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Geographical development of agricultural entrepreneurship: The case of pig farming in Greece

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This paper focused on the spatial and typological analysis of the economic activities of a major entrepreneurial sector of agricultural economy: pig farming. By applying the K-Mean Cluster analysis methodology, the "profile" of various pig farms was studied, regarding the geographical region, corporate structure, educational level of their owners and the type of invested capital. The K-Mean Cluster analysis results indicated that there were three clusters of farms that verified its criteria. The farms in first cluster were mainly active in the regions of Western Thessaly and the area of Evia-Viotia. The majority was family farms, which had not yet invested in the modernisation of their fixed assets, and this led to a high cost of use of the said assets. The farms in second cluster were active in the regions of Central Thessaly, Attica and Viotia. They were shareholder enterprises, and attained the best financial results compared to the other clusters. These farms combined a high productivity rate with investments in a more rational exploitation of their fixed assets. The farms in third cluster were active in Eastern Thessaly, Etoloakarnania, Attica and Viotia, and were also shareholder enterprises. They presented a high rate of modernisation, but still required investments of a higher quality in order to improve their performance.

Key words: Pig farms, agricultural investments, financing, K-mean cluster analysis.

INTRODUCTION

The theories that have occasionally made regarding the siting of economic activities allow a deeper understanding of the relations and interdependencies that determine the installation of various economic activities in space, aiming at the social and economic development of different regions (Lambrianidis, 1992; Kostov and McErlean, 2006). On this basis, changes are put into effect regarding the spatial distribution of economic activities, according to the new economic conditions under formulation, and the various tools used for their implementation (regional development incentives, financing policies, taxation) (Barnes et al., 2007).

The development of typologies, e.g. through Cluster Analysis (Hair et al., 1995; Coakes and Steed, 1999), helps to promote such groups or enterprise clusters, that share common or similar characteristics, have the same requirements as regards production coefficients, experience common problems in developing their activities etc. Typology development is based on recording data pertaining to various enterprises, mainly through the use of a questionnaire (Aldenderfer and Blashfield, 1984).

Pig farming is one of the most important rural economy sectors in the EU, since the EU is the second largest "producer" after China, with an annual pork production volume of 21.6 mil tonnes (Eurostat, 2008). Pig farming is also the most business-oriented sector, as regards animal farming in Greece. Its share in the gross value of animal production in Greece is estimated at 10%. In addition, pig farming accounts for 25% of the domestic meat production volume and, during the period, 1990-2006, covered 33% of the country's pork consumption

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requirements (Ministry of Rural Development and Food, 2008).

The present paper focuses on a siting and typological analysis of pig farming activities in Greece and the definition of similar units-clusters, based on socio-economic parameters. Such a typological analysis is considered to be particularly timely, since its results can lead to a more rational distribution and use of the available production coefficients, based on the comparative advantages of each region. Furthermore, through the definition of the clusters, the individual needs of the pig farms are identified as regards financing or support for their development, based on their economic profile.

The objective of this paper is to use cluster analysis in order to examine the extent to which the pig farms "resemble" one another, according to certain economic parameters, and form units-clusters that share the same characteristics and have a clear spatial orientation. For this purpose, the pig farms are classified in accordance to their capacity, livestock value, gross revenue, total feeding costs, and the payments for land-buildings and mechanological equipment (annual expenses). Following this, the "profile" of the clusters is examined based on their geographical region of activity, corporate structure, the educational level of their owners, and the type and form of invested capital. The above parameters are particularly significant, since they play a major role in shaping the cost of production, and also determine the sector's productivity, competitiveness and growth potential.

