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ECONOMIC PERFORMANCE AND CROP FARM EFFICIENCY IN MOUNTAINOUS AND OTHER LESS FAVOURED AREAS IN GREECE

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Abstract

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The upcoming changes in the EU concerning the socio - economic criteria that were used since mid-70's to determine less favored areas and the introduction of «intermediate» regions, which will now be based on physical handicaps, are going to affect the level of support given to these areas throughout Europe. This in turn may have repercussions on profitability and efficiency of farming in less favored areas, a subject of great importance for many rural areas in Greece. This study estimates the degree of technical efficiency of crop farms in mountainous and other less favored areas of the prefecture of Thessalonica in Greece, first in a competitive environment without subsidies, and, following the granting of compensatory allowances. In addition, it carries out a comparative analysis of farm economic performance to investigate the relative contribution of subsidies to farm incomes and profitability. To accomplish the research objectives, primary data were collected with personal interviews from a sample of 78 farms. Data Envelopment Analysis was used for the estimation of pure technical, overall technical and scale efficiency. Research results show that the average overall efficiency of crop farms is around 49 %, while average technical efficiency is estimated at 65% and average scale efficiency is 76.9%. The farms in other less favored areas, despite higher production costs, achieve better economic performance than those in mountainous areas, due to the production of higher value crops. Compensatory allowances have a critical role for farm profitability in both mountainous and other less favored areas. However, a way forward for LFAs, in view of diminishing financial support, is the production of better quality and goods that are more competitive.

Key words: technical efficiency, scale efficiency, Data Envelopment Analysis, economic performance, less favored areas, crop farms, compensatory allowances, Greece

Abbreviations: **LFAs:** Less Favored Areas; **DEA:** Data Envelopment Analysis; **DMUs:** Decision Making Units; **CRS:** Constant Returns to Scale; **VRS:** Variable Returns to Scale

Introduction

In the mountainous and other less favored areas of Greece agriculture is a significant sector in terms of land use, management of natural resources and diversification of economic activities. The improvement of agriculture's competitiveness in less favored areas (LFAs), which is in fact a direct priority of EU rural development policy for the near future, is an issue of great concern for the country. The degree of efficiency

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in the use of farm inputs affects productivity and consequently the potential of farms to perform well and be competitive. The measurement of technical efficiency of farms that use similar inputs, produce the same output and operate under comparable conditions can be achieved through the application of data envelopment analysis (DEA), a non-parametric method used in applied research (Farrell, 1957; Charnes et al., 1978; EU, SEC, 2009).

The DEA method has been used extensively in order to measure the efficiency of farms both in the crop and livestock sector. A study in Greece, (Tzouvelekas et al., 2001) measured the efficiency of 84 organic and 87 conventional olive-growing farms in a comparison of conventional and organic systems of olive oil production. DEA was used to explore the effect of farm size on the efficiency of 209 coffee farms in Vietnam reaching the conclusion that smaller farms are less efficient (Rios et al., 2005). Similarly, a study in New Zealand measured pure technical efficiency of 264 cow-breeding farms, trying to establish a size-efficiency relationship for each farm (Jaforullah and Whiteman, 1998). A study in Poland aiming at measuring pure technical efficiency based on Polish data for 222 crop and 250 livestock farms indicated that livestock farms are more efficient than crop farms (Latruffe, 2004). DEA was used to explore the factors, which determine both technical and allocative inefficiency in the production of cotton in Pakistan (Shafiq and Rehman, 2000). In Greece, it was used to measure the technical efficiency of animal farms that have implemented farm improvement schemes (Rezitis et al., 2005) and the efficiency of sheep farms and dairy farms (Fousekis, 2001, Manos and Psychoudakis, 1997).

The efficiency of farms in the use of resources appears to be influenced by the system of financial support that is given to producers in order to shelter them from competition. The partial decoupling of compensation payments affects the technical efficiency of farms as indicated by research results on cotton farms in Greece (Emvalomatis et al., 2008). It is argued that the compensation per acre of land cultivated with cotton reduces the efficiency of farms, because of resource diversion away from products for which there is a compensatory area payment and towards those products for which the subsidy is linked to the volume of production. Another study in Spain examines the effect of compensatory allowances to the technical efficiency of olive farms in less favored areas (Lambarraa and Kallas, 2009). Results suggest that this kind of financial assistance had a negative impact on technical efficiency of farms in the less favored areas of the country.

