Territory and innovation behaviour in agri-food firms: does rurality matter?

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Abstract

Innovation behaviour of agri-food firms depends on the firm structure but also on the characteristics of the territory in which they are established. Spatial considerations are important to determine the propensity of a firm to innovate. Using a database of innovative and non-innovative agroi-food firms located in the Autonomous Community of Valencia, the paper assesses the effect of firms' variables and also the territorial features such as urban/rural areas, percentage of native population, education level of population and distance to technological institutes. Results show that rural areas are not a handicap for innovation but improved access to training services and technological institutes have a significant influence ion innovation.

***Keywords**: enterprises, initiatives, innovation, Spain.*

Résumé

Le comportement innovant des entreprises agro-alimentaires dépend de leur propre structure mais aussi des caractéristiques du territoire sur lequel elles sont implantées. Des considérations spatiales sont donc importantes pour déterminer la propension des entreprises à innover. Dans ce travail, en nous appuyant sur une base de données concernant les entreprises agro-alimentaires innovantes et non innovantes, localisées dans la Communauté autonome de Valence, nous analysons l'effet des variables des entreprises et des caractéristiques du territoire telles la répartition en zones urbaines-rurales, le pourcentage de population locale sur la population totale, le niveau d'instruction de la population et la proximité des centres technologiques. Les résultats montrent que les zones rurales ne constituent pas une contrainte pour l'innovation et que l'accessibilité aux services de formation et aux instituts techniques influe sur l'innovation d'une manière significative.

Mots-clés: entreprise, initiative, innovation, Espagne.

1. Introduction

Innovation behaviour in firms is to a large extent a territorially implanted process. This paper provides an empirical assessment of the territorial variables affecting innovation decisions by agri-food firms across urban and rural areas. Once innovative firms are identified, the contribution of territorial variables to support innovative businesses can be assessed, the underlying question being how far rural areas provide an adequate environment for innovation compared to urban areas.

Research on regional innovation systems has shown that the innovative activity of firms is based to a large degree on localized resources such as a specialized labour force, regional systems, local learning, traditions for co-operation and entrepreneurial culture (Asheim and Coenen, 2005; Cooke *et al*., 1997; Cooke 2001; Fagerberg *et al*., 2012).

Given the importance of exploring the determinants of rural development, it is outstanding that published research has paid little attention to the influence of territorial variables on innovation behaviour in rural areas (De Noronha *et al*., 2006; Aznar and Galdeano, 2011; Fearne, 2012). Copus *et al*. (2008) found that central areas present higher rates of innovative activity than peripheral areas. For decades, rural areas in OECD economies have been experiencing deep economic and social transformations (Pezzini, 2001), suffering dramatic depopulation and demographic ageing, accentuated by limited access to public services compared to urban areas (OECD, 2006a). Nevertheless, positive signs have recently emerged towards economic diversification and the development of manufacturing industrial districts in rural areas (Boix and Galetto, 2008). Agri-food businesses are playing a role in this transformation and are showing more resilience in the present declining economic climate than other industries (OECD, 2009). National policy makers have shown a growing interest in the influence of territorial factors on innovation (Europe Innova, 2007). Recent European Commission's proposals to reform the Common Agricultural Policy (European Commission, 2011) recognise the role of knowledge transfer and cooperation, aimed at promoting resource efficiency, productivity, as well as sustainable development.

Further evidence is needed to clarify what determines innovation in rural areas. Fearne *et al*. (2012) investigated the extent to which rural areas in the Autonomous Community of Valencia (ACV) are handicapped to host innovative firms. However, Fearne *et al.* did not control a number of variables characterising LLS, beyond their differentiation between rural or urban LLS, or their classification as industrial districts. Are firms innovative because they are lo-

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cated in industrial districts (I-district effect) or because they are located in urban/rural areas, or because of a range of specific territory-related characteristics? Is it therefore possible to draw a more selective picture of factors determining innovation in LLS? To bring light to this question, the causes of differences in innovation behaviour and performance of firms were investigated by using agri-food business micro-data collected in the region of Valencia, mixed with territorial variables based on theoretical literature.

