Influence of structure, behavior and territory on innovation in small agricultural holdings: a multilevel approach.

FourthConference of the Italian Association of

Agricultural and Applied Economics (AIEAA)

Ancona, June 11-12, 2015

Innovation, productivity and growth:

Towards sustainable agri-food production

Keywords: Small agricultural holders; Innovation behavior; Local system; Multilevel model

1. Introduction

This paper attempts to examine the determinants on the innovation adoption of small agricultural holdings, with focus on the role of structural, behavioral and spatial variables. A multilevel model explains the relevance of such variables on the innovativeness in a sample of agricultural holdings of two Spanish regions selected for the analysis, Comunidad Foral de Navarra and Comunidad Valenciana.

Three are the advantages of the present study with respect to the existing knowledge on the innovation behavior of agricultural firms. The first one is to propose a way to measure the innovative behavior of farms. The second contribution is that structural, behavioral and spatial factors can be combined to explain farm behavior, which considers a wide range of resources affecting the farmers' innovation attitude, including not only structural variables (human and capital assets) but also behavioral aspects (learning and market orientation). The third aspect is that an adequate analysis of farm behavior has to consider its geographical context given by the LS where farmers develop their activity. Considering the innovation attitude as a dependent variable defined at individual level, this study defines a multilevel analysis where several nested levels were undertaken, including the individual variables measured by the survey data, and the aggregate data defined at LS that will be later defined.

2. Theoretical framework

In Spain, like in other Southern and Eastern European countries, small and medium sized farms prevail, with possibly low ambition to engage on innovation. Following a Resource-Based approach, firm's innovation activities depend on their own resources and capacities and on the territorial context where they evolve. Own resources include capital assets, capabilities and behavior that can be represented by structural variables and behavioral variables.

As for structural variables, literature underlines the role of firm size, firm experience and human capital as crucial aspects that determine innovation behavior (Cassiman and Veugelers, 2006, Schmiedeberg, 2008 and Vega-Jurado et al., 2008). As for firm size empirical evidence does not give a clear relationship between firm size and the probability to innovate, which can be negative or positive. Farm size induces to increasing returns to scale but also to a certain irreversibility of innovation and investment, which could hamper the likelihood to undertake radical

changes. Firm experience can be proxied by the age of the firm, without a clear hypothesis on the impact of farm experience on innovation. On the one hand, farm experience involves the improvement of managerial competences. On the other hand, aged firms may show organizational inertia to adjust firm's capabilities.

Behavioral factors are rather based on opinions and they relate to firm strategies (i) Farmers' market orientation (MO) as a key strategy to lead to technical improvements; (ii) learning orientation (LO) as a cultural resource; (iii) and the willingness to networking with other agents or businesses. MO has been extensively researched during the last few decades. Later studies successfully proved the hypothesis that a true MO can be observed a culture that commits the firms to the continuous creation of higher value for customers. LO is also a cultural value that affects the willingness of farms to undertake better business practices and can be an important determinant of firm performance and innovativeness. As for farmers attitude towards networking, literature often emphasizes the positive results arising from the interactions among the actors who collaborate by cross fertilization of ideas and access to external sources of knowledge through sharing the costs of innovation activities. Firms' participation in associations and co-ops could involve some organizational advantages to carry out innovation activities (Salavou and Avloniti, 2008; Rosenbusch et al., 2011).

Innovation also depends on the local context. This can be taken into account in two levels: first, as spatial variables that affect innovation; and second, as a possible intra-group correlation of farms located in homogenous geographical or economic areas. Many rural areas have suffered demographic decline in Europe, and the lack of economic dynamism may negatively affect the innovativeness of agricultural holdings located in such areas. Intra-group correlations can arise from unobserved LS characteristics that affect farmers' outcomes (Garcia-Alvarez-Coque et al., 2014). These unobserved variables could lead to correlation between outcomes for holding located at similar contexts, which suggests the adequacy of a multilevel analysis of farms grouped in LS.

In summary, the analysis will explore the impact on innovativeness of small agricultural holdings, which can depend on:

- Structural variables: farmers' experience and education and farm size.
- Behavioral variables: MO and LO, measured as a constructs from survey results; and the willingness to participate in organizations and networks.
- Spatial variables: are considered by grouping the farms in LS and by classifying such LS

by some characteristics related to the degree of rurality and their economic and demographic dynamism.

3. Methods and data

LS data include territorial variables linked to the degree of rurality and the dynamism of the LS in which Navarra and Valencia regions can be subdivided. Sampled farms are located in 31 LS in Valencia and 15 in Navarra. In our study, LS were classified according to their degree of rurality, based on the OECD criterion of density of population.