The European Union (EU) has been offering support to farmers in mountainous and other less favored areas already since 1975, with the intention to compensate for 'permanent physical handicaps' which cause high production costs and low farm incomes. Inherent difficulties result in the abandonment of farming which often leads to depopulation and environmental degradation. The mountainous and other less favored areas are lagging behind due to their particular land features. The mountainous areas are being characterized, among other things, by limited options in the use of land and augmented labor costs whereas other less favored areas are faced by low productivity land, low and often declining population density (Official Journal of the European Communities, 19.05.1975, N128/97, 75/268).

The mountainous and other less favored areas of Greece have been determined by Directive 81/645/EEC. Like other member states, Greece has extended these areas to include more farmers who would benefit from compensatory allowances, the main rural policy measure for mountainous and other less favored areas (Papageorgiou and Spathis, 2000) thereby offsetting, the effects of changes in price policies (Maraveyas and Mermigas, 1997). Overall, less favored areas cover 82.6% of the area of the country (56.4% mountainous, 21.8% other less favored areas and 4.4% areas with specific handicaps), with 61.1% of the farms operating in these regions (Council of the European Union, 2005, EU, SEC, 2009)

It should be noted that up until 2010, the criteria for mountainous, other less favored areas and areas with specific handicaps remain unchanged. After 2010, there will be a change for less favored areas and in particular, the Commission proposes to use criteria, which relate only to physical conditions, which in general do not change over time. The EU, seeking an objective classification of areas with natural disadvantages for agricultural activities has identified eight soil and climatic

criteria. The policy aim is to implement an objective taxonomy that reflects the true situation in the EU for less favored areas. Therefore, the socio-economic criteria that were used from mid-1970 to determine the LFAs, are abolished and in many cases are now considered obsolete. Member States should introduce new intermediate LFAs in accordance with specific provisions to be included in the regulations.

The objective of this paper is to measure the degree of technical efficiency and to study the economic performance of crop farms in mountainous and other less favored areas in Greece, both in a competitive environment without subsidies, and after the granting of compensatory allowances. It is essential to obtain a broad representation of the structure of farm production particularly taking into account the forthcoming changes regarding the abolition of socio - economic criteria and the redefinition of "intermediate" regions based on their physical handicaps.

Materials and Methods

The Prefecture of Thessalonica was the chosen area of study for the purposes of this research, for having a large proportion of mountainous and other less favored areas. A sample of 78 crop farms was used, representing 5.4% of crop farmers registered as beneficiaries of compensatory allowance. The registry of farmers entitled to compensatory allowance issued by the Rural Development and Food Directorate of the Thessalonica Prefecture was chosen as the sampling field, from which farmers' records were taken. Data collection was carried out by means of questionnaires and direct personal interviews. Random sampling was used to calculate the magnitude of the sample by means of the formula: $n = N (zs)^2 / \{Nd^2 + (zs)^2\}$, where n is the sample size, N size of population, z credibility, d the desired accuracy set by the researchers and s the standard deviation estimated from a preliminary sample of 8 farmers (Siardos, 1997). Data collection was based on agricultural accounting methods aiming at recording farm assets and then proceeding to the analysis of farm structures and infrastructure and the estimation of farm economic results: a) with subsidies, b) without subsidies and c) with compensatory allowance only.

The Data Envelopment Analysis (DEA) a non-parametric method of data analysis was used for assessing farm efficiency (Charnes et al 1978, 1981; Farrell, 1957). DEA is referred to in bibliography as one of the most significant and popular estimation methods of units' efficiency, otherwise known as Decision Making Units (DMUs) of a group, which consume different quantities of input and produce different quantities of output. The model refers to constant returns to scale (CRS) (CCR model) and is used to estimate overall technical efficiency (Charnes et al., 1978). On the other hand, another DEA model is based on variable returns to scale (VRS) (BCC model). Overall, technical efficiency may be decomposed into pure technical efficiency and scale efficiency. The latter is calculated as the ratio of the two: overall technical efficiency over pure technical efficiency.

The mathematical expression of the non-linear DEA model is as follows:

$$max\ h_j = \frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}}$$

under the restrictions: $$\frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \leq 1 \quad (j= 1, 2,\ldots,n)$$

$$u_r v_i \geq 0 \quad (r= 1, 2,\ldots,s),\ (i=1, 2,\ldots,m)$$

where

n: the number j of the (DMUs) that are compared,
m: number of inputs,
s: number of outputs,
h_j: relative efficiency of farm j,
x_{ij} : the i input of DMU j,
y_{rj} : the r output of DMU j,
u_r,v_i: the weights for output r and input i, respectively.