MATERIALS AND METHODS

The most important pig farms in Greece were selected for the research. These are located in four geographical regions, namely Attica-Viotia-Evia, Thessaly, Central Macedonia and Western Greece. In these specific regions, 83,924 sows have been recorded (representing 59.5% of the total number of sows in the country) (Ministry of Agriculture, Animal Production Dir/ate, 2003). The variety of breeding conditions in these regions, allows for a generalisation of the research results for the whole of Greece, with no major deviation from reality. The technical-economic data for the research refers to the period 2000-2002 and was collected using specially structured questionnaires (Siardos, 2005; Kamenidou et al., 2002). Then, during the period 2003-2004, there was an updating of the relevant data, as regards the type and form of invested capital. The sampling method used for the definition of the sample was proportionate stratified sampling per region and pig farm size (Apostolopoulos et al., 2001; Galanopoulos et al., 2006). More specifically, the total number of farms from the four regions of interest (358 farms) were divided into 3 categories, based on size, according to the number of sows (Whittemore, 1993):

- M_1, low-capacity farms, with 20 to 199 sows. These are family-run farms that use basic equipment for their operation.
- M_2, medium-capacity farms, with 200 to 399 sows. These are farms with integrated feeding mix preparation systems that operate at various levels of automation, depending on their size.
- M_3, high-capacity farms, with 400 or more sows. These are industrial-type farms, with a high degree of verticalisation.

The above classification means that the sample was proportionately selected out of 12 strata (4 regions x 3 sizes). The size of the sample is set at 80 pig farms, which represent 22.4% of the total number of pig farms in the selected areas, and 9% of the total number of pig farms in Greece. More specifically, the sample includes 43 farms from Thessaly, 5 farms from Macedonia, 18 farms from Attica-Viotia-Evia and 14 from Etoloakarnania.

Cluster analysis was used for the spatial and typological analysis of the pig farms (Hair et al., 1995; Coakes and Steed, 1999). The formulation of the groups-clusters is based on simple computerised routines (Kinnear and Taylor, 1996), which, despite having remarkable mathematical properties, nevertheless constitute nothing more than smart algorithms, the result of which is mainly interpreted through the use of practical rules. Cluster analysis is applied in many scientific fields and is consequently used both for the computerised and the interpretory part of the analysis. When examining a sample, the cluster analysis methodology that is most commonly used is K-mean Cluster analysis (Churchill, 1995; Kamenidou et al., 2003).

In order to classify the pig farms into similar units-clusters, the following economic parameters were used:

a) Sows in production
b) Value of livestock
c) Gross revenue
d) Total feeding costs
e) Land and buildings-mechanological equipment (in annual expenses), as calculated based on the primary research data (Aggelopoulos, 2004).

These parameters are of particular importance due to their major role in formulating the overall cost of production, the profit gained by the pig farms, and their level of competitiveness.

In order to examine the "profile" of the clusters, specific characteristics of the farms in the clusters were studied, pertaining to their geographical region of activity, corporate structure, the educational level of their owners, and the type of invested capital (value and age of the buildings and mechanological equipment, payment for hired labour).

RESULTS AND DISCUSSION

A "Hierarchical Cluster Analysis" was initially carried out, in relation to the economic parameters, which indicated that we should look for 2 or 3 clusters of farms.

Then, K-mean Cluster Analysis was applied in order to examine two solutions, one involving two clusters and another involving three clusters of farms. The solution with the best physical interpretation was the one with three clusters of pig farms. In both of the above cases, the "z-scores" of the variables were used.

The K-Mean Cluster Analysis showed that there are three clusters of farms. The first cluster includes 49 pig farms (61.25%), the second 8 farms (10%), and the third 23 farms (28.75%). The first level cluster analysis, based on the pre-determined parameters, is presented in Table 1. In this table, we can observe the "variability" of the above-mentioned parameters that were defined for the groups of farms in the cluster analysis (F). The formulation of the clusters was affected by the following factors, in priority order: feeding costs, gross revenue, the number of productive sows, livestock value and, finally, the value o f the land-buildings and mechanological

