Determinants of agri-food firms' participation in public funded R&D.

ABSTRACT

A database of over 2,700 agri-food businesses in the region of Valencia, Spain was used to test the influence of internal characteristics of the firm and of external characteristics linked to local systems on the willingness to participate in R&D activities promoted by knowledge supporting institutions. A Probit model was estimated, correcting possible intra-group correlations when group variables are combined with individual data. Results show that R&D activities are enhanced in medium and large firms, co-ops, experienced firms and better physical access to technological centers. [JEL Codes: Q130, Q160].

1. INTRODUCTION

This paper focuses on a relevant source of innovation, which is the participation of agri-food firms in R&D projects. In particular, the article's main objective is to provide an explicit test on how firm characteristics, local systems (LS), and access to knowledge affect the agri-food firms' willingness to carry out R&D activities[1].

Given that in the EU small and medium sized enterprises (SME) prevail; understanding how to increase their participation in R&D projects is relevant for the EU agri-food economy in order to face competition in both domestic and international markets (Grunert et al., 1997; Capitanio et al., 2009; FoodDrinkEurope, 2012; Rama, 2008; Traill & Meulenberg, 2002; Bayona et al., 2013). Partnerships of agri-food firms with public institutions reduce the costs and risks of private R&D, produce social

[1] There are, of course, other sources of innovation in agriculture as, for example, as an adopter of innovation through the acquisition of innovation intensive products or the adaptation of products and processes to customers (see Omta, 2002; Beckeman, M., & Skjöldebrand, 2007; García Alvarez-Coque et al., 2012).

returns (Alston et al., 2010), and enhance investment in applied discoveries (Alfranca, 2005).[2]. Our intention is to provide further evidence that could bridge the gap between SME and R&D activities in the agri-food sector. The participation of firms in R&D is considered here in a broad sense in order to describe various activities, including R&D collaborative agreements, patent applications and participation in scientific publications.

There are several studies (Belderbos et al, 2004, Howells, 2006, Jacob at al., 2013) that analyze the cooperative relationships between public entities and companies. With some exceptions (Muscio, 2007), most studies note that there is not sufficient knowledge regarding the factors that influence the likelihood of firms to collaborate with scientific and institutions of innovation (Zhang & Li, 2010, Badillo&Moreno, 2014). In addition, there is a significant gap in the literature about which factors influence the participation of agri-food firms in R&D activities (Capitanio et al., 2009; Klerk&Leeuwis, 2009).

R&D participation involves a diverse set of actors (businesses, organizations, technology centers, universities) working together in the field of research and technological development. The agri-food sector presents three characteristics that require specific analysis, and refer to the nature of their firms, their location, and the role of the public system in supporting R&D.

A first characteristic is that agri-food firms are, for the most part, composed of micro and small enterprises. Our analysis tests the participation of this group of firms in R&D projects. Previous literature has emphasized that engagement in R&D activities

[2] The Commission has launched recent program to support the creation of a favorable ecosystem for SME innovation and growth . One example is the "Innovation in SMEs" program as a bridge between the core of research program Horizon 2020 and the provision of support to research, development and innovation projects in SME.

may vary with size. However the most widely used Spanish innovation databases (PITEC[3] and STIE[4]) rarely include data of firms with fewer than 10 employees, which justifies the construction of a specific database as was undertaken during this study. Our paper draws on a database of over 2,700 Food, Beverage and Tobacco enterprises. The firm characteristics considered relate to age, legal form and size.

Considering the second characteristic; the firm's location. Agri-food businesses often spread across the territory and are considered a key element of any rural development strategy. While recent studies have considered determinants of innovation in Spanish firms without specifically taking into account the agri-business economy (Badillo&Moreno, 2014) the role of local systems in the businesses' propensity to engage in R&D activities has not been sufficiently studied. In the European Union context, the analysis gains relevance as the European Commission recognizes the role of innovation as a cross cutting theme in the six priorities of the Rural Development Policy 2014-2020 (European Commission, 2011) [5]. Determinants of innovation in remote European areas were explored by Copus et al. (2008) focusing on the analysis of 12 case studies and a survey of 50 businesses in each case study area. They found that central areas present higher rates of innovative activity than peripheral areas. Determinants of innovation in agri-food firms were also previously considered in Fearne (2013) and Garcia Alvarez-Coque et al. (2013), showing that rural areas do not represent a handicap *per se*. R&D activities are the result of interactive processes that involve many different players and institutions, maintained through bilateral relations between actors, but also through access to R&D networks, many of regional relevance

[3] Technological Innovation Panel.
[4] Survey on Technological Innovation in Enterprises.
[5] A political agreement was reached on 26 june 2013. See http://ec.europa.eu/agriculture/cap-post-2013/agreement/index_en.htm.

(Fernández & Rubiera, 2013 and Van Hemert et al., 2013) involving institutions that aim to generate innovations or new knowledge. Our business database identifies the base of agri-food firms in the region of Valencia distributed throughout 82 local systems.

A third characteristic of the agri-food economy is the considerable weight of public funded research in EU Member States in comparison with private expenditure (Eurostat, 2014, OECD, 2014). This implies that public institutions such as Government agencies supporting SME and universities currently play a key role in supporting firms' R&D. Knowledge acquisition of SME is assumed to benefit from geographical proximity to universities and other research institutions (Audretsch at al., 2005) which is particularly relevant for agri-food firms which are located in rural areas (Maietta, 2014).

Considering the specificities of the agri-food sector, a Probit model will be specified in this paper in order to explain how firm characteristics, local systems, and access to public knowledge centres affect the participation of agri-food firms in R&D activities

Local systems influence R&D choices for firms located in rural and urban areas. In section 2 we discuss the determinants of R&D partnership, with reference to local systems and the firms' characteristics, including size. Section 3 presents the choice model used to determine the likelihood of the firms to take part in R&D activities. The data are described in section 4, followed, in section 5, by the presentation and discussion of the main findings of the empirical application. Finally, section 6 provides the main conclusions of the analysis.

2. DETERMINANTS OF R&D PARTICIPATION.

Agri-food businesses are playing a role in the economic and social changes observed in EU rural areas (Pezzini, 2001, OECD, 2009). The agri-food system has been classified as a low R&D intensive sector (Connor & Schiek, 1997, Garcia-Martinez & Briz, 2000). A scoping paper (Oleaga et al, 2008) indicated that the food industry was below the European manufacturing average with regard to most standard measurements of innovation activities. Determinants of innovation in small agri-food firms have attracted empirical research pointing to a wide range of aspects such as introduce new products, develop new processes, make changes in the organizational structure and explore new markets (Avermaete et al, 2003; Batterink et al. 2010). Our focus in this paper is the participation of rural firms in R&D projects.