The aim of the above problem of non-linear programming is to maximize the efficiency of unit j under the restriction that the relative efficiency of all DMUs and each one separately is less than or equal to unity.

The solution is found with the transformation into the following linear programming model:

$$max\ h_j = \sum_{r=1}^{s} u_r\ y_{rj}$$

with the restrictions: $$\sum_{r=1}^{s} u_r\ y_{rj} - \sum_{i=1}^{m} v_i\ x_{ij} \leq 0$$

$$\sum_{i=1}^{m} v_i\ x_{ij} = 1$$

$$u_r v_i \geq 0 \text{ (r= 1, 2,…s), (i=1, 2,…,m)}$$

In the present paper, the input-oriented model has been used with constant as well as variable returns to scale for the estimation of pure technical, overall technical and scale efficiency, while for uniformity and comparability purposes one model has been developed with four inputs and one output, the latter common to both models. The model includes 78 crop farms with four input variables (family and hired labor costs, fixed capital, variable capital, cultivated land in hectares) and one output variable (gross return, i.e. the quantity of harvested crops expressed in monetary terms). No subsidy was included initially in farm gross revenues, to be able to estimate farm efficiency without subsidy contribution, while subsequently the actual amounts of compensatory allowance received by each farm in 2006 were added, in order to assess the impact on farm efficiency.

Results and Discussion

Technical and economic analysis of crop farms in mountainous and other less favored areas

The average size of the crop farm in the mountainous area is 19.33 hectares from which 3.69 are privately owned and 15.64 are rented. Almost all cultivated land is dry-farmed (99.6%) with only a fraction of 0.4% being irrigated (Table 1).

Winter wheat is the dominant crop in the farm production plan with hard and soft wheat covering 59.0% and 14.9% of farmland respectively. Family labor corresponds to 83.3% of the total labor input whereas 16.7% is hired labor (Table 1). Average production costs amount to €17 354.80. The participation of the factors of production in total production costs is 50.0% for capital, 36.3% for labor and 13.7% for land. The gross revenue of the average farm is €19 069.40 with 34.1% coming from the value of crops and 65.9% from financial support (5.2% corresponds to compensatory allowances and 60.7% the remaining subsidies) (Table 1).

When all the subsidies are taken into account, farms in the mountainous region appear to be profitable (Table 2). More specifically, the farm average profit amounts to €1714.60 farm income, which is the index of productivity of all inputs used by the farm during the year, is €11 315.50 the farm family income which specifies the living standard of the farm family is €8421.00

Table 1
Production plan, land, labour and revenue of the average crop farm in mountainous and other less favoured areas

	Average crop farm in mountainous areas	Average crop farm in other less favoured areas
Crops (hectares)		
Soft wheat	2.88	0.94
Hard wheat	11.41	10.66
Barley	0.36	0.00
Rye	0.00	0.02
Medick	0.00	0.51
Sunflower	0.11	0.04
Oats	0.00	0.17
Maize	0.00	1.75
Basmas Tobacco	1.33	0.67
Virginia Tobacco	0.00	0.18
Pear trees	0.04	0.01
Oregano	0	0.37
Fallow plants	3.06	0.93
Watermelon plants	0.00	0.02
Potatoes	0.00	0.04
Tritikale	0.00	0.16
Walnut trees	0.06	0.00
Cherry trees	0.07	0.00
Apple trees	0.01	0.00
Total	**19.33**	**16.47**
Gross Revenue (€)		
Crop sales	6 502.70	13 779.80
Compensatory allowance	985	826
Other subsidies	11 581.70	11 032.10
Gross Revenue total	**19 069.40**	**25 637.90**

Source: Research data

and gross profit is €11 738.70. The economic results related to three factors of production (land revenue, income from employment and net income) reflect their productivity in the average farm. Therefore, when all the subsidies are included, land revenue of the average farm is €4094.40 income from work is €8007.50 and net income amount to €5022.50 (Galea et al, in press) (Table 2).

When no subsidies are included, the average farm is no longer profitable and shows a loss around €-10 852.10. Given that profits or losses determine economic performance, the crop farms in the mountainous region, achieve negative economic results, when no subsidies are taken into account. Finally, the presence of compensatory allowances while improving the economics of farms with gross margins being positive (€157.10), they are not sufficient to turn the loss-making farms into profitable ones (Galea et al., in press) (Table 2).

