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Policy impact on technical efficiency of Spanish olive farms located in Less Favored Area.

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Abstract
Most of Spanish olive farms are concentrated in Less-Favoured Areas (LFA) with the majority of producer areas are under Objective 1 of the EU Regional Policy. The EU has long recognized such distinctive characteristics of those holdings with a specific support measures aiming to prevent the abandonment of olive groves as well as to support sustainable development of this sector. The main objective of this study is to evaluate the impact of LFA payment on the olive farms technical efficiency. Two sample farms located in LFA (63 farms receiving LFA payment support and 99 farms do not) have been observed from 2000 to 2004. A stochastic frontier production has been used.

Results indicate that LFA payment, age of manager, tenure regimes of land, workforce composition and farm size affect efficiency levels. The LFA payment coefficient indicates a significant negative impact on the technical efficiency of Spanish olive farms. The farms that not receive the LFA payment has a technical efficiency rate 0.15 percentage units upper compared to those that receive this payment. Thus, the payment policy could decreases farms technical efficiency which could represents a handicap for farms economic survival and its persistence in the long term period.

Keywords: *LFA payment, olive farm, technical efficiency*

JEL codes: *Q180, D210*

1. INTRODUCTION

The Spanish olive sector has a distinguished presence in worldwide agriculture sector. Such situation is manifested by the importance of its production and exportation, being the leading country with 38.9% and 40% respectively (IOC, 2009). Moreover, this sector covers 2,483,697 hectares with 308 million trees, representing more than 25% of the world's growing area (MARM, 2009).

This sector is mainly made up of a large number of small farms size whose productions is characterized by vulnerability to annual variation, low profitably, and heterogeneity, both in space and time. Most of those holdings are concentrated in Less Favored Areas (hereafter, LFA), and are considered under Community Regional Policy Objective 1 with a few exceptions. Beside its production function, in these areas the olive sector represents an important source of employment and a solid column of the social and economic development. It provides a full-time as well as seasonal employment -olive picking in particular- which supplement farm workers' income since demand for farm labor is concentrated in the rest of year. Moreover, olive farms play a role in the protection of the vulnerable area from desertification and loss of biodiversity. The olive cultivation is considered as an instrument tool in addressing environmental problems given it high undemanding, efficient water resource use and well-adaptability to Mediterranean region conditions. Its positive impact on the environment makes it's an important tool to combat desertification in these region.

The European Union (EU) has long recognized such special characteristics of the LFA. They has identified two main LFA types: a) mountain areas (in Spain, areas with a minimum altitude of 1000m or a slope greater than 20% or a minimum altitude of 600m plus a slope of at least 15%) and b) other LFA characterized by poor productivity, specific handicaps, low population, etc. It is worth to mention that 58% of the total Utilized Agriculture Area (UAA) in the EU is classified as LFA, while in Spain, 81.8% of UAA is located in LFA, in which 33.7% is LFA-Mountain and 48.1% in LFA-others.

The EU under the rural development program applied during 2000-2006[1] (Regulation No 1257/1999) has provided the LFA farms with a specific support measures as compensatory payment granted per hectare of agricultural area. These measures aim to avoid the abandonment of olive groves in marginal areas, to maintain a viable rural community, to promote sustainable farming systems which in particular take account of environmental protection requirements and to support a sustainable development through the promotion of healthy and quality products.

Previous literature has demonstrated that policy support could have impact on different farms' aspects. In this line, some papers have analyzed their impact on production decision (Moro and Sckokai, 1999; Oude Lansink and Peerlings, 1996), investment decision (Oude Lansink *et al.*, 2001; Carey and Zilberman, 2002 and Wabi *et al.*, 2006) and technical efficiency (Bezlepkina *et al.*, 2005, Kleinhanß *et al.*, 2007, and Lambarraa *et al.*, 2009). However, up to date, there are no published studies that have analyzed the impact of LFA payment on farm's technical efficiency, especially in Spain.