Enterprises can start several forms of R&D collaboration: innovation projects, patents, utility models, peer-review journals, memberships in technological centers and spin-offs. In this paper, we examine the willingness of an agri-food firm to undertake R&D activities, based on (i) business' characteristics which include the size of the firm, its experience and the role played by cooperative firms (co-ops) to share knowledge; (ii) characteristics of the local system where the firm has its base; and (iii) access to knowledge, based on the accessibility to technological centers and universities.

(i) Firm's characteristics

Among the firm characteristics influencing the ability to carry out R&D projects in partnership with public institutions are firm size, experience and the legal form. As for firm size, evidence suggests a positive and linear (e.g., Baldwin et al., 2002) or non-

linear (e.g., Bhattacharya & Bloch, 2004) relationship between firm size and the probability to innovate while earlier studies have also documented a negative relationship (e.g., Pavitt et al. 1987). Firm size also is related to R&D expenditures (Lee & Sung, 2005; Tsai & Wang, 2005). Firm size induces a risk-uncertainty-irreversibility framework that may handicap the competitiveness of SME in rural areas. The uncertainty characteristics of an innovation process are the degree of market competition (Abel, 1983), the degree of returns to scale (Caballero, 1991), irreversibility of innovation and investment (Dixit & Pindyck, 1994) and the possibilities to obtain external credit (Bougheas, 2004). However, recent literature revels a dual perspective on the relation between firm size and R&D efforts. As we said previously, some authors detected a positive relation between larger firms and innovation, because of improved access to human, financial resources and profit persistence (Bayona et al.,2013; Karantininis et al., 2010; Laforet, 2008; Lin & Lin, 2012; Naranjo-Gil, 2009; Segarra & Arauzo, 2008; Hirch & Gschwandter, 2013; Triguero et al., 2013). On the contrary, other authors underline the ability of SMEs firms to innovate, based on their flexibility, interpersonal communication, etc (Bayona et al., 2001; ; O'Regan et al., 2005; Maravelakis et al., 2006; Pla-Barber & Alegre, 2007; Alarcón & Sánchez, 2013). Some other authors do not detect relation between R&D and firm size (Pisano, 1990; Pla-Barber & Alegre, 2007 and Robertson & Gatignon, 1998), so the impact of size on R&D is a question that needs further research, as it is undertaken in this paper.

As for other aspects affecting the propensity to perform R&D activities, experience and cooperation can be considered. Firm experience can be proxied by the age of the firm (Sørensen & Stuart, 2000; Huergo & Jaumandreu, 2004). No clear hypothesis can be posed on the impact of firm experience on R&D. On the one hand,

firm experience involves the improvement of managerial competences. On the other hand, aged firms may show organizational inertia" to adjust firm's capabilities (Balasubramanian & Lee, 2008). As for cooperation, firms' associations and co-ops could show some organizational advantages to carry out innovation activities (Giannakas & Fulton, 2005)

(ii) Local systems (LS)

Urban areas enjoy better access to services, which could place them in a better position to locate firms with R&D activities. North & Smallbone (1996) provided evidence that remote rural firms are less innovative than urban businesses. Lack of infrastructure and access to capital markets may also affect the knowledge and technological acquisition in agri-food rural firms. Willingness to innovate can be affected by the access to raw materials (proximity to agricultural areas) or the nature of the local labor market. Many rural areas have suffered demographic decline in Europe, which has been to a certain extent compensated by migrant foreign labor, leading to decreasing labor costs, but without clear improvements in productivity (Webber et al., 2009).

Some agri-food firms are located in *industrial districts* that that provide knowledge spill-over (Asheim & Gertler, 2004,).[6] Boix & Galetto (2008) suggest dynamic economic performance of rural areas with industrial districts.

Agri-food enterprises experience significant competition. Copus et al. (2008) provide evidence that competition can affect the R&D expenditures up to a certain

[6] Most references to the origin of industrial districts go back to Alfred Marshall (1919) as a process of "concentration of specialized industries in particular localities" Last developments of the concept have emphasized socio-economic models linking business relationships with social and institutional structures, and organizations governed by trust and co-operation (Beccatini, 1989).

point. If the actual level of competition is very high in a particular country or at the international level then increasing competition could lead to dissipation in innovation rents and hence reduced incentives to invest in innovation (Spithoven et al. 2010). Our exercise does not supply specific test for the impact of competition on R&D participation. In fact, competition is carried out by agri-food firms at the domestic and international markets, so we don't have a measure of the competition faced by firms in the LS considered in the study. However, part of the competition effects can be subsumed in the firm size and the industrial district effects. The industrial districts are associated with the conditions for learning from competitors through horizontal co-operation in innovation, although some authors suggest that food manufacturers are less resting on competitors as a source for innovation than on information flows from customers (Copus et al., 2008) or suppliers (García Alvarez-Coque, et al. 2012). Spatial conditions also influence R&D effects on productivity growth (Fernández & Rubiera, 2013). Finally, Van Hemert et al., (2013) explored the positive effect of regional networks on SMEs.

(iii) Access to knowledge

The literature often emphasizes the positive results arising from the interactions among the actors who collaborate on R&D (Hagedoorn, 2002; Gellynck & Vermeire, 2009). These advantages include: cross fertilization of ideas between members of the network, access to external sources of knowledge, benefits of shared costs of innovation projects, etc. But collaboration has also disadvantages, especially transaction costs associated with the exchange of information (Koput, 1997). Beyond this dichotomy, the most recent literature (Laursen & Salter, 2006; Cantner et al, 2010) presents an

intermediate alternative in relation to the results derived from the collaboration between different actors in R&D. Such empirical investigations suggest the existence of an inverted U relationship between collaboration and performance. Thus, there may be a point in the partnerships from which increased collaboration has a negative effect on the results.

Analyses devoted to the effects of knowledge spill-over, which attempt to assess the local intensity of these externalities, have stressed the impact of geographic proximity on R&D activities. The institutional infrastructure (universities, technology centers, etc.) located in territorial environments provides enterprises a wide range of possibilities for collaboration in R&D. This institutional infrastructure does not only supply direct services to enterprises, but also takes an intermediary role that serves to strengthen interaction and collaboration both between local actors and external networks (Inkinen & Suorsa, 2010). The role of the institutional infrastructure is twofold. First, it refers to the transfer of technology, especially through testing and validation of technologies. Second, it considers collaboration with actors of the innovation system to identify, adjust and adapt knowledge in order to generate new applications Specially in regional contexts, universities also act as instruments to promote economic development at a territorial level (Gertler, 2010). The collaboration between companies and universities has long been considered (Veugelers & Cassiman, 2005, Un et al, 2010). Capello & Lenzi (2013) highlight the need to consider the spatial context to understand the relationship among knowledge, innovation and economic growth.

