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RANKING EUROPEAN COP FARMS IN TERMS OF FINANCIAL VIABILITY THROUGH A PCA-TOPSIS APPROACH

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Abstract

The aim of this paper is to assess the evolution of European farms from COP sector (in 2009 and 2013) in terms of financial viability. In our research approach, we applied a combination between the non-parametric method PCA, the multi-criteria decision analysis method TOPSIS and k-means cluster analysis. Our database comprised eight ratios, calculated based on FADN data from 94 regions specialised in COP production (23 countries). The results revealed the disparities created between farms during the 2009-2013 period due to different agricultural political conditions and to different recovery from financial crisis.

Key words**:** *economic and financial performance, profitability ratios, financial ratios, dimension reduction (PCA), multi-criteria evaluation (TOPSIS)*

INTRODUCTION

Farm financial viability is an important issue in the assessment of European farms. These papers analyse in general the relation between financial viability and subsidies [13], prices [8] [8] [12], agricultural practices [10], etc. Aggelopoulos [1] proved that farms with low labour intensity have also a low level of financial viability and Strijker [12] indicated that fluctuating balance of input and output prices is the main risk to financial viability of farming. Also, according to Vrolijk [15], about 20% of the farms from COP sector were affected by the abolishment of the decoupled payments. Many farmers from France, Ireland, Finland, Germany, Sweden, the UK etc. are included in this category due to their level of loans or interest levels and due to their financial structure.

All these papers and many more tried to assess the financial viability of farms to explain ultimately the differences in performance between regions and countries. In terms of performance, many authors indicate in the last years a decrease in overall costs and investments or an increase in production level [14], but we can't generalize the situation due to the cost differences between farm sizes [3] or to the inequality in the distribution of direct payments [2].

MATERIALS AND METHODS

The performance of a firm can be measured in terms of financial, operational, technical, etc. effectiveness [6]. According with actual literature, the financial performance can be analysed through different indicators like ROE, ROA, ROI, ROS, profit margin, etc. and there are a lot of methods which are used to assess firm performance (AHP, PCA, DEA, etc.) [17]. The multiple-criteria evaluation of alternatives methods (TOPSIS, ELECTRE, etc.) are frequently used in this type of studies (see [16]). We mention here the studies of Šišková [11] and Kuncová [7] in which the economic performance from agriculture is measured by TOPSIS approach.

TOPSIS method ('Technique for Order Preference by Similarity to Ideal Solution') can be used when we have to compare numerous alternatives according to the different selected criteria. This method can rank the alternatives based on the relative distance from the ideal alternative and the information about the weights of criteria [9].

To apply this method, we firstly defined the criteria for assessment starting from the available information from FADN database for COP farms. The farms used like alternatives in the decision matrix were selected from FADN, based on the available

data of 94 European regions from COP sector (last available year 2013) (Table 1):

Table 1. Available data 2009-2013

Country	Regions	Country	Regions
Austria	1	Italy	13
Bulgaria	6	Latvia	1
Cyprus	1	Lithuania	1
Czech Republic	1	Poland	4
Denmark	1	Portugal	3
Estonia	1	Romania	7
Finland	2	Slovakia	1
France	18	Slovenia	1
Germany	12	Spain	10
Greece	3	Sweden	1
Hungary	1	United Kingdom	4
Ireland	1		

Source: based on FADN

To evaluate the profitability and financial viability of farms we use eight ratios:

- Labour intensity (AWU/100 ha):

$$LI = \frac{Total\ labour\ (SE010)}{Total\ UAA\ (SE025)} \quad (1)$$

- Capital intensity (Euro/100 ha)

$$CI = \frac{Total\ assets\ (SE436)}{Total\ UAA\ (SE025)} \quad (2)$$

- Input/Output Ratio

$$IO = \frac{Total\ input\ (SE270)}{Total\ output\ (SE131)} \quad (3)$$

- Cost-Revenue with subsidies Ratio

$$CRS = \frac{Total\ specific\ costs\ (SE281)}{Gross\ Farm\ Income\ (SE410)+Total\ subsidies\ (SE605)} \quad (4)$$