Being the farm holders the central focus of the study, we have selected the survey methodology, widely used in social research. Farm data include structural and behavioral factors. A first step was developed in a series of meetings and interviews with experts and focus groups that helped us make adjustments on the pre-test. A second step was carried out on a sample of 30 stakeholders related to the farming sector to ensure the validity and user-friendliness of the questionnaire. Finally, the final survey was launched, by the technical agricultural institutions INTIA[1] and IVIFA[2], to a random sample to farm holders in Navarra and Valencia. Data collection finalized in January 2012 in Valencia and in December 2012 in Navarra. The final total of usable questionnaires was 207, with77from Navarra and 130from Valencia.

Considering the innovation attitude as a dependent variable defined at individual level this study verifies the hypotheses by factorial analysis and multilevel regression modeling. Innovativeness is measured through a construct that summarizes a series of scales that represent the innovation attitude of agricultural holdings. First, we employ the exploratory factor analysis to summarize the innovation capabilities, MO and LO of the farms selected.. Second, with the individual factor scores obtained a multilevel analysis was performed to analyze the dimensions that affect the innovativeness in agricultural holdings. Multilevel model was used to address unobserved heterogeneity within the context of a hierarchical structure dataset grouped by Local System (LS).

4. Findings and discussion

Table 1 shows the descriptive statistics and correlation matrix of the variables analyzed. The correlations between the explanatory variables do not show high values, thus initially ruling out

[1]Instituto Navarro de Tecnología e Infraestructuras Agroalimentarias (INTIA, S.A). See: www.intiasa.es.
[2]Instituto Valenciano de Investigación y Formación Agroambiental (IVIFA). See: www.ivifa.es.

multicollinearity problems

Table 1.Correlation Matrix of the variables

Navarra	Innovation capabilities	1	2	3	4	5		6	7	8
Innovation capabilities										
Structural Variables										
Education	0.091									
Founding year	-0.168*	-0.058								
Size	-0.133	0.014	0.166*							
Competitive Pressure	0.227**	-0.08	0.046	-0.082						
Behavioral Variables										
Market Orientation (MO)	0.176	0.076	0.09	0.221**	0.308***					
Learning Orientation (LO)	0.420***	0.073	0.034	0.075	0.311***	0.400***				
Willingness to participate in organizations	0.499***	-0.069	-0.083	-0.073	0.181*	0.199*		0.321***		
Spatial Variables										
Rurality	-0.052		0.083	-0.09	0.011	-0.182*	0.04	0.012	0.280***	
Demographic dynamism	0.044		-0.153*	0.074	-0.039	0.183*	0.042	0.029	-0.167*	-0.785***
Valencia	**Innovation capabilities**	**1**	**2**	**3**	**4**	**5**		**6**	**7**	**8**
Innovation capabilities										
Structural Variables										
Education	0.192***									
Founding year	-0.046	-0.025								
Size	0.211***	-0.085	-0.019							
Competitive Pressure	0.492***	0.11	-0.071	0.024						
Behavioral Variables										
Market Orientation (MO)	0.366***	0.023	-0.152**	0.12	0.356***					
Learning Orientation (LO)	0.424***	0.032	0.035	0.144**	0.300***	0.463***				
Willingness to participate in organizations	0.055	-0.019	-0.198***	0.222***	0.159**	0.178**		0.078		
Spatial Variables										
Rurality	-0.192***	-0.167***	-0.019	0.153**	-0.082	-0.216***		-0.043	0.029	
Demographic dynamism	-0.005	0.051	-0.08	0.117*	-0.006	0.123		0.163**	0.066	-0.01

Note: Level of significance: '***' 1% '**' 5% '*' 10%. Source: Authors' calculations.

A necessary condition for running a multilevel model[3]is that significant between-group variance exists for the dependent variable. The significance of the effect group has been analyzed through an LR test[4](likelihood ratio approach). Both regions showed significant LR test much higher than the critical value 3.8414 ($\chi^2_{1;0.05}$).The estimated parameters obtained for the multilevel model are shown on Table 2.

[3] All models are estimated using R-software (R Core Team, 2014).
[4] LR test is a likelihood ratio approach; comparing the null multilevel model with a null single-level model.

Table 2.Estimation results for Agricultural Holding's innovation capabilities, Multilevel Random Intercept models.

		Navarra			Valencia		
		Estimate	Std. Error		Estimate	Std. Error	
	Intercept	-0.764	(0.610		-1.134	(0.378)	***
Agricultural Holding level Variables							
Structural Variables	Education	0.242	(0.107)	**	0.240	(0.090)	***
	Founding year	-0.104	(0.043)	**	0.017	(0.042)	
	Size	-0.006	(0.116)		0.183	(0.064)	***
	Competitive Pressure	0.051	(0.093)		0.360	(0.075)	***
Behavioral Variables	Market Orientation (MO)	-0.012	(0.095)		0.058	(0.085)	
	Learning Orientation (LO)	0.172	(0.096)	*	0.232	(0.077)	***
	Willingness to participate in organizations	0.390	(0.103)	***	0.042	(0.081)	
System Local level Variables	Rurality	0.152	(0.202)		0.143	(0.077)	
	demographic dynamism	0.030	(0.081)		-0.025	(0.022)	*
	Observations	77			130		
	Number of country groups	15			31		
	Akaike Information Criterion	185.538			320.375		
	Pseudo R2 Marginal	0.329			0.415		
	Pseudo R2 Conditional	0.469			0.421		
	Random effects parameters:						
	sigma_v	0.125	(0.354)		0.006	(0.077)	
	sigma_e	0.474	(0.689)		0.615	(0.784)	
	sigma_e	0.474	(0.689)		0.615	(0.784)	