2. Spatial considerations and agri-food innovation in rural areas

A question arises regarding the extent to which innovation can be seen as a local process, based on territorial resources and information (Romanelli and Schoonhoven, 2001). Ideas for innovation are largely related to the immediate environment where enterprises are located (Audretsch, 2003; Kalantaridis and Bika, 2006). Firm localization is emerging as a key consideration in the innovation process.

The general hypothesis is in line with the existence of spatial externalities that play a role in economic performance (Fujita and Thisse, 2002). Based on such hypothesis, three theoretical frameworks can be helpful to identify local variables affecting innovation behaviour: (i) the learning economies, (ii) Porter's competitive advantages, and (iii) regional systems based on local labour systems and industrial districts. These frameworks could be easily combined and even merged in a general discourse (Doloreux and Parto, 2005), but we prefer keeping them separately as they contribute to the construction of the empirical exercise that we develop below.

Learning economies

The learning region model emphasizes evolutionary economies, learning processes, and the working and social interaction as success factors for territories. Morgan (1997) provides an explanation of the logic of the learning region, claiming the role of knowledge as a strategic resource and learning as an important process.

The business environment in rural regions suffers from weaknesses in the quality of schools and transportation networks, as well as other infrastructure which make it difficult to access modern support services and use advanced technologies. Hiring human capital from outside the rural areas can be a source of incorporated skills (Webber *et al.*, 2009), but again limited access to public services can hinder the transfer of trained staff. Remoteness can impede innovation if there is a relative absence of non-local networks (Atterton, 2007). To consider this effect the variable "education level of the population" is included.

Firm experience has received limited attention in the context of innovation (Sørensen and Stuart, 2000; Huergo and Jaumandreu, 2004) and can be proxied by the age of the firm. Firm experience has been associated with two opposite effects in the literature. The first is the accumulation of experience and managerial competences. The second is "organizational inertia" to adjust the firm's capabilities (Hannan and Freeman, 1984; Balasubramanian and Lee, 2008). Giannakas and Fulton (2005) stressed the potential of coops for organizational advantages with respect to investment and innovation activity. Another cultural factor is communication with migrants in rural areas which can contribute to expanding investment and entrepreneurial activities (OECD, 2006a). To test this effect we will include a variable measuring the share of native population in total population.

Spatial competition

One analytical approach is Porter's cluster, which has the advantage of considering all the determining factors of competitiveness, including economic dynamism of the territories (Porter, 1998). The interaction between industry specialization and locational drivers is also present in Porter's analysis (Porter, 2003).

Firms in rural economies do not enjoy some of the advantages of industries located in the urban areas. This poses the question of the influence of the rurality degree on innovative firms. Some intermediate rural areas, including periurban areas, often offer advantages for local resources as well as access to urban markets. Remote rural areas make it difficult for firms to build economies of scale and easy resource supply. Capital markets are also affected by lack of proximity to metropolitan areas, as transaction costs for venture capital access are higher (Henderson, 2002). Although there is a consensus on the gap with respect to urban areas, it seems that a substantial heterogeneity exists in terms of economic performance among rural regions in Spain (Regidor, 2008).

Agri-food firms can make use of local resources, based on natural and labour conditions, and at the same time, overcome the challenges of size, distance and access to inputs with embodied technology. Firm specialization, such as producing or processing agricultural products obtained in the territory where they are located, can be a source of spatial advantages. We will take into account the industry specialization of the territories with respect to agricultural production. There is another source of advantage, access to the labour market, which has been hampered in rural areas by the depopulation suffered in past decades (Findlay *et al.*, 2000). Many firms have been able to compensate such a handicap by contracting migrant labour, mainly foreigners, through a strategy based on low labour costs.

Regional innovation systems

The concentration of competing firms in industrial districts stimulates the development of unique pools of specialized skills and the promotion or attraction of specialized suppliers (Beccatini *et al.,* 2003). Clusters enhance innovation in three ways. First, they improve productivity because firms have easy access to specialized suppliers, skills, information, training and techniques in a demanding compet-

itive environment. Second, clusters allow firms to perceive opportunities for new products and new processes. Third, clusters lower transaction costs and the barriers to entry of new firms, expertise and credit. Local labor systems (LLS) are defined as communities of firms and people, a territory where the productivity and social structure have a strong interaction. Recent work has identified at least three industrial districts in the ACV based on food processing (Ybarra *et al*., 2008; Boix, 2008). These areas may show a local cluster effect, as they provide local resources for agri-food industries. Recent criticisms have questioned the efficiency of industrial districts and LLS or argued that this efficiency is static and based on lower costs due to over-exploitation of hired labour, self-exploitation of small entrepreneurs and precarious living conditions whereas the district is not innovative or creative enough to generate dynamic efficiency (Beccatini and Musotti, 2004). Criticisms have been counteracted by evidence of "district effects" or increased evidence in areas referred to as industrial districts which provide higher efficiency for local firms (Fabianni *et al*., 2000; Bronzini, 2000).