- Cost-Revenue without subsidies Ratio

$$CR = \frac{Total\ specific\ costs\ (SE281)}{Gross\ Farm\ Income\ (SE410)} \quad (5)$$

- Financial stress Ratio

$$FS = \frac{Rent\ paid\ (SE375)+Interest\ paid\ (SE380)}{Total\ output\ (SE131)} \quad (6)$$

- Indebtedness Ratio (solvency)

$$I = \frac{Total\ liabilities\ (SE485)}{Total\ assets\ (SE436)} \quad (7)$$

- Leverage Ratio

$$L = \frac{Total\ liabilities\ (SE485)}{Net\ worth\ (SE501)} \quad (8)$$

Labour and capital intensity are used to measure structural performance. Lower values of labour intensity and higher values of capital intensity are characteristic for medium and large farms with usually a higher economic performance. For the other selected financial indicators, a lower value means better economic performance. Taking this in account, in our approach to use TOPSIS, we selected inside the model to maximize the value of CI and to minimalize the value of LI, IO, CRS, CR, FS, I and L.

The weights for criteria (indicator) needed in TOPSIS were establish based on principal components analysis. PCA application implied the checking up of the internal consistency of the data base, the calculation of the *KMO test (*Kaiser-Meyer-Olkin) for partial correlations between variables verification (close to 60% or over), the Varimax rotation option selection (minimization of the number of variables with big factor loadings) and the Bartlett scores verification (the Bartlett test must have a $p<0.05$ probability).

The final TOPSIS scores were processed inside a cluster analysis. This method permits the classification of variables into relatively homogeneous groups and the identification of groupings with similar characteristics [4]. The application of this analysis supposes: the utilization as inputs of scores resulting from TOPSIS; the visual identification of cluster number by hierarchical clustering using Ward's method [5]; *k-means cluster* application to generate the number of clusters which characterizes European COP farms according with financial performance.

We used in our research the SDI Tool Triptych (demo version) to generate TOPSIS and SPSS (demo version) to apply PCA and cluster analysis.

RESULTS AND DISCUSSIONS

Database construction

The descriptive analysis of the necessary variables for the TOPSIS model reveals from

structural point of view a decrease in labour intensity and an increase in capital intensity and an improvement from financial performance point of view (Table 2):

Table 2. Descriptive statistics

	Year	Minimum	Maximum	Mean	Std. Deviation
LI	2009	0.747	6.808	2.181	1.409
	2013	0.652	6.287	2.142	1.387
CI	2009	46495.4	3159669.2	621157.2	637941.3
	2013	52300.7	3762577.9	725587.0	714699.1
IO	2009	0.529	2.941	1.209	0.288
	2013	0.694	1.852	1.029	0.205
CRS	2009	0.153	0.701	0.414	0.139
	2013	0.190	0.731	0.410	0.121
CR	2009	0.251	1.495	0.709	0.267
	2013	0.284	1.151	0.617	0.197
FS	2009	0.000	0.381	0.135	0.073
	2013	0.000	0.354	0.110	0.063
I	2009	0.000	0.530	0.161	0.158
	2013	0.000	0.475	0.157	0.149
L	2009	0.000	1.128	0.245	0.289
	2013	0.000	0.903	0.229	0.249

Source: Based on FADN

Principal component analysis

The Kaiser-Meyer-Olkin Measure test on the global sampling measure was 0.603 in 2009 and 0.529 in 2013, which suggests that the analysis is acceptable (Table 3). The Bartlett's sphericity test measuring the difference between the proper correlation matrix and the identity matrix is significant ($p < 0.001$), which permits us to reject the null hypothesis and to conclude that there are correlations within the database opportune for PCA running.

