Agri-environmental schemes and their territorial impact in the North of Spain

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Paper prepared for presentation at the 150th EAAE Seminar

"The spatial dimension in analysing the linkages between agriculture, rural development and the environment"

Jointly Organised between Scotland's Rural College (SRUC) and Teagasc

Scotland's Rural College, Edinburgh, Scotland
October 22-23, 2015

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Abstract

Agri-environment policy in Europe has been applied for more than two decades, reaching great importance both economically and at spatial level. There is a debate in the academy about the tangible environmental benefits achieved with this policy. The present work analyses a whole Agri-environmental Program (6,523 beneficiary farms) for the community support period 2007-2013, focusing on its incidence and effects in the Galician province of Lugo, as well as the degree of implementation in relation to demographic, economic and agricultural structure. Descriptive statistics were used to determine the distribution in the territory of Agri-environmental Schemes (AES) and grant amount. Multiple linear regression analysis was used to determine the effects of different variables on the proportion of AES, using Akaike's Information Criterion procedure. The results show that population dynamics have significant incidence in explaining the spatial distribution of AES In mountain areas with lower population density and higher aging rateAES reveals to support the income of the least productive and marginal farms and, at the same time, the conservation of Nature, especially tackling the proliferation of forest fires. Some were widely adopted in the province, while others focused on specific geographical areas. The ecological improvement of the physical environment under Natura 2000 measures has the least impact on the territory.

1 Introduction

Agri-environmental schemes (AES) have been widely studied since their generalization in Rural Development Policies inside the European Union. Most of these studies have focused on farmer's attitudes towards AES and factors affecting their participation on those voluntary schemes such as financial factors, continuance of the farm, contract design, social network actors and farm structure like size (Unay & Bojnec, 2015). Some have addressed the ecological impact of measures and their effects on environmental protection but few of them have dealt with the socio-economic and territorial impact of these measures on regions where they have been applied. It has been said that marginal farms (small, highly fragmented and confronted to natural restrictions to production but with high natural values) are more likely to adopt AES than others (Batáry, Dicks, Kleijn, & Sutherland, 2015). In the other side, some studies have described how big farms are likely to adopt agri- environmental measures because they would take more profit since payments are established per hectare (Ortiz-Miranda & Hodge, 2012 and Unay & Bojnec, 2015).

However, the European Court of Auditors has pointed out that the evaluation of AES at the European level does not show a clear quantification of environmental benefits, finding that the objectives of AES are not well justified with respect to environmental benefits (European Court of Auditors, 2011).

The Galician Agri-environmental program here studied establishes a five years contract called Sustainable Farming Agreement (here called CES) for farms voluntary adhered to the program. The program comprises 9 measures with different environmentally friendly farming practices that go beyond legal obligations. The farmer could subscribe more than one measure and receives payments for that (Consellería do Medio Rural e do Mar, 2015). Galicia is a region in the NorthWest of Spain with an autonomous government responsible for the Rural Development Policy. We analyse the implementation of the Agri-environmental program in one of the four provinces: Lugo. This territory is

characterized for a high degree of land fragmentation of farms (Corbelle *et al.*, 2009), hilly mountains in the oriental side of the province and a plain in the western half. Here, 6,523 farms adopted AES comprising 18% of total Utilized Agricultural Area (UAA) of the province.

We have worked under the hypothesis that marginal areas with extensive farming practices, less productive but with high environmental values would attract more CES in order to support farm incomes (Ortiz-Miranda & Hodge, 2012 y Unay & Bojnec, 2015). To do that, we characterized farms structure adopting AES during the period 2007-2011. After that we analyze some different variables at the municipality level: demography, farm structure and socio-economic variables.