Table 1 presents a summary of the theoretical approaches. Indicators will be selected and measured at the firm level, by using business micro-data, or at a territorial level, by using social and economic variables of the areas.

Table 1 - *Theoretical approaches to innovative behaviour*.

Theoretical approach	Concept
Learning economy	Access to education Access to knowledge Experience Potential for cooperation Cultural links with outside world
Spatial competition	Locational advantages, access to infrastructure and economies of agglomeration Industrial specialization Economic dynamism New labor force
Regional innovation systems	I-District effect

Source: own elaboration based on literature review.

3. A Model to explain innovative behaviour

A particular case in Probit models will be used to consider a group of variables that can affect the decision of innovation by firms. The model employed, to be selected or not as an innovative organization, is derived from the traditional neoclassical perspective to maximize the utility (Javorcik, 2002; Pratridge, 2003; Lee, 2004; Nannicini, 2006; Donald and Lang, 2007; Tsoodle and Turner, 2008; Lera-López et al. 2012; Gil et a., 2010; Torlger et al., 2010; D'Angello and Lilla, 2011). The model is based on the comparison of the utilities *Uij* of the firms *i* to each alternative *j*, in our case *j*=1 if the firm innovates and *j*=0 if the firm does not innovate. The utility *U* assigned to each firm is a lineal function with a vector of individual characteristics (*Xi*) which is an observable heterogeneity.

$$U_{ij} = X'_{ij}\beta_{ij} + \varepsilon_{ij} \quad j = 0,1 \text{ and } i = 1,2,\ldots..,\ n \qquad (1)$$

The expression ε_{ij} is the random error or non-observable heterogeneity. Each firm will select the $j=1$ alternative if the utility obtained is higher than the utility of the $j=0$ alternative. The $i=0$ presents the complementary event. If this situation is shown, with an observable innovation measure Yj and, in probabilistic terms in function of the firm's selection, the expression is:

$$\begin{aligned} P(Y_j = 1)\big(P(U_{i1} > U_{i0}) &= P\big(X'_{i1}\beta_1 + \varepsilon_{ij}\big) > X'_{io}\beta_0 + \varepsilon_{io}\big) \\ &= P(X'_i(\beta_1 - \beta_0) + (\varepsilon_{i1} - \varepsilon_{i0}) > 0) = P\,(X'_i\beta + \varepsilon_i) > 0 = P\big(\varepsilon_i > -X'_j\beta\big) \\ &= F(X'_i\beta) = \frac{1}{\sqrt{2\pi}}\int_{-\infty}^{x} e^{\frac{-x^2}{2}}\,dx \end{aligned} \qquad (2)$$

If the random error follows a normal distribution, the model used to estimate will be a probit model, where *P* represents the probability of a firm to be innovative and *F* is the distribution function of a standard normal. Assuming *N* independent observations distributed identically, the estimation is carried out by maximum likelihood.

The present study combines a business sample including innovative and the rest of agri-food firms in the region, considering the individual information of each one with other aggregate variables defined at the local labour system level to capture territorial information that affects business behaviour. According to Moulton (1990), when estimating the impact of aggregate variables on individual outcomes, unobservable characteristics at the aggregate level can affect all observations within a cluster and exaggerate the statistical significance of the aggregate variable. The existence of intra-group correlation causes errors in the standard deviations, which gives rise to inefficient estimators. For this, the Probit models estimated (see below) have incorporated the Moulton transformation that provides corrected standard deviations taking into account intra-group correlations.

