Investigating the Impact of Farm Characteristics, Socioeconomic Characteristics and of the Single Farm Payment on the Viability of Farms: The Case of Greece

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Abstract

This study utilized a Bayesian ordered probit formulation and ten years (2001-2010) of farm level data, obtained from the Farm Accountancy Network, to identify factors that influence the economic viability of farms in Greece. The findings indicate that decoupled payments increase the probability of farms being classified as economically viable. Moreover, the results highlight that a transition towards horticulture and livestock production will increase the probability that farms are classified as viable. Lastly, non-viability is directly related to the age of the farm manager.

Key Words: Farm Viability, Greece, FADN, Ordered Probit

Introduction

Despite the declining importance of agriculture in Europe, farming remains an important industry for the Greek Economy. Specifically, with 723,060 farms in 2010 the agricultural sector accounted for 3.3% of the Greek GDP. This value increased to 3.8% in 2014. At the same time, approximately 13% of the population has some form of agriculturally related employment. Furthermore, the vast majority of the farm holdings are small or medium scale enterprises. In particular, the average physical farm size is 4.8 hectares, and three quarters of the agricultural holdings have less than 5 hectares of utilized agricultural area, while the economic size (measured as standard output) is less than 4,000 Euros in 52 percent of all farms (Eurostat, 2015).

The evaluation of the economic viability of these farms is becoming a more important question every day, due to a couple of factors. First, since the early 1990's, after each major reform of the Common Agricultural Policy (CAP), the Greek agriculture exhibits substantial loses in terms of production and income, as a result of the reduction at the level of support and protection for farms. One of the most important reforms of CAP was launched in 2003/2004, introducing the single farm payment (SFP) instead of direct payments and a series of subsidies; this reform started to be fully implemented in Greece in 2006. Second, in addition to the CAP reforms, the profound crisis of the Greek economy further reduced the funds available for the Greek agricultural sector.

The main objective of the present study is to examine the relationship of farm economic viability to a series of farm and household characteristics, as well as policy changes. The data set used in the study is obtained from the Farm Survey FADN (Farm Accountancy Data Network), and includes analytical data for Greek farms for the period 2001 through 2010.

The remainder of this paper is organized as follows: The next section briefly overviews related work in farm viability, while a description of the FADN sample utilized in the study is presented in the third section. Next, the econometric procedures and the empirical estimation of the model are described. Finally, we discuss our findings and provide some concluding remarks.

Literature Review

Farm viability, broadly defined as the ability of a farm operation to earn enough income to meet its financial obligations and continue to operate and expand (Salant et al., 1986; Adelaja and Sullivan, 1998; Argiles, 2001), was among the initial objectives of every agricultural policy. Today, despite: i) the continuous reforms of agricultural policies, ii) the declining importance of farming, especially in developed countries, and, iii) the trade liberalization, farm viability remains an important policy concern (Arglies, 2001; Vrolijk et al., 2010; Barnes et al., 2014; Harris et al., 2009).

Nowhere is this truer than in the European Union (EU), where the majority of farm operations are family businesses. Consequently, economic farm non-viability may result in substantial negative impacts for the rural and family economy and way of life (Davies, 1996). Farm viability is also an important issue in the USA, especially during periods of financial downturn (Smale et al., 1986; D'Antoni et al., 2009).

Because of the aforementioned importance of farm viability, researchers and policy makers are increasingly interested to identify the factors that may influence whether or not a farm operation will be economically viable. To achieve this objective, scholars have primarily utilized financial ratios and logistic regressions.

For example, Franks (1989) and Barnes et al. (2014) used multinomial logit regressions to examine the factors that influence farm financial stress and the impact of diversification on farm viability respectively. The former research, using a sample of 105 farms from United Kingdom's farm business survey, indicated that farms with higher value of total assets, income and return on equity are less likely to be classified as financially stressed. On the other hand, the probability that a farm is classified as financially stressed was higher for farms located in Less Favored Areas (LFAs). The latter research using the Swedish and Scottish farm account survey highlighted that diversified farms are more likely to be viable. In line with Franks (1989), Barnes et al. (2014) indicated that LFAs is an important factor for Swedish farms, however, it was not statistically significant for farms located in Scotland. The European Commission (1994) has similar findings regarding the role of location as a parameter of financial success.