[1] The regulation 1698/2005 is the actual rural development program applied from 2007 to 2013

The main objective of this study is to analyze the determinants factor of farms technical efficiency as well as the impact of LFA payment on such efficiency. To achieve this objective, we assess a technical efficiency of two different samples farms located in LFA and differentiate by receiving or not a support payment using a stochastic frontier (SF) model. The analysis focuses on farm-level data observed from 2000 to 2004, based on the Farm Accountancy Data Network (FADN).

The remainder of this paper is organized as follows. The second section gives a review of the SF methodology. This is followed by an empirical application. In Section 4 the results are discussed. Finally, some conclusions are outlined.

2. METHODOLOGY

To analyze the impact of LFA payment on technical efficiency, first a stochastic frontier methodology has been used. This technique implies a specification of two error components. The technical inefficiency error term that measures the extent to which actual production falls short of maximum attainable output, and is augmented by a two-sided error component (v) representing other factors that might generate irrelevant noise in the data (such as measurement error and unobserved inputs). v_{it} is assumed to be iid $N(0,\sigma_v^2)$, and u_{it} is a vector of independently distributed and nonnegative random disturbances.

We use maximum likelihood techniques to estimate the stochastic production frontier model. This model can be expressed as follows:

$$y_{it} = f(x_{it}, t; \beta) e^{v_{it} - u_{it}} \qquad [1]$$

where y_{it} is the output of the *i-th* firm ($i = 1,..., N$) in period $t = 1,...,T$, $f(x_{it}, t; \beta)$ represents the production technology, x_{it} is a $(1 \times K)$ vector of inputs and other factors influencing production associated with the i-*th* firm in period t, β is a $(K \times 1)$ vector of unknown parameters to be estimated.

The technical efficiency of a producer at a certain point in time can be expressed as the ratio of actual output to the maximum potential output:

$$ET_{it} = \frac{y_{it}}{f(x_{it}, t; \beta) e^{v_{it}}} = e^{-u_{it}} \qquad [2]$$

Following Battese and Coelli (1995), technical inefficiency is assumed to respond to the following pattern of behavior: $u_{it} = g(\delta z_{it}) + \eta_{it}$, where z_{it} is a $(M \times 1)$ vector of that includes the determinants of a farm's technical inefficiency, δ is a $(1 \times M)$ vector of unknown coefficients, and $\eta_{it} \sim N(0, \sigma_\eta^2)$ is a random variable defined by the truncation of the normal distribution such that the truncation point is $-\delta z_{it}$.

3. EMPIRICAL APPLICATION

As mentioned for empirical application we have used the FADN data for the period 2000-2004. The FADN Data set was launched in 1965 with the objective to monitor the income and business activities of agricultural holdings and to evaluate the impacts of the Common Agricultural Policy measures. It is a European system of sample surveys that take place each year and collect information from each farm includes physical, structural, economic and financial data. This data set provides representative data of EU agricultural holdings along three dimensions: region, economic size and type of farming. This dataset classifies farms into different typologies that allow identifying the main types of farming. In this study, we used the olive farms located in LFA other than mountains, given that the majority of the data available is located in this area. Moreover, This LFA type is more representatives in the Spanish case representing 60% of Spanish LFA area. Aggregates data on annual input and output price indices are taken from Eurostat. A two unbalanced panel data sample of Spanish olive farms are used. A total of 162 olive farms are observed from 2000 to 2004, which 99 farms of the sample receive the LFA payment support.

Following previous studies (e.g Karagiannis and Tzouvelekas, 2001), the production frontier function in [1] is specified as a Translog function that takes the form:

$$Lny_{it} = \beta_0 + \sum_{k=1}^{K} \beta_k Lnx_{kit} + \sum_{k=1}^{K}\sum_{j=1}^{K} \beta_{jk} Lnx_{kit} Lnx_{jit} + e_{it} \qquad [3]$$

Where $i = 1,\ldots,N$ indexes the farms in the sample, $t = 1,\ldots,T$ indicates the time period, $k, j = 1,\ldots,K$ indicate the conventional inputs used in the production process, β is the vector of parameters to be estimated, and, as noted, $e_{it}=v_{it}-u_{it}$ is a stochastic composite error term.