Table 3. The variable correlation matrix, KMO test, Bartlett test and communalities

	2009		2013	
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	0.603		.529	
Bartlett's Test of Sphericity	Chi-Square	774.759	Chi-Square	833.893
	df.	28	df.	28
	Sig.	.000	Sig.	.000

Source: Data processing in SPSS

The optimum factorial solution is that with three extracted factors (Table 4). In 2009 the first factor explains 53.35% of the total common variance of variables, the second factor 13.03% and the third 11.53%. In 2013 the first factor explains 49.09% of the total common variance of variables, the second factor 16.53% and the third 13.41%. On a cumulated basis, these factors explain 77.92% of the total common variance of variables in 2009 and 79.03% in 2013.

Table 4. Factor projection and explained variance of variables

PC	Extracted sum of the quadratic saturations			
	2009		2013	
	% of variance	% Cumulative	% of variance	% Cumulative
1	53.352	53.352	49.092	49.092
2	13.033	66.385	16.526	65.618
3	11.533	77.918	13.408	79.025

Source: Data processing in SPSS of FADN data

After the factor rotation, it can be noticed that the variables *I* and *L* correlate strongly and positively with the first factor, while the variables *LI* and *CI* correlate moderate and negatively. *CRS* and *CR* correlate strongly and positively with the second factor and *IO* and *FS* correlate strongly and positively with the third factor (Table 5).

Table 5. The structure matrix by the orthogonal rotation of factors

		Rotation 2009			Rotation 2013		
		1	2	3	1	2	3
1	LI	-.542			-.757		
2	CI	-.677			-.664		
3	IO			.837			.874
4	CRS		.926			.917	
5	CR		.913			.935	
6	FS			.825			.753
7	I	.812			.831		
8	L	.817			.811		

Source: Data processing in SPSS

Starting from the degree of representativeness of principal components and the variables loading on factors we calculated average values for each criteria to establish the estimated weights necessary for TOPSIS model (Table 6).

Table 6. Weight of criteria for TOPSIS model

	Criteria weight
LI	14.194
CI	14.870
IO	8.285
CRS	9.387
CR	9.432
FS	7.600
I	18.183
L	18.049

Source: Own calculation

TOPSIS ranking

Table 7 shows the final ranking of farms in years 2009 and 2013 based on TOPSIS method that reflects the weights of criteria calculated in Table

6 (the data are sorted according with 2013 ranking). The table presents and compares the scores of relative closeness to ideal solution and the ranks of farms of those two years, which can reveal the trends of regional disparities regarding financial performance.