3. DATA AND SOURCES

Valencia is a region where urban populated coastal areas combine with less populated inland rural areas, with representation of agri-food firms in both types of areas. The investigation points to identify firms performing or not R&D activities, and measuring variables that may affect their R&D participation, including the businesses' characteristics, the nature of the local systems there are located and the access to technological centers and universities.

It is clear that the analysis is influenced by the data availability. A sample of enterprises was built from a thorough selection of agri-food enterprises in the Valencia region, including crossing with those that carry out R&D activities, according to Lopez-Estornell (2010). The regional database was classified into micro and small enterprises (MSE), and medium and large enterprises (MLE), to test the size effect, where size is based on the number of persons employed, a criterion of classification based on OECD (2013), and used for international comparisons (Schaper, 2006, Schaper et al., 2008).).

A first step was the selection of enterprises that perform R&D activities. One possibility would be to consider R&D intensity (Mohnen et al., 2007), which in Spain is provided by the STIE (Survey on Technological Innovation in Enterprises, INE). However, STIE does not provide the specific location of firms and excludes firms with less than 10 workers, excluding MSE of the analysis of innovation behavior. Instead, in the present research, we collected data on R&D activities by firms from public databases to find out indicators on collaboration between technological institutions (including universities, research and knowledge transference centers) and firms and other participation in R&D projects. The criteria to select firms participating in R&D projects were the following: (i) collaborations in innovation and R&D projects funded

by regional public institutions, in Valencia the Small and Medium Enterprise Institute (IMPIVA, 2000-2006) and the Technological Industry Development Centre (CDTI) 2003-2006); (ii) patent applications (2000-2006), or utility models (2000-2008) in the Spanish Office of Patents and Trademarks (OEPM); (iii) scientific papers published with at least one of the authors belonging to the firm's staff (INGENIO database, 1995-2006); (iv) partnership agreements with public R&D and technological institutes, including contracts (INGENIO database, 1999-2003), associations to technological institutes, associations to the European Centre of Enterprises and Innovation (CEEI) or spin-off from research centers in the region. This comprehensive way of selecting firms participating in R&D projects captures a multidimensional set of activities that provides a wide picture of R&D, including partnership with public institutions. Moreover, our database allows for an identification of the selected firms, in particular their location, and reports activities for companies with less than 10 workers, which are predominant in the Spanish economy.

The firms' database, including firms participating in R&D activities and other firms, draw on SABI (Iberian System of Balance Sheet Analysis). Firms belong to NACE codes 01, 10 and 11. Firms were classified according to their local system and size, according to the number of employees: MSE) (< 50 employees), MLE (> 50). The agri-food business data in SABI were crossed with the list of firms that carry out R&D activities. This allowed us to identify the 247 firms in SABI that undertake R&D activities within a whole data set including 2,741.[7]

[7] Firm specialization in particular value chains, such as wine, fruit and vegetables, olive oil or other agri-food industries could also be considered a source of spatial advantages. However, We did not control for the industry specialization as the database did not clarify the specific specialization of many firms. This is partly compensated with the definition of the local systems as specialized in agriculture and food industry (see below).

To account for the influence firms' location, LS were categorized to test their influence on R&D participation. Boix & Galetto (2008) classified local systems using the population census (INE, 2001) and the Central Directory of Firms. 806 LSs where defined in Spain, 82 of them located in the region of Valencia. In our study, LS were classified according to their degree of rurality, based on density of population (OECD, 1994)[8]. A community was considered urban if its population density is higher than 150 inhabitants per square kilometer. A LS is predominantly rural (RURAL) when more than 50% of the population lives in rural communities; an intermediate area, when 15 and 50% of the population lives in rural communities; and a predominantly urban LS (URBAN) when 15% of the population lives in rural communities. Following such criteria 40 LSs in the Valencia region were defined as predominantly urban, 8 intermediate and 34 predominantly rural.

Table 1 summarizes the distribution of firm types across LS types in the region. Even if most of the agri-food firms are MSE, a larger number of MLE are located in urban areas where they can take advantage of agglomeration.

The data collection was completed by variables that are considered determinants of the business participation in R&D projects, which are summarized in Table 2. This includes firm's characteristics, spatial variables linked to local systems and access to knowledge centers. SABI also allows to identifying firm sizes, co-ops (COOP) and the age of the firm (AGE), which can influence the business participation in R&D projects. Dummy variables are defined to indicate if LSs with primary production specialization (AGRI) and food specialization (FOOD) are categorized as industrial districts,

[8] Attempts have been made to review and improve the OECD approach and also alternative methodologies have been proponed (Jonard et al, 2009). We prefer to stick to the standard OECD classification to avoid colineality with the distance variables accounting for accesibility or remoteness.

following Boix & Galetto 2008 and López-Estornell (2010)[9]. As LS are defined at small spatial scale, we include neighborhood effects represented by the variables N-URBAN (areas with neighboring urban LS) and N-DISCT (areas with neighboring LS that are classified as industrial districts).

Finally, apart from the rural/urban classification and the identification of some LS as industrial districts, other variables characterizing the LS were considered using the census of population (INE, 2001) and the statistical yearbook of La Caixa (2009). These variables include: the share of foreign-born migrants within total population (FOREIGN1 and FOREIGN2).

Access to knowledge centers was approach by the distance to the nearest technological institute (DIST-TC) and to the nearest university (DIST-U).

[Table 1. Firms with R&D activities and local systems]

[Table 2. Variables influencing R&D participation]

4. MODELING R&D CHOICE

A common technique for the detection and characterization of R&D choices is to use information obtained from surveys (Kang & Park, 2012). The Probit model used in this paper tests the effect of certain variables (Xi), including firm size, on firm participation in R&D activities. Each firm will select an alternative, with an observable measure Y =1 if takes part in R&D activities and Y = 0 if the firm does not take part in R&D.

Individual characteristics Xi affecting firm's choice Y are given in Table 2, where variables refer to firm's characteristics (Xi = AGE, COOP and MSE); Local

[9] Both authors drew on Sforzi (1990) who provided the first rigorous attempt to find criteria to identify industrial districts.

systems' characteristics (Xi = FOREIGN1, FOREIGN2, AGRI. FOOD, N-DISTRICT, URBAN, N-URBAN, RURAL); and access to technological centers (Xi = DIST-TC, DIST-U).