The average farm size in the other less favored areas is 16.47 ha of which 2.48 are owned and 13.99 is rented. 83.7% of the total acres are arid and 16.3% irrigated, while the main crop in the production plan is hard wheat (64.7%) (Table 1). Farm labor is employed for 2100 hours on average with 83.3% of all labor force corresponding to family labor and 16.7% of the work offered by seasonally employed farm workers (Table 1).

Farm production costs in the other less favored areas, amount to €21 622.30 on average with capital expenditure accounting for 55.6% of production costs, labor costs 29.7% and the cost of land 14.7% of total expenditure.

The gross revenue of the average farm is around €25 637.90 whereas 53.8% of gross income is attributed to the value of crops and 46.2% to all financial compensation (Table 1). When taking into account all the subsidies, the average farm in the disadvantaged region earns profits amounting to €4015.60 the land revenue is at €7193.10 net income at €8540.80 and income from labor around €10 426.8. Finally, agricultural income amounts to €14 952.0 farm family income to €11 111.20 and gross profit is about €15 686.20 on average (Table 2).

If no subsidy of any kind is granted the average farm in the other less favored areas sustains a loss of (€-7842.50). Regarding other financial results, only agricultural income and gross profit turn positive. If compensatory allowance is the only financial compensation considered in the calculation of financial results, then the average farm still suffers a loss of (€-7016.50) in agricultural income, whereas gross profit and farm family income in this case, take positive value (Galea et al., in press) (Table 2).

Crop farm efficiency

The results presented in Table 3 show that the technical efficiency of crop farms is 64.9%. This means that the average farm could reduce the inputs used by about 35.0%, with no observed change in the level of production, and the inefficient farms would then operate efficiently. From the frequency distributions, in which crop farms are grouped depending on the level of their technical efficiency, it can be seen that 21.8% of farms are efficient, which means that they combine

Table 2
Average Farm Economic Results (€)

Economic results	Average crop farm in mountainous areas			Average crop farm in other less favoured areas		
	With subsidies	Without subsidies	With compensatory allowance	With subsidies	Without subsidies	With compensatory allowance
Profit or loss	1 714.60	-10 852.10	-9 867.10	4 015.60	-7 842.50	-7 016.50
Family farm income	8 421.00	-4 145.70	-3 160.60	11 111.20	-746.9	79.1
Farm income	11 315.50	-1 251.20	-266.2	14 952.00	3 093.90	3 919.90
Land income	4 094.40	-8 472.30	-7 487.30	7 193.10	-4 665.00	-3 839.00
Labour income	8 007.50	-4 559.20	-3 574.20	10 426.80	-1 431.30	-605.3
Net income	5 022.50	-7 544.20	-6 559.10	8 540.80	-3 317.30	-2 491.30
Gross profit	11 738.70	-828	157.1	15 686.20	3 828.10	4 654.10

Source: Galea et al (in press)

the quantities of their inputs efficiently, therefore, no change can be made in their inputs, without affecting gross revenue. The majority of farmers (55.1%) operate with low technical efficiency (0.0% to 59.9%) and only 10.3% could reduce their inputs by 20.0% and produce the same amount of output (Table 4).

The crop farms in the mountainous region achieve lower rates of technical efficiency in comparison with the farms in other less favored areas. More specifically, 76.1% of farms in the mountainous area operate with a technical efficiency less than 60.0% and 23.9% greater than 80.0% while the corresponding rates for the other less favored areas are 47.3% and 35.1% respectively (Table 4). The model of constant returns to scale (CCR model) is applied in order to calculate the overall efficiency of crop farms. According to the model, overall efficiency of crop farms is 49.3%, which means that by reducing expenditure in half and with proper management, inefficient farms can operate efficiently (Table 3).