Table 7. Comparison of farms´ ranking by TOPSIS in the years 2009 and 2013

	2009	Rank 2009	2013	Rank 2013	Rank +/-
Austria (0660)	0.605	31	0.596	25	6
Bulgaria (0833)	0.503	68	0.428	71	-3
Bulgaria (0831)	0.468	75	0.432	70	5
Bulgaria (0832)	**0.426**	**80**	**0.449**	**65**	**15**
Bulgaria (0834)	0.570	49	0.426	72	**-23**
Bulgaria (0835)	0.389	82	0.381	80	2
Bulgaria (0836)	0.534	59	0.397	76	**-17**
Cyprus (0740)	0.594	37	0.562	36	1
Czech (0745)	0.524	63	0.481	62	1
Denmark (0370)	0.551	54	0.452	64	**-10**
Estonia (0755)	0.479	71	0.441	66	5
Finland (0670)	**0.563**	**50**	**0.555**	**39**	**11**
Finland (0690)	0.529	60	0.501	58	2
France (0121)	0.435	78	0.412	73	5
France (0131)	**0.363**	**86**	**0.400**	**75**	**11**
France (0132)	0.303	94	0.342	86	8
France (0133)	0.309	92	0.285	94	-2
France (0134)	0.359	87	0.341	87	0
France (0136)	0.343	90	0.313	92	-2
France (0141)	0.509	66	0.396	78	**-12**
France (0151)	0.378	85	0.347	85	0
France (0152)	0.477	72	0.388	79	-7
France (0153)	0.419	81	0.355	84	-3
France (0162)	0.388	83	0.368	81	2
France (0164)	0.346	89	0.330	88	1
France (0182)	0.428	79	0.324	91	**-12**
France (0183)	0.439	77	0.357	82	-5
France (0192)	0.475	74	0.397	77	-3
France (0193)	0.476	73	0.408	74	-1
France (0201)	0.381	84	0.310	93	-9
France (0203)	0.452	76	0.436	68	8
Germany (0010)	0.615	29	0.540	48	**-19**
Germany (0030)	0.641	22	0.643	15	7
Germany (0050)	0.651	21	0.637	18	3
Germany (0060)	0.596	36	0.549	44	-8
Germany (0070)	0.592	38	0.548	45	-7
Germany (0080)	0.547	55	0.512	57	-2
Germany (0090)	0.688	13	0.644	14	-1
Germany (0112)	0.357	88	0.357	83	5
Germany (0113)	0.309	91	0.329	89	2
Germany (0114)	0.516	65	0.483	61	4
Germany (0115)	0.481	70	0.434	69	1
Germany (0116)	0.497	69	0.473	63	6
Greece (0450)	0.605	32	0.569	32	0
Greece (0470)	**0.580**	**43**	**0.571**	**31**	**12**
Greece (0480)	0.601	34	0.581	27	7
Hungary (0764)	**0.524**	**62**	**0.531**	**52**	**10**
Ireland (0380)	0.815	2	0.714	3	-1
Italy (0222)	0.701	10	0.690	7	3
Italy (0230)	0.726	8	0.701	6	2
Italy (0243)	0.846	1	0.787	1	0
Italy (0244)	0.752	5	0.707	4	1
Italy (0260)	0.755	4	0.761	2	2
Italy (0270)	0.756	3	0.683	8	-5
Italy (0281)	0.668	15	0.640	16	-1
Italy (0282)	0.689	12	0.667	11	1
Italy (0292)	0.615	28	0.612	24	4
Italy (0301)	0.678	14	0.639	17	-3
Italy (0311)	0.745	6	0.704	5	1
Italy (0312)	0.691	11	0.648	13	-2
Italy (0320)	0.658	20	0.654	12	8
Latvia (0770)	0.308	93	0.326	90	3
Lithuania (0775)	0.518	64	0.487	60	4
Poland (0785)	0.547	56	0.521	53	3
Poland (0790)	0.589	39	0.539	49	**-10**
Poland (0795)	0.573	47	0.552	41	6
Poland (0800)	0.585	40	0.535	50	**-10**
Portugal (0615)	0.577	45	0.561	37	8
Portugal (0630)	0.545	57	0.521	54	3
Portugal (0640)	0.601	33	0.554	40	7
Romania (0840)	0.559	51	0.533	51	0
Romania (0841)	0.576	46	0.546	46	0
Romania (0842)	0.545	58	0.520	55	3
Romania (0843)	0.554	52	0.544	47	5
Romania (0844)	**0.551**	**53**	**0.569**	**33**	**20**
Romania (0845)	0.577	44	0.556	38	6
Romania (0846)	0.571	48	0.551	42	6
Slovakia (0810)	**0.508**	**67**	**0.515**	**56**	**11**
Slovenia (0820)	0.584	41	0.550	43	-2
Spain (0515)	0.583	42	0.494	59	**-17**
Spain (0520)	0.598	35	0.577	28	7
Spain (0530)	0.613	30	0.577	29	1
Spain (0535)	0.718	9	0.615	23	**-14**
Spain (0545)	0.631	24	0.563	35	**-11**
Spain (0550)	0.616	27	0.575	30	-3
Spain (0555)	0.623	25	0.588	26	-1
Spain (0560)	0.727	7	0.620	21	**-14**
Spain (0570)	0.618	26	0.568	34	-8
Spain (0575)	0.660	18	0.625	20	-2
Sweden (0710)	0.527	61	0.438	67	-6
UK (0411)	0.638	23	0.631	19	4
UK (0412)	0.664	16	0.675	9	7
UK (0413)	0.659	19	0.674	10	9
UK (0431)	0.663	17	0.619	22	-5

