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## Determinants of technological innovation in SMEs. Firm-level factors, agglomeration economies and the role of KIBS providers

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## **Determinants of technological innovation in SMEs.**

### **Firm-level factors, agglomeration economies and the role of KIBS providers**

#### **1. Introduction**

Endogenous growth models have widely emphasised the role of technological-knowledge progress based on R&D activities and innovative behaviour in promoting long-run economic growth (Romer, 1990; Grossman and Helpman, 1991). In fact, as recent contributions have underlined, innovation - in its broad sense - represents a key source of competitive advantage for a country as well as for regions and firms within it (Porter and Stern, 1999; Becheikh *et al.*, 2006; Fagerberg and Verspagen, 2009). It follows that studying innovation processes and their determinants at the firm level becomes essential in order to disentangle the role of different factors leading to growth at the macroeconomic level.

Even though several theoretical and cross-country empirical contributions have analysed firms' innovation process, there is still lack of consensus on its determinants. In fact, while some scholars have followed a resource-based approach focusing on internal and firm-specific drivers of innovations, others have adopted a broader perspective by considering also factors external to the firm. These last contributions have emphasised a positive role played by public institutions, R&D laboratories as well as inter-firm networks developed with suppliers and customers. Along these lines, the analysis of the determinants of firms' innovation activities has been addressed also by regional economics scholars who have put the emphasis on the geographic and locally bounded nature of innovation. More recently, great attention has been put on private firms providing specialised knowledge-intensive business services - i.e. KIBS firms - which may represent a source of external knowledge for innovative firms: the idea is that KIBS firms act as knowledge-producing actors able to provide targeted and high-qualified solutions to industrial firms involved in innovation processes.

This paper tries to put further insights on the determinants of firms' innovation processes focusing on technological innovation - namely product and process innovations - and moving from previous theoretical and empirical contributions in the field. Specifically, it blends together two main research streams: the resource-based theory of the firm and the new economic geography framework. Therefore, the empirical analysis carried out aims at testing the role of several firm-specific factors (i.e. size, age, productivity and R&D investments) and factors external to a firm's boundaries (i.e. agglomeration economies) giving particular

attention to the role that KIBS providers may have in the innovative behaviour of manufacturing firms.

The empirical exercise employs a sample of 4,367 Italian manufacturing small and medium sized firms (SMEs, henceforth) observed over the period 2004-2006. Probit models are estimated to test the relationship between several potential determinants of firms' propensity of introducing technological innovations, also accounting for possible heterogeneity in firms' absorptive capacity.

The rest of paper is organised as follows. Section 2 presents the theoretical framework and it develops the research hypotheses. Section 3 describes the dataset and the econometric methodology. Section 4 presents and discusses the empirical results. Finally, section 5 highlights some concluding remarks and it presents limitations and ideas for future research.

## **2. Theoretical Framework**

The academic interpretation of the innovation process has widely changed over time (Malerba and Orsenigo, 1996), moving from the first Schumpeterian idea of innovation carried out by small entrepreneurs introducing new technologies in the market thus replacing incumbent firms (Schumpeter, 1934), to the second Schumpeterian idea of innovation with large firms and R&D-intensive technological processes driving the economic progress (Schumpeter, 1942). More recently, scholars have started to describe the innovation process as environmentally embedded and resulting from repeated interactions across different actors (Lundvall, 2007; Carayannis and Ziemnowicz, 2007).

Along these lines, several models have been proposed to describe the innovation process and the determinants of firms' innovation activities, such as the interactive model of innovation (Kline and Rosenberg, 1986) or the open innovation model (von Hippel, 1988). Anyway, the common feature of the most recent theoretical contributions concerns the idea that innovation is not developed by a single agent in isolation, but it comes from a cross-fertilisation of new ideas and technologies which are put in place by several actors interacting with each other at different levels. This means that successful innovations come from firms able to overcome their boundaries in order to get external *stimuli* (e.g. knowledge flows) coming from other firms as well as from knowledge-producing actors and to combine them with their internal resources and capabilities (Rigby and Zook, 2002; Chesbrough, 2003; Almirall and Casadesus-Masanell, 2010).

Even though there is a wide literature concerning the determinants of firms' innovative behaviour, results seem to be rather than conclusive. Moving from previous empirical

contributions and drawing on multiple theoretical perspectives, this paper tries to provide new knowledge on the factors driving successful technological innovations in manufacturing SMEs by considering both internal (i.e. firm-specific) and external factors. Specifically, the analysis is built on two main research streams, namely the resource-based theory of the firm and the new economic geography framework, and it gives particular attention to the role that (private) knowledge-producing actors (i.e. KIBS firms) may have in influencing manufacturing firms' innovative behaviour.

## 2.1. The Resource-Based Approach

According to the resource-based theory, the firm emerges as a unique bundle of resources characterised by its own specific knowledge base, organisational practices and routines as well as dynamic capabilities (Barney, 1991). The key idea of this approach is that each firm develops its own peculiar set of internal resources which constitutes its primary source of sustainable - and long-lasting - competitive advantage (Teece, 2007). It follows that, under this perspective, the way in which a firm decides on its innovation process relies entirely on its organisational structure and internal resources. Therefore, external factors (developed by other firms or institutions) are considered as simple complements of the internal core human, organisational and technological capitals (Teece, 1986; Kogut, 1988; Dierickx and Cool, 1989; Das and Teng, 2000).

Innovation studies based on the resource-based approach have focused on the firm-specific determinants of the innovation process neglecting the environment within which firms operate as well as the external factors influencing firms' decisions and behaviour. Among the key firm-specific factors driving innovation, the literature has emphasised the role of size, age and R&D expenditure (Hall *et al.*, 2010).

Looking at the size dimension, the main idea is that small sized firms often lack sufficient financial and human resources to innovate (Cosh and Zhang, 2012). In fact, innovation processes may involve large fixed costs related to both the acquisition of new technologies and the employment of high-qualified personnel, and innovation-related activities (e.g. in-house R&D department) may require scale and scope economies in the development of the innovation. Moreover, large firms may be less risk-adverse and therefore more prone to engage in innovation processes since they may have the resources required to easily overcome unsuccessful projects (Vossen, 1999). The idea that larger firms have higher probability (and capacity) to carry out successful innovations is also widely supported by the data: in fact, empirical evidence tends to find a positive relationship between firm size and

innovation activity, independently of the way in which innovation is measured (e.g. de Jong and Vermeulen; 2004; Charoenporn, 2005; Silva and Leitão, 2007; Coad *et al.*, 2013b; Conte and Vivarelli, 2013; Murro, 2013).