4. Data and sources

Agri-food businesses were sampled to investigate their comparative behaviour and performance across rural and urban areas in the ACV. The causes of differences in innovation behaviour and performance of innovative firms were investigated by using business micro-data collected from existing surveys combined with information on the territory where firms are located. The empirical implementation of the model described in the last section entails some problems related to measurement and data collection. These are: (1) classification of economic areas or local systems; (2) measurement of innovation; (3) business data; and (4) local systems' data.

Rural and urban local labour systems

Boix and Galetto (2005) delimited 806 LLSs in Spain, 82 of which located in the ACV. We classified LLSs according to their degree of rurality to determine possible relations between innovation and rural territories. For that, the OECD classification for rural and urban territories, based on density of population, was used (OECD, 1994). A community is considered urban if its population density is higher than 150 inhabitants per square kilometer. Below that level a community is considered to be rural. Three types of regions are defined: predominantly rural (PR), if more than 50% of the population lives in rural communities; intermediate areas (IN), if between 15 and 50% of the population lives in rural communities; and predominantly urban (PU), if less than 15% of the population lives in rural communities. Following the OECD criteria there are 40 LLSs that are predominantly urban, 8 intermediate and 34 predominantly rural in the ACV (Table 2).

Table 2 - *Rural/Urban classification of LLS in the Valencia region according to OECD criteria.*

	Predominantly urban	Intermediate	Predominantly rural	Total
Number of LLS	40	8	34	82
Population (% of total)	84%	2%	13%	100%
Surface (% of total)	42%	8%	50%	100%

Source: Authors' calculations based on Boix and Galetto (2005) and OECD (1994).

Measuring innovative behaviour

Most studies consider innovation-related indicators, the most popular of them being the R&D intensity (Hansen and Birkinshaw, 2007; Mohnen *et al*., 2007), which in Spain is provided by the ICS (Innovation in Companies Survey, INE). However, the ICS has the limitation that it does not provide the exact location of plants, which prevents the analysis of spatial considerations. Besides this, the ICS does not consider firms smaller than 10 workers, a severe restriction in a region such as Valencia where there are plenty of small firms. The present study makes use of a regional database on innovating enterprises, developed by Lopez-Estornell (2010), which includes a variety of public files, mainly reflecting partnership collaboration between scientific and technological institutions and firms. Such an approach has also been adopted by studies that conduct benchmarking analyses to assess various national and regional innovation systems (Braczyk *et al*., 1998; Hollanders, 2009). The database includes a list of innovative enterprises, which fulfil at least one of the following criteria (i) to have successfully applied for innovation projects called by regional public institutions, such as IMPIVA (Small and Medium Enterprise Institute in Valencia, 2000-2006) and CDTI (Technological Industry Development Centre, 2003-2006); (ii) to have applied for a patent between 2000 and 2006, or a utility model between 2000 and 2008, in the OEPM (Spanish Office of Patents and Trademarks); (iii) to have published a scientific journal paper (at least one of the authors should be part of the firm's staff) during the period 1995-2006 (INGENIO database); (iv) to have established partnership agreements with public R&D and technological institutes, including contracts with a Valencian public institute during the period 1999-2003 (INGENIO database), such as a membership of a technological institute, a partner of the CEEI (European Centre of Enterprises and Innovation) or a spin-off from the universities or research institutes in Valencia.

Business data

As for the construction of the agri-food firm sample in the analysis, business data are drawn from the SABI (Iberian System of Balance Sheet Analysis) database, which is the Spanish branch of the AMADEUS database family generated by the private firms INFORMA and Bureau Van Dyck. The sample includes all agri-food firms in the database belonging to primary agricultural products (NACE 01) and food processing and drinks (NACE 10, 11). Thorough checking was made in order to eliminate repetitions, complete the information available and correct mistakes.

The results of the query were further checked in order to detect abnormalities such as enterprises classified in the selected NACE but whose activity description was inconsistent or did not show the number of workers registered. Enterprises' bases were localised by selecting those having their headquarters in the ACV. The companies with headquarters in another Spanish region were not considered in the sample. This led to a certain loss of information with a limited impact on the basis of the results provided by the ICS, which highlights low levels of innovation efforts made in the ACV by these companies.