Table 1. Economic characteristics of the pig farms in the clusters

Pig farm clusters	Capacity (sows in production)	Value of livestock (euros/sow)	Gross Revenue (in euros/sow)	Feeding costs (in euros/sow)	Land-buildings-machinery (in euros/sow)
F distribution:	235.75	229.31	237.88	293.39	35.63
1st cluster:					
Avg	118.27	314.62	1868.59	1153.08	3.29
Sample size	49	49	49	49	49
Standard deviation	5.9	13.3	93.4	57.8	0.19
2nd cluster:					
Avg	761.88	378.09	2036.22	1080.21	1.57
Sample size	8	8	8	8	8
Standard deviation	44.57	18.6	101.4	54.2	0.09
3rd cluster:					
Avg	372.17	367.04	2009.40	1163.48	2.50
Sample size	23	23	23	23	23
Standard deviation	18.82	18.3	100.5	53.6	0.1

equipment. Furthermore, Table 1 presents the characteristics of the pig farms in the clusters, based on the economic parameters that were used.

The first cluster (S_1) consists of small-sized pig farms that are family run. They present the lowest livestock value, the highest cost for fixed asset use, and the highest feeding costs. The farms in this cluster attain the lowest value for gross revenue.

The second cluster (S_2) consists of industrial-type farms. These farms present the lowest feeding costs and lowest cost for fixed asset use, while their livestock is of the highest value. The farms in this cluster attain the highest gross revenue value.

The third cluster (S_3) consists of medium-capacity farms, with a high livestock value and a high gross revenue. The farms are characterised by a high cost for fixed asset use and the highest feeding costs.

At the next stage, a second level analysis was performed, based on selected socio-economic parameters. More specifically, Table 2 presents the formulation of the second level profile of the first cluster. Of the farms in the first cluster, 8.2% are located in Macedonia, 61.2% in Thessaly, 20.4% in the region of Evia-Attica-Viotia, and 10.2% in Etoloakarnania. As we can observe, the majority of the owners of the first cluster farms have com-pleted either secondary school or elementary education. The cluster consists of M_1 size farms by 81.6% and M_2 size farms by 18.4%. Of the farms in the first cluster, 73.5% are sole proprietorships and 26.5% are general partnerships. The average value of the buildings is 215370.21 €, and their average age is 15 years. As regards the mechanological equipment, its average value is 96855.18 €, and its average age 13 years. The farms in the first cluster spend, on average, 7068.12€ on hired labour.

Table 3 presents the second level profile of the farms in the second cluster (S_2). Their owners have mainly attended tertiary education (at a university or technical institute). All the farms in the second cluster are M_3 size, and they are all shareholder enterprises. Of the farms in the second cluster, 62.5% are located in Thessaly and 37.5% in Evia-Attica-Viotia.

The average value of the buildings is 845337.10€, and the average age 14 years. The average value of the mechanological equipment is 692128.28€, and the average age is 12 years. Finally, the farms in the second cluster, on average, pay out the highest amounts for hired labour, that is, 35512.19€.

Table 4 presents the second level profile of the third cluster of farms (S_3). The owners of these farms have either completed secondary or elementary education. The third cluster consists of M_2 size farms by 60.9% and M_3 size farms by 39.1%. Of the farms in the third cluster, 4.3% are located in Macedonia, 34.9% in Thessaly, 21.7% in Evia-Attica-Viotia and 39.1% are located in Etoloakarnania. The farms in this cluster are sole proprietorships by 52.2% and shareholder enterprises by 47.8%. The average value of the buildings is 448036.10€, and they have an average age of 10.5 years. As far as the mechanological equipment is concerned, its average value is 327370.70€, and its average age 9 years. Thefarms in the third cluster, pay out on average 24211.29€ for hired labour.