Looking at the age dimension, two opposite views emerge in the literature. On the one hand, older firms may be expected to show higher propensity to innovate thanks to knowledge, experience and resources accumulated over time (Coad *et al.*, 2013a; Nightingale and Coad, 2013); in this context, firms' innovation activities may be seen as the result of a dynamic learning process which develops along the life-cycle of the firm - i.e. learning effects (Sorensen and Stuart, 2000). On the other hand, organisation *inertia* may emerge as the firm becomes older thus hindering its ability to learn and, therefore, constraining its innovation propensity (Majumdar, 1997); in this case, younger firms may be expected to be more prone to innovate in order to gain a competitive advantage in the marketplace (Huergo, 2006; Balasubramanian and Lee, 2008; Sorensen and Stuart, 2000). According to these opposite views, the empirical literature has found both negative (e.g. de Jong and Vermeulen, 2004; Coad *et al.*, 2013b; Murro, 2013) and positive (e.g. Hansen, 1999; Sivadas and Dwyer, 2000; Tripsas and Gavetti, 2000; Avermaete *et al.*, 2003; Charoenporn, 2005) effects of firm age on innovation.

Several empirical contributions underline the importance of R&D investments and activities in promoting successful innovation processes (e.g. Stokey, 1995; Hall, 1996; Bayoumi *et al.*, 1999; Frenkel *et al.*, 2001; Charoenporn, 2005; Shefer and Frenkel, 2005; Parisi *et al.*, 2006; Antonietti and Cainelli, 2009; Raymond and St-Pierre, 2010; Conte and Vivarelli, 2013). In fact, formal R&D represents a direct input of the innovation process, even though investing in R&D does not directly imply successful innovation outputs. Moreover, even though R&D has been traditionally associated to large - vertically integrated - firms, also SMEs engage in R&D activities often cooperating with other firms or local scientific laboratories (Santarelli and Sterlacchini, 1990; Belderbos *et al.*, 2004).

Another firm-specific characteristic which may influence a firm's innovation output is its productivity level. The economic literature has generally analysed the innovation-productivity relationship focusing on the role of innovation in affecting firms' productivity (growth) - see Hall (2001) for an exhaustive review of empirical contributions on this theme. However, the advantage of including a productivity measure on the right-hand side of the innovation equation may be twofold: first, such a specification may allow to account for some observed heterogeneity across firms, thus clearing the effect of traditional firm-specific factors accounted for in analysing firms' innovative behaviour; second, it may allow to

capture a firm's efficiency level (e.g. through a measure of Total Factor Productivity) or the efficiency of a firm's human resources (e.g. through a measure of labour productivity). In particular, the inclusion of a labour productivity measure may be more appropriate in studying innovation processes since it can be expected that higher efficiency of the employees may result in higher (overall) capacity of the firm in conveying all the available knowledge, competences and (material and immaterial) resources towards the innovative output.

Drawing on this framework, the following set of hypotheses is postulated and empirically tested:

- H1. The larger is a firm, the higher is its probability of introducing technological innovations.
- H2. The older is a firm, the higher is its probability of introducing technological innovations.
- H3. The more a firm engages in R&D activities, the higher is its probability of introducing technological innovations.
- H4. The higher is the productivity level of a firm, the higher is its probability of introducing technological innovations.

## 2.2. The Role of External Forces

As previously underlined, innovation studies has started to enlarge the *spectrum* of possible factors affecting firms' innovative behaviour by considering, besides firm-specific characteristics, forces external to the firm. This has led to identify several domains which may represent sources of new knowledge, ideas and technologies for industrial firms, such as networks developed along the value chain or with knowledge-producing actors (e.g. Universities, R&D laboratories, KIBS providers, etc.) (Romijn and Albaladejo, 2002; Freel, 2003; Doloreux and Shearmur, 2012b) or out-of-the-market (tacit) relationships through which knowledge flows arise (i.e. agglomeration externalities). The key idea is that innovations result from interactive learning processes where several economic agents cooperate (Asheim and Gertler, 2005; Doloreux and Shearmur, 2012b).

Following Boschma (2005), proximity is a key concept underlying knowledge-based interactions which may lead to successful innovations. This concept comprehends several dimensions, among which geographic proximity - which often materialises in spatial concentration of agents - seems to play a central role (Wolfe, 2009).

### 2.2.1. The New Economic Geography Perspective

Recent theoretical and empirical contributions in the field of the new economic geography have emphasised the role of the local industrial structure in promoting economic growth at both firm and local level<sup>1</sup>. The key idea is that geographic proximity - in the form of industrial agglomeration - facilitates knowledge flows and technology diffusion across actors operating in bounded local systems thus increasing their likelihood to adopt innovative behaviours and, consequently, fostering their economic performance (Parr, 2002; Baltzopoulos, 2009).

Two main types of agglomeration externalities have been widely investigated in the literature: specialisation and Jacobs externalities. Specialisation externalities (Glaeser *et al.*, 1992) arise from the spatial concentration of firms operating in the same industry and they are expected to promote incremental and process innovations thanks to the tacit transmission of information facilitated by the common competence base shared by firms - i.e. thanks to intra-industry knowledge spillovers (van der Panne and van Beers, 2006; Frenken *et al.*, 2007). On the contrary, Jacobs externalities (Jacobs, 1969) are external to both firms and industries and they arise from the diversity and variety of the local economic structure; the idea is that firms may gain more operating in a diversified environment rather than in a specialised one since the variety of geographically concentrated industries, promoting the exchange and the cross-fertilisation of existing ideas and technologies (i.e. inter-industry knowledge spillovers), facilitates radical and product innovations (Frenken *et al.*, 2007; Baltzopoulos, 2009).

The key question addressed in the literature concerns which type of agglomeration force is more effective in promoting firms' innovative behaviour. In fact, several contributions have empirically analysed the role of agglomeration economies in promoting technology adoption and innovation processes, leading to inconclusive and contrasting results. However, even though several contributions suggest that both specialisation and Jacobs externalities promote innovation (Paci and Usai, 2000; Greunz, 2004; van der Panne and van Beers, 2006) or report a greater role played by specialisation externalities rather than by Jacobs ones (van der Panne, 2004), there is wide evidence of a greater impact of Jacobs externalities with respect to specialisation ones in promoting innovation processes (Rosenberg, 1982; Harrison *et al.*, 1996; Feldman and Audretsch, 1999; Duranton and Puga, 2000; No, 2002). This suggests that innovation is more likely to be developed by firms operating in diversified local systems where different knowledge- and technologically-based inputs are available from firms

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<sup>1</sup> See Beaudry and Schiffauerova (2009) for an extensive review.

operating in a variety of industries, i.e. that industrial variety at the local level is more likely to promote innovation than high-specialised local industrial structures.

Drawing on previous empirical evidences, the following hypothesis is specified:

H5. Diversification (specialisation) externalities positively (negatively) affect firms' probability of introducing technological innovations.

### 2.2.2. The Role of KIBS firms

Besides spillover-based (i.e. out-of-the-market) relationships among firms, also pecuniary (i.e. market) relationships may influence firms' innovative behaviour on the base of knowledge flows. In this context, KIBS firms play a central role due to their knowledge-based nature and their main function of providing specialised services which are complementary to manufacturing firms' core-business activities.