Given the vector of individual observable characteristics (Xi) and *N* observations the model is estimated by maximum likelihood. The Probit models were estimated by maximum likelihood[10].

Enterprises in the database could in fact present similarities within the local systems and then show intra-LS correlations. This possibility led us to a correction for clustering. In this article, the Moulton method was applied to consider intra-group correlations[11]. Moulton found that a formula derived from a simpler special case studied by Kloek (1981) often provides a good, rough approximation of the bias from using the incorrect standard errors and t statistics for the estimated coefficients of aggregate regressors. Instead of using the covariance matrix $\hat{s}^2(X'X)^{-1}$, the true covariance matrix of the OLS estimator of β is expressed as:

$$C = s^2(X'X)^{-1}X'VX(X'X)^{-1} = s^2(X'X)^{-1}\left[1 + r(N-1)\right] \qquad (3)$$

where $N = X'ZZ'X(X'X)^{-1}$. Moulton (1986) showed that the magnitude of the downward bias for the standard errors increases with the average group size, the interclass correlation of the disturbances, and the interclass correlation of the regressors. For an aggregate regressor, which is fixed within the groups, the intra-class correlation of the regressor is 1. Additionally, Moulton (1990) found that a formula derived from a simpler special case studied by Kloek (1981) often provides a good, rough approximation of the bias from using the incorrect standard errors and *t* statistics for the

[10] The correlogram of residuals was used to test the adequacy of this method of estimation.
[11] Moulton corrections have been recently employed in Donald & Lang, 2007; Cameron & Miller, 2010; D'Angello & Lilla, 2011; Conger et al., 2012.

estimated coefficients of aggregate regressors. Kloek considered a case where all the regressors are fixed within groups and all groups have exactly *m* observations, in which case the true OLS covariance matrix (for σ^2 and ρ known) is:

$$C = s^2 (X'X)^{-1} \left[1 + (m-1) r \right] \qquad (4)$$

Following Moulton (1990), this formula is not exact when other regressors, not fixed within groups, are included or when the groups are not equal in size, but if often provides a reasonably good numerical approximation[12]. Cameron (2011) and Schmidheiny (2012) present in the same line the particularities of the robust inference with clustered data.

Two cluster aggregate variables, economic activity and degree of studies, were used to estimate the correction. Their selection was based on their possible influence on R&D activities. Crescenzi et al., (2013) show the relevance of socio-economic conditions for the location decisions of investments and to the access to knowledge (see also Vecchiato & Roveda, 2014; and Wang & Zhou, 2013). Other authors, such as Katsuhiko & Yamada (2013), and Batabyal & Nijkamp (2013) suggest a relationship among education, innovation and long-run economic growth.

5. FINDINGS AND DISCUSSION

Table 3 shows the results of Probit models with two aggregate variables used to estimate the Moulton correction: 1) the index of economic activity[13]; and 2) the degree

[12] Cheah (2009) argues that modeling the clustering of the data using multilevel methods might a better approach than fixing the standard errors of the OLS estimate. However, Schmidheiny (2012) justifies the asymptotic approximation when the number of clusters is large (> 50).

[13] Participation of the LS in the national economic activity (see La Caixa yearbook, 2009).

of studies for inhabitant between 30 and 39 years[14]. Results of both models seem consistent in suggesting the difficulties faced by MSE to carry out R&D in rural and urban areas, though other variables are also relevant in explaining participation in public funded R&D.

Urban LS appear to have a positive effect on R&D activities, especially in model 2. However, as indicated in a previous work (Fearne et al. 2013), rurality is not perceived as a significant constraint on firm's activities.

In model 2, food industrial district's effect is significant and positive (as are the effects of neighboring industrial districts), which is consistent with Garcia-Alvarez-Coque et al. (2012) that identify the food industry as an activity with relatively high technological intensity. However, model 1 doesn't show a clear influence by agricultural and food industrial districts on the probability of incorporating R&D activities. It has to be noted that spatial competition could dissipate in some districts the incentives to innovate (Copus et al., 2008).

Many MSE are supply-dominated firms with low technological intensities, low entrepreneurship and cheap labor (Christensen et al., 1996, Grunert et al., 1997, Alba et al., 2011). In this sense, the private investment in R&D is lower than other EU sectors (0.53% of sales in 2009) (FoodDrinkEurope, 2012). The knowledge base in this sector is highly distributed with significant technological transfers from other industrial sectors (Capitanio et al., 2009 and 2010; García-Martínez, 2013; Hyman, 2013). Additionally, the agri-food sector still exhibits marked characteristics, which make it vulnerable to a global, changing and unstable environment characterized, among others factors, by the dependence of the production process on uncontrollable factors, perishable production

[14] Education level of population between 30 and 39 years old (0 for illiterates to 4.5 for PhD graduates). See La Caixa, yearbook, 2009.

and raw material (Fayos et al., 2009). In this context, presence of foreign-born population appears to be significant with a negative coefficient. Foreign-born population has been associated to lower labor costs and the variable appears to be associated with lower propensity to innovate.

Although R&D partnerships occur in all types of firms (see Table 1), the likelihood of performing R&D activities in MSE is significantly lower in all estimated models. This poses the question on the sources of innovation in regional economies dominated by small firms. The results also show higher propensity undertake R&D activities by co-ops that are prone to carry out of private-public agreements that define an enterprise as innovative. As for firm's age, results are consistent with the work developed by Jovanovich (1982) and Evans (1987) relating firm age to learning and knowledge accumulation, though further investigation is needed on the links between new firm creation and public R&D projects.

Closer proximity to knowledge centers appears to favor R&D in all models. Technology centers deliver consulting, technological development and innovation services to enterprises, especially small and medium size. Technology centers have a twofold purpose: first the transfer and dissemination of knowledge among their clients, on the other hand, cooperation in R&D for its application in production activities according to the needs of firms. The acquisition of these services by companies operating in traditional sectors allows them to increase their competitive advantage In this way and with the provision of these services, technology centers become strategic partners for firms (Albors-Garrigues et al, 2010).

