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An empirical study of the sheep meat production with fuzzy logic

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Abstract

In this paper, an effort was made in order to classify the European Union (EU) countries according to the quantity of the sheep meat production. In particular, the implementation of Fuzzy classification, indicated three sheep meat production classes in EU, according to their percentage of accession. Furthermore, the convergence in the sheep meat production for the same group with the application of a panel unit root test was studied. The next step involved the application of a unit root test to each time series studied. For all the I(1) time series we then proceeded the application of the Johansen cointegration technique within each group. According to the results of the aforementioned technique we confirmed one cointegrating vector in every group, indicating a relation in the long run between the domestic production of each country within each group. Finally, the application of Granger causality test confirmed in some cases that the domestic sheep meat production of a country affects and is affected by other countries within the same group.

Keywords: European Union, Granger causality, Fuzzy classification, sheep meat production.

INTRODUCTION

The Fuzzy Logic Theory (Zadeh, 1965) has been applied in many scientific areas, such as in the environmental science (Kouncheva et al., 2000; Dubois and Prade, 1985; 1997; Yager and Filev, 1994; Grabisch, 1995), in the fish stock management (Chen et al., 2000; Karr, 1991; Kosko, 1993; Mackinson et al., 1999; Takagi and Sugeno, 1983; Welstead, 1994), in medicine (Dubois, Prade and Testemale, 1988) and others. The Fuzzy expected intervals have been applied in time series modelling. This method provides a reliable tool for short term forecasts in fish production (Koutroumanidis et al., 2006). Furthermore, the Fuzzy classification system (F.C.S.) based on the Fuzzy Membership Function (Chen et al., 2000) was used for the classification of the wine producer countries of the European Union within the time period 1961 - 2002 (Koutroumanidis, 2005) . Fuzzy logic has also been used for the classification of the agricultural cooperatives for the year 2000 (Koutroumanidis et al., 2004) while Iliadis et al. (2003),calculated the Fuzzy expected interval (F.E.I.) for the prices of the wood industries in Greece and based on those they classified the firms for the year 2000. Furthermore, the hypothesis of convergence has been a subject to numerous studies with the application of different econometric tools (McCosky, 2002). The regional convergence in the agricultural sector has been surveyed by Ball et al. (2001), while Rezitis (2009), has studied convergence across Europe with the application of unit root tests in panel data.

Granger causality test is another method introduced by Granger (1969), that has been very helpful in studying causality among different economic variables (Sims, 1972; Geweke, 1984). The Granger causality test has not been widely used in the agricultural sector though.

The present paper aims to examine the evolution of the sheep meat production in different countries of EU during the period 1961 - 2006, to make a classification of those countries using a fuzzy classification system and to study the integration of the sheep meat market within each group as well as the existence of bivariate causality in

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these groups

The role of cap in the volatility of sheep meat production

The economics of the sheep farming has not been extensively a subject of study in the past. Different models have been structured in order to study the economics of sheep farming. One of them was introduced by Stokhonft (2008), who considered sheep as capital held by farmers as long as their capital value exceeds their slaughter, or meat, value. Farmers are therefore portfolio managers aiming to find the optimal combination of different categories of animals. Yields are compared to the yields from other assets.

The productivity in the sheep sector within the European Union was slightly studied, given the great diversity and the low political weight of this sector in European level. Thus, it is of great importance to carry out European analyses of this sector (Canali, 2006).

European sheep production represents important economic environmental and sociological issues (de Rancourt et al., 2006). As confirmed in the same study, the most important characteristic of the sheep meat production in E.U. is the dependence of meat systems on subsidies. Additionally, the CAP reform plays an extremely important role in the subsidies, making the paths to success rather uncertain considering this new reform.

Nevertheless, de Rancourt et al. (2006), have identified different ways that the CAP reform progress according to systems and regions. Thus the present paper makes an effort to classify the different European countries according to the sheep meat production. This will enable the policy makers to make forecasts on the effectiveness of the CAP reform as well as regarding the general future in the sector of sheep meat production.

FUZZY CLASSIFICATION

The main objective of this study is to develop and apply a fuzzy logic model, based on the sheep meat production of the countries of the EU.

To be more specific, we rank the 'degree of membership' of each country of the EU in the Low (L), Middle low (ML), Middle high (MH) and High (H) sheep meat productivity status, thus producing an indirect sheep meat classification system.