Two key phenomena have favoured the emerging role of KIBS firms as central actors of a country's economic structure: on the one hand, an increasing process of outsourcing carried out by large vertically-integrated firms which, in the 1970s, started to delegate service activities to external firms in order to focus on their core-business functions; on the other hand, firms operating in the services sector started to become highly specialised and able to provide highly targeted knowledge-intensive services to their new - mainly, industrial - clients (Miles *et al.*, 1995; Doloreux and Shearmur, 2012b).

In fact, KIBS firms represent the core of the "knowledge-based economy" (Miles *et al.*, 1995) thanks to their ability of creating, accumulating and transmitting new (codified and tacit) knowledge (Miles *et al.*, 1995; den Hertog, 2000; Bettencourt *et al.*, 2002). In this sense, KIBS firms act as knowledge brokers (Hargadon and Sutton, 1997): thanks to their central position in extended networks of industrial firms, KIBS providers can easily absorb knowledge generated in different industrial sectors - to which their clients belong - thus (re)combining it with their internally-generated knowledge in order to provide new solutions to highly targeted problems (Muller and Zenker, 2001; Bettiol *et al.*, 2012).

It follows that KIBS firms have two main properties, i.e. learning and providing knowledge. Along these lines, the literature has identified few key characteristics of KIBS firms (Miles *et al.*, 1995; den Hertog, 2000; Castaldi *et al.*, 2013; Muller and Doloreux, 2007; Strambach, 2008): first, they concentrate highly qualified and skilled workers which contribute to the generation of new (technical and professional) knowledge; second, they sell knowledge-intensive services targeted to clients' specific problems; third, their activity



requires complex and intensive interactions with the client: the deeper is the interaction, the easier is the diffusion of knowledge (Ciriaci and Palma, 2012).

According to von Hippel (1988), the link between KIBS firms and innovative behaviour of (manufacturing) clients relies in the ability of KIBS firms of absorbing and recombining knowledge which is specific to a variety of different industries. In this context, KIBS firms act as catalysts of resources which may enter the innovation process (Muller and Zenker, 2001; Castellacci, 2008; Castaldi, 2009; Muller and Doloreux, 2009). This "innovation-pushing" role of KIBS firms may emerge in both an informal and a formal way. Informally, KIBS firms contribute to client firms' innovation processes through their consultancy activity. Formally, KIBS firms may become co-producers of innovations (den Hertog, 2000; Muller and Doloreux, 2009) especially if client firms are characterised by deep commitment to innovation and high absorptive capacity: in this case, cooperative innovation processes are likely to emerge (Tether and Tajar, 2008), where inputs provided by both the client firm and the KIBS provider are conveyed towards the innovation output (Wood, 2004). Moreover, even though the role of KIBS providers as (active) source of manufacturing firms' innovation processes may be related to both technological and organisational innovations, a stronger link is likely to emerge in the case of technological innovation: in fact, its development requires the use of external services in different phases - e.g. R&D processes, testing activities, commercialisation, etc. (Miles, 2008; Doloreux and Shearmur, 2012b)<sup>2</sup>.

As previously underlined, successful relationships between KIBS providers and client firms are more likely to happen if they are developed *via* deep and continuous interactions: in fact, face-to-face contacts and direct presence of the consultant in the client firm may allow a better understanding of the problematic as well as faster and higher transmission of (tacit) knowledge. Therefore, it may be argued that geographic proximity between the two actors may matter (Muller and Doloreux, 2009; Bettiol and Di Maria, 2012; Doloreux and Shearmur, 2012a)<sup>3</sup>. This reasoning is in line with the well-established idea that innovation processes are spatially bounded: in fact, there is a wide literature studying regional innovation systems

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<sup>2</sup> Doloreux and Shearmur (2012b) provide one of the few quantitative studies on the relationship between KIBS providers and innovation in manufacturing firms. Their results, based on a sample of 804 manufacturing establishments located in the province of Quebec (Canada), suggest that the use of KIBS plays a crucial role for firms' innovation activities, and this holds in particular for technological (product and process) innovations with respect to organisational ones. Specifically, it emerges that innovative firms tend to combine expertises from several services providers in developing technological innovations, while organisational innovations benefit from marketing, management, and human resource services.

<sup>3</sup> In contrast to this idea, Doloreux and Shearmur (2012b) underline the absence of a geographic scope in services utilisation. According to their results, Canadian firms search for the best KIBS provider independently of its location and once a relationship has been established, communication technologies replace face-to-face contacts.

which claims the importance of local availability of specialised inputs, services and resources required for the innovation process (Cooke *et al.*, 2004; Doloreux, 2004; Asheim and Gertler, 2005; Wolfe, 2009).

On the base of this framework, it can be argued that manufacturing SMEs' propensity of introducing technological innovations may be (positively) influenced by interactions with KIBS providers and, in particular, that spatial clustering of KIBS firms may facilitate SMEs' successful innovation processes thanks to a large (local) availability of differentiated services. Therefore, the following hypothesis is specified:

H6. The higher is the (geographic) density of KIBS providers, the higher is a firm's probability of introducing technological innovations.

### **3. Data and Econometric Methodology**

#### **3.1. The Dataset**

The empirical investigation employs Italian micro-data drawn from the 10<sup>th</sup> wave of the *Survey of Manufacturing Firms* run by Unicredit-Capitalia, which provides detailed qualitative and quantitative information for a sample of 5,137 firms observed over the period 2004-2006.

The original sample has been cleaned by removing firms in non-manufacturing sectors as well as firms for which the location at the province level (corresponding to the NUTS-3 level of the European Union territorial classification) was not available. Moreover, firms with missing or incomplete information in terms of innovation activity, year of establishment, value added, number of employees and R&D investments were also removed. The cleaning procedure left with a cross-section of 4,367 manufacturing SMEs observed over the three-year period 2004-2006<sup>4</sup>.

Table 1 reports the sample distribution in terms of size, geographic area of location and technological sector - defined according to the Pavitt's (1984) classification. Looking at the whole sample, it emerges that the majority of firms - about 72% - is of small size, i.e. it employs less than 50 people. Moreover, about 43% of firms is located in the North West area of Italy while about 12% of firms is located in a Southern region or in an island. The sample

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<sup>4</sup> Table A.1 in Appendix reports the sample distribution by industry at the two-digit level of the Ateco 1991 classification of the economic activities. All industries are represented in the sample, excluded the industries "16 - Manufacture of tobacco products" and "37 - Repair and installation of machinery and equipment".

is composed mainly by firms operating in traditional sectors - about 50% of the sample firms - while high-tech firms represent less than 5% of the sample.

The same criteria of classification are considered when the focus is on innovative firms, i.e. firms which have introduced product and/or process innovations over the period 2004-2006. Table 1 shows that the distribution of innovative firms is in line with the distribution of the whole sample in terms of geographic area of location and technological sector; looking at the size, it emerges that the percentage of medium sized innovative firms - i.e. firms with a number of employees between 50 and 249 - increases from 27.6% to more than 31%.