[Table 3 Probit models with Moulton correction explaining R&D choices]

As for universities, none of the models show clear evidence that physical proximity to regional universities plays a role in enhancing R&D activities. This might be due to various reasons. First, collaboration with universities can take place at a national or even international level, frequently using IT, so the most innovative businesses don't rely on the physical proximity to universities at the Valencia region. Second, partnerships between universities and companies are influenced by the productive structure prevailing in each particular territorial context. So in contexts dominated by technology-intensive activities, universities generally exert drag effect in the innovation process (Gertler, 2010), but contexts dominated by traditional sectors, the role of universities may face certain restrictions (Belussi & Sedita, 2009). These limitations are related to functional adaptation in terms of response time and services of universities to the specific needs (Tether, 2002) of the small scale, especially in relation to collaboration for the final stages of the value chain, for example, in the commercial process.

Our findings support the recent strategy initiated by the European Commission, which recognizes the importance of attracting SME enterprises to innovation networks as a horizontal theme in the six priorities of the Rural Development Policy 2014-2020. This will involve new schemes and mechanisms supporting SMEs and larger firms. In the past, the Commission had launched the Competitiveness and Innovation Framework Program (CIP) that runs from 2007 to 2013 which was divided into three operational programs. The Entrepreneurship and Innovation Program (EIP) is one of the three CIP operational programs with an overall budget of 2.17 billion euro. In particular, EIP aims at facilitating access to finance for the start-up and growth of SMEs, encouraging investment in innovation activities, at creating an environment favorable to SME

cooperation, at promoting all forms of innovation in enterprises and supporting eco-innovation, at promoting an entrepreneurship and innovation culture and at promoting enterprise and innovation-related economic and administrative reform. Even more, there is also the ENFFI initiative (European Networking for Financing Food Innovation).

6. CONCLUSIONS

The agri-food sector is one of the most important branches of the economy in the European Union (FoodDrinkEurope, 2012). It is therefore critical that agri-food companies increase their competitiveness in order to continue contributing to and promoting economic growth. For that, the participation of small agri-food firms in R&D activities is seen as an essential activity to promote innovation in rural areas. The EU Commission has understood this during the design of rural development policies. This research has examined the determinants that affect the implementation of R & D activities in the specific case of food companies. These factors have been grouped into three sections: first, the characteristics of the companies; second, the characteristics of the local system in which the firm is located; third, the proximity to knowledge centers (universities and technology centers).

The database included small enterprises with less than 10 workers, overcoming one of the main qualifications of the Spanish innovation survey. R&D collaborations were seen in broad sense to describe firms taking part in research and technological development, very often in partnership with public institutions.

Of over 2,700 enterprises studied in 82 local systems, around 9% undertook R&D activities and one fourth of them were located in rural and intermediate areas. The Probit model, with corrected standard deviations to take into account intra-group

correlations, confirmed a series of characteristics that are expected to explain R&D partnership like the firm's size and experience. Regarding the first aspect, the results are consistent with other studies that highlight the problems of micro and small enterprises to carry out R&D. Regarding the second factor, the effect of industrial districts appears as ambiguous in terms of the models considered. As for the connection to knowledge centers, while the proximity appears as significant in the case of technology centers, however no clear evidence emerges that physical proximity to universities positively influence the performance of R&D.

R&D results problematic for MSE. However, location in or proximity to industrial districts with food specialization was found to contribute positively to more intensive R&D collaboration and, consistently with previous works, ruralilty does not appear *per se* as a handicap for firms to carry out R&D. Access to technological centers, scattered across the territory, also favors involvement of firms in research activities. By contrast, physical access to universities was not found significant which would be the case of a geographical context that is not dominated by technology-intensive activities. Co-ops are found to be collaborative in R&D activities, which could be explained by their willingness to take part in public programs.

The findings suggest several conclusions with policy implications and future research. First, in general, although each of the factors has been analyzed in isolation, the findings suggest the desirability of considering the interactions that occur between the various factors considered, are to be considered in future research. Thus, the effect of firm size may be moderated by their joint interaction with location and collaboration with intermediary bodies. This interaction may be different depending on the context. Indeed, other research (Aleck et al, 2006, Cantwell & Piscitello, 2005) have emphasized

that the interaction between actors (companies, universities, ..) is linked on one side with the geographical proximity that favors the transmission of knowledge, and on the other side by the acceptance of certain cultural norms and informal rules (Hassink, 2005) that are unique to each specific context.

Second, the results of this research show that the choice of a specific type of knowledge center is a relevant option. Recent studies (Barge-Gil et al., 2011) point out that companies cooperating with certain knowledge centers have a higher propensity to participate simultaneously with other entities. This reflects on the one hand, the need for greater understanding of potential complementarities between the different service providers and R&D, and, on the other hand, the convenience of knowing the factors influencing simultaneous access to various knowledge centers. In any case, it is essential to have a more nuanced view of the differences and similarities between the R& services offered by different knowledge centers.

Third, the analysis highlights the importance of public policies that promote R&D services for companies. Public efforts to promote access to knowledge-intensive services could gain efficiency if such actions have a more specific nature. This could be achieved through support programs tailored to each local context in terms of: (i) the type of knowledge center that provides such services, (ii) the specific characteristics of the companies that use these services. However, at present most regions follow linear-type policies that are not adapted to the system of innovation in which they are applied (Fernández, 2010). In short, it is appropriate to move forward in strengthening decentralization of innovation policies so that such policies are adapted to the specific characteristics of the companies and their local environment.

Finally, though the managerial literature reflects a broad agreement on innovation as a key driver for firms' success (Paladino, 2008), further evidence is needed on the question about not only the factors affecting R&D participation but also the impact of R&D on agri-food firms' performance in rural and urban areas

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REFERENCES

Abel, A.B. (1983). Optimal Investment Under Uncertainty. The American Economic Review, 73, 228-233.

Alba M., Mas F. & García-Alvarez-Coque J.M. (2011). New firm creation and innovation: industrial patterns and inter-sectoral linkages. International Entrepreneurship and Management Journal (DOI 10.1007/s11365-011-0210-3).

Albors-Garrigos, J., Zabaleta, N., & Ganzarain, J. (2010). New R&D management paradigms: rethinking research and technology organizations strategies in regions. R&D Management 40 (5), 435–454.

Alarcón, S. &Sánchez, M. (2013). External and internal R&D, capital investment and business performance in the Spanish agri-food industry. Journal of Agricultural Economics, 64 (3), 654-675.

Alecke, B., Alsleben, F., Scharr, F. & Untiedt, G. (2006). Are there really high-tech clusters? The geographic concentration of German manufacturing industries and its determinants, Annals of Regional Science, 40,(1), 19-42.

Alfranca, O. (2005). "Private R&D and Spillovers in European Agriculture", International Advances in Economic Research, , 11, (2), 201-213.