Table 3
Farm Technical and Scale Efficiency Scores

	Average efficiency of crop farms	
	Without subsidies	With compensatory allowance
Overall technical efficiency	49.3%	52.9%
Pure technical efficiency	64.9%	66.7%
Scale efficiency	76.9%	80.1%

Source: Research data

Table 4
Farm Frequency Distribution of Pure Technical Efficiency

Pure technical efficiency, %	Mountainous and otherless favoured areas	
	Without subsidies, %	With compensatory allowance, %
0.0 – 49.9	29.5	28.2
50.0 – 59.9	25.6	17.9
60.0 – 79.9	12.8	21.8
80.0 – 99.9	10.3	10.3
100.0	21.8	21.8
Total	100.0	100.0

Source: Research data

From the distribution of farms, it may be observed that the majority of crop farms (79.5%) have been operating inefficiently up to 60.0%, while differences in overall efficiency among the farms of the two regions are shown in Table 5. The ratio of overall efficiency to technical efficiency gives scale efficiency and the results are presented in Table 6, where the differences in percentages in the various classes of efficiency of scale show the difference between the two study areas.

The comparison of efficiency of the average farm in the two cases (excluding subsidies or with compensatory allowances) leads to the conclusion that the addition of compensatory allowances in the output improves the efficiency of the average crop farm (Table 3). There is also some variation in the percentages of different efficiency classes as they appear after the addition of compensatory allowance in gross revenues. Table 4 shows

Table 5
Farm Frequency Distribution of Overall Technical Efficiency

Overall technical efficiency, %	Mountainous and otherless favoured areas	
	Without subsidies, %	With compensatory allowance, %
0.0 – 49.9	66.7	52.5
50.0 – 59.9	12.8	23.1
60.0 – 79.9	6.4	7.7
80.0 – 99.9	3.8	6.4
100.0	10.3	10.3
Total	100.0	100.0

Source: Research data

Table 6
Farm Frequency Distribution of Scale Efficiency

Scale efficiency, %	Mountainous and otherless favoured areas	
	Without subsidies, %	With compensatory allowance, %
0.0 – 49.9	7.7	3.8
50.0 – 59.9	6.4	6.4
60.0 – 79.9	42.3	30.8
80.0 – 99.9	33.3	48.7
100.0	10.3	10.3
Total	100.0	100.0

Source: Research data

the percentage of crop farms found in each efficiency class. Comparisons of percentages with those of Table 4 suggest that compensatory allowance improves only marginally the efficiency of farms. In terms of overall efficiency (Table 5) and scale efficiency (Table 6), the amount of compensatory allowance received by any one-crop farm in the sample, did not affect the percentage of farms found in the last two classes. This effectively means that the number of farms that achieve efficiency more than 80.0% did not increase.

Conclusions and Recommendations

The mountainous and other less favored areas are essential for the primary sector of the Greek economy, since most of crop farms are located in these areas. The present study evaluated the economic performance and measured the efficiency of crop farms in mountainous and other less favored areas in the prefecture of Thessalonica, initially without regard to subsidies and then by taking into account compensatory allowances. The farms in other less favored areas achieve higher gross revenues than those in mountainous areas, due to the production of higher valued crops. When taking into account the received subsidies, all farms are profitable. In the absence of subsidies, they record losses, while the contribution of compensatory allowance alone is not enough to change non-profitable farms into profitable ones. A comparative analysis shows that the economic results of the average farm in other less favored areas are better than the average farm in the mountainous area. However, when all subsidies are included differences between farms diminish, because the subsidies to farms in mountainous areas account for a larger percentage in gross revenues. The same is observed when financial results are calculated considering only compensatory allowance due to its low share in gross revenues.

The average technical efficiency of crop farms is about 65.0%, which means that to be efficient they should reduce their inputs by an average of 35.0%. Approximately 22.0% of all farms are fully efficient and given their size, no change can be made in the use of inputs, without affecting gross revenues. The average overall efficiency of farms was estimated at 49.3%, which means that by reducing costs by almost half and proper management, inefficient farms can operate effectively. From these farms, 79.5% work with overall efficiency lower than 60.0%. 10.3% of farms are fully efficient, which means that they combine their inputs efficiently, producing the expected outputs. The average scale efficiency of farms is 76.9%. 10.3% of farms operate at optimum size and do not have any problem with the use of their inputs.

The mountainous areas need more support in comparison with the other less favored areas, mainly due to the particular geomorphologic characteristics that affect economic performance. The anticipated post-2010 removal of socio - economic criteria for determining LFAs and the redefinition of intermediate areas based only on physical constraints can lead in the long term to a better match between any financial assistance and physical and other handicaps. However, in the short run this might lead to a decline in agricultural activities, which in many cases is a prerequisite for maintaining the countryside. The shift of farms in both mountainous and other less favored areas towards the production of more competitive goods, but also the improvement in the quality of already produced output will help to achieve better economic performance.

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