We then consider a set,

$$S=\{s_1, s_2 ,....,s_n\}$$

where n = 20 the sheep meat production countries and $x(s_i)$ the sheep meat production of each s_i - country, i = 1,2,….,20. Sheep meat production of the s_i - country is non-dimensionalised by applying:

$$z_i = z\{x(s_i)\} = \frac{x(s_i) - \min\{x(s_k)\}}{\max_k\{x(s_k)\} - \min_k\{x(s_k)\}} \quad (1)$$

where k = 1,2,….,20.

This process transforms sheep meat production $x(s_i)$ into z_i, where $z_i \in [0, 1]$ and we define the value $k(z_i)$, as;

$$k\{z_i\} = \frac{z^{20}_{i\ i}}{20} \quad (2)$$

General definition Of Fuzzy membership degree

A fuzzy set F on a universe of discourse X by a membership F taking its values on the continual interval [0, 1].

1. If x does not belong to F Membership degree F(x) = 0

2. If x belongs entirely to F Membership degree F(x) = 1

3. If x belongs partially to the fuzzy set F Membership degree 0 < F(x) <1

The Fuzzy Membership Function which defines the fuzzy membership degree is given on Figure 1.

According to the Fuzzy membership function (Chen et al., 2000), each value z_i for each the s_i - country and for each year corresponds to the values $L(z_i)$, $ML(z_i)$ or $H(z_i)$, $MH(z_i)$ is as follows:

if $z_i < k\{z_i\}$ then z_i corresponds to $L(z_i)$ and $ML(z_i)$ as:

$L(z_i) + ML(z_i) = 1$

where;

$$\mu_L(z_i) = 1 - \frac{1}{k} z_i \quad \text{and} \quad \mu_{ML}(z_i) = \frac{1}{k} z_i \quad (3)$$

if $z_i > k$ then z_i corresponds to $H(z_i)$ and $MH(z_i)$ as:

$H(z_i) + MH(z_i) =$

1, where;

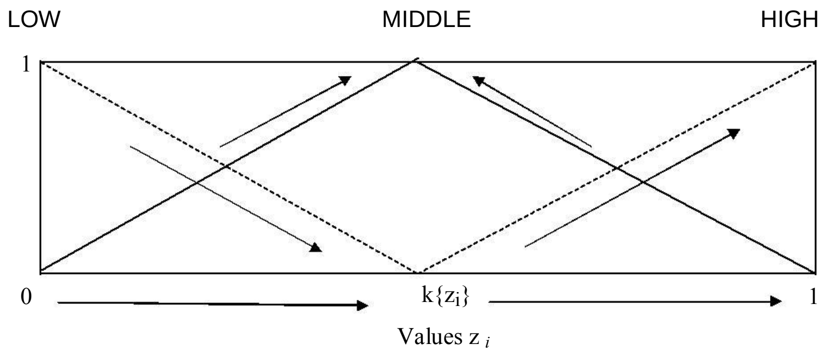

Figure 1. Definition of Fuzzy membership degree.

Table 1. Mean value and standard deviation of the proportion of the participation of the first group in the production classes MH and H .

Countries	MH		H	
	Average	SD	Average	SD
France	0.68	0.13	0.32	0.14
Greece	0.70	0.10	0.30	0.10
Italy	0.75	0.08	0.25	0.08
Spain	0.06	0.09	0.94	0.09
UK	0.07	0.11	0.93	0.11

$$\mu_H(z_i) = \frac{1}{1-k} \quad (z_i - k)$$

and

$$\mu_{MH}(z_i) = \frac{1}{k-1}(z_i - 1) \qquad (4)$$

if z_i = k then z_i corresponds to (z_i) =1.

Following the procedure described above, the sheep meat production $x(s_i)$ is transformed to a local class membership degree ($_L(z_i)$, $_{ML}(z_i)$) or ($_H(z_i)$ and $_{MH}(z_i)$) which corresponds to Low (L) and Middle Low (ML) or Middle High (MH) and High (H) sheep meat production classes of the EU.

The data employed in this paper concern the annual production (PR) (tonne) of sheep meat of the EU for the time period 1961 - 2006 (FAOSTAT) for twenty countries and for all the countries in EU with exception the countries of Latvia, Slovenia, Slovakia, Czech Republic, Estonia and Lithuania for which there are no sufficient data. The data for Belgium and Luxemburg are studied together for the time period 1961 - 1999 (FAOSTAT).The results of the Fuzzy classification (FC) have indicated three groups of countries having as a criterion their production classes of the EU, accompanied by the following prices ($_L(z_i)$, $_{ML}(z_i)$) or ($_{MH}(z_i)$ and $_H(z_i)$).