Alston, J. (2010). The benefits from agricultural research and development, innovation and

productivity growth. OECD, Food, Agriculture and Fisheries Papers No. 31. http://dx.doi.org/10.1787/5km91nfsnkwg-en.

Asheim, B. & Gertler, M. (2004). Understanding regional innovation systems. In Fagerberg J., Mowery D., Nelson, R. (Ed.) Handbook of Innovation. Oxford: Oxford University Press.

Audretsch, D.B., Lehman, E.E. &Warning, S. (2005). University spillovers and firm location. Research Policy,34, 1113-1122.

Avermaete, T., J. Viaene, E. J. Morgan & N. Crawford. (2003). Determinants of innovation in small food firms. European Journal of Innovation Management, 6 (1), 8-17.

Badillo, E.R. & Moreno, R. (2014). Are R&D collaborative agreements persistent at the firm level? Empirical evidence for the Spanish case. Research Institute of Applied Economics. Universitat de Barcelona. Barcelona, Spain

Balasubramanian N. & Lee J. (2008). Firm age and innovation. Industrial and Corporate Change. 17 (5), 1019–1047.

Baldwin, J., Hanel, P., & Sabourin, D. (2002). Determinants of innovative activity in Canadian manufacturing firms. In: Kleinknecht, A. & Monhen, P. (Eds), Innovation and Firm Performance. , (pp 86-111). Palgrave

Barge-Gil, A., Santamaría, L. & Modrego, R. (2011). Complementarities between universities and technology institutes. New empirical lessons and perspectives. European Planning Studies 19 (2), 195-215.

Batabyal, A. & Nijkamp, P. (2013). A multi-region model of economic growth with human capital and negative externalities in innovation. Journal of Evolution Economics, 23, 909-924. .

Batterink, M.H., Wubeen, E., Klerkx, L. & Omta, S.W.F. (2010). Orchestrating innovation networks: The case of innovation brokers in the agri-food sector. Entrepreneurship & Regional Development: An International Journal . 22 (1), 47- 76.

Bayona, C., García-Marco, T. & Huerta, E. (2001). Firms' innovations for cooperative R&D: an

empirical analysis of Spanish firms. Research Policy, (30), 1289-1307.

Bayona, C., Cruz, C., García, T., & Sánchez, M. (2013). The effects of open innovation practices of Spanish Agri-Food firms on the innovation performance..In García, M. (ed) *Open innovation in the food and beverage industry*.(pp 74-96) Woodhead Publishing Ltd.

Beckeman, M., & Skjöldebrand, C. (2007). Clusters/networks promote food Innovations. Journal of Food Engineering, (79), 1418-1425

Belderbos, R., Carreeb, M., Diederen, B., Lokshin, B., & Veugelers, R. (2004). Heterogeneity in R&D cooperation strategies. International Journal of Industrial Organization, (22), 1237–1263.

Belussi, F & Sedita, S. (2009), Life Cycles vs. Multiple Path Dependency in Industrial Districts. European Planning Studies, Vol. (17), 505-527.

Bhattacharya, S. & Bloch, H. 2004. Determinants of innovation. Small Business Economics (22), 155-162.

Boix R. & Galletto V. (2008). Marshallian Industrial districts in Spain. Scienze Regionali, (7) , 29-52.

Bougheas, S. (2004). Internal vs External Financing of R&D. Small Business Economics (22), 11-17.

Caballero, R.J. (1991). Competition and the Non-Robustness of the Investment-Uncertainty Relationship. The American Economic Review (81), 279-288.

Cantner, U., Conti, E., & Meder, A. (2010). Networks and Innovation: The Role of Social Assets in Explaining Firms' Innovative Capacity. European Planning Studies, (18), 1937-1956.

Capitanio F., Coppola A. & Pascucci S. (2009). Indications for drivers of innovation in the food sector. British Food Journal. . (111) , 820-838.

Capitanio, F.; Coppola, A. & Pascucci, S. (2010). Product and process innovation in the Italian food industry. Agribusiness, 26 , 503-518.

Cameron, A.C. & Miller, D.L. (2010). Robust inference with Clustered Data. In Ullah, A.&Gellis, D.E. (Ed.) Handbook of Empirical Economics and Finance.

Cameron, A.C. (2011). Robust Inference with Clustered Data. Mexico Stata Users Group Meeting. Mexico City May.

Cantwell, H. & Piscitello, L. (2005). Recent location of foreign-owned research and development activities by large multinational corporations in the European regions: the role of spillovers and externalities. Regional Studies, 39, 1-16.

Capello, R. & Lenzi, C. (2013). Territorial patterns of innovation and economic growth in European regions. Growth and Change, 44 (2), 195-227.

Cheah, Ban Chuan (2009). Clustering Standard Errors or Modeling Multilevel Data. Working paper, Columbia University,

http://www.stat.columbia.edu/~cook/movabletype/mlm/RevisitMoulton_2.pdf.

Christensen, J.L., Rama, R., & Von Tunzelmann, N. (1996). Study on Innovation in the European Food Products and Beverages Industry. Luxembourg: European Commission, Directorate General XIII.

Conger, D. (2012). Inmigrant Peers and Academic Performance in High School. George Washington University Working Paper.

Connor J. & Schiek W. (1997). Food processing: an industrial powerhouse in transition. 2nd ed. John Wiley & Sons, NY.

Copus, A., Skuras, D. & Tsegenidi, K. 2008. Innovation and Peripherality: An Empirical Comparative Study of SMEs in Six European Union Member Countries. Economic Geography 84(1), 51-82.

Crescenzi, R., Pietrobelli, C. & Rabellotti, R. (2013). Innovation drivers, value chains and the geography of multinational corporations in Europe. Journal of Economic Geography, 1-34.

D'Angello, E. & Lilla, M. (2011). Social networking and inequality: the role of clustered networks. Regional Economic Society, 4 (1), 63-77.

Dixit A.K. & Pidnyck, R.S. (1994). Investment under Uncertainty. Princeton University Press. Princeton.

Donald, S.G. & Lang, K. (2007). Inference with Difference-in-Differences and Other Panel Data. The Review of Economics and Statistics, 89 (2), 221-233.

European Commission (2011). Proposal for a Regulation of the European Parliament and of the Council on Support for Rural Development by the European Agricultural Fund for Rural Development (EAFRD). Brussels, 19.10.2011 COM(2011) 627 final/2.

Eurostat (2014). Science and Technology Indicators, available at: http://epp.eurostat.ec.europa.eu/portal/page/portal/science_technology_innovation/data/database

Evans, D. S. (1987). The relationship between firm growth, size, and age: estimates for 100 manufacturing industries. Journal of Industrial Economics XXXV, 567-581.