Production, y_{it}, is defined as an implicit quantity index by dividing total olive sales in currency units by the olive price index. Vector x_{it} is defined as a (1×15) vector that contains five inputs. The first input, x_1, includes labor input and is measured in labor hours per year, x_2 comprises pesticides, x_3 represents fertilizers, x_4 symbolizes the hectares occupied by olive groves, and x_5 comprises variable crop-specific inputs other than fertilizers and pesticides. Input use variables x_2, x_3 and x_5 are expressed as implicit quantity indices by dividing the consumption of these inputs in currency units by their respective price indices.

Given that the Battese and Coelli (1995) model does not really exploit the nature of panel data, an alternative method are used to overcome such a limitation. A restricted version of the fixed effects technique is used by incorporating regional dummies into the production technology function (Álvarez and Orea, 2004 and Lambarraa et *al.*, 2007). The use of regional dummies assumes that farms are heterogeneous across regions, while homogeneity is assumed within regions only for unobserved variables. Specifically, we used 5 dummy variables to identify the different Spanish regions.

The technical inefficiency effects function is specified as a linear function $u_{it} = \sum_{m=1}^{M} \delta z_{mit} + \eta_{it}$, with $M = 7$. The components of z_{it} include a constant (z_1), a workforce composition (z_2) which is computed as the ratio of family labor hours to total labor hours, a dummy variable equal to 1 if the holding is renting agricultural land and zero otherwise (z_3), the age of the holding's primary decision maker (z_4), time (z_5), farm size (z_6) expressed in European Size Unit (ESU), and payment ratio (z_7) which is computed as the ratio of LFA subsidies about total subsides. Maximum-likelihood methods are applied in model estimation.

Rental land is expected to increase farm's efficiency (Lambarraa *et al.*, 2007). Direct costs of land rentals may create stronger incentives to work the land in a more efficient manner, relative to the opportunity costs borne by owned land. A farmer's age is also likely to influence technical efficiency. Younger farmers should be expected to be more prone to introduce changes in farm management techniques that increase efficiency, relative to elderly ones (Battese and Coelli, 1995). The variable time is also expected to influence technical efficiency. Since farm managers are likely to learn from their errors, the passage of time should be expected to improve technical efficiency (Battese and Coelli, 1995). To the extent that family labour is more relevant in small, less competitive farms, it may be associated to a higher level of inefficiency (Lambarraa *et al.,* 2007 and 2009). Family size is expected to increase farms technical efficiency (e.g. Gianakas *et al.,* 2003; Alvarez and Arias, 2004 and Tsionas, 2006). While, subsidies are expected to have negative impact about technical efficiency (e.g. Bezlepkina *et al.,* 2005, Kleinhanß *et al.,* 2007, and Lambarraa *et al.,* 2009). Results derived from the estimation of the model are presented in the following section.

4. RESULTS

Summary statistics for the variables used in the analysis are given in Table 1. This table shows that sample farms' average annual output totals around 26,379.38 €. Table 1 also indicates that sample farms employ 3,022 labour hours per year, 79% of which are family labour. They spent by year 1,424 € for fertilizers, 1,448 for pesticides and 3,829 as other crop specific cost by. Sample farms have, on average, 25.13 ha of land, of which 8% is rented. The farms size expressed in European Size Unit (ESU) is about 30. The average farmer's age in the sample is 57 years.

Table 1.
Description of the sample data

Variable	Unit of measure	Mean	Std Dev	Minimum	Maximum
Fertilizers	€	1,424.40	2,961.82	0.00	55,093
Pesticides	€	1,448.53	3,555.72	0.00	62,123.31
Other crop costs	€	3,828.92	4,715.28	91.19	70,315.61
Labour	hour	3,022.97	1,600.28	850	19,117
Land	ha	25.13	42.50	0.00	377
Output	€	26,379.38	38,044.62	2	494,547.14
Workforce composition		0.79	0.19	0.00	1.00
Age	Year	57	14.88	30	100
Size	(ESU)	30	67.08	2.52	452
Rented area ratio		0.08	0.23	0.0	1.0

Results derived from simultaneously estimating the Translog production frontier and the technical inefficiency equation are presented in Table 2. The variance parameter, γ, is statistically significant which suggests the relevance of technical inefficiency in explaining output variability among Spanish LFA area olive farms. Estimated δ coefficients provide an explanation of the determinants of sample farms' technical inefficiency. As expected, the coefficient representing a farmer's age is positive and statistically significant for both models which suggests that young farmers are more efficient in comparison to older ones. Thus, younger farmers may be more likely to introduce efficiency-improving changes in their holdings relative to aged ones. Farms renting land are shown to be more efficient relative to farms owning cultivated land. This provides evidence that land rental costs motivate more efficient operations relative to the opportunity costs of owned land.