France, Greece, Italy, Spain and United Kingdom participate as a percentage in the MH and H levels of sheep meat production, during the period 1961 - 2006, as they are formulated within the EU.

The second group involves two transition economies Bulgaria, Romania for which we are aware of the fact that Bulgaria belongs to the (MH and H) production class during the period 1961 - 1987 and in (L and ML) production class during the time periods 1988 - 1993 and 2003 - 2006 given the fact that the data for the time period 1994 - 2002 are not available. Regarding Romania with exception the year 2002 during which it belongs to the (L and ML), class production for all the other time period under preview Romania belongs to (MH and H) production class.

Finally, the third group involves the countries Austria, Belgium-Luxembourg, Cyprus, Denmark, Finland, Germany, Ireland, Netherlands, Norway, Poland, Portugal, Sweden, Hungary. The main feature of this group is that all countries belong to the production class (L and ML) during the whole time period 1961 - 2006. Tables (3 - 5) present the mean and the standard deviation of the proportions of participation of each country in the production groups. According to the results of the Table 1 Spain diversifies from the rest countries of the group given the fact that the participation percentage in the production class is only 0.06 while in is approximately 0.94, contrary to the other countries that present high percentages of participation in class and low percentages in class.

According to the results of the Table 3, Finland and Germany diversify from the rest countries of the group given the fact that the percentages of their participation in L class are only 0.06 and 0.07 respectively, while in ML class are high, 0.94 and 0.93 respectively.

Furthermore, Ireland and Portugal consist a special participation to (L and ML) or (MH and H) sheep meat group given the fact that they present participation

Table 2. Mean and standard deviation of the percentages of the participation of the countries of the second group in MH and H, ML and L production classes.

Countries	MH		H	
	Average	sd	Average	sd
Bulgaria	0.68	0.13	0.32	0.14
Romania	0.70	0.10	0.30	0.10
	L		ML	
	Average	sd	Average	sd
Bulgaria	0.75	0.11	0.25	0.11
Romania	0.82	0.09	0.18	0.09

Table 3. Mean and standard deviation of the percentages of the participation of the countries of the first group in MH and H production classes.

	L		ML	
	Average	SD	Average	SD
Austria	0.68	0.13	0.32	0.14
Belg-Lux	0.70	0.10	0.30	0.10
Cyprus	0.75	0.08	0.25	0.08
Denmark	0.06	0.09	0.94	0.09
Finland	0.07	0.11	0.93	0.11
Germany	0.33	0.20	0.67	0.18
Ireland	0.86	0.04	0.14	0.04
Netherlands	0.71	0.03	0.29	0.03
Norway	0.71	0.13	0.29	0.13
Poland,	0.44	0.12	0.56	0.12
Portugal	0.95	0.02	0.05	0.03
Sweden	0.90	0.07	0.10	0.07
Hungary	0.68	0.13	0.32	0.14

Source: FAOSTAT

percentages of medium size in L class (0.33, 0.44) as well as in ML class (0.67, 0.56).

UNIT ROOT AND COINTEGRATION TEST

The fuzzy classification as mentioned above separated the countries of European Union in three main groups. Our analysis will be completed with the application of Im et al. (2003), unit root test, the application of ADF unit root test on each individual time series, the application of Johansen cointegration technique (1991)and will be terminated with Granger causality test. All these econometric tools were chosen in order to survey the integration and the cointegration in the domestic production within each group. Furthermore, the Granger causality test is a useful and reliable econometric tool for the survey of interrelationships in the domestic sheep meat production for every group.

The unit root test

The next step in our analysis is the application of a unit root test. The particular test examines the existence of a unit root in the individual time series of the domestic production of each group. The method used was introduced by Im et al. (2003). The unit root test was applied in panel data in levels and in first differences. The results of this test are given in Table 4.

According to the results of the unit root test the null hypothesis cannot be rejected for every significance level (5, 1, 10%) in the first and in the second group when the time series under preview are in levels. Regarding the third group, non - stationarity is confirmed for 5% significance level, while the null hypothesis is rejected for 10% significance level. When the time series studied are in levels then the null hypothesis cannot be rejected implying the non stationarity of the individual process for the first two groups, while the opposite is valid for the third group. The stationarity in the third group implies integration in the sheep meat market within this group. The next step involves the stationarity test for each time series studied. For each country we implement KPSS stationarity test, in orde r to examine the rank of integration for each time series of each group. The results of this test have indicated that all time series are I(1) within the first and the second group, implying that all the time series used are nonstationary in levels and stationary in first differences. Regarding the third group most of the time series are I(1) including the following countries; Austria, Finland, Norway, Sweden, Ireland, Netherlands and Portugal. The rest of them are I(0). The process that followed was the implementation of the Johansen cointegration technique.