Table 1. Sample distribution by size, geographic area and Pavitt's (1984) taxonomy.

	Whole Sample		Innovative Firms	
	a.v.	%	a.v.	%
<i>Size<sup>(a)</sup></i>				
Small (<50)	3,163	72.43	1,722	68.58
Medium (50-249)	1,204	27.57	789	31.42
<i>NUTS-1</i>				
North West	1,863	42.66	1,069	42.57
North East	1,268	29.04	716	28.51
Centre	726	16.62	451	17.96
South & Islands	510	11.68	275	10.95
<i>Pavitt Taxonomy</i>				
Traditional Sectors	2,179	49.90	1,180	46.99
Scale Sectors	820	18.78	473	18.84
Specialised Sectors	1,180	27.02	736	29.31
High-Tech Sectors	188	4.31	122	4.86
Total Firms	4,367	100.00	2,511	100.00

Notes: Percentage values are expressed on column totals. <sup>(a)</sup> Number of employees in parentheses. North West includes Piemonte, Valle d'Aosta, Liguria and Lombardia. North East includes Trentino-Alto Adige, Veneto, Friuli-Venezia Giulia and Emilia-Romagna. Centre includes Toscana, Umbria, Marche and Lazio. South includes Abruzzo, Molise, Campania, Puglia, Basilicata and Calabria. Islands are Sicilia and Sardegna.

### 3.2. Econometric Methodology

The aim of the paper is to empirically investigate the determinants of manufacturing SMEs' innovative behaviour, which is captured by an output measure of innovation. Specifically, the survey asks firms whether they have introduced product and/or process innovations over the period 2004-2006. Therefore, due to the discrete nature of the information available, the best way to model such relationship is through a probabilistic regression approach.

Probit models are specified and estimated by Maximum Likelihood in order to investigate the determinants of SMEs' technological innovation. The Probit model can be specified *via* a latent-variable interpretation (Greene, 2003):

$$y^* = \mathbf{x}'\boldsymbol{\beta} + \varepsilon$$

$$y = \begin{cases} 1 & \text{if } y^* > 0 \\ 0 & \text{if } y^* \leq 0 \end{cases} \quad (1)$$

where  $y$  denotes the discrete observed output which value - i.e. whether the firm has ( $y = 1$ ) or not ( $y = 0$ ) introduced technological innovations - depends on an unobserved variable  $y^*$ , for instance denoting profits earned by the firm through the innovation introduced;  $\mathbf{x}'$  is a vector of explanatory variables,  $\boldsymbol{\beta}$  denotes the vector of associated parameters and the error term  $\varepsilon$  is assumed to be normally distributed.

The vector  $\mathbf{x}'$  defined in equation (1) comprehends four sets of explanatory variables, i.e. firm-specific, agglomeration, KIBS-related and control variables. In order to test hypotheses H1 to H4, which are derived from the RB setting, four firm-specific variables - referring to the year 2004, i.e. the beginning of the three-year period of observation of the dependent variable - are defined: a variable for firm age ( $Age_i^{2004}$ ), computed as the natural logarithm of the difference between the year 2004 and the year of firm establishment, a variable for firm size ( $Size_i^{2004}$ ), computed as the natural logarithm of the number of employees, a variable capturing labour productivity ( $LP_i^{2004}$ ), defined as the natural logarithm of the ratio between deflated value added and number of employees, and a variable capturing R&D efforts ( $R\&D_i^{2004}$ ), computed as the natural logarithm of the R&D investments, where  $i = 1, \dots, 4,367$  is the firm index.

The second set of explanatory variables concerns hypothesis H5, which is related to the agglomeration-innovation relationship. Specifically, two variables capturing agglomeration effects are constructed using data provided by ISTAT (Italian National Institute of Statistics). The two agglomeration variables aim at capturing, respectively, specialisation externalities and Jacobs - or diversification - externalities. Specialisation externalities are captured by a relative specialisation index ( $RSI_{g,p}^{2004}$ ), which is defined as follows (Glaeser *et al.*, 1992):

$$RSI_{g,p}^{2004} = \ln[(LU_{g,p}^{2004} / \sum_g LU_{g,p}^{2004}) / (\sum_p LU_{g,p}^{2004} / \sum_p \sum_g LU_{g,p}^{2004})] \quad (2)$$

where  $LU_{g,p}^{2004}$  denotes the number of local units operating in the two-digit industry  $g$  and located in the province  $p = 1, \dots, 107$  in the year 2004. Jacobs externalities are captured by the inverse of a Herfindahl-Hirschman Index (HHI), which is defined as follows (Henderson *et al.*, 1995):

$$HHI_{g,p}^{2004} = \ln \left\{ 1 / \sum_{\substack{j=1 \\ j \neq g}}^J [LU_{j,p}^{2004} / (LU_p^{2004} - LU_{g,p}^{2004})]^2 \right\} \quad (3)$$

where  $LU_{g,p}^{2004}$  denotes the number of local units operating in the two-digit industry  $g$  and located in province  $p = 1, \dots, 107$  in the year 2004, while  $LU_{j,p}^{2004}$  denotes the number of local units operating in the two-digit industry  $j \neq g$  and located in province  $p$ .

A variable capturing KIBS firms' geographic concentration is considered in order to test the relationship between KIBS and SMEs' innovative behaviour, i.e. hypothesis H6. Specifically, this variable is defined as the natural logarithm of a density measure of KIBS firms computed at the province level:

$$KIBS_p^{2004} = \ln(\sum_k LU_{k,p}^{2004} / A_p) \quad (4)$$

where  $LU_{k,p}^{2004}$  denotes the number of local units belonging to the three-digit industry  $k$  defined as KIBS located in province  $p$  in year 2004, and  $A_p$  denotes the area in square kilometres of each province  $p$ .

Following Miles *et al.* (1995), KIBS firms are also split between "professional" (business and management services, legal accounting and activities, market research, etc.) and "technological" (IT-related services, engineering, R&D consulting, etc.) KIBS providers. Therefore, the geographic concentration measure defined in equation (4) is computed for both professional KIBS ( $P\_KIBS_p^{2004}$ ) and technological KIBS ( $T\_KIBS_p^{2004}$ ) providers<sup>5</sup>.

The choice of the province as geographic unit of analysis for calculating the variables for KIBS firms' geographic concentration, as well as the agglomeration variables capturing localisation and Jacobs externalities, is based on three main reasons (Cainelli *et al.*, 2013): first, each province has an average population of about 600,000 people; second, the number of firms in the sample is not large enough to guarantee some critical mass using local labour

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<sup>5</sup> Table A.2 in Appendix reports the three-digit industries of the Ateco 1991 classification of the economic activities considered in defining the KIBS sector.

systems - i.e. places where people commute for working reason - as geographic unit of analysis; third, provinces have administrative powers which may influence the performance and behaviour of firms.

Finally, four geographic dummy variables are included in the estimated models in order to account for structural differences among NUTS-1 Italian areas, and a set of two-digit industry dummies is included to control for systematic factors characterising all firms operating in the same manufacturing industry<sup>6</sup>.