The workforce composition shows that farms with a higher proportion of family labour and not receiving payment are more efficient relative to the farms with a higher proportion of remunerated work. The negative coefficient for the variable time in the case of the model representing farms not receiving payment suggests that the technical efficiency of those farms tended to increase throughout the period studied. This result suggests that farm managers not receiving subsidies learn from their errors and experience, and has an optimal allocation of managerial effort. For the farms located in LFA but receiving payment, the results shows that technical inefficiency of those farms has been decreasing over time. This provides evidence that farmers receiving payment does not improve their efficiency levels with the passage of time.

The impact of subsidies on technical efficiency is analyzed through the payment ratio coefficient. The results show a significant negative impact of subsidies on the technical efficiency of LFA Spanish olive farms. Specifically, LFA payment seems to have had a relevant negative effect on the technical efficiency level of Spanish olive farms. This result is compatible with reduced motivation to produce efficiently as a response of farmer's decision to trade off market income for subsidy income. Other studies that analyze the impact of subsidies on technical efficiency of farms located in conventional area find similar results (e.g. Lambarraa et al., 2009; Bezlepkina et al., 2005; Guyomard et al., 2006; Kleinhanß et al., 2007 and Emvalomatis et al., 2008).

Table 2.
Maximum likelihood estimates of the SF model for LFA olive farms in Spain

		Farms not receiving payment		Farms receiving payment	
Variables	Parameter	Estimate	Standard Error	Estimate	Standard Error
Frontier production function					
Constant	β_0	-1.819169	(1.150838)**	4.366926	(0.288369)***
Labor	β_{LB}	1.329936	(0.715413)**	-0.006458	(0.005961)*
Pesticides	β_P	-0.008546	(0.000878)***	-0.006552	(0.001994)***
Fertilizers	β_F	-0.285566	(0.685340)	0.009719	(0.020920)
Land	β_L	0.012262	(0.007185)**	-0.000126	(0.002011)
Other Inputs cost	B_I	-0.003682	(0.006810)	-0.000301	(0.002323)
Fertilizers× Pesticides	$\beta_{F.P}$	0.230452	(0.043881)***	0.005919	(0.009247)
Pesticides × Labour	$\beta_{P.LB}$	0.001539	(0.000960)*	-0.001328	(0.002005)
Land × Pesticides	$\beta_{L.P}$	0.620959	(0.154610)***	0.008218	(0.009243)
Fertilizers × Labour	$\beta_{F..LB}$	0.006574	(0.001820)***	0.001521	(0.001816)
Fertilizers × Land	$\beta_{F.L}$	0.425518	(0.158870)***	-0.013078	(0.007831)**
Land × Labour	$\beta_{L.LB}$	0.004138	(0.001925)***	-0.000175	(0.002313)
Other Inputs × Pesticides	$B_{I.P}$	-0.043305	(0.038298)*	-0.001684	(0.012417)
Fertilizers × Other Inputs	$\beta_{F.I}$	0.001028	(0.000966)*	0.002321	(0.002223)*
Other Inputs × Labour	$B_{I.LB}$	0.062396	(0.087600)	0.050065	(0.009201)***
Other Inputs × Land	$B_{I.L}$	-0.000947	(0.001346)	0.001888	(0.002056)
Inefficiency effects model					
Constant	δ_0	-0.409155	(0.915886)	-16.81055	(3.944711)***
Workforce composition	δ_{WC}	-0.160004	(0.077375)***	0.002787	(0.014996)
Land rental	δ_{RP}	-0.004693	(0.003472)*	-0.187509	(0.033665)***
Age	δ_A	0.075494	(0.052626)*	0.197012	(0.036342)***
Time	δ_T	-0.001201	(0.003336)	0.044359	(0.009054)***
Farm size	δ_{FS}	-0.143274	(0.051590)***	-0.063397	(0.009828)***
Payment ratio	δ_{PR}			0.147402	(0.024559)***
sigma-squared	σ^2	1.0610633	(0.16641533)***	18.848632	(3.579496)***
gamma	γ	0.8832044	(0.03129757)***	0.992639	(0.002424)***
Log likelihood function			-348.6593		-233.2492
LR test of the one-sided error			84.785261		82.080646