The Johansen cointegration technique

As mentioned above, the cointegration test was applied only for the I(1) time series (for those that are non-stationary in levels and stationary in first differences). Consequently the Johansen cointegration technique was applied For all three groups. The results of the cointegration test regarding the first and the second group are given in the following Tables 5 and 6 and 7 respectively.

According to the results of both statistics applied regarding the first group no cointegration was validated and consequently there is no interrelationship between the countries of the first group. According to the results of the trace as well as of the maximum Eigen value statistic in the case of the second group, no cointegration was validated and consequently no interrelationship between the domestic production of the two transition economies can be confirmed.

According to the results of the first test, five co-integrating equations have been confirmed while the second test indicated only one cointegrating equation at 5% level of

Table 4. Results of unit root test for the domestic production of the three groups (panel data for every group).

Im. Pesaran and Shin statistic	Prob	Group
- 0.1343	0.4467	First group (in levels)
- 11.7356	0.000	First group (in first differences)
0.08896	0.5354	Second group(in levels)
- 12.0872	0.000	Second group (in first differences)
- 1.37173	0.0851	Third group (in levels)
- 19.6547	0.000	Third group (in first differences)

Table 5. Results of cointegration test for the first group.

Unrestricted cointegration rank test (Trace)				
Hypothesized no. of CE(s)	**Eigen value**	**Trace statistic**	**0.05 Critical value**	**Prob.****
r = 0	0.437796	63.72269	69.81889	0.9391
$r \leq 1$	0.353476	38.38353	47.85613	0.2855
$r \leq 2$	0.185733	19.19316	29.79707	0.4791
$r \leq 3$	0.123869	10.15259	15.49471	0.2692
$r \leq 4$	0.093805	4.334047	3.841466	0.0374
Unrestricted cointegration rank test (maximum Eigen value)				
Hypothesized no. of CE(s)	**Eigen value**	**Max-Eigen statistic**	**0.05 Critical value**	**Prob.****
r = 0	0.437796	30.33916	33.87687	0.2424
$r \leq 1$	0.353476	19.19037	27.58434	0.4000
$r \leq 2$	0.185733	9.040567	21.13162	0.8291
$r \leq 3$	0.123869	5.818547	14.26460	0.6366
$r \leq 4$	0.093805	4.334047	3.841466	0.0374

Table 6. Results of cointegration test for the second group.

Unrestricted cointegration rank test (Trace)				
Hypothesized no. of CE(s)	**Eigen value**	**Trace statistic**	**0.05 Critical value**	**Prob.****
r = 0	0.102744	13.873172	15.49471	0.7135
$r \leq 1$	0.008914	0.295492	3.841466	0.5867
Unrestricted cointegration rank test (maximum Eigen value)				
Hypothesized no. of CE(s)	**Eigen value**	**Max-Eigen statistic**	**0.05 Critical value**	**Prob.****
r = 0	0.102744	11.577680	14.26460	0.2410
$R \leq 1$	0.008914	0.295492	3.841466	0.5867

Table 7. Results of cointegration test for the third group.

Unrestricted cointegration rank test (Trace)				
Hypothesized no. of CE(s)	**Eigen value**	**Trace statistic**	**0.05 Critical value**	**Prob.****
r =0	0.698599	174.7158	125.6154	0.0000
$r \leq 1$	0.578415	123.1453	95.75366	0.0002
$r \leq 2$	0.501713	86.00476	69.81889	0.0015
$r \leq 3$	0.445767	56.05187	47.85613	0.0070
$r \leq 4$	0.360986	30.67452	29.79707	0.0395
$r \leq 5$	0.221271	11.41791	15.49471	0.1871
$r \leq 6$	0.015322	0.663924	3.841466	0.4152
Unrestricted cointegration rank test (maximum Eigen value)				
Hypothesized no. of CE(s)	**Eigen value**	**Trace statistic**	**0.05 Critical Value**	**Prob.****
r = 0	0.698599	51.57048	46.23142	0.0123
$r \leq 1$	0.578415	37.14057	40.07757	0.1033
$r \leq 2$	0.501713	29.95289	33.87687	0.1371
$r \leq 3$	0.445767	25.37734	27.58434	0.0933
$r \leq 4$	0.360986	19.25662	21.13162	0.0896
$r \leq 5$	0.221271	10.75398	14.26460	0.1670
$r \leq 6$	0.015322	0.663924	3.841466	0.4152

significance.