Source: Own calculation with Triptych

The shortest relative closeness to ideal solution are achieved by farms from Italy and the farthest are achieved by farms from France. Like we may observe farms from different regions of Bulgaria, Finland, France, Greece, Hungary, Romania and Slovakia performed better from a financial point of view and farms from other regions of France, Spain, Germany, Bulgaria and Poland present low financial viability.

Cluster analysis

By applying hierarchical cluster method on TOPSIS data we observed that, according with their score and by Ward option, the COP farms can be grouped in four clusters. The k-means method generated the four-cluster solution by countries (see fig. 1). In table 8 we point out the major changes in financial performances by regions and in table 9 we detailed the main characteristics of generated clusters. We observe changes in cluster classification in the case of 28 types of COP farms (Table 8), but also the disparities created inside each cluster in 2013

faced to 2009 (Fig. 1).

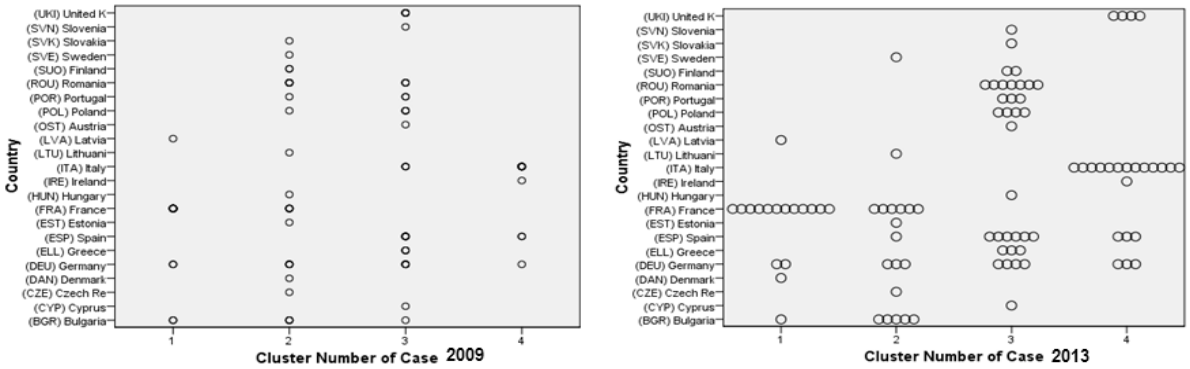

Fig. 1. COP farms clustering by TOPSIS score in 2009 and 2013

Table 8. Changes in financial performance – COP farms, 2009-2013 periods

Country	Regions'farms	Cluster 2009	Cluster 2013	Tendency	Country	Regions'farms	Cluster 2009	Cluster 2013	Tendency
(BGR) Bulgaria	(0832) Severen tsentralen	1	2	higher	(ITA) Italy	(0320) Sicilia	3	4	higher
(BGR) Bulgaria	(0834) Yugozapaden	3	2	lower	(POL) Poland	(0785) Pomorze and Mazury	2	3	higher
(DAN) Denmark	(0370) Denmark	2	1	lower	(POR) Portugal	(0630) Ribatejo e Oeste	2	3	higher
(DEU) Germany	(0080) Baden-Württemberg	2	3	higher	(ROU) Romania	(0840) Nord-Est	2	3	higher
(DEU) Germany	(0030) Niedersachsen	3	4	higher	(ROU) Romania	(0842) Sud-Muntenia	2	3	higher
(DEU) Germany	(0050) Nordrhein-Westfalen	3	4	higher	(ROU) Romania	(0843) Sud-Vest-Oltenia	2	3	higher
(ESP) Spain	(0515) Pais Vasco	3	2	lower	(ROU) Romania	(0844) Vest	2	3	higher
(ESP) Spain	(0575) Andalucia	3	4	higher	(SUO) Finland	(0670) Etela-Suomi	2	3	higher
(FRA) France	(0152) Alsace	2	1	lower	(SUO) Finland	(0690) Pohjanmaa	2	3	higher
(FRA) France	(0121) Île-de-France	1	2	higher	(SVK) Slovakia	(0810) Slovakia	2	3	higher
(FRA) France	(0131) Champagne-Ardenne	1	2	higher	(UKI) United K	(0411) England-North	3	4	higher
(HUN) Hungary	(0764) Észak-Magyarország	2	3	higher	(UKI) United K	(0412) England-East	3	4	higher
(ITA) Italy	(0281) Marche	3	4	higher	(UKI) United K	(0413) England-West	3	4	higher
(ITA) Italy	(0292) Abruzzo	3	4	higher	(UKI) United K	(0431) Scotland	3	4	higher

Source: Data processing in SPSS