In a related strand of the literature Argiles (2001) and Argiles and Slof (2003), using data sets obtained from the Spanish Farm Accounting Data Network (FADN) for Catalonia, Spain, examined the impact of using financial reports on farm viability. Despite the use of different viability indicators and different econometric techniques (dichotomous logit and multiple regression models for Argiles (2001) and Argiles and Slof (2003) respectively) the results indicate that utilization of financial reports reduces the probability of farms being classified as non-viable. In contrast to Franks (1989), Barnes et al. (2014) and the European Commission (1994), Argiles (2001) and Argiles and Slof (2003) findings indicate that location in LFAs does not significantly affect the probability of a farm being viable. However, in line with previous research their findings indicate that bigger farms are less likely to be classified as non-viable.

Following the pioneering work of Shepard and Collins (1982) and Hughes et al. (1985) a number of scholars examined the impact of agricultural policies on farm viability. For example, Davies (1996) using a forward and backward regression indicated that lagged land prices (which are substantially affected by the CAP) are positively related with the rate of farm insolvency in

England and Wales. More recently Coppola et al. (2013) using Italian FADN data calculated three types of profitability indices to gain insights regarding the long term viability and profitability of Italian farms. Their findings indicate that the type of enterprise, farm size and location significantly affect profitability. Furthermore, they highlight that a reduction of public aid will increase the number of farms classified as "weak". Miceikiene et al. (2015) found similar results using a sample of 97 Lithuanian Farmers. Specifically, the authors indicate that farm subsidies play an important role in the viability of farms, especially for small and medium scale farms. On the other hand, larger farms may remain viable even without the subsidies.

Discussion of the FADN data

The data set utilized to achieve the objectives of the present study is obtained from the Greek Farm Accountancy Data Network (FADN). FADN, introduced in 1965, is the only source of harmonized data in the European Union (European Commission, 2014). Specifically, FADN is an annual survey of commercial farms in the European Union (EU). According to the European Commission, a commercial farm is defined as: "a farm which is large enough to provide a main activity for the farmer and a level of income sufficient enough to support his/her family" (EC regulation NO 1217/2009).

The FADN survey collects data regarding structural, production, economic and financial attributes of the EU farms. FADN surveys are conducted by different liaison agencies in every member country. In order to accommodate for the heterogeneity of farms in the EU, the farm population is stratified based on economic size and type of farming. Currently, FADN data includes records on 80,000 farms, representing a population of five million farmers in the EU.

The panel we employed in the present study covers the time period 2001- 2010. Over this time period the number of surveyed farms in Greece fluctuates from 4,345 in 2001 to 3,456 in

2010. The final data set consists of 38,238 observations. Table 1 provides summary statistics for our sample.

Farm Classification

A point long recognized in the empirical literature, is the lack of consensus among scholars regarding the most appropriate measure of farm viability. For instance, Slavickiene and Savickiene (2014) provide a review of twenty three financial and ten non-financial indicators utilized to measure farm economic viability. Other authors have adopted physical output to measure farm performance (i.e. Lazarus et al., 1990; Tomaszwesky et al., 2000). The selection of the most appropriate measure depends on a number of factors such as the data set available, the location examined and the research problem (Argiles and Slof, 2003; Slavickiene and Savickiene, 2014; Vrolijk et al., 2010).

For the objectives of the present study, we adopted two criteria. Firstly, the on-farm family labor converted into full-time equivalent jobs (called annual working units or AWU in agriculture). Secondly, a monetary measure of performance; specifically, following Sorrentino et al. (2011) family farm income (FFI) per AWU is adopted as a measure of profitability. To examine if the farms are viable we compared the FFI/AWU with a reference income. This reference income is based on the gross annual earnings of non-agricultural workers (i.e. it is the income that producers can obtain in alternative occupations). Based on this comparison and various combinations of these two criteria we classified farms in 4 different groups: viable, potentially viable, declining and marginal (Table 2). The classification of farms in these four groups for the examined period is presented in Table 3.