The database of innovative firms was crossed with the list of agri-food firms included in SABI in the ACV, so the whole data set included 247 enterprises reflecting innovative behaviour and 2,494 agri-food enterprises in the ACV that do not fulfil any of the aforementioned innovation criteria. The sample was classified according to the activity sector (NACE), local labour system (as explained above) and size, according to the number of employees: micro and small (<50 employees) and medium and large enterprises (>50 employees). This division facilitated the assessment of the firm differential innovative behaviour according to the size (see Acs and Audretsch, 2005 and Lee and Sun, 2005, for detailed surverys on the relationships between firm size and innovation behaviour).

Local systems' data

Beyond the rural/urban classification and the clusters and industrial district effects, territorial variables have an influence on the innovation capacity of firms located in the area considered. There are not many sources of information including municipality data. In the paper two databases have been checked: the Spanish census of population and houses – Censo de Población y Vivienda – (INE, 2001) and the s-

tatistical yearbook of La Caixa (2009). More than 77% of the firms sampled are located in urban areas.

The territorial variables considered to characterize LLS are: the share of native-born population within total population, the share of foreign-born migrants within total population, the education level of the population between 30 and 39 years old, the distance to the nearest technological institute and the economic activity index (see table 2)

Taking into account these variables, urban areas show the lowest rates of native-born population. The economic activity index, elaborated by La Caixa, at municipal level, is much higher than in rural and intermediate areas. The education profile is also better than in other areas and the distance to a technological center is around 30 minutes. The education profile of population is worse in rural areas than in urban and intermediate areas. Rural areas are relatively far from the nearest technological institute.

Intermediate areas show values of native born population, economic activity and education level of population between those values of rural and urban areas. However, intermediate areas are, on average, closest to technological institutes (25 minutes).

Even if most of the firms are micro and small, the largest percentage of large firms is located in urban areas where they can take advantage of agglomeration. Co-ops are more represented in rural areas. The age of firms tends to be longer, on average, in rural areas than in urban and intermediate areas. The variables considered in the models are summarized in table 3.

5. Findings and discussion

To determine the probability for a firm to be innovative, according to the different characteristics and local situation of the enterprise, alternative Probit Models were developed. The dependent variable takes the value 1 if the firm is classified as innovative, and takes the value 0 if the firm does not fulfil the innovation alternatives proposed in the paper.

Tables 4 and 5 show the results obtained considering two types of firms according to the size. Table 4 includes the results for the micro and small (MS) enterprises and Table 5

Table 3 - *Firm and spatial variables*.

Variable	Definition	Source	Name
Activity sector	Dummy accounting for 1 if agriculture is the main branch of firm's activity	SABI	AGRI
	Dummy accounting for 1 if the LLS has agriculture as the main sector.	Boix and Galetto, 2008, López-Estornell, 2010	AG
	Dummy accounting for 1 if the LLS has food industry as the main sector.		FOOD
Local Labour Systems	Dummy accounting for 1 if the LLS is considered urban according to OECD criterion.	Own delimitation based on OECD, 1994	OECD-U
	Dummy accounting for 1 if the LLS is considered rural according to OECD criterion.	Own delimitation based on OECD, 1994	OECD-R
Firm's characteristics	Number of years from constitution date until 2011.	SABI	AGE
	Dummy accounting for 1 if the legal status of the firm is a co-op.	SABI	COOP
Spatial variables	Proportion of native born population in total resident population.	Population and houses census, 2001. INE (Spanish national statistical service)	NAT
	Proportion of foreign born population (non EU origin) in total resident population.	Population and houses census, 2001. INE (Spanish national statistical service)	FOREIGN
	Education level of population between 30 and 39 years old accounting for 0 to illiterates and 4.5 to PhD graduates.	Population and houses census, 2001. INE (Spanish national statistical service)	EDU30-39
	Distance to the nearest technological institute, measured in minutes.	Redit (Network of Technology Institutes of the Valencian Region) and Google maps.	DIST
	Contribution of the community to the national economic activity. Total index at national level is 100,000 units, related to the business tax collection.	Statistical yearbook, La Caixa, 2009	ECON

Source: Authors' elaboration.

presents the values obtained for medium and large (ML) firms. Some authors have previously found differences in innovative behaviour depending on the firm's size (Verhees and Meulenberg, 2004; De Noronha *et al*., 2006; Salavou and Avlonitis, 2008).