In the Cluster 4, with the better financial performance, are included farms from the following regions: Germany (3 - Niedersachsen, Nordrhein-Westfalen, Bayern), Spain (Andalucia), Italy (13 - Marche, Abruzzo, Sicilia, Piemonte, Lombardia, Veneto, Friuli-Venezia, Emilia-Romagna, Toscana, Umbria, Molise, Puglia, Basilicata), United K (4 - England-North, England-East, England-West, Scotland), Spain (2 - Cataluna, Comunidad Valenciana) and Ireland. They present in average a higher and increasing labour and capital intensity and they succeeded to reduce all the financial viability indicators. As observed, they present a decrease of financial stress with almost 30% and of indebtedness with over 50% and of financial leverage with almost 65% (Table 9).

Table 9. The main characteristics of clusters in terms of financial viability in 2013 faced with 2009

	1	%	2	%	3	%	4	%
Number	17	-	19	-	34	-	24	-
LI	1.241	**95.03**	1.345	**81.45**	2.472	**97.78**	2.941	107.83
CI	290156.4	**78.51**	400894.7	**125.83**	443805.6	**95.04**	1685641.2	134.07
IO	1.118	**86.41**	1.084	**85.42**	1.012	**82.53**	0.947	88.01
CRS	0.533	**97.87**	0.440	**97.75**	0.381	**100.81**	0.346	99.82
CR	0.805	**83.56**	0.650	**83.88**	0.586	**89.22**	0.507	91.95
FS	0.130	**83.71**	0.156	**88.08**	0.103	**80.97**	0.070	71.37
I	0.391	**120.74**	0.273	**107.30**	0.068	**69.92**	0.029	47.51
L	0.649	**121.93**	0.385	**98.29**	0.078	**61.32**	0.032	35.07

Source: Data processing in SPSS

On the last places (Cluster 1) are the farms from the following regions: Denmark, Bulgaria (Yuzhen tsentralen), Germany (2 - Brandenburg, Mecklenburg-Vorpommern),

France (Alsace, Picardie, Haute-Normandie, Centre, Bourgogne, Lorraine, Franche-Comté, Pays de la Loire, Poitou-Charentes, Aquitaine, Midi-Pyrénées, Languedoc-Roussillon) and Latvia. They have a higher indebtedness (a lower solvency) due to a higher share of liabilities in total assets and their costs are higher compared with their revenues. The farms from Cluster 2 and 3 are very similar, with a medium financial viability.

CONCLUSIONS

Faced with year 2009, only 24 types of farms have really improved their performance comparing with the others and they moved in a superior group of farms and 4 had a lower financial performance. All the others farms maintained their position to the ideal solution. From 94 analysed European types of COP farms, 53 had a medium financial performance, 17 had a lower financial viability and only 24 had a higher financial viability. The evolution of the clusters revealed however an improvement in financial viability with the exception of farms from the first cluster.