Econometric Procedures

Considering the discrete nature of the dependent variable, we utilized a Bayesian ordered probit regression to examine the association between farm viability and a number of explanatory variables. A number of reasons dictated the choice of a Bayesian approach. First, the Bayesian point and interval estimators do not require large sample assumptions. Second, for large samples, the Bayesian method yields similar estimations to the maximum likelihood estimation (MLE). Third, the Bayesian approach facilitates the use of prior information or experts' belief through the specification of prior distributions. The present section discusses in detail the formulation of the model.

Following Green (2008), we introduce a continuous latent variable y* for each farm/year such that:

(1) $y^* = BX + \varepsilon$

Where, B is the vector of the parameters to be estimated, X is the vector of explanatory variables and ε is a random error term that is hypothesized to follow a standard normal distribution. The value of the dependent variable Y_i (viability of farm i) is then connected with the explanatory variables through the aforementioned latent variable, satisfying the following model:

(2) $$Y_i = \begin{cases} 0, \text{ if } y^* \leq A_1 \\ 1, \text{ if } A_1 < y^* \leq A_2 \\ 2, \text{ if } A_2 < y^* \leq A_3 \\ 3, \text{ if } y^* > A_3 \end{cases}$$

where A_1, A_2, and A_3 are unknown cutoff values to be estimated with B.

Based on the previous literature the following groups of explanatory variables are included in the present study:

(i) Continuous variables: Manager's age, logarithm of fixed assets, logarithm of total area

(ii) Dummy variables: Rent, single farm payment, year 2009 or later (this variable was included to capture the effect of the financial crisis on farm viability).

(iii) Ordinal categorical variable: Altitude (levels: 1, 2, 3, and 4, with 1 corresponding to plain areas with altitude less than 300 meters).

(iv) Categorical variables: Region (Central, North, West-South, East-South, base category: Central), farm type (field crops, horticulture, wine, permanent crop, milk, livestock, granivores, mixed; base category: field crops).

Empirical Estimation

In Bayesian inference, model parameters θ are considered as random. For the ordered probit model θ = (A, B). Before collecting data, one specifies prior distributions of the parameters according to results of previous studies or experience from domain experts. Alternatively, when there is a lack of concrete prior knowledge, one can adopt non-informative priors. We denote the prior density function as π(θ). Then, according to Bayes theorem, the density of the posterior distribution can be expressed as:

$$(3)\ p(\theta|\ y) = \frac{f\ (y\ |\theta)\ \pi(\theta)}{f(y)}$$

where, f (y|θ) is the likelihood function and f(y) is the marginal likelihood.

Once the posterior density is computed, one can use point estimators such as the posterior mean to estimate the parameters. If, $p(\theta|\ y)$ does not have a tractable form the posterior mean can be obtained via Monte Carlo approximation. Since the knowledge of the entire posterior distribution is available, in addition to point estimators, Bayesian inference also provides interval estimators called credible intervals. A 90% credible interval indicates the range of values that the true parameter "falls" into with 90% probability. For the objectives of the present study we adopted the Highest Posterior Interval (HPD), which has the shortest length among all credible intervals of the same credible level (Hoff, 2009, pp. 42).

For the choice of prior distribution we utilize the non-informative prior distribution recommended by Gelman et al. (2008). Specifically, each explanatory variable is center to a mean of zero and each continuous explanatory variable is scaled to a standard deviation of 2.5. Then, each coefficient in B has an independent Cauchy prior with scale 2.5. Lastly, each cut-off value has an independent Cauchy prior with scale 10.

A Markov Chain Monte Carlo (MCMC) algorithm is implemented to draw samples from posterior distributions. With the aid of the latent parameter y*, conditional posterior distributions of all parameters have closed forms so that a Gibbs sampler can be implemented (Gelfand and Smith, 1990). For the present study, we generated a Markov chain of length T=200,000 iterations, as a large T guarantees convergences from any starting point of the chain. However, the simulation requires a burn-in starting period to allow for the chain to converge and make accurate approximations. The first S=100,000 iterations are treated as the burn-in period and are discarded. The posterior means of A and B are approximated using sample means of the remaining MCMC samples. Similarly, posterior standard deviations are approximated by sample standard deviations. Furthermore, for each regression coefficient its 90% and 95% HPD intervals are estimated.