2 Material and methods

This study uses data from the Land Parcel Identification System (called SIGPAC) as well as the regional Integrated Administration and Control System[1] (IACS) used by the payment agency to manage payments from Common Agricultural Policy (CAP), including those of AES. Both databases are maintained by the Regional Ministry of Rural Affairs and Fisheries. For this study an anonymized set of data concerning parcels obtaining support, detailing the agri-environmental scheme and amounts paid per farm for the time period selected (2007-2011) was accessed. For the territorial analysis, Agricultural Census data is used (IGE, 2009) including variables characterizing the structure of farming sector at municipal level (i.e. UAA, technical-economic orientation labour force and total gross margin)... The demographic and economic information is obtained from Spanish and Galician Statistical Institutes, INE and IGE respectively. Descriptive statistics were selected of number of contracts, payments amount and surface covered to determine the distribution of AES at territorial level. To analyze the degree of implementation of the agri-environment program related to the demographic, economic and farm structure variables, a regression model for dependent variables and quantitative analysis is developed using a multivalent factorial method.
A multiple linear regression model for each AES line was built including the selected economic, demographic and agrarian structure variables, according to the following structure:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_n X_n + \varepsilon$$

The response variable in the model is the proportion of farms under each of the analyzed AES regarding the total number of farms at municipal level; β_0, β_1, β_2 ...β_n are parameters estimate; $X_1, X_2 \ldots X_n$ the independent variables; and $\varepsilon$the error made in calculating the parameters. The model is built with independent variables that have a Pearson correlation coefficient statistically significant (95% confidence).

Variables selection is made automatically with regression statistical Akaike's Information Criterion backward stepwise, discarding the variables that do not contribute to the model,

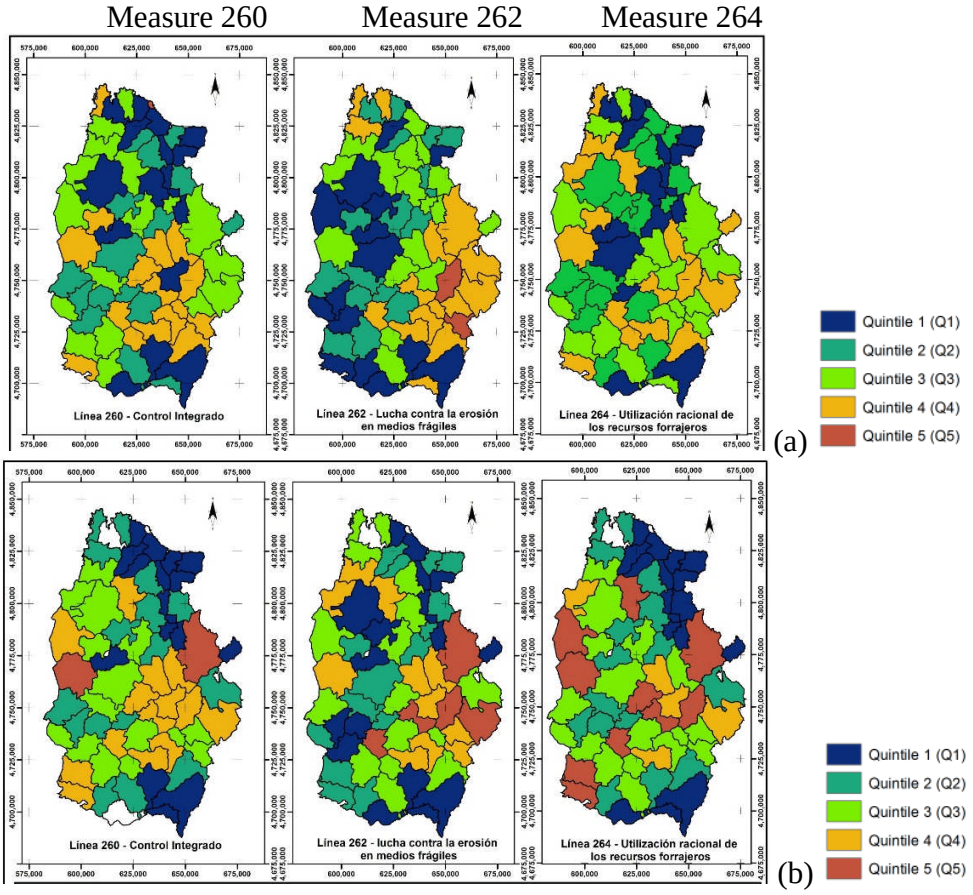
[1] IACS is the system for the management and control of payments to farmers made by the Member States in application of the Common Agricultural Policy