#### **4. Empirical Results**

Several Probit models are specified for both the whole sample of firms and the subsamples of low- and high-tech firms. In fact, it may be possible to detect a different behaviour in firms' innovativeness according to their technological regime.

Table 2 reports results of Probit models estimated for the whole sample of firms, where the dependent variable is a dummy capturing the introduction of technological innovations - namely, product and/or process innovations. Looking at the set of firm-specific characteristics, results suggest a positive effect on the innovation activity of labour productivity, size, age, and R&D investments. Specifically, a 1% increase in the labour productivity level increases the probability of introducing product and/or process innovation by about 2.3%, while a 1% increase in the R&D investments level increases the probability of introducing innovation by about 4.7%. Moreover, it emerges that older firms as well as larger firms have higher probability of introducing some kind of innovation: this result may be explained in terms of both higher (accumulated) experience and greater availability of knowledge as well as internal (physical and human) resources.

The coefficients of the variable capturing specialisation externalities are positive but they are not statistically significant, while the variable for diversification externalities has positive and significant coefficients: it emerges that a 1% increase in the level of local industrial diversification increases a firm's probability of introducing technological innovations by about 21%. These results suggest that firms' innovativeness benefits from location in a diversified economic environment rather than close to firms operating in the same industry. Looking at the variables for KIBS providers' density, results suggest that being located in areas characterised by a high density of KIBS firms does not increase firms' probability of introducing some kind of innovation. This result holds when considering all

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<sup>6</sup> Tables A.3 and A.4 in Appendix report descriptive statistics and the correlation matrix of the dependent and the main explanatory variables.

KIBS sectors as well as professional and technological KIBS separately<sup>7</sup>. Even though manufacturing SMEs can easily outsource and get access to specialised services in their local area, it seems that technical and professional external expertises do not significantly affect their innovation processes. On the contrary, it seems that firms' innovative behaviour depends on internal characteristics and it is favoured by inter-industry (out-of-the-market) externalities.

Table 2. Results for the whole sample.

	(1)	(2)	(3)	(4)	(5)
$LP_i^{2004}$	0.062** (0.025) [0.023]	0.063** (0.025) [0.023]	0.063** (0.025) [0.023]	0.063** (0.025) [0.023]	0.063** (0.025) [0.023]
$SIZE_i^{2004}$	0.170*** (0.025) [0.063]	0.170*** (0.025) [0.063]	0.170*** (0.025) [0.063]	0.170*** (0.025) [0.063]	0.170*** (0.025) [0.063]
$AGE_i^{2004}$	0.107*** (0.023) [0.039]	0.107*** (0.023) [0.039]	0.107*** (0.023) [0.039]	0.107*** (0.023) [0.039]	0.107*** (0.023) [0.039]
$R\&D_i^{2004}$	0.128*** (0.012) [0.047]	0.128*** (0.012) [0.047]	0.128*** (0.012) [0.047]	0.128*** (0.012) [0.047]	0.128*** (0.012) [0.047]
$RSI_{g,p}^{2004}$	...	0.004 (0.037)	0.004 (0.037)	0.004 (0.037)	0.004 (0.037)
$HHI_{g,p}^{2004}$	...	0.587* (0.304) [0.216]	0.575* (0.309) [0.211]	0.567* (0.310) [0.209]	0.581* (0.308) [0.214]
$KIBS_p^{2004}$	...	...	-0.006 (0.021)	...	...
$P\_KIBS_p^{2004}$	...	...	...	-0.008 (0.019)	...
$T\_KIBS_p^{2004}$	...	...	...	...	-0.004 (0.023)
No. Obs.	4,367	4,367	4,367	4,367	4,367
No. Clusters	1,047	1,047	1,047	1,047	1,047
Pseudo R <sup>2</sup>	0.058	0.058	0.058	0.058	0.058
Log Pseudolikelihood	-2806.297	-2804.232	-2804.191	-2804.149	-2804.219
Wald $\chi^2$	274.557***	287.302***	287.967***	288.248***	287.709***
Mean VIF	1.09	1.07	1.07	1.07	1.07

Notes: \* denotes significance at 10%; \*\* denotes significance at 5%; \*\*\* denotes significance at 1%. All variables are defined in natural logarithm. Standard errors are clustered at the province/industry level. Clustered-robust standard errors are shown in parentheses. Marginal effects are shown in brackets only for significant coefficients. All specifications include two-digit industry dummies and NUTS-1 geographic dummies.

<sup>7</sup> The variables for density of professional and technological KIBS providers show high correlation (0.985). Therefore, they are not included together in the regression model in order to avoid biased results.

Table 3 reports results for the sub-sample of low-tech SMEs. Results are in line with previous ones: firms' probability of introducing technological innovations seems to be driven by internal factors rather than by external ones. In fact, the variables for labour productivity, size, age and R&D investments show positive and statistically significant coefficients, while neither the variables for specialisation and diversification externalities, nor the variables capturing KIBS firms' density have statistically significant coefficients.

Table 3. Results for the sub-sample of low-tech firms.

	(1)	(2)	(3)	(4)	(5)
$LP_i^{2004}$	0.071** (0.030) [0.026]	0.071** (0.030) [0.027]	0.071** (0.030) [0.026]	0.071** (0.030) [0.026]	0.071** (0.030) [0.026]
$SIZE_i^{2004}$	0.146*** (0.030) [0.055]	0.148*** (0.030) [0.055]	0.148*** (0.030) [0.056]	0.148*** (0.030) [0.055]	0.149*** (0.030) [0.056]
$AGE_i^{2004}$	0.108*** (0.027) [0.041]	0.108*** (0.027) [0.040]	0.108*** (0.027) [0.040]	0.108*** (0.027) [0.040]	0.108*** (0.027) [0.040]
$R\&D_i^{2004}$	0.138*** (0.015) [0.052]	0.138*** (0.015) [0.052]	0.138*** (0.015) [0.052]	0.138*** (0.015) [0.052]	0.138*** (0.015) [0.052]
$RSI_{g,p}^{2004}$	...	0.026 (0.043)	0.028 (0.043)	0.027 (0.043)	0.028 (0.043)
$HHI_{g,p}^{2004}$	...	0.539 (0.374)	0.556 (0.377)	0.554 (0.377)	0.555 (0.376)
$KIBS_p^{2004}$	...	...	0.012 (0.028)	...	...
$P\_KIBS_p^{2004}$	...	...	...	0.009 (0.026)	...
$T\_KIBS_p^{2004}$	...	...	...	...	0.016 (0.030)
No. Obs.	3,069	3,069	3,069	3,069	3,069
No. Clusters	720	720	720	720	720
Pseudo R <sup>2</sup>	0.052	0.052	0.052	0.052	0.052
Log Pseudolikelihood	-2004.603	-2002.996	-2002.884	-2002.932	-2002.824
Wald $\chi^2$	171.622***	174.748***	177.419***	176.962***	177.907***
Mean VIF	1.09	1.07	1.07	1.06	1.07

Notes: see Table 2.