Group effects estimation for standard errors use the correction for common variance components within groups proposed by Moulton (1990). A simple formula for the standard error of a clustered estimate is derived from the true variance-covariance matrix, which includes the intra-class correlation that measures the dependence of units within a cluster for a given aggregate variable. Three aggregated variables were selected to apply the Moulton correction: 1) the fixed effect to denominate urban LLS (urban = 1, rest of LLSs = 0); 2) the index of economic activity; and 3) the degree of studies for people aged 30 to 39 years. The three corrections used are presented in Table 4 and 5 showing quite homogenous results. For each aggregate variable, two models were estimated: Model 1 uses the NACE classification to classify enterprises, and Model 2 employs the concept of district to identify the activity sector.

Table 4 - *Probit models with Moulton Correction for micro and small firms*.

Aggregate variable: OECD Urban				Aggregate variable: Economic Activity Index				Aggregate variable: Degree of Studies Age 30-39 years			
Variables	Model 1	Variables	Model 2	Variables	Model 1	Variables	Model 2	Variables	Model 1	Variables	Model 2
Constant	-3.49*** (-5.15)	Constant	-2.62*** (-7.78)	Constant	-3.51*** (-2.86)	Constant	-2.63** (-2.19)	Constant	-0.73* (-1.82)	Constant	-0.74** (-1.94)
Activity Sector		Activity Sector		Activity Sector		Activity Sector		Activity Sector		Activity Sector	
AGRI	-1.10*** (-5.15)	AG	-0.09 (-0.46)	AGRI	-1.10*** (-9.59)	AG	-0.09 (-0.51)	AGRI	-1.09*** (-8.61)	AG	-0.04 (-0.22)
		FOOD	0.01 (0.08)			FOOD	0.005 (0.07)			FOOD	0.01 (0.18)
Local Labor System		Local Labor System		Local Labor System		Local Labor System		Local Labor System		Local Labor System	
				OECD-U	0.14 (0.54)	OECD-U	0.09 (0.36)	OECD-U	0.19 (0.86)	OECD-U	0.14 (0.62)
OECD-R	0.098 (0.05)	OECD-R	0.11*** (6.80)	OECD-R	0.22 (0.73)	OECD-R	0.19 (0.75)	OECD-R	0.22 (0.75)	OECD-R	0.21 (0.83)
Other characteristics		Other characteristics		Other characteristics		Other characteristics		Other characteristics		Other characteristics	
AGE	-0.001*** (-2.78)	AGE	-0.003*** (-3.33)	AGE	-0.0001* (-1.78)	AGE	-0.0003** (-2.23)	AGE	-0.0001 * (1.81)	AGE	-0.0003** (-2.11)
COOP	1.20*** (7.99)	COOP	1.04*** (450)	COOP	1.19*** (6.74)	COOP	1.04 (5.38)***	COOP	1.19*** (5.53)	COOP	1.03*** (4.51)
Spatial variables		Spatial variables		Spatial variables		Spatial variables		Spatial variables		Spatial variables	
NAT	0.006 (0.90)	NAT	0.001 (0.38)	NAT	0.005 (0.72)	NAT	0.001 (0.20)	NAT	0.001 (0.27)	NAT	-0.001 (-0.22)
FOREIGN	-0.13*** (-3.64)	FOREIGN	-0.15*** (-3.56)	FOREIGN	-0.14*** (-3.19)	FOREIGN	-0.15*** (-3.31)	FOREIGN	-0.12*** (-2.75)	FOREIGN	-1.44*** (-3.35)
EDU30-39	0.91*** (5.25)	EDU30-39	0.61*** (3.85)	EDU30-39	0.89*** (2.61)	EDU30-39	0.59* (1.75)	DIST	-0.01*** (-4)	DIST	-0.011*** (-4.41)
DIST	-0.005*** (-6.71)	DIST	-0.007*** (-15.12)	DIST	-0.005* (-1.91)	DIST	-0.007** (-2.2)				
Number of observations	2242	Number of observations	2242	Number of observations	2242	Number of observations	2242	Number of observations	2242	Number of observations	2242
X^2	165***	X^2	161.2***	X^2	172.35	X^2	153.26	X^2	291.81***	X^2	272.19***
Log-Likelihood	-497.10	Log-Likelihood	-560.13	Log-Likelihood	-496.96	Log-Likelihood	-560.06	Log-Likelihood	-499.19	Log-Likelihood	-561.16
Pseudo R^2	0.20	Pseudo R^2	0.099	Pseudo R^2	0.20	Pseudo R^2	0.099	Pseudo R^2	0.197	Pseudo R^2	0.097

Source: Own calculation. Note: ***p<0.01; **p<0.05; *p<0.10.