REFERENCES

[1]Aggelopoulos, S., Samathrakis, V. and Heocharopoulos, A., 2007, Modelling Determinants of the Financial Viability of Farms. Research Journal of Agriculture and Biological Sciences,3 (6): 896-901

[2]Cimpoieș, L., 2016, CAP direct payments as the main tool to support the EU farmers: an analysis of their implementation based on Spain experience, Theoretical and Scientific Journal Economy and Sociology

[3]Dachin, A., 2016, Production costs of field crops by economic size of farms in Romania. Scientific Papers Series-Management, Economic Engineering in Agriculture and Rural Development, 16(3), pp.103-106

[4]Everitt, B.S., Landau, S., Leese, M., Stahl, D., 2011, Cluster Analysis. 5th edition. John Wiley & Sons

[5]Hair, J.F., Anderson, R.E., Tatham, R.L., & Black, W.C., 1998, Multivariate Data Analysis. Upper Saddle River: Prentice-Hall

[6]Hult, G. T. M., Ketchen, D. J., Chabowski, B. R. et al., 2008, An assessment of the measurement of performance in international business research, Journal of International Business Studies, Vol. 39, No. 2008, pp. 1064 –1080. ISSN 0047-2506

[7]Kuncová, M., Doucek, P., 2011, Comparison of the Cluster Analysis and the Methods of the Multi-criteria Evaluation of Alternatives Used to Create a Groups of Countries Similar in the Take up of the Internet Services, In: Proceedings of the Mathematical Methods in Economics 2011 Conference [CD-ROM]. Prague: University of Economics in Prague, University of Economics in Bratislava. ISBN 978-80-7431-059-1

[8]Lefebvre, M., Nikolov, D., Gomez-y-Paloma, S., Chopeva, M., 2014, Determinants of insurance adoption among Bulgarian farmers. Agricultural Finance Review, 74(3), pp.326-347

[9]Poledníková, E., 2014, Multicriteria analysis of regional disparities in the context of the EU cohesion. In International Colloquium on Regional Sciences. Brno: Masaryk University (pp. 54-61)

[10]Serra, A., 2015. European farmers and agricultural practices, Thesis

[11]Šišková, J., 2015, Application of Multi-Criteria Analysis in the Evaluation of Biogas Plants with Respect to the Stability of the Agricultural System, Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis, Vol. 63, No. 3, pp. 853–860.

[12]Strijker, D., 2005, Marginal Lands in Europe-causes of Decline, Basic and Applied Ecology 6(2): 99-106

[13]Stulpinienė, V., Čiulevičienė, V., Universitety, A.S., 2014, Agricultural Support Influence On Farm Financial Stability. Economy & Business Journal, 8(1), pp.936-946

[14]Vlad, M., Tudor, V., Stoian, E., Micu, M.M., 2015, Farms regional economic developments identified in the FADN panel, Proceedings of the Symposium on Agrarian Economy and Rural Development: Realities and Perspectives for Romania, pp. 128

[15]Vrolijk, H. C. J., De Bont, C. J. A. M., Blokland, P. W., Soboh, R. A. M. E., 2010, Farm viability in the European Union: assessment of the impact of changes in farm payment, LEI Wageningen UR

[16]Yalcin, N., Bayrakdaroglu, A., Kahraman C., 2012, Application of fuzzy multi-criteria decision making methods for financial performance evaluation of Turkish manufacturing industries, Expert Systems with Applications, Vol. 39, No. 1, pp. 350–364

[17]Yang, H., Yeung, J. F. Y., Chan, A. P. C., et. al., 2010, A critical review of performance measurement in construction, Journal of Facilities Management, Vol. 8, No. 4, pp. 269–284.