Table 4 refers to the sub-sample of high-tech firms. Results show positive and statistically significant coefficients of the variables for size, age and R&D investments, while the coefficients of the labour productivity variable are positive but not statistically different



from zero. The variable for specialisation externalities shows negative and statistically significant coefficients, while the variable for diversification externalities shows positive and slightly significant coefficients: it emerges that a 1% increase in the level of local specialisation reduces firms' probability of introducing technological innovations by about 9%, while a 1% increase in the level of industrial diversification seems to increase firms' innovativeness by about 50%. As for the whole sample and the sub-sample of low-tech firms, the coefficients the variables for KIBS providers' density are not statistically significant.

Table 4. Results for the sub-sample of high-tech firms.

	(1)	(2)	(3)	(4)	(5)
$LP_i^{2004}$	0.046 (0.044)	0.053 (0.044)	0.054 (0.044)	0.054 (0.044)	0.054 (0.044)
$SIZE_i^{2004}$	0.224*** (0.045) [0.079]	0.230*** (0.046) [0.080]	0.228*** (0.046) [0.080]	0.228*** (0.046) [0.080]	0.228*** (0.046) [0.080]
$AGE_i^{2004}$	0.103** (0.043) [0.036]	0.103** (0.043) [0.036]	0.103** (0.043) [0.036]	0.103** (0.043) [0.036]	0.103** (0.043) [0.036]
$R\&D_i^{2004}$	0.107*** (0.019) [0.038]	0.108*** (0.019) [0.038]	0.108*** (0.019) [0.038]	0.108*** (0.019) [0.038]	0.108*** (0.019) [0.038]
$RSI_{g,p}^{2004}$	...	-0.188** (0.092) [-0.066]	-0.178* (0.093) [-0.062]	-0.177* (0.093) [-0.062]	-0.179* (0.093) [-0.063]
$HHI_{g,p}^{2004}$	...	0.930* (0.500) [0.325]	0.848 (0.526)	0.837 (0.530)	0.861* (0.523) [0.301]
$KIBS_p^{2004}$	...	...	-0.019 (0.031)	...	...
$P\_KIBS_p^{2004}$	...	...	...	-0.018 (0.029)	...
$T\_KIBS_p^{2004}$	...	...	...	...	-0.018 (0.033)
No. Obs.	1,298	1,298	1,298	1,298	1,298
No. Clusters	328	328	328	328	328
Pseudo R <sup>2</sup>	0.058	0.060	0.061	0.061	0.061
Log Pseudolikelihood	-798.467	-796.140	-796.017	-795.998	-796.038
Wald $\chi^2$	90.243***	106.947***	109.692***	109.721***	109.668***
Mean VIF	1.08	1.12	1.16	1.17	1.16

Notes: see Table 2.

The non-significant effect of the geographic concentration of KIBS providers on SMEs' innovative behaviour may be explained in terms of heterogeneity of firms' absorptive capacity

(Cohen and Levinthal, 1990). In fact, firms may benefit from being located near KIBS providers and they may be able to translate this proximity advantage in innovation outputs only if they have the knowledge required to interact with KIBS firms.

In order to test this hypothesis, Probit models are estimated including interaction terms between the three variables for KIBS providers' density and the variables for firm age and R&D investments. On the one hand, older firms may have accumulated knowledge and experience on the market and on how to develop innovation processes such that they may be able to translate inputs from KIBS firms into product and process innovations. On the other hand, firms investing in R&D activities may have the internal (human and capital) resources required to internally materialise the (tacit and codified) knowledge flows coming from KIBS firms: in fact, greater internal technological capacity may increase a firm's ability to assimilate, recombine and employ external acquired knowledge (Cohen and Levinthal, 1990; Monery *et al.*, 1996; Tsai, 2001; Vinding, 2006; Cosh and Zhang, 2012).

Table 5 reports results of Probit models with interaction terms estimated for the whole sample of SMEs<sup>8</sup>. The coefficients of the firm-specific variables, as well as of the variable for diversification externalities, are positive and statistically significant, while the variables for specialisation externalities and KIBS firms' density show non-significant coefficients. Interesting results concern the interaction terms: on the one hand, the coefficients of the age-interacted variables are positive even though not significant; on the other hand, the coefficients of the interaction terms between R&D investments and, respectively, KIBS and technological KIBS firms' density are positive and statistically different from zero. These results suggest that the level of absorptive capacity of a firm matters for gaining from proximity to KIBS providers: specifically, it seems that only firms which already have internal (human and physical) resources devoted to the innovation process may be able to benefit from knowledge flows from KIBS firms.

In particular, it seems that firms' probability of introducing technological innovations is mainly affected by the presence of technological KIBS firms: this result underlines that firms may benefit from being located close to firms providing technical, scientific and highly specialised services which can be directly employed in the innovation activity carried out by the firm, while the presence of firms providing professional services plays no role, maybe because this type of services is not directly usable in the innovation process. In fact, technological services - e.g. activities concerning informatics, R&D, engineering or technical

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<sup>8</sup> The main variables of the interaction terms have been mean-centred in order to reduce possible collinearity problems.

consultancy - may enter the innovation process increasing its probability of success by providing specialised solutions to several potential problems, as well as guiding the innovation activity along its several phases. However, results clearly suggest that only firms endowed with a certain level of knowledge and expertise to carry out innovations may increase their probability of introducing successful technological innovations through (market-based) collaborations with specialised services firms.

Table 5. Results for the whole sample with interaction terms.

	(1)	(2)	(3)
$LP_i^{2004}$	0.064*** (0.025) [0.023]	0.064*** (0.025) [0.023]	0.064** (0.025) [0.023]
$SIZE_i^{2004}$	0.171*** (0.025) [0.063]	0.171*** (0.025) [0.063]	0.171*** (0.025) [0.063]
$AGE_i^{2004}$	0.108*** (0.023) [0.040]	0.108*** (0.023) [0.040]	0.108*** (0.023) [0.040]
$R\&D_i^{2004}$	0.129*** (0.012) [0.047]	0.129*** (0.012) [0.047]	0.129*** (0.012) [0.047]
$RSI_{g,p}^{2004}$	0.006 (0.037)	0.006 (0.037)	0.006 (0.037)
$HHI_{g,p}^{2004}$	0.583* (0.307) [0.214]	0.575* (0.308) [0.211]	0.591* (0.306) [0.217]
$KIBS_p^{2004}$	-0.003 (0.022)	...	...
$P\_KIBS_p^{2004}$	...	-0.005 (0.020)	...
$T\_KIBS_p^{2004}$	...	...	-0.000 (0.023)
$(AGE_i^{2004}) \times (KIBS_p^{2004})$	0.025 (0.018)	...	...
$(AGE_i^{2004}) \times (P\_KIBS_p^{2004})$	...	0.024 (0.017)	...
$(AGE_i^{2004}) \times (T\_KIBS_p^{2004})$	...	...	0.025 (0.019)
$(R\&D_i^{2004}) \times (KIBS_p^{2004})$	0.021* (0.013) [0.008]	...	...
$(R\&D_i^{2004}) \times (P\_KIBS_p^{2004})$	...	0.019 (0.012)	...
$(R\&D_i^{2004}) \times (T\_KIBS_p^{2004})$	...	...	0.023* (0.013)

			[0.008]
No. Obs.	4,367	4,367	4,367
No. Clusters	1,047	1,047	1,047
Pseudo R <sup>2</sup>	0.059	0.059	0.059
Log Pseudolikelihood	-2801.613	-2801.612	-2801.617
Wald $\chi^2$	296.943***	297.614***	296.284***
Mean VIF	1.06	1.06	1.06

Notes: see Table 2.