Marginal Effects

To get a better understanding of the impact of each of the explanatory variables examined on the farm viability we also calculated the marginal effects associated with the ordered probit formulation. Specifically, following Cameron and Trivedi (2005), the marginal effects for each farm/year i=1,2,….,n, explanatory variable j, and the response category k=0,1,2,3 are calculated as:

$$(4)\quad \frac{\partial P(y=k|X_i)}{\partial X_j} = [\ \varphi\ (A_{k-1} - X_i B) - \varphi(A_k - X_i B)]B_j$$

where the function φ(.) is the pdf of standard normal distribution. The Monte Carlo estimators of the marginal effects for the four response levels are obtained by simply taking the average of all iterations after the burn-in as follows:

$$(5)\ \widehat{ME_{y=0,J}} = \frac{1}{T-S}\sum_{t=S+1}^{T} -\varphi(A_1^{(t)} - \overline{X'}B^{(t)})B_j^{(t)}$$

$$(6)\ \widehat{ME_{y=1,J}} = \frac{1}{T-S}\sum_{t=S+1}^{T} [\varphi\left(A_1^{(t)} - \overline{X'}B^{(t)}\right) - \Phi\left(A_2^{(t)} - \overline{X'}B^{(t)}\right)]B_j^{(t)}$$

$$(7)\ \widehat{ME_{y=2,J}} = \frac{1}{T-S}\sum_{t=S+1}^{T} [\varphi\left(A_2^{(t)} - \overline{X'}B^{(t)}\right) - \Phi\left(A_3^{(t)} - \overline{X'}B^{(t)}\right)]B_j^{(t)}$$

$$(8)\ \widehat{ME_{y=3,J}} = \frac{1}{T-S}\sum_{t=S+1}^{T} \varphi(A_3^{(t)} - \overline{X'}B^{(t)})B_j^{(t)}$$

where $A^{(t)}$ and $B^{(t)}$ are the samples in the t^{th} iteration of the MCMC chain, and $\overline{X}$ is the column-wise mean of the design matrix.

Empirical Results

Table 4 reports the estimation results for the Bayesian ordered probit model. Furthermore, for comparison purposes, Table 4 reports parameter estimates based on a Maximum Likelihood Estimation (MLE) ordered probit formulation. The marginal effects for the Bayesian estimation are reported in table 5. As it can be seen from Table 4, the majority of the variables have statistically significant coefficients at the 5% level. Furthermore, most of the parameter estimates are consistent with the previous literature. However, there are also some differences. A t-test for the MLE approach and the HPD credible intervals (for the Bayesian) were utilized to examine if the three cut-off points (A_1, A_2, A_3) are equal. Based on the results, we rejected the null hypothesis, thus the four categories should not be collapsed.

The positive coefficient associated with the variable rent (Table 4) indicates that producers who rent land are more likely to be financially viable. This finding is consistent with Franks (1998) who illustrated that tenants are less likely to be classified as financially stressed, compared to owners. For example, producers who rent land are 5.92 percentage points more likely to have a financially viable operation compared to those that do not rent land (Table 5). Furthermore, in line with the findings of Barnes et al. (2014) and Miceikiene et al. (2015) for Sweden and Lithuania respectively, our results indicate that farmers who received single farm payments (SFP) are more likely to be financially viable (Table 4). Specifically, as it can be seen from Table 5, farmers who received SFP are 0.85 percentage points more likely to be in the viable group. This finding is also consistent with the results of Howley et al. (2012), who indicated that SFP can actually partially subsidize non profitable farms.

In line with our initial expectations, the type of farming and the location of the farm were found to significantly influence the probability that a farm operation will be economically viable. Specifically, compared to farms with field crops, the horticulture, wine, permanent crop, milk, livestock, granivores and mixed farms are more likely to be economically viable (Table 4). For example, compared to a farm with field crops, mixed operations are 14.9 percentage points more likely to belong in the viable group and 9.7 percentage points more likely to belong in the potentially viable group (Table 5). Similarly, from Table 5 it can be seen that horticultural operations are 13.9 percentage points more likely to belong in the viable group and 9 percentage points more likely to belong in the potentially viable group compared to our base category (field crops). A potential explanation for this finding lies in the limited land that most Greek farmers have. Thus, specializing in value added crops, or including a certain amount of livestock activity, may offset this constraint.