The results indicate good levels of reliability in all models. Testing the influence of aggregate variables on firms' innovation behaviour allows controlling a number of factors beyond the rural/urban nature of the LLS. Higher levels of education in the area and closer proximity to knowledge centres appeared to favour innovation in all models estimated for MS enterprises, while the effects are less evident, and even contradictory, for ML firms. As for the percentage of native-born population, it is only significant in one of the models for ML firms, with higher innovation propensity when the share of native-born population is lower. This would suggest a positive influence of migration on innovation, though this is not confirmed in the rest of the estimated models. Presence of foreign-born population in non-EU countries appears to be not significant in the models estimated for ML enterprises, but significant with a negative coefficient in the models for MS enterprises. Foreign-born population has been associated to low labour costs and the variable appears to be associated with lower propensity to innovate in the MS business model.

Urban LLS seem to have a positive effect on innovation in ML enterprises. However, influence of rurality does not seem to be constraining for MS enterprises in any of the models. Despite their spatial weaknesses, rural areas do not pose a determinant handicap to MS firms to undertake innovative actions. This is consistent with the results of qualitative surveys on rural economic performance (Courtney *et*

Table 5 - *Probit models with Moulton correction for medium and large firms.*

Aggregate variable: OECD Urban				Aggregate variable: Economic Activity Index				Aggregate variable: Education level Age 30-39 years			
Variables	Model 1	Variables	Model 2	Variables	Model 1	Variables	Model 2	Variables	Model 1	Variables	Model 2
Constant	12.15**	Constant	3.36	Constant	13.3*	Constant	2.42	Constant	-2.4	Constant	-0.61
	(2.21)		(0.48)		(1.61)		(0.37)		(0.91)		(-0.33)
Activity Sector		Activity Sector		Activity Sector		Activity Sector		Activity Sector		Activity Sector	
AGRI	-2.79***	AG	-0.71***	AGRI	-3.11***	AG	-0.91	AGRI	-2.8***	AG	-0.93*
	(-4.84)		(-14.05)		(-3.88)		(-1.69)		(-4.11)		(-1.59)
		FOOD	0.11			FOOD	-0.17			FOOD	-0.16
			(0.2)				(-0.49)				(-0.45)
Local Labor System		Local Labor System		Local Labor System		Local Labor System		Local Labor System		Local Labor System	
				OECD-U	-0.62	OECD-U	1.71*	OECD-U	-0.37	OECD-U	1.71*
OECD-R	-0.19	OECD-R	-0.14		(-0.49)		(1.67)		(-0.3)		(1.76)
	(-0.41)		(-1.04)	OECD-R	-0.81	OECD-R	1.41	OECD-R	-0.41	OECD-R	1.44
					(-0.56)		(1.29)		(-0.31)		(1.58)
Other characteristics		Other characteristics		Other characteristics		Other characteristics		Other characteristics		Other characteristics	
AGE	-0.015**	AGE	-0.02***	AGE	-0.014***	AGE	-0.018**	AGE	-0.014***	AGE	-0.018**
	(-6.99)		(-20.1)		(-2.88)		(-2.4)		(-2.85)		(-2.27)
COOP	3.0***	COOP	2.23***	COOP	3.04***	COOP	2.39***	COOP	3.03***	COOP	2.38***
	(3.82)		(6.97)		(7.96)		(5.48)		(6.89)		(5.50)
Spatial variables		Spatial variables		Spatial variables		Spatial variables		Spatial variables		Spatial variables	
NAT	-0.03***	NAT	-0.004	NAT	-0.03	NAT	-0.003	NAT	-0.002	NAT	
	(-31.6)		(-0.29)		(-0.84)		(-0.1)		(-0.08)		
FOREIGN	-0.22	FOREIGN	-0.14	FOREIGN	-0.19	FOREIGN	-0.24	FOREIGN	-0.23	FOREIGN	-0.25
	(-1.46)		(-0.44)		(-0.82)		(-1.1)		(-0.95)		(-1.41)
EDU30-39	-2.75*	EDU30-39	-0.72	EDU30-39	-2.92	EDU30-39	-0.85	DIST	-0.038***	DIST	-0.02*
	(-1.7)		(-0.44)		(-1.55)		(-0.53)		(-3.03)		(-1.68)
DIST	-0.05**	DIST	-0.03***	DIST	-0.05***	DIST	-0.02				
	(-2.11)		(-3.4)		(-3.01)		(-1.47)				
Number of observations	133	Number of observations	133	Number of observations	133	Number of observations	133	Number of observations	133	Number of observations	133
X^2	134.2	X^2	131	X^2	123.64	X^2	128.61	X^2	202 ***	X^2	111.93***
Log-Likelihood	-41.25	Log-Likelihood	-54.64	Log-Likelihood	-41.12	Log-Likelihood	-52.47	Log-Likelihood	-42.04	Log-Likelihood	-52.59
Pseudo R^2	0.54	Pseudo R^2	0.39	Pseudo R^2	0.54	Pseudo R^2	0.41	Pseudo R^2	0.53	Pseudo R^2	0.4145