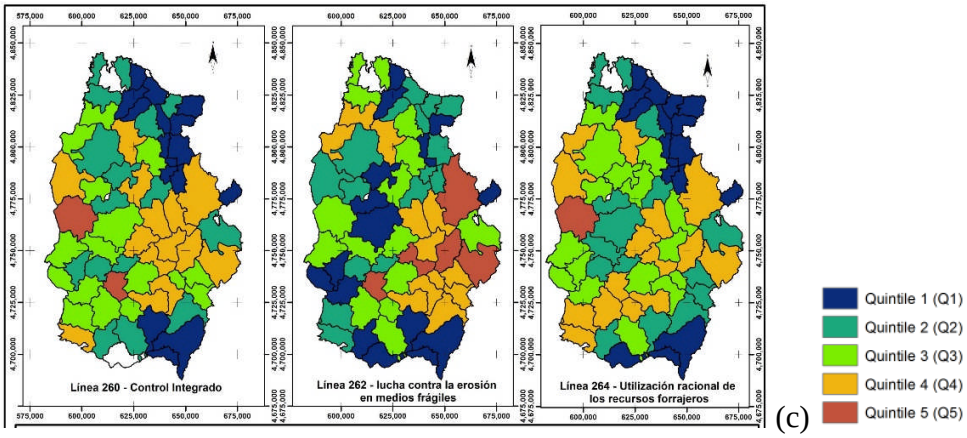
(Bozdogan, 1987). Finally, the requirements for the model residuals are analyzed: Normality; homoscedasticity; non-existence of autocorrelation; and no multicollinearity.
Graphical representation of some statistics and adjusting the multiple linear regression models were performed using R (R Core Team, 2013), especially the packages *Graphics* (Becker, Chambers, & Wilks, 1988) and *stepAIC* (Venables & Ripley, 2002) are used respectively. For mapping the ESRI ArcGIS ® software is used.

3 Results

3.1 Sustainable farming agreements (CES): territorial distribution

Of the nine measures integrated in the Galician Program only three account for the 96.38% of contracts, 95.1% of payments and 98.7% of hectares. They were the measure of Integrated Pests Control (code 260), Prevention of Erosion in Fragile Environments (code 262) and Sustainable Management of Forage Resources (code 264). The last one represents the 42.9% of contracts, according to the specialization of the region on livestock production (García, Ónega, & Pérez, 2013).
Figure 1 represents the territorial distribution of the three main AES by CES inside the province. Contracts are distributed in quintiles.





(c)

Figure 1. Distribution of Main AES in the Territory by Quintiles. (a) Proportion of Utilized Agricultural Area (UAA); (b) Number of CES; (c) Amount.

Number of contracts and surfaces under AES are concentrated in the centre and oriental side of the province, where mountains are located. The measure 264 – Sustainable Management of Forage Resources, concentrates about 50% of contracts in the centre of the province. Taking into account the three main measures, we find that the highest values of number of contracts, hectares and payments are concentrated on farms between 10 and 20 hectares.

3.2 Multiple Linear Regression Analysis

We have identified some demographic, economic and agricultural variables in order to explain the degree of adoption for AES at municipality level. We have adjusted three Multiple linear regression models (one for each of the three measures with a major weight) for analyzing the effects of our explaining variables on AES contracts. See Table 1.