As far as the location is concerned, compared to the base region (central) farm operations located in east-south and west-south Greece are more likely to be viable (Table 4). A potential explanation for this finding is related to the type of farming activities in each of these regions. For example, the east-south region includes the island of Crete, where there are a number of greenhouse operations that may increase farm profitability. In contrast to our initial expectations, and to the findings of the European Commission (1994), our findings indicate that an increase in the altitude of the farm location is combined with a higher and statistically significant probability of a farm being viable (Table 4). This result may be related to the geographic factors of Greece, where a great percentage of the country is mountainous (approximately 80% of the country consists of mountains); in these areas, the most frequent types of farming include livestock, mixed or permanent crops.

From the explanatory variables examined, the age of the farm manager and the financial crisis (after 2009) are the only ones that were found to have a negative influence on the probability of a farm being viable (Table 4). For instance, a one-year increase in the age of the farm manager is associated with a 0.14 percentage points decrease in the probability of a farm being in the viable group (Table 5). This finding is in line with the results of Argiles and Slof (2003), who indicated that the age of the farmer had a negative influence on the profitability of the farm. A potential explanation of this finding is that younger producers are more educated, and have better adopted to the new marketing and legislative status of agriculture compared to older producers.

Lastly, regarding the size of the farm operation, our findings indicate that although the land size is not statistically significant, farms with greater value of fixed assets are more likely to be viable (Table 4). This finding is consistent with Vrolijk et al. (2010) who indicated that, for the case of Greece, the most important viability predictor is the land productivity, while the economic size of the farm is negatively correlated with the farm viability.

Concluding Remarks

Examining the factors that affect farm viability is an issue that has attracted the interest of researchers and policy makers alike. This question becomes even more important during periods of economic crisis and/or when important policy changes take place. During the last decade farmers in Greece had to cope with both of these events almost simultaneously. Specifically, the Single Farm Payment scheme, introduced by the 2003 Mid Term Review of the Common Agricultural Policy (fully implemented in Greece since 2006), increasingly liberalized markets in the European Union by decoupling payments from production. Furthermore, during the last years the Greek economy is under a major economic crisis. It is expected that both of these factors had a major impact on the economic viability of the farmers in Greece.

The present study utilized data from the Farm Accountancy Data Network and an ordered probit analysis to investigate the impact of several factors on the viability of Greek farms. The results indicate that a transition away from field crops towards value added products (i.e. livestock or horticultural products), and renting land will increase the probability of economic viability for producers. However, in contrast to some of the previous literature, our findings indicate that older growers and farms at a lower altitude are less likely to be economically viable. A potential explanation for this finding lies in the structure of Greek agriculture. Lastly, policy makers may be interested in the finding that SFP reduced the probability of farms classified as non-viable.

The lack of data regarding off-farm activities is an important limitation of this study. Off-farm activities are relatively popular, especially among smaller farmers, in Greece and may substantially influence the results regarding farm viability. Future work may include the comparison of our findings with different countries in Northern Europe, especially regarding the role of single farm payments.

Table 1: Summary Statistics

Variable	Mean	Std. Dev.	Min.	Max.
Age (years)	47.14	11.36	18	86
Rented Land (Dummy)	0.59	0.49	0	1
Utilized Agricultural Area (Hectares)	538.43	1139.67	1	31884
Fixed Assets (Euro)	88,362	80,650.04	40	1200153
Location Variables				
Central (Dummy, 1 if region = Central)	10.55%			
East – South (Dummy, 1 if region =ES)	21.77%			
North (Dummy, 1 if region = N)	41.99%			
West-South (Dummy, 1 if region = WS)	25.68%			
Production Type				
Field crops (Dummy, 1 if production type =field crops)	49.89%			
Horticulture (Dummy, 1 if production type = Horticulture)	2.63%			
Wine (Dummy, 1 if production type = wine)	3.43%			
Permanent crop (Dummy, 1 if production type = permanent crop)	25.25%			
Milk (Dummy, 1 if production type =milk)	0.43%			
Livestock (Dummy, 1 if production type = Livestock)	10.55%			
Gravivores (Dummy, 1 if production type = Granivores)	0.26%			
Mixed (Dummy, 1 if production type = Mixed)	7.55%			