Tables 6 and 7 report results for the sub-samples of, respectively, low- and high-tech firms. Results show positive and significant coefficients of the variables capturing size, age and R&D investments, while it seems that the level of labour productivity positively affects firms' probability of introducing technological innovations only in the case of low-tech firms. The variables for specialisation and diversification externalities show positive but non-significant coefficients for low-tech firms, while it emerges a negative (positive) significant effect of specialisation (diversification) externalities for high-tech firms.

Results concerning the variables for KIBS firms' density differ significantly between low- and high-tech firms. It emerges that proximity to KIBS providers plays no significant role in the innovation process of high-tech firms (see Table 7): hence, it can be stated that, independently of a firm's experience, knowledge and R&D-type endowment, high-tech firms do not benefit from external specialised (knowledge) inputs coming from KIBS providers and that, therefore, high-tech manufacturing SMEs' innovation activity is mainly driven by internal firm-specific resources. On the contrary, it emerges that low-tech SMEs' probability of introducing technological innovations increases as the presence of specialised services providers in the local area increases (see Table 6): on the one hand, this statement holds only for those firms endowed with a certain level of R&D-type resources which allows them to effectively comprehend and materialise external inputs into internal innovation processes (i.e., absorptive capacity matters); on the other hand, it emerges that low-tech SMEs benefit from being located in areas characterised by a high concentration of both professional and technological KIBS providers. This last result may be due to the fact that low-tech SMEs lack a variety of expertises concerning the innovation process (e.g. property rights, patenting, etc.) such that their innovation activity benefits from external specialised knowledge which enters the innovation process both directly (i.e. the one provided by technological KIBS firms) and indirectly (i.e. the one provided by professional KIBS firms).

Table 6. Results for the sub-sample of low-tech firms with interaction terms.

	(1)	(2)	(3)
$LP_i^{2004}$	0.070** (0.030) [0.026]	0.069** (0.030) [0.026]	0.070** (0.030) [0.026]
$SIZE_i^{2004}$	0.148*** (0.030) [0.055]	0.148*** (0.030) [0.055]	0.148*** (0.030) [0.055]
$AGE_i^{2004}$	0.114*** (0.027) [0.042]	0.114*** (0.027) [0.043]	0.113*** (0.027) [0.042]
$R\&D_i^{2004}$	0.145*** (0.015) [0.054]	0.144*** (0.015) [0.054]	0.145*** (0.015) [0.054]
$RSI_{g,p}^{2004}$	0.031 (0.043)	0.031 (0.043)	0.031 (0.043)
$HHI_{g,p}^{2004}$	0.565 (0.375)	0.562 (0.375)	0.565 (0.374)
$KIBS_p^{2004}$	0.021 (0.029)	...	...
$P\_KIBS_p^{2004}$	...	0.016 (0.027)	...
$T\_KIBS_p^{2004}$	...	...	0.025 (0.031)
$(AGE_i^{2004}) \times (KIBS_p^{2004})$	0.037 (0.024)	...	...
$(AGE_i^{2004}) \times (P\_KIBS_p^{2004})$	...	0.037 (0.022)	...
$(AGE_i^{2004}) \times (T\_KIBS_p^{2004})$	...	...	0.036 (0.025)
$(R\&D_i^{2004}) \times (KIBS_p^{2004})$	0.034** (0.014) [0.013]	...	...
$(R\&D_i^{2004}) \times (P\_KIBS_p^{2004})$	...	0.032** (0.013) [0.012]	...
$(R\&D_i^{2004}) \times (T\_KIBS_p^{2004})$	...	...	0.037** (0.015) [0.014]
No. Obs.	3,069	3,069	3,069
No. Clusters	720	720	720
Pseudo R <sup>2</sup>	0.054	0.054	0.054
Log Pseudolikelihood	-1999.099	-1999.186	-1999.036
Wald $\chi^2$	199.003***	198.933***	198.887***
Mean VIF	1.06	1.06	1.07

Notes: see Table 2.

Table 7. Results for the sub-sample of high-tech firms with interaction terms.

	(1)	(2)	(3)
$LP_i^{2004}$	0.055 (0.044)	0.055 (0.044)	0.055 (0.044)
$SIZE_i^{2004}$	0.230*** (0.047) [0.080]	0.230*** (0.047) [0.080]	0.230*** (0.047) [0.081]
$AGE_i^{2004}$	0.103** (0.047) [0.036]	0.104** (0.047) [0.036]	0.102** (0.048) [0.036]
$R\&D_i^{2004}$	0.105*** (0.021) [0.037]	0.105*** (0.021) [0.037]	0.105*** (0.021) [0.037]
$RSI_{g,p}^{2004}$	-0.176* (0.092) [-0.062]	-0.175* (0.092) [-0.061]	-0.177* (0.092) [-0.062]
$HHI_{g,p}^{2004}$	0.851 (0.525)	0.840 (0.528)	0.865* (0.521) [0.302]
$KIBS_p^{2004}$	-0.018 (0.031)	...	...
$P\_KIBS_p^{2004}$	...	-0.018 (0.029)	...
$T\_KIBS_p^{2004}$	...	...	-0.018 (0.033)
$(AGE_i^{2004}) \times (KIBS_p^{2004})$	0.001 (0.030)	...	...
$(AGE_i^{2004}) \times (P\_KIBS_p^{2004})$	...	-0.001 (0.028)	...
$(AGE_i^{2004}) \times (T\_KIBS_p^{2004})$	...	...	0.003 (0.032)
$(R\&D_i^{2004}) \times (KIBS_p^{2004})$	0.013 (0.019)	...	...
$(R\&D_i^{2004}) \times (P\_KIBS_p^{2004})$	...	0.012 (0.018)	...
$(R\&D_i^{2004}) \times (T\_KIBS_p^{2004})$	...	...	0.013 (0.020)
No. Obs.	1,298	1,298	1,298
No. Clusters	328	328	328
Pseudo R <sup>2</sup>	0.061	0.061	0.061
Log Pseudolikelihood	-795.751	-795.742	-795.766
Wald $\chi^2$	118.192***	118.344***	118.097***
Mean VIF	1.16	1.16	1.16

Notes: see Table 2.