Next, the χ^2 test and Cramer's V correlation coefficient

Table 2. Second level profile of Cluster S_1

Socio-economic factors		Absolute frequency
Educational level	Post-graduate	0
	Tertiary education	6(12.3%)
	Secondary school	20(40.8%)
	Elementary school	23(46.9%)
Size of Farms	M_1	40(81.6%)
	M_2	9(18.4%)
	M_3	0(0.0%)
Geographical region	Macedonia	4(8.2%)
	Thessaly	30(61.2%)
	Evia-Attica-Viotia	10(20.4%)
	Etoloakarnania	5 (10.2%)
Corporate structure	Sole proprietorship	36(73.5%)
	General partnership	13(26.5%)
	LLP	0(0.0%)
	LLC	0(0.0%)
	S.A.	0(0.0%)
Investment activities	**Avg. value of investment**	
	Value of buildings (in €)	215370.21
	Avg. age of buildings (in years)	15.08
	Total cost of mechanological equipment (in €)	96855.18
	Avg. age of mechanological equipment (in years)	13.05
	Total payment for hired labour (€/month)	7068.12

were used to examine the statistical and practical significance of the relation between the four socio-economic parameters, that were selected in order to study the second level profile, as regards the three types-clusters of farms (Table 5). The χ^2 statistical test of independence showed that there is a statistically significant relation between the selected socio-economic parameters and the clusters of farms. More specifically, the intensity of the association between a) the size of the farms and b) their corporate structure, is very strong ($V \geq 0.60$). The intensity of the association between the educational level of the owner of each farm and the clusters of farms is considered to be strong ($V=0.468$). The geographical region of activity seems to have a medium influence on the clusters of farms ($V=0.285$). The spatial distribution of the farms in the three clusters is presented in Figure 1.

Conclusions

The activities of the pig farms are described and analysed with the help of a typology. Through the application of cluster analysis, the pig farms are classified into three units with shared characteristics, based on their economic results.

The first cluster consists of pig farms that are mainly located in Western Thessaly and Evia. This cluster includes small-sized pig farms, that are primarily family run, and the educational level of their owners is equivalent to secondary or elementary education. The farms in the first cluster do not seem to pay particular attention to owning genetic material of a high value. Their economic results indicate that these farms attain the lowest gross revenue, while presenting the highest cost of use for buildings and mechanological equipment, the lowest livestock value and the highest feeding costs. The farms in this cluster have the oldest buildings with the lowest value. Their mechanical equipment is also of the lowest value, and very outdated. They are farms lacking in investments for the modernisation of their fixed assets, and this leads to a high cost of use of the said assets. Targeted rural policy measures should be assets. Targeted rural policy measures should be implemented in these regions, in order for them to be incorporated in relevant financial aid programmes.

The pig farms in the second cluster are mainly located in Central Thessaly, Attica and Viotia. The cluster

Table 3. Second level profile of Cluster S_2

Socio-economic Factors		Absolute frequency
Educational level	Post-graduate	1(12.5%)
	Tertiary education	5(62.5%)
	Secondary school	2(25%)
	Elementary school	0 (0.0%)
Size of Farms	M_1	0 (0.0%)
	M_2	0 (0.0%)
	M_3	8 (100%)
Geographical region	Macedonia	0 (0.0%)
	Thessaly	5 (62.5%)
	Evia-Attica-Viotia	3 (37.5%)
	Etoloakarnania	0 (0.0%)
Corporate structure	Sole proprietorship	0 (0,0%)
	General partnership	0 (0,0%)
	LLP	0 (0,0%)
	LLC	5 (62.5%)
	S.A.	3 (37.5%)
Investment activities	**Avg. value of investment**	
	Value of buildings (€)	845337.10
	Avg. age of buildings (in years)	14.33
	Total cost of mechanological equipment (in €)	692128.28
	Avg. age of mechanological equipment (in years)	11.83
	Total payment for hired labour (€/month)	35512.19

consists of industrial-type farms, with a high degree of verticalisation. The educational level of their owners is high. They have lower feeding costs, probably due to the fact that they use animal foods they produce themselves, and they have a clear orientation towards the purchase of high value genetic material. Based on the economic parameters under study, it came to our notice that the pig farms in the second cluster present the best economic results. It is a fact that high-capacity farms present a higher level of pork production per sow, since the large size of the farms means that they can achieve "economies of scale", which lead to an increase of gross revenue proportionate to the size of the farm. Furthermore, the farms in the second cluster have the lowest feeding costs and also the lowest cost of use of their buildings and mechanical equipment. More specifically, the buildings and mechanical equipment they own are of the highest value. These are farms that combine a high productivity rate with investments in and a more rational exploitation of fixed assets. They pay out the highest amounts for hired labour, a fact that is linked to the industrialisation of their breeding systems.