Table 2: Farm Viability Classification Criterion

Viability Group	On-Farm Family AWU[1]	Farm Family Income/on-farm Family AWU, as percentage of the Reference Income
viable	≥ 1	> 100%
potentially viable	0,50 - 0,99	≥ 100%
potentially viable	≥ 1	50% - 100%
declining	0,50 - 0,99	50% - 100%
declining	< 0,50	> 100%
declining	≥ 1	< 50%
marginal	All other Cases	

[1] Annual Work Unit (AWU) corresponds to 1750 hours

Table 3: Distribution of Farms by Viability Group, 2001- 2010

Viability Group	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Viable	4.9%	21.2%	19.5%	20.1%	20.2%	15.9%	24.3%	22.1%	19.9%	24.2%
Potentially Viable	5.2%	32.0%	31.4%	30.9%	30.2%	19.5%	32.3%	29.2%	28.6%	29.5%
Declining	54.9%	32.6%	34.2%	33.4%	33.1%	36.7%	31.1%	33.1%	33.8%	31.8%
Marginal	35.0%	14.2%	14.9%	15.7%	16.5%	27.8%	12.3%	15.6%	17.7%	14.5%
Total Farms	3209	3491	4154	4257	4067	3995	4025	4091	3771	3267

Table 4: MLE and Bayesian Ordered Probit Parameter Estimates

	MLE Estimation		Bayesian Estimation	
	Coefficient	Standard Error	Coefficient	Standard Error
Rent	0.2464**	0.0150	0.2640**	0.0148
Age	-0.0059**	0.0005	-0.0059**	0.0005
SFP	0.0357**	0.0139	0.0353**	0.0138
Altitude	0.0875**	0.0083	0.0872**	0.0082
After 2009	-0.0569**	0.0169	-0.0571**	0.0170
Log (Fixed Assets)	0.4472**	0.0071	0.4472**	0.0072
Log (Total Area)	-0.0038	0.0036	-0.0037	0.0036
Region: ES	0.3925**	0.0226	0.3918**	0.0214
Region: N	0.0151	0.0196	0.0142	0.0197
Region: WS	0.5751**	0.0230	0.5742**	0.0222
Horticulture	0.5800**	0.0371	0.5804**	0.0381
Wine	0.2757**	0.0322	0.2752**	0.0329
Permanent Crops	0.0918**	0.0176	0.0919**	0.0180
Milk	1.0619**	0.0924	1.0515**	0.0971
Livestock	0.9862**	0.0217	0.9870**	0.0219
Granivores	0.4293**	0.1134	0.4220**	0.1111
Mixed	0.6200**	0.0242	0.6202**	0.0233
A_1	4.3170	0.0859	4.3137	0.0871
A_2	5.4615	0.0871	5.4600	0.0883
A_3	6.3738	0.0881	6.3731	0.0886

*,** Denote significance level of 0.10 and 0.05 respectively

Table 5: Marginal Effects

	y = 0	y =1	y = 2	y = 3
Rent	-0.0563	-0.0414	0.0385	0.0592
Age	0.0014	0.0010	-0.0009	-0.0014
SFP	-0.081	-0.0060	0.0055	0.0085
Altitude	-0.0200	-0.0147	0.0137	0.0210
After 2009	0.0131	0.0096	-0.0089	-0.0137
Log (Fixed Assets)	-0.1024	-0.0753	0.0700	0.1076
Log (Total Area)	0.0008	0.0006	-0.0006	-0.0000
Region: ES	-0.0897	-0.0660	0.0613	0.0943
Region: N	-0.0033	-0.0024	0.0022	0.0034
Region: WS	-0.1314	-0.0967	0.0899	0.1382
Horticulture	-0.1329	-0.0977	0.0909	0.1397
Wine	-0.0630	-0.0463	0.0431	0.0662
Permanent Crops	-0.0210	-0.0155	0.0144	0.0221
Milk	-0.2407	-0.1770	0.1646	0.2531
Livestock	-0.2259	-0.1661	0.1545	0.2376
Granivores	-0.0966	-0.0710	0.0661	0.1016
Mixed	-0.1420	-0.1044	0.0971	0.1493

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