The Granger causality test

The final step of our survey involves the implementation of the Granger causality test among the countries that belong in the same group in order to survey the existence of bilateral interrelationships in the sheep meat production production within the each group. As it is well known all the countries that belong in the European Union are subject to a regime of subsidies and S.F.P. within the Common Agricultural Policy. The application of a unit root and a cointegration test is significant in order to survey the existence of interrelationships in the domestic production within the same group.

The result of this test can be helpful for the policy makers in order to decide whether there should be diversity in the policies implemented in every country of the E.U. in order convergence within the same group (given that they have the same production capacity) in the sheep meat production to be achieved.

The results of the Granger causality test for the first group are given on Table 8. According to the results of the Granger causality test the domestic production of France Granger causes the domestic production of all the other countries whereas as the opposite is not valid (for significance level 5%). Furthermore, the domestic sheep meat production Granger causes the domestic production of Spain as well as that of United Kingdom. Greece in sheep meat is being Granger caused by the production in Austria, Germany and Netherlands countries with which belong in the same first group (MH and H levels of sheep meat production). The existence of Granger causality and the rejection of cointegration between the domestic production of the countries of the third group implies weak exogeneity of the domestic production of the countries mentioned above on the others.

Finally, the domestic sheep meat production of Spain Granger causes the domestic production of Greece without the opposite to be in valid. Consequently, although the countries examined above are the leaders in the sheep meat production no interrelationship between them can be confirmed. This result implies that the decisions for the quantity of the sheep meat production are not affected by the bilateral relationship of those two countries.

The Granger causality test was also implemented for two transition economies that have become recently members of the European Union, Romania and Bulgaria

Table 8. Granger causality test for the first group.

Null hypothesis	F-statistic	Probability
Greece does not Granger cause France	1.90059	0.16307
France does not Granger cause Greece	5.83058	0.00609
Italy does not Granger cause France	1.20293	0.31121
France does not Granger cause Italy	4.02660	0.02572
Spain does not Granger cause France	4.97938	0.01186
France does not Granger cause Spain	5.77942	0.00633
U.K. does not Granger cause France	1.14056	0.33007
France does not Granger cause U.K.	3.68621	0.03417
Italy does not Granger cause Greece	1.47966	0.24022
Greece does not Granger cause Italy	0.26287	0.77019
Spain does not Granger cause Greece	3.16671	0.05316
Greece does not Granger cause Spain	0.39498	0.67636
U.K. does not Granger cause Greece	0.53298	0.59107
Greece does not Granger cause U.K.	1.44658	0.24772
Spain does not Granger cause Italy	0.38247	0.68471
Italy does not Granger cause Spain	3.52504	0.03915
U.K. does not Granger cause Italy	0.97438	0.38642
Italy does not Granger cause U.K.	4.02818	0.02569
U.K. does not Granger cause Spain	2.10737	0.13519
Spain does not Granger cause U.K.	1.55459	0.22409

All the variables are in first differences.

Table 9. Results of the Granger causality test within the second group.

Null hypothesis	F-statistic	Probability
Romania does not Granger cause Bulgaria	0.91024	0.41401
Bulgaria does not Granger cause Romania	0.71118	0.49972

All the variables are in first differences.

Bulgaria. Those two countries enjoy a favorable for them regime since the European Union intends to amplify the productivity of those countries as well as to exercise protectionism against their production. The results of this test are given in Table 9. According to the results of Table 9 within the second group of transition economies also no interrelationship between the sheep meat production according to the results of the Granger causality test can be concluded.

Finally the same test was implemented for the countries of the third group in which belongs the majority of European countries. The results of this test are given in the Table 10. According to the aforementioned results of the Granger causality test applied, within the third group a unidirectional relationship with direction from Austria to Cyprus, Denmark, Ireland and Norway was confirmed, whereas the vice versa relationship is valid for Germany, Hungary and Sweden. Furthermore, a unidirectional relationship from Belgium – Luxemburg to Ireland as well as to Sweden. Additionally, a interrelationship in the sheep meat production was confirmed from Finland and Portugal to Cyprus while at the same time a bi - directional relationship among Germany and Cyprus.