Source: Own calculation. Note: ***p<0.01; **p<0.05; *p<0.10.

al., 2004), which show that peripherality is not perceived to be a significant constraint on firm performance, in particular for MS firms, although peripheral areas show lower activity rates (Copus *et al*., 2008). Our investigation confirms that knowledge and skills are important drivers of innovation in agri-food firms and rural areas.

The hypothesis of the learning region seems further supported by the higher propensity to innovate in co-op businesses. Co-ops can take part in the kind of private-public partnerships that define an enterprise as innovative. In the models considered firms' age does not positively affect innovation. Despite theoretical work developed by Jovanovich (1982) and Evans (1987) relating firm age to learning and knowledge accumulation, other empirical evidence shows that age has a negative effect on the probability to innovate (Acs and Audretsch, 1990). This would invite to investigate the extent to which new firm creation is connected with private-public collaboration for implementing innovations.

We focused on agri-food firms, which are scattered across rural and urban regions. With regard to the specialization sector, agricultural firms seem to be less innovative than food processing firms. None of the models suggest that food industrial districts have influence on the probability of incorporating innovative activities. Firms based in areas where agriculture is important seem to be less innovative. Some elements could explain that agricultural firms are less innovative than food processing firms such as the fact that agriculture is focused on commodity products, while food processing firms deal with differentiated products for which more facilities to innovate are offered. Besides, agricultural firms can be considered supply-dominated businesses, which have been associated with low technology inputs and lower entrepreneurship rates (Alba *et al*., 2011) and in many cases are based on low labour costs. Results support the argument that there is no exact correspondence between rural development and the development of the agricultural sector, as the first can lead to innovative processes not directly linked to primary activities. The positive role of food processing is consistent with the results of previous studies, which characterise food manufacturing as an industry with relatively high technologically input in the Autonomous Community of Valencia (Garcia-Alvarez-Coque *et al*., 2012).

5. Concluding remarks

Innovation appears to be strengthened in co-ops which seem to be more willing to collaborate with innovation support services. The territorial factors positively affecting innovation are education, physical access to knowledge centres and presence of firms in industrial districts with food specialization. Innovative micro and small firms attract more local population, with trained young people and proximity to technological centres. Such effects are not so relevant for medium and large firms, which seem to innovate more in urban areas.

Availability of farm products and cheap labour does not prove to support innovative behaviour. Rurality does not seem to be *per se* a handicap for innovative firms, in particular for MS enterprises. However, this does not contradict the need for policies with a territorial approach addressing constraints to innovation. Thus, our investigation provides further arguments favouring policies to improve access to knowledge. This includes EU policies aimed at promoting the economic diversification of rural areas and supporting measures to encourage efficiency of producer organisations due to their positive impact on innovation. The European Commission has recently recognized the importance of innovation and has included it as a cross-cutting theme in the six priorities of the Rural Development Policy 2014-2020. This will involve new schemes and mechanisms to stimulate innovation in SMEs in order to promote a smart, sustainable and inclusive growth.

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