Note: Level of significance: '***' 1% '**' 5% '*' 10%. R-Squared values according to Nakagawa and Schielzeth (2013).
Source: Authors' calculations

Both models are statistically significant with a Chi-Square of 139.78 for Navarra and 282.81 for Valencia, which are higher than the critical value 16.9189 ($\chi^2_{9;0.05}$). There are no problems of multicollinearity in the database as is indicated in the VIF test carried out. The goodness-of-fit measures show that the model has an acceptable fit.

In general terms the results obtained show the importance of the three categories of farm variables considered: structural, behavioral and spatial variables. All they have different effects according to the region where the agricultural holding is located. LS seem to be more similar in Valencia with a more market-oriented agriculture (fruit and vegetables, in areas less supported by the CAP payments), while Navarra has more differences between their LS with an established agriculture.

As regards to the structural variables, the model shows that the education has significant importance for the innovativeness of the agricultural holding in both regions. The level of education has a positive effect for the innovativeness. Contrary the founding year of agricultural holding is negatively related to the innovativeness, which would suggest that older holdings, with more experience would be more prone to innovate. On the other hand, the size of these agricultural holdings has significant influence on innovativeness in Valencia, and this size is positively related. In contrast, the size has negative and non-significant coefficients in Navarra. And the willingness to participate in organizations and networks has positive effect in Navarra and this effect is significant. Finally, the competitive pressure has significant relationship with innovativeness only in Valencia.

Therefore, with respect to structural variables, their importance is clear respect to the innovative capacity of farms. In this line, for the two analyzed regions the more educated farmers appear to be prepared for the changes. Also in Valencia larger farms seem more prepared for the innovation and holders show more sensitive to competitive pressures. However, in Navarre the farmers more active in innovation are the most involved in professional organizations and networks. In any case, the structural variables are important in defining the innovative capacity.

On the other hand, and related to the behavioral variables, LO is positively related to innovativeness in both regions. By contrast MO has no significant importance for innovativeness. Therefore, in this first analysis learning behavior seems more relevant for the innovation than the interest in market knowledge.

Finally, LS rurality does not show to be a spatial characteristic that constrains innovation. Demographic dynamism, which is connected with growth rates at the LS level, shows significant in Valencia, but with negative coefficient. That could be explained by the model of economic growth in the region, in the past decade, which was very much based in services and construction and might not favor a business environment supporting innovation.

5. Concluding remarks

The modeling approach followed in this contribution combines structural, behavioral and spatial factors influencing innovation capacities in a sample of regions in two Spanish regions: Valencia, with a production system orientated to Mediterranean products, and Navarra, with a more diversified structure. Common features of the multilevel analysis, in both regions, are (i) the significant and positive effect of education and learning orientation on innovativeness; (ii) the

relatively small relevance of spatial factors, which show that rurality does not hamper innovation; (iii) the no significance of MO, what suggests that it can perhaps favours innovation, but does not seem sufficient for innovation capacity. There are other elements that explain innovation, such as experience and networking in Navarra, and competitive perception in Valencia. These factors are related to the culture of each region and the product specialization, but invite to further investigation.

References

Cassiman, B.,Veugelers, R. (2006). In search of complementarity in innovation strategy: internal R&D and external knowledge acquisition. *Management Science,* 52 (1): 68-82.

Garcia-Alvarez-Coque, J.-M., Mas-Verdu, F. Sanchez García, M. (2014), Determinants of Agri-foodFirms' Participation in PublicFundedResearch and Development.*Agribusiness*,doi: 10.1002/agr.21407.

Rosenbusch, N., Brinckmann, J., Bausch, A. (2011). Is innovation always beneficial?.A meta-analysis of the relationship between innovation and performance in SMEs.*Journal of Business Venturing*, 26: 441-457.

Salavou, H., Avlonitis, G. (2008). Product innovativeness and performance: a focus on SMEs. *Management Decision*, 46 (7): 969-985.

Schmiedeberg, C. (2008). Complementarities of innovation activities: an empirical analysis of the German manufacturing sector. *ResearchPolicy,* 37: 1492-1503.

Vega-Jurado, J., Gutiérrez-Gracia, A., Fernández-de-Lucio, I. (2008). How do Spanish firms innovate?.An empirical evidence. *Journal of Technology Management and Innovation,* 3 (3): 100-111.