The Granger causality test has confirmed the existence of unidirectional relationships in the domestic production with direction from Denmark to Sweden, from Finland to Hungary, from Finland to Sweden, from Germany to Ireland, from Germany to Portugal and to Sweden, from Netherlands to Hungary, from Hungary to Portugal, from Sweden to Hungary, from Norway to Portugal to Ireland, Ireland to Sweden, Netherlands to Portugal, finally from Norway and Portugal to Sweden.

All the results based on the Granger causality test have shown that the domestic sheep meat production of countries of the same capacity (that belong in the same group),affect the domestic production of the other countries (are weak exogenous with exception those of the third group) and consequently lags of those help in making forecasts for the present value of the domestic production.

Table 10: Results of the Granger causality test within the third group

Null hypotheses	F-Statistic	Probability
BELGI_LU does not Granger Cause AUSTRIA	0.3005	0.74218
AUSTRIA does not Granger Cause BELGI_LU	0.53468	0.591
CYPRUS does not Granger Cause AUSTRIA	1.18857	0.31573
AUSTRIA does not Granger Cause CYPRUS	3.23759	0.05031
DENMARK does not Granger Cause AUSTRIA,	1.24519	0.29908
AUSTRIA does not Granger Cause DENMARK	2.74290	0.07681
FINLAND does not Granger Cause AUSTRIA	1.03918	0.36333
AUSTRIA does not Granger Cause FINLAND	2.07182	0.13960
GERMANY does not Granger Cause AUSTRIA	5.85927	0.00596
AUSTRIA does not Granger Cause GERMANY	0.43734	0.64888
HUNGARY does not Granger Cause AUSTRIA	3.49898	0.04511
AUSTRIA does not Granger Cause HUNGARY	1.27715	0.29575
IRELAND does not Granger Cause AUSTRIA	0.53587	0.58940
AUSTRIA does not Granger Cause IRELAND	4.33081	0.02002
NETHERLA does not Granger Cause AUSTRIA,	0.70846	0.49863
AUSTRIA does not Granger Cause NETHERLA	3.28596	0.04799
NORWAY does not Granger Cause AUSTRIA,	0.41073	0.66600
AUSTRIA does not Granger Cause NORWAY	4.28609	0.02077
PORTUGAL does not Granger Cause AUSTRIA,	2.05142	0.14220
AUSTRIA does not Granger Cause PORTUGAL	2.46795	0.09790
SWEDEN does not Granger Cause AUSTRIA ,	4.21232	0.02206
AUSTRIA does not Granger Cause SWEDEN	3.66092	0.03491
CYPRUS does not Granger Cause BELGI_LU	0.12676	0.88138
BELGI_LU does not Granger Cause CYPRUS	0.76775	0.47241
DENMARK does not Granger Cause BELGI_LU,	1.99069	0.15316
BELGI_LU does not Granger Cause DENMARK	0.40999	0.66709
FINLAND does not Granger Cause BELGI_LU	1.45570	0.24827
BELGI_LU does not Granger Cause FINLAND	0.71287	0.49786
GERMANY does not Granger Cause BELGI_LU,	0.32848	0.72242
BELGI_LU does not Granger Cause GERMANY	0.26858	0.76617
HUNGARY does not Granger Cause BELGI_LU,	0.41928	0.66224
BELGI_LU does not Granger Cause HUNGARY	1.74945	0.19532
IRELAND does not Granger Cause BELGI_LU	0.65670	0.52541
BELGI_LU does not Granger Cause IRELAND	2.69887	0.08258
NETHERLA does not Granger Cause BELGI_LU	2.41093	0.10585
BELGI_LU does not Granger Cause NETHERLA	0.15511	0.85696
NORWAY does not Granger Cause BELGI_LU	1.35823	0.27154
BELGI_LU does not Granger Cause NORWAY	0.10291	0.90250
PORTUGAL does not Granger Cause BELGI_LU	1.12680	0.33659
BELGI_LU does not Granger Cause PORTUGAL	1.76101	0.18812
SWEDEN does not Granger Cause BELGI_LU	1.22015	0.30855
BELGI_LU does not Granger Cause SWEDEN	5.17360	0.01130
DENMARK does not Granger Cause CYPRUS	0.50834	0.60553
CYPRUS does not Granger Cause DENMARK	0.18350	0.83309
FINLAND does not Granger Cause CYPRUS	3.17545	0.05306
CYPRUS does not Granger Cause FINLAND	0.09224	0.91209