Note: ***, ** and * indicate that the parameter is significant at the 1% and 5% and 30% respectively.

The negative impact of LFA payment on farms technical efficiency is explained by the fact that subsidies guaranteed a large part of farmer's income in LFA which decrease TE. This decrease is caused by a non-optimal allocation of managerial effort which is manifested by sign difference of time coefficient for both models. Thus, farmers not receiving LFA payment improve their TE through time, while farms receiving LFA payment doesn't.

Results on technical efficiency distribution by year and interval in both cases are presented in Table 3. As we can see, the evolution of TE by year shows an upper TE average level for farms not receiving payment along years. The difference of TE average level between both farms (receiving and not) fluctuate from a minimum of 8 points to a maximum of 22 points registered in 2003, in all case a higher level of technical efficiency is registered at level of farms that doesn't receive payment. Moreover, such distribution shows that 68% of farms that do not receive payments are concentrated in high TE interval level (>60 %), while just 40% of farms that receive payment are present in these interval. Estimated average efficiency levels for sample farms receiving payment are about 52.6% while for those not receiving payment are 66.2%.

Table 3.
Mean technical efficiency by year and farms

Efficiency interval	2000		2001		2002		2003		2004	
	P	NP	P	NP	P	NP	P	NP	P	NP
<20	3	0	3	0	5	2	17	7	0	0
20-30	3	2	3	5	0	2	4	3	0	0
30-40	3	3	8	7	2	9	7	5	0	5
40-50	1	7	6	6	6	7	0	5	0	6
50-60	3	17	6	7	4	5	6	18	4	9
60-70	15	17	10	7	7	12	2	32	0	18
70-80	10	29	12	22	11	23	4	15	0	30
80-90	3	11	1	36	8	32	4	5	0	14
90>	0	1	0	2	1	0	0	0	0	0
Mean	59	67	53	70	60	68	36	58	55	68

Note: P and NP refer to farms receiving LFA payment and do not respectively.

5. CONCLUSION

Spanish LFA presents more than 80% of total utilized agriculture area. The olive sector is one of the main farming activities mostly located in these areas. Given the relevance of this sector in the Spanish agriculture and the prominent position of Spanish production and exportation worldwide, the relative technical efficiency has been analyzed of Spanish olive farms located in LFA. Specifically, this paper assesses the impacts of LFA compensatory payment on technical efficiency of Spanish olive farms. A stochastic frontier model was estimated using a two unbalanced panel data of 162 olive farms observed from 2000 to 2004, which 99 farms receive the LFA payment support.

Estimated average efficiency levels for sample farms are about 52.6% for farms receiving payment and 66.2% for farms do not. Parameters of technical inefficiency equation suggest that several variables affect efficiency levels, but do not have the same impact in both cases. Technical efficiency scores seem to be positively correlated with farms' size, age of manager, while, the farm rents cultivated land decrease it. On the other hand, workforce composition shows that farms with a higher proportion of family labour and not receiving payment are more efficient relative to the farms with a higher proportion of remunerated work.

Result also suggests that farm managers which not receive compensatory allowance learn from their errors and experience, and has an optimal allocation of managerial effort. Such results are supported by the negative sign of payment ratio coefficient, which provides a negative direct impact of LFA aid scheme on technical efficiency of LFA olive farms. Finally, the LFA aid scheme applied during the 2000-2004 has had a negative impact on technical efficiency of olive farms located in these areas.

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