Fayos, T. Calderón, H., & Mir, J. (2009). Eficiencia, competitividad y políticas de promoción empresarial. Estudio del sector agroalimentario en España. *Economía Industrial*, 373, 111-122.

Fearne A., García Álvarez-Coque, J.M., López-García Usach, T. & Sánchez García, M. (2013). Innovative firms and the urban/rural divide: the case of agro-food system in the Valencia region. Management Decision. 5 (6), 1293 – 1310.

Fernandez I; Mas-Verdú, F., Tortosa, E. (2010) Regional Innovation Policies: The Persistence of the Linear Model The Service Industries Journal 30, (5), 749–762.

Fernández, E. & Rubiera, F. (2013). Estimating regional variations of R&D effects on productivity growth by entropy econometrics. Spatial Economic Analysis, 8 (1), 54-70.

FoodDrinkEurope (2012). Priorities for the development of an EU industrial policy for food. Competitiveness Report 2012. Brussels: FoodDrinkEurope.

FoodDrinkEurope (2014). Data & Trends of the European Food and Drink Industry 2013-2014. Brussels: FoodDrinkEurope.

García-Alvarez-Coque, J.M., Alba, M & López-García Usach, T. (2012). Innovation and sectoral linkages in the agri-food system in the Valencian Community. Spanish Journal of Agricultural Research, 10, (1), 18-28.

García-Alvarez-Coque, J.M., López-García Usach, T., & Sanchez-García, M. (2013). Territory and innovation behaviour in agri-food firms: does rurality matter?. New Medit 12 (3), 2- 10.

García-Martínez, M. (2013). Co-creation of value with consumers as an innovation strategy in the food and beverage industry: the case of Molson Coors' 'talking can'. In Garcia Martinez, M. (ed.) Open Innovation in the Food and Beverage Industry. Cambridge: Woodhead Publishing.

Gellynck, X. & Vermeire, B. (2009). The Contribution of Regional Networks to Innovation and Challenges for Regional Policy. International Journal of Urban and Regional Research, 33, 719-737.

Gertler, M. (2010). Rules of the game: the place of Institutions in Regional Economic Change. *Regional Studies*, 44, (1), 1-15

Giannakas, K. & Fulton. M. (2005). Process Innovation Activity in a Mixed Oligopoly: The Role of Cooperatives. American Journal of Agricultural Economics 87, 406-422.

Grunert, K. , Harmser, H., Meulenberg, M., Kuiper, E., Ottowitz, t.,Declerck, F., Traill, B. & Göransson, G. (1997). A framework for analysing innovation in the food sector. Product and process innovation in the food industry. Blackie Academic and Professional. London. UK.

Hagedoorn, J. (2002). Inter-firm R&D partnerships: an overview of major trends and patterns since 1960. Research Policy, 31, 477-492.

Hirch, S., Schiefer, J., Gschwandtner, A. & Harmann, M. (2013). Profit persistence in the food industry: evidence from five European countries. European Review of Agricultural Economics, 40 (5), 741-759,

Jovanovich, B. (1982). Selection and evolution of industry. Econometrica 50, 649-670.

Hassink, R. (2005): "How to unlock regional economies from path dependencies? From learning region to learning cluster", European Planning Studies, 13, 521-535.

Howells, J. (2006). Intermediation and the role of intermediaries in innovation. Research Policy, 35, 715-728.

Huergo, E. & Jaumandreu, J. (2004). Firms' age, process innovation and productivity growth. International Journal of Industrial Organization, 22, 541–559.

Hyman, J. (2013). Open Innovation in the food and beverage industry. Woodhead Publishing Limited. Cambridge. UK.

Klerk, L. & Leeuwis, C. (2009). Establishment and embedding of innovation brokers at different innovation system levels: Insights from the Dutch agricultural sector. Technological Forecasting and Social Change, 76 (2), 849-860.

INE (several years). Encuesta sobre innovación de las empresas. Instituto Nacional de Estadística, Madrid.

INE (2011). Censo de población y vivienda. Instituto Nacional de Estadística, Madrid.

Inkinen,T. & Suorsa, K. (2010). Intermediaries in Regional Innovation Systems: High-Technology Enterprise Survey from Northern Finland. European Planning Studies, 18, (2), 169–187.

Jacobs, J., Belderbos, R., Gilsing, V. (2013). Technology alliances in emerging economies: persistence and interrelation in European firms' alliance formation. R&D Management 43(5), 447 – 460.

Jonard, F., Lambotte, M., Ramos, F., Terres, J.M. & Bamps, C. (2009). Delimitations of rural areas in Europe using criteria of population density, remoteness and land cover, JRC Scientific and Technical Reports, Institute for Environment and Sustainability, JRC European Commission.

Kang, K.N. & Park, H. (2012). Influence of government R&D support and inter-firm collaborations on innovation in Korean biotechnology SMEs. Technovation, 32, 68-78.

Karantininis, K.; Sauer, J. & Furtan, W.H. (2010). Innovation and integration in the agri-food industry. Food Policy, 35 (2), 112-120.

Katsuhiko, H. & Yamada, K. (2013). Education, innovation and long-run growth. The Japanese Economic Review, 64 (3), 295-318.

Kloek, T. (1981). OLS estimation in a model where a microvariable is explained by aggregates and contemporaneous disturbances are equicorrelated. Econometrica, 19, 205-207.

Koput, K.W. (1997). A chaotic model of innovative search: Some answers, many questions. Organization Science, 8, 528-542.

La Caixa (2009). Spanish estatistical yearbook, 2009. http://www.anuarieco.lacaixa.comunicacions.com/java/X?cgi=caixa.anuari99.util.ChangeLanguage&lang=esp.

Laforet, S. (2008). Size, strategic, and market orientation affects on innovation. Journal of Business Research, 61, 753-764.

Laursen, K. & Salter, A. (2006). Open for innovation: The role of openness in explaining innovation performance among UK manufacturing firms. Strategic Management Journal,27, p. 131

Lee, C-Y & Sung, T. (2005). Schumpeter's legacy: A new perspective on the relationship between firm size and R&D. Research Policy 34, 914-931.

Lin, F. & Lin, V. (2012). The determinants of successful R&D consortia: government strategy for the servization of manufacturing. Service Business, 6, 489-502.