Table 10. Contd

GERMANY does not Granger Cause CYPRUS	3.74944	0.03265
CYPRUS does not Granger Cause GERMANY	6.08389	0.00510
HUNGARY does not Granger Cause CYPRUS	0.91695	0.41277
CYPRUS does not Granger Cause HUNGARY	0.46498	0.63347
IRELAND does not Granger Cause CYPRUS	2.02195	0.14640
CYPRUS does not Granger Cause IRELAND	0.35594	0.70283
NETHERLA does not Granger Cause CYPRUS	1.77453	0.18333
CYPRUS does not Granger Cause NETHERLA	0.65374	0.52585
NORWAY does not Granger Cause CYPRUS	1.17925	0.31851
CYPRUS does not Granger Cause NORWAY	1.08689	0.34752
PORTUGAL does not Granger Cause CYPRUS	2.88240	0.06831
CYPRUS does not Granger Cause PORTUGAL	0.03649	0.96420
SWEDEN does not Granger Cause CYPRUS	0.49316	0.61455
CYPRUS does not Granger Cause SWEDEN	1.69637	0.19694
FINLAND does not Granger Cause DENMARK	0.25491	0.77627
DENMARK does not Granger Cause FINLAND	0.25699	0.77468
GERMANY does not Granger Cause DENMARK	1.85963	0.16928
DENMARK does not Granger Cause GERMANY	0.57435	0.56776
HUNGARY does not Granger Cause DENMARK	1.84258	0.17850
DENMARK does not Granger Cause HUNGARY	1.28927	0.29250
IRELAND does not Granger Cause DENMARK	1.78540	0.18117
DENMARK does not Granger Cause IRELAND	0.09157	0.91269
NETHERLA does not Granger Cause DENMARK	0.76552	0.47195
DENMARK does not Granger Cause NETHERLA	0.49957	0.61062
NORWAY does not Granger Cause DENMARK	1.26156	0.29451
DENMARK does not Granger Cause NORWAY	0.74884	0.47959
PORTUGAL does not Granger Cause DENMARK	1.89130	0.16446
DENMARK does not Granger Cause PORTUGAL	0.30369,	0.73982
SWEDEN does not Granger Cause DENMARK	0.34219	0.71233
DENMARK does not Granger Cause SWEDEN	5.41415	0.00841
GERMANY does not Granger Cause FINLAND	1.14561	0.32850
FINLAND does not Granger Cause GERMANY	0.80073	0.45624
HUNGARY does not Granger Cause FINLAND	1.88128	0.17256
FINLAND does not Granger Cause HUNGARY	2.64277	0.09020
IRELAND does not Granger Cause FINLAND	0.97082	0.38774
FINLAND does not Granger Cause IRELAND	0.26319	0.76995
NETHERLA does not Granger Cause FINLAND	1.44667	0.24770
FINLAND does not Granger Cause NETHERLA	1.22386	0.30514
NORWAY does not Granger Cause FINLAND	0.18632	0.83074
FINLAND does not Granger Cause NORWAY	1.84492	0.17157
PORTUGAL does not Granger Cause FINLAND	0.37666	0.68862
FINLAND does not Granger Cause PORTUGAL	0.63244	0.53665
SWEDEN does not Granger Cause FINLAND	1.05232	0.35883
FINLAND does not Granger Cause SWEDEN	3.14991	0.05394
HUNGARY does not Granger Cause GERMANY	1.55675	0.22984
GERMANY does not Granger Cause HUNGARY	1.35626	0.27525
IRELAND does not Granger Cause GERMANY	0.16519	0.84832

