 DYME – Dynamic Models in Economics.

References

Barnes, A., Sutherland, L.-A., Toma, L., Matthews, K., Thomson, S. (2016). The effect of the Common Agricultural Policy reforms on intentions towards food production: Evidence from livestock farmers. *Land Use Policy*, *50*: 548–558.

Everitt, B. S., Landau, S., Leese, M., Stahl, D. (2011). *Cluster Analysis*. London: John Wiley & Sons. Wiley Series in Probability and Statistics. 5th edition, 346 p.

Galiana, L., Aguilar, S., Lázaro, A. (2013). An assessment of the effects of forest-related policies upon wildland fires in the European Union: Applying the subsidiarity principle. *Forest Policy and Economics*, *29*: 36–44

Löster, T. (2017). Comparison of results of selected clustering methods on real data set, In *The 11th International Days of Statistics and Economics (MSED 2017)*, 886–896.

Pechrová, M., Šimpach, O. (2015). Are there any differences in efficiency between Czech agricultural holdings managed by male or female farmers? In *Agrarian Perspectives XXIV. – Global Agribusiness and Rural Economy*, 340–346.

Šimpach, O. (2013). Application of Cluster Analysis on the Demographic Development of Municipalities in the Districts of Liberecky Region. In *7th International Days of Statistics and Economics*, 1390–1399.

Šimpach, O., Pechrová, M. (2016a). Searching for Suitable Method for Clustering the EU Regions according to Their Agricultural Characteristics. In *Mathematical Methods in Economics 2016*, 821–826.

Šimpach, O., Pechrová, M. (2016). Cluster analysis of EU's regions according to demographic criteria. In *The 10th International Days of Statistics and Economics (MSED 2016)*, 1806–1815.

Uthes, S., Li, F., Kelly, E. (2017). Does EU rural expenditure correspond to regional development needs? *Land Use Policy*, *60*: 267–280.

Ward, J. H. (1963). Hierarchical grouping to optimize an objective function. *Journal of the American Statistical Association, 58*: 236–244.

Contact

Marie Šimpachová Pechrová
Institute of Agricultural Economics and Information
Mánesova 75, 120 00 Prague 2, Czech Republic
simpachova.marie@uzei.cz

Ondřej Šimpach
University of Economics Prague, Faculty of Economics and Statistics
W. Churchill Sq. 4, 130 67 Prague 3, Czech Republic
ondrej.simpach@vse.cz