The pig farms in the third cluster are mainly located in the geographical regions of Eastern Thessaly and Etoloakarnania. The third cluster consists of farms that have a shareholder structure; the owners are graduates of secondary and elementary education. These farms present a clear orientation towards the purchase of high value genetic material, but are also characterised by high feedings costs and a relatively low productivity level. In addition, they have modern buildings and mechanical equipment of a relatively high value. Based on the economic results of the analysis, we can conclude that the pig farms in the third cluster display a rapid rate of modernisation, but still require investments of a higher quality (livestock, animal food production plants, etc).

Finally, the typological analysis is of particular importance, since it leads to the definition of clusters of farms with a similar socio-economic profile and comparable problems and weaknesses that can be addressed through the implementation of rural policy measures or through financing and support of structures. Based on the spatial and typological analysis, it is possible to formulate the following proposals:

The economics and productivity of the small farms in Western Thessaly and Evia (S_1) can be improved through

Table 4. Second level profile of cluster S_3.

Socio-economic Factors		Absolute frequency
Educational level	Post-graduate	0 (0.0%)
	Tertiary education	8 (34.9%)
	Secondary school	14 (60.9%)
	Elementary school	1 (4.3%)
Size of Farms	M_1	0 (0.0%)
	M_2	14 (60.9%)
	M_3	9 (39.1%)
Geographical region	Macedonia	1 (4.3%)
	Thessaly	8 (34.9%)
	Evia-Attica-Viotia	5 (21.7%)
	Etoloakarnania	9 (39.1%)
Corporate structure	Sole proprietorship	0 (0.0%)
	General partnership	11 (47.9%)
	LLP	1 (4.3%)
	LLC	5 (21.7%)
	S.A.	6 (26.1%)
Investment activities	**Avg value of investment**	
	Value of buildings (in €)	448036.10
	Avg age of buildings (in years)	10.52
	Total cost of mechanological equipment (in €)	327370.70
	Avg age of mechanological equipment (in years)	9.17
	Total payment for hired labour (€/month)	24211.29

Table 5. Correlations between the Socio-Economic parameters and the pig farm clusters.

Socio-economic factors	Clusters of farms
Geographical region	Cramer's V=0.285, χ^2=13.024, β.ε=6, p=0.042
Size of farm	Cramer's V=0.684, χ^2=74.917, df=4, p=0.000
Educational level of owner	Cramer's V=0.468, χ^2=35.044, df=8, p=0.000
Corporate structure	Cramer's V=0.656, χ^2=68.895, df=8, p=0.000

The observed level of significance of the χ^2 test (p-value), was calculated by using the Monte Carlo simulation method. This method is available in the Exact-tests subsystem of the SPSS statistical package.

a modernisation of their technologically outdated buildings and mechanical structures, the acquisition of high value genetic material and the reduction of feeding costs.

The medium-sized farms in Eastern Thessaly and Etoloakarnania can ameliorate their economic results through a more rational organisation of their operations under the guidance of specialised geotechnical staff, through the use of a suitable system for renewing their existing genetic material or commercially cross-breeding it with appropriate breeds, and through a reduction of their feeding costs. The use of various developmental programmes (ADP 2007-2013) to finance the modernisation of small and middle-sized farms and to ensure the acquisition of high value genetic material, would lead to improved animal maintenance and management conditions and an increase in productivity, that would reduce the cost of production.

Furthermore, the implementation of genetic improvement programmes in our country, and the creation of Greek breeds of pigs, that would be acclimatised and adapted to Greek breeding conditions, would provide the sector with more suitable and more economical animals in production.