Table 10. Contd

GERMANY does not Granger Cause IRELAND	2.47329	0.09744
NETHERLA does not Granger Cause GERMANY	0.62419	0.54096
GERMANY does not Granger Cause NETHERLA	1.33956	0.27375
NORWAY does not Granger Cause GERMANY	0.25371	0.77719
GERMANY does not Granger Cause NORWAY	6.57317	0.00347
PORTUGAL does not Granger Cause GERMANY	0.09245	0.91189
GERMANY does not Granger Cause PORTUGAL	7.66957	0.00155
SWEDEN does not Granger Cause GERMANY	1.91675	0.16069
GERMANY does not Granger Cause SWEDEN	5.04140	0.01129
IRELAND does not Granger Cause HUNGARY	1.94313	0.16350
HUNGARY does not Granger Cause IRELAND	0.75949	0.47801
NETHERLA does not Granger Cause HUNGARY	3.60283	0.04158
HUNGARY does not Granger Cause NETHERLA	1.68068	0.20586
NORWAY does not Granger Cause HUNGARY	1.11375	0.34349
HUNGARY does not Granger Cause NORWAY	1.26479	0.29910
PORTUGAL does not Granger Cause HUNGARY	0.07798	0.92520
HUNGARY does not Granger Cause PORTUGAL	5.84854	0.00799
SWEDEN does not Granger Cause HUNGARY	2.62006	0.09192
HUNGARY does not Granger Cause SWEDEN	0.11187	0.89459
NETHERLA does not Granger Cause IRELAND	0.28998	0.74988
IRELAND does not Granger Cause NETHERLA	1.14053	0.33008
NORWAY does not Granger Cause IRELAND	3.17358	0.05285
IRELAND does not Granger Cause NORWAY	0.77528	0.46754
PORTUGAL does not Granger Cause IRELAND	6.51156	0.00363
IRELAND does not Granger Cause PORTUGAL	1.60008	0.21485
SWEDEN does not Granger Cause IRELAND	0.85699	0.43227
IRELAND does not Granger Cause SWEDEN	5.63148	0.00710
NORWAY does not Granger Cause NETHERLA,	0.04008	0.96076
NETHERLA does not Granger Cause NORWAY	2.41314	0.10279
PORTUGAL does not Granger Cause NETHERLA	1.03474	0.36487
NETHERLA does not Granger Cause PORTUGAL	2.92158	0.06572
SWEDEN does not Granger Cause NETHERLA	0.20568	0.81497
NETHERLA does not Granger Cause SWEDEN	0.42687	0.65556
PORTUGAL does not Granger Cause NORWAY	1.39861	0.25905
NORWAY does not Granger Cause PORTUGAL	2.23154	0.12090
SWEDEN does not Granger Cause NORWAY	1.86458	0.16851
NORWAY does not Granger Cause SWEDEN	5.03634	0.01133
SWEDEN does not Granger Cause PORTUGAL	1.59664	0.21553
PORTUGAL does not Granger Cause SWEDEN	3.31705	0.04673
PORTUGAL does not Granger Cause NORWAY	1.39861	0.25905
NORWAY does not Granger Cause PORTUGAL	2.23154	0.12090

All the variables are in first differences.

CONCLUSION

The EU plays worldwide an important role in the sheep meat production. According to the Meat and Livestock Commission (MLC) for many years the EU was the largest producer of sheep and goat meat in the world. The declining trend of the average production since 1990 can be attributed to the reform of the CMO in 1992. Nowadays, China is the leader in the sheep meat production. Additionally, the sheep meat production does not play an equal role for all the European countries. In particular, Sheep and goat farming is therefore of much greater economic importance to the peripheral southern and north western Member States of the EU than to the central and north eastern ones (SAC, 1999).

The present study applies Fuzzy Classification which is proved to be a very useful tool of classification for the EU countries. The Fuzzy classification model has the ability to enrol simultaneously as a percentage each country in the two levels of sheep production in the EU (in the L - ML level or in the MH - H). Thus, we can depict real position of each country compared to the other countries for the different sub - periods within the whole time period studied. Simultaneously, with the medium percentage of integration and the standard deviation we can observe the behaviour of integration of each country in each productive level.

Furthermore, we applied the unit rood test of Im et al. (2003), with which we surveyed the integration of the market within each group. In the next stage we examined the stationarity of the individual time series in order to confirm whether they are I(1). For all the times series that were confirmed as I(1), we applied the Johansen cointegration technique within each group based on the Fuzzy classification system. The application of the panel unit root test confirmed nonstationarity in levels and stationarity in first differences for the data of the first and the second group. The unit root test of Im et al. (2003), though indicated stationarity of the third group in 10% level of significance and consequently, integration of the sheep meat market for the countries in the low production group (third group). Regarding the results of the application of the ADF test on each individual time series of the sheep meat production, we confirmed that the majority of them is I(1). Regarding the application of the Johansen cointegration technique for the first two groups validated no cointegration in both groups, while at the same time the Granger causality test indicated that the domestic sheep meat production in some countries of the E.U. Granger cause the domestic production of the others in the same group implying weak exogeneity of the domestic production of some countries on the others. The same result is not valid for all the groups and for all the countries within the group. Lack of convergence in the sheep meat production for each individual group (the first and the second) implies the diversity in the policies that have to be imposed concerning the economic aid to the domestic producers. Furthermore, the measure of decoupling from the production in the small ruminant sector will probably not affect in a similar way the countries of the same group and consequently the effectiveness of this measure does not imply a certain result in countries that belong in different groups.

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