López-Estornell, M. (2010). *Empresa Innovadora, Conocimiento y Distrito industrial*, Unpublished doctoral dissertation; Universitat Politècnica de València. Valencia

Maietta, O. (2014). Innovation Systems Research in the Italian Food Industry, Centre for Studies and Economics Finance, University of Naples Federico II, Working Paper nº 358,

Maravelakis, E., Bilabis, N., Antoniadis, A., Jones, K.A. & Moustakis, V. (2006). Measuring and benchmarking the innovativeness of SMEs: a three dimensional fuzzy logic approach. Production Planning and Control, 17 (3), 283-292.

Marshall, A. (1919). Industry and Trade, A study of industrial technique and business organization; and of their influences on the conditions of various classes and nations, London, Macmillan, First Edition.

Mohnen, P.; Mairesse, J. & Dagenais, M. (2007). Innovativity: A comparison across seven European countries. Economics of Innovation and New Technologies, 15. (4/5), 391-413.

Moulton, B.R. (1986). Random Group Effects and the Precision of Regression Estimates. Journal of Econometrics, 32, 385-397.

Moulton, B. R. (1990). An illustration of a pitfall in estimating the effects of aggregate variables on microunits. Review of Economics and Statistics, 72(2), 334-338.

Muscio, A. (2007). The impact of absorptive capacity on SME's collaboration. Economics of Innovation and New Technology, 16, 653–668.

Naranjo-Gil, D. (2009). The influence of environmental and organizational factors on innovation adoptions: consequences for performance in public sector organizations. Technovation, 29, 810-818.

North, D. & Smallbone, D. (1996). Small business development in remote rural areas: the example of mature manufacturing firms in Northern England. Journal of Rural Studies 12 (2), 151–167

OECD (1994). Creating Rural Indicators for Shaping Territorial Policies, OECD Publishing, Paris.

OECD (2006). *OECD* Rural Policy Reviews: The New Rural Paradigm: Policies and Governance. OECD Publishing. Paris.

OECD (2009). OECD Rural Policy Reviews: Spain, OECD Publishing. Paris.

OECD (2013). Entrepreneurship at a Glance OECD Publishing.

OECD (2014). Research and Development Statistics. Available at http://stats.oecd.org

Oleaga, M., Caladrero, A., Ugalde, I. (2008). Prospective innovation challenges in the food and drink sector. Europe Innova, Final Report.

Omta S.W.F. (2002). Innovation in Chains and Networks. Journal on Chain and Network Science, V2, (2), 73-80.

O'Regan,N. & Ghobadian, A., Sims, M. (2005). Fast tracking innovation in manufacturing SMEs. Technovation, 1-11.

Paladino, A. (2008). Analyzing the effects of market and resources orientations on innovative outcomes in times of turbulence. Journal of Product Innovation Management, 25, 577-592.

Pavitt, K., Robson, M. & Townsend, J. (1987). The size distribution of innovating firms in the UK: 1945-1984. Journal of Industrial Economy 45, 297-306.

Pezzini, M. (2001). Rural Policy Lessons from OECD Countries. *International Regional Science Review*, , 24 . (1), 134-145.

Pisano, G. (1990). The R&D boundaries of the firm: an empirical analysis. Administrative Science Quarterly, 35, 153-176.

Pla-Barber, J. & Alegre, J. (2007). Analysing the link between export intensity, innovation and firm size in a science-based industry. International Business Review, 16, 275-293.

Rama, R. (2008). Handbook of innovation in the food and drink industry. New York. Haworth Press.

Robertson, T. & Gatignon, H. (1998). Technology development mode: a transaction cost conceptualization. Strategic Management Journal, 19, 515-531.

Schaper, M. (2006) 'Distribution patterns of small firms in developed economies: Is there an emergent global pattern?' International Journal of Entrepreneurship and Small Business, 3, (2), 183–189.

Schaper, M. T, Dana, L.P., Anderson, R.B. & Moroz, P.W. (2009). Distribution of firms by size: observations and evidence from selected countries. International Journal of Entrepreneurship and Management Journal10 (1), 88-96.

Segarra, A. & Arauzo, J.M. (2008). Sources of innovation and industry-university interaction: evidence from Spanish firms. Research Policy, 37, 1283-1295.

Sforzi, F. (1990). The quantitative importance of Marshallian industrial districts in the Italian economy. In Pyke F., Becattini G., and Sengenberger W., (Eds.) Industrial Districts and Inter-firm co-operation, ILO Geneva.

Schmidheiny, K. (2012). Clustering in the Linear Model, Short Guides to Microeconometrics, http://www.schmidheiny.name/teaching/clustering.pdf.

Sørensen, J. B. & Stuart, T. E. (2000). Aging, obsolescence and organizational innovation. Administrative Science Quarterly, 45(1), 81–112.

Spithoven, A., Clarysse, B. & Knockaert, M. (2010). Building absorptive capacity to organise inbound open innovation in traditional industries. Technovation, 30, 130-141.

Tether, B. (2002). Who co-operates for innovation, and why: An empirical analysis. Research Policy, 31, (6), 947-967.

Traill, B. & Meulenberg, M, (2002). Innovation in the food industry. Agribusiness, 18, 1-21.

Triguero, A., Córcoles, D. & Cuerva, M.C. (2013). Differences in innovation between food and manufacturing firms: an analysis of persistence. Agribusiness, 29 (3), 1-20.

Tsai, K-H & Wang, J-C. (2005). Does R&D performance decline with firm size? - A re-examination in terms of elasticity. Research Policy 34, 966-976.

Un, C., Cuervo-Cazurra, A. & Asakawa, K. (2010). R&D Collaborations and Product Innovation. Journal of Product Innovation Management, 27, 673-689

Van Hemert, P., Nijkamp, P. & Masurel, E. (2013). From innovation to commercialization through networks and agglomerations: analysis of sources of innovation, innovation capabilities and performance of Dutch SMEs. Annals of Regional Science, 50, 425-452.

Veugelers, R. & Cassiman, B. (2005). R&D cooperation between firms and universities. Some empirical evidence from Belgian manufacturing. International Journal of Industrial Organization, 23, (5-6), 355-379.

Wang, Y. & Zhou, Z. (2013). The dual role of local sites in assisting firm with developing technological capabilities: evidence from China. International Business Review, 32, 63-76.

Webber, D., Curry, N. & Plumridge, A. (2009). Business Productivity and Area Productivity in Rural England. Regional Studies. 43, 661-675.

Vecchiato, R. & Roveda, C. (2014). Foresight for public procurement and regional innovation policy: the case of Lombardy. Research Policy, 43, 438-450.

Zhang, Y. & Li, H. (2010). Innovation search of new ventures in a technology cluster: the role of ties with service intermediaries. Strategic Management Journal, 31, (1), 88–109.