A reduction in feeding expenses can be achieved through the elaboration of a balanced and economic

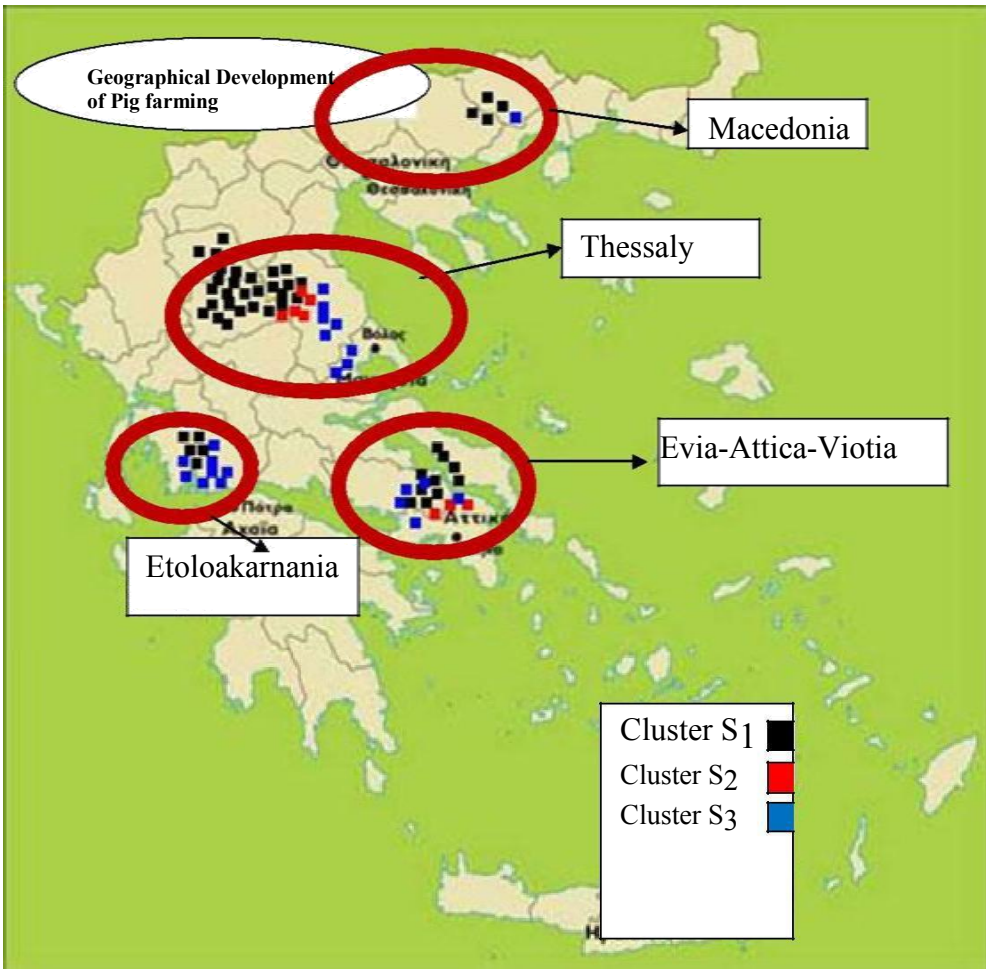

Figure 1. Geographical development of pig farming.

ration, that will be based on the requirements of the animals, that are a function of the genetic material being bred and the breeding conditions; it will also depend on the nutrient content of the animal food, and on the existence of suitable facilities for the mixing, supply and storage of the animal food. In addition, a decrease in feeding costs could also be achieved by increasing the production of at least part of the animal foods required by the farm. This indicates the need for a national policy that will include a) the provision of incentives and b) information given by the competent services regarding the exploitation and promotion of domestic animal foods, along with the cultivation of animal foods in areas deemed suitable for such crops, where other agricultural products are no longer considered to be competitive (e.g. tobacco, cotton).

Finally, a further improvement to the competitiveness and economicity of all the pig farms can be achieved through high quality training and specialisation courses offered to the pig farmers, on issues regarding the proper management of the animals, and also to the other staff that is responsible for the well-being of the livestock.

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