Table 1. P Values and Regression Coefficients for Agri-Environmental Measures: 260, 262 & 264.

VARIABLE	MODEL MEASURE 260	MODEL MEASURE 262	MODEL MEASURE 264
Constant	(< 2e-16 ***)	(8.57e-09 ***)	(< 2e-16 ***)
	0.2961226	0.192768	0.494831
UAA per municipality	(-0.098551)		
	0.1195861		
Total Gross Margin			
Density of farms -Nº/ km^2			
Farm average size at municipality level			
Average altitude of the Municipality			
Annual work unit			
Elders proportion			
Population Density	**(0.000379***)**	**(3.69e-05 ***)**	**(0.000430 ***)**

VARIABLE	MODEL MEASURE 260	MODEL MEASURE 262	MODEL MEASURE 264
	-0.0002072	**-0.000276**	**-0.0002804**
Population variation (2007-2011)			
TEO*-General Agriculture	**(0.019544*)**		
	-0.0030004		
TEO*-Meat cattle and cattle breeding		**(4.86e-05 ***)**	**(0.000376 ***)**
		0.002252	**-0.0023121**
TEO*-Dairy and Meat cattle and cattle breeding		**(0.00395 **)**	**(0.001491 **)**
		-0.011295	**0.0152894**
TEO*-Dairy cattle	**(0.168839)**		
	0.0006372		
TEO*-Vineyards and other			
TEO*-Crops and livestock			
TEO*-Livestock			
TEO*-Poultry		**(0.06480)**	
		-0.015269	
TEO*-Vegetables and flowers			
TEO*-Others			
TEO*-Sheep and goats			
TEO*-Mix of cultures			
GDP per capita			
F statistic	**10.02**	**13.70**	**19.00**
R^2 adjusted	**0.3927**	**0.4692**	**0.4750**
Significant at '*' 0.001 '**' 0.01 '*' 0.05; between brackets**			

*TEO: Technical-economic orientation of the farm

The measure 260 –Integrated Pest Control- is significantly and negatively affected by demographic variables such as Population density (P value = 0.0003) and productive variables such as Specialization on General Agriculture (P value = 0.0195). For the measure 262 – Prevention of Erosion in fragile environments-, demographic variables as Population density (P value = 3.69e-05) affect the model in negative way; productive variables as specialization on Beef cattle and cattle breeding (P value = 4.86e-05) and Beef and dairy cattle and cattle breeding (P value = 0.00395) have a positive influence on the model. In the same way, population density (P value = 0.000430) and the abundance of meat cattle and cattle breeding farms in the municipality seem to have a slight (but statistically significative) negative influence on the adoption of Measure 264. On the other hand, the abundance of dairy and meat cattle farms seems to have a positive influence on the adoption of this last measure.

4 Discussion

As we have already said, some results from previous studies state opposite conclusions about the willingness to adopt AES. Merckx & Pereira (2015) have pointed out that the marginal character of farms with small sizes, fragmentation and natural restrictions to production makes them likely to adopt these measures (See also Batáry, Dicks, Kleijn, & Sutherland, 2015). In the other side, Ortiz-Miranda & Hodge (2012) and Unay & Bojnec (2015) have considered that big extensive farms would be more interested in AES since the payment is established per hectare considering that their extension permits economies of scale for the provision of environmental services. In the province of Lugo results are consistent with both statements. The major number of CES is on marginal municipalities placed in the mountainous areas of the province. Here farms have sizes over the Galician average presenting high natural values associated. This is coherent with the results of Wilson & Hart, (2000) or Wynn, Grabtree, & Potts (2001). Farms under CES have between 10 and 20 hectares in the studied area, while the Galician average is 8.5 ha. We couldn't demonstrate that big intensive farms would be interested in CES.

The literature has identified structural factors of farms that explain a major degree of AES adoption (Lastra-Bravo, Hubbard, Garrod, & Tolón-Becerra, 2015) and that are consistent with our results. Average size (Wilson & Hart, 2000), to be placed in mountainous areas specialized in extensive beef breading and with extensive pastures (Capitanio, Adinolfi, & Malorgio, 2011), production specialization in cattle (Polman & Slangen, 2008) and low productivity of lands (Wilson & Hart, 2000 y Dupraz, Vermersch, Henry De Frahan, & Delvaux, 2003). The most important agri-environmental measures of the Galician program reflect these factors. The Sustainable Management Forage Resources measure accounts for the 42.9% of contracts (2,798) and 57.67% of UAA (67,662 ha), reflects the cattle production specialization of the province (García, Ónega, & Pérez, 2013), especially of the municipalities in the mountainous area (Capitanio, Adinolfi, & Malorgio, 2011). Average farm size for this measure is very high in comparison with the Galicia average reaching 24.15 hectares. The rest of most applied measures Integrated Pest Control and Erosion Prevention in Fragile environments, are consistent as well with the territorial localization of contracts and with the pasture importance in farms under AES. Even though, the average height of municipalities was included in the multiple regression analysis but it have not statistical significance.
At the municipality level the variability of UAA under CES is quite wide ranging from 2.45 % of total UAA to 60.6%. The cartography shows a major concentration of CES in the oriental half of the province even if the statistical analysis doesn't find a defined pattern of distribution.

The Multiple Regression Analysis shows demography as the factor with a major signification in order to explain the presence of AES along the territory. The population density (hab/km2) affects negatively the percentage of CES by municipality for the three measures analyzed. This is coherent with the localization of CES in mountainous areas. The productive orientation (according to livestock specialization in the province of Lugo) presents higher coefficients values in Beef and Dairy cattle variables, especially for the 264 measure, located in the periphery of the province where extensive farms are present. The abundance of Beef cattle and beef breeding productive orientation, which occurs in

the mountainous area, has a positive effect on the adoption of the erosion prevention measure.

1 Conclusions

It has been discussed whether the European agri-environmental policy was mainly favoring large landowners rather than family farms (Ortiz-Miranda & Hodge, 2012). In the case studied, most of the measures have benefited farms with an average size above of the studied area. However, the work shows that these farms are in the less productive areas with lower densities and marginalized populations. Most of them need income support since that no other economic activities are present on this territory. That great size allows farms to achieve the demands of extensification of livestock density, which however cannot be met at the area where intensive farms are concentrated. This strip is the one that appears on our maps with a lower number of contracts and UAA under these measures.

Moreover, the report of the European Court of Auditors (2011) emphasized the need to refocus policy at European level to make a more obvious contribution to the conservation of nature and the environment. The present research shows how the population density is significant in explaining the geographical distribution of contracts. Areas with a low population density, and therefore marginal, have been the most benefited from the contracts. Corbelle & Crecente, (2009) have pointed out the relationship between abandonment and forest fires, an important environmental problem of Galicia. Thus, the agriculture present in these areas contribute to manage a substantial part of the surface which otherwise was at risk of abandonment. By this way, AES contribute to the avoidance of fire and environmental conservation as stated by García, Ónega, & Perez (2013).

Another interesting finding was that not all measures are distributed on the territory in the same way. Although the legislative intent was to support farm incomes, the fact is that not all measures have done likewise. While the extent of Integrated Pest Control has been applied in many of the farms, the measure 264 -Sustainable Management of Forage Resources- attracting the most part of UAA under AES, it is not distributed in the same way throughout the country, focusing on the periphery of the province especially in mountain areas and therefore more fragile in socio-economic and natural terms.

Finally, the limited impact of the measures that have to do with support to farms on Natura 2000 Network is very surprising. Although on this we can say that is not an isolated fact that differentiates this region from others, but it is a common fact in Europe (Hodge, Hauck, & Bonn, 2015). The most part of the Lugo surface is covered by this protection figure. More research is needed to explain this fact.

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