Empirical results confirm hypotheses H1 to H4, thus suggesting that SMEs' different innovative behaviours (and capacities) depend on internal firm-specific characteristics. In particular, innovative firms tend to be larger, older, R&D-intensive and characterised by

higher labour productivity levels than their counterparts. Hypothesis H5 is partially confirmed: on the one hand, it emerges that being located in a highly specialised local system reduces firms' probability of introducing technological innovations - for high-tech firms, at least; on the other hand, little evidence emerges on a positive effect of diversification externalities on firms' innovative behaviour. Finally, hypothesis H6 is partially confirmed: in fact, results suggest that it is not the geographic concentration of KIBS providers *per se* which favours SMEs' propensity to innovate, but the positive effect of being located near a dense pool of KIBS providers depends on the (R&D-based) absorptive capacity of the firm acquiring the service. This last result holds for both professional and technological KIBS, but only for low-tech firms; in fact, high-tech firms seem to develop their innovation processes relying primarily on their internal resources.

## **5. Concluding Remarks**

This paper has empirically investigated the determinants of manufacturing SMEs' innovative behaviour focusing on technological innovations and considering, simultaneously, firm-specific and external factors. The theoretical framework has been developed from multiple perspectives: specifically, the resource-based theory of the firm and the new economic geography framework have been blend together also explicitly considering the role of KIBS firms in the innovation process.

The empirical exercise has been carried out on a large sample of Italian manufacturing SMEs, and Probit models have been estimated also accounting for technological differences among firms and possible heterogeneity in firms' absorptive capacity. Overall, empirical results suggest that SMEs' innovation activity is mainly driven by firm-specific characteristics: experience and knowledge accumulated over time, availability of human and capital resources, as well as high levels of labour productivity and R&D investments positively affect firms' innovative behaviour. On the contrary, inter-firm (out-of-the-market) knowledge and technological spillovers seem to play a little role, and mainly in the form of inter-industry - rather than intra-industry - externalities: overall, results suggest that (high-tech) firms slightly benefit from diversification externalities, while specialisation externalities have a negative (or negligible) effect on firms' innovative behaviour. Finally, results show that the geographic concentration of KIBS providers plays a positive role, but only for (low-tech) SMEs already endowed with the internal resources - related to the innovation process - necessary to interact with KIBS providers and to materialise their knowledge flows into

technological innovation processes - i.e. absorptive capacity matters for successful interactions between KIBS firms and manufacturing clients.

Overall, the quantitative results presented in this paper are in line with previous findings. First, the key role played by firm-specific characteristics is confirmed - in particular, the importance of R&D investments. Second, results on the agglomeration-innovation relationship tend to confirm previous evidences showing, overall, a positive effect of local industrial diversification on firms' innovativeness. Finally, results on KIBS firms confirm previous - mainly qualitative - evidences of their positive role: the key finding is that high availability of KIBS providers matters if and only if client firms already have the knowledge and (technical) resources needed to (actively) learn from KIBS firms.

This paper has also some limitations, which future research would be able to address and overcome: in particular, organisational innovation should be considered besides technological one and the sample should include also service firms which, according to the existing literature, show interesting differences in behaviour and performance with respect to manufacturing firms.

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## Appendix

Table A.1. Sample distribution by industry.

Ateco 1991 - Two-digit level classification	No. Firms	
	a.v.	%
15 - Manufacture of food products and beverages	368	8.43
16 - Manufacture of tobacco products	0	0.00
17 - Manufacture of textiles	289	6.62
18 - Manufacture of wearing apparel	130	2.98
19 - Manufacture of leather and related products	159	3.64
20 - Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	130	2.98
21 - Manufacture of paper and paper products	130	2.98
22 - Printing and reproduction of recorded media	160	3.66
23 - Manufacture of coke and refined petroleum products	11	0.25
24 - Manufacture of chemicals and chemical products	191	4.37
25 - Manufacture of rubber and plastic products	232	5.31
26 - Manufacture of other non-metallic mineral products	304	6.96
27 - Manufacture of basic metals and alloys	150	3.43
28 - Manufacture of fabricated metal products, except machinery and equipment	693	15.87
29 - Manufacture of mechanic machinery and equipment	634	14.52

30 - Manufacture of office equipment, computer and informatics systems	25	0.57
31 - Manufacture of machinery and electrical equipment n.e.c.	172	3.94
32 - Manufacture of radio, television and communication equipment	78	1.79
33 - Manufacture of medical and precision equipment, optical instrument and swatch	117	2.68
34 - Manufacture of motor vehicles, trailers and semi-trailers	60	1.37
35 - Manufacture of other transport equipment	43	0.98
36 - Manufacture of furniture; Other manufacturing	291	6.66
37 - Repair and installation of machinery and equipment	0	0.00
Total sample	4,367	100.00

Table A.2. Definition of KIBS, professional KIBS and technological KIBS sectors.

Ateco 1991 - Three-digit level classification		
KIBS	Technological KIBS	721 - Consultancy for the installation of electronic elaborator
		722 - Software supply and informatics advice
		723 - Electronic data elaboration
		724 - Activities over databanks
		725 - Maintenance and repair of office equipment and electronic elaborator
		726 - Other informatics activities
		731 - Experimental R&D in natural sciences and engineering
		732 - Experimental R&D in social and humanistic sciences
		742 - Architectural, engineering and other technical activities
		743 - Test and technical analysis
	Professional KIBS	741 - Legal and accountability activities, marketing activities, fiscal and commercial consultancy, holding
		744 - Advertising
		745 - Employment research and selection activities

Table A.3. Descriptive statistics of dependent and main explanatory variables.

	Mean	Std. Dev.	Min.	Max.
<i>Dependent Variable</i>				
Technological Innovation (d)	0.575	0.494	0	1
<i>Explanatory Variables</i>				
$LP_i^{2004}$	10.604	0.806	5.680	16.437
$Age_i^{2004}$	2.928	0.880	0	5.541
$Size_i^{2004}$	3.358	0.864	0	5.501
$R\&D_i^{2004}$	0.845	1.886	0	9.643
$RSI_{g,p}^{2004}$	0.314	0.645	-2.818	3.180
$HHI_{g,p}^{2004}$	2.390	0.099	1.983	2.592
$KIBS_p^{2004}$	1.317	1.073	-1.084	3.609
$P\_KIBS_p^{2004}$	0.498	1.138	-2.120	2.941



$T\_KIBS_p^{2004}$	0.724	1.026	-1.600	2.891
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Notes: Number of Observations equals 4,367. The dependent (dummy) variable refers to the three-year period 2004-2006, while all explanatory variables refer to the year 2004.

Table A.4. Correlation matrix among main explanatory variables.

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	
$LP_i^{2004}$	[1]	1								
$Age_i^{2004}$	[2]	0.188	1							
$Size_i^{2004}$	[3]	0.010	0.273	1						
$R\&D_i^{2004}$	[4]	0.062	0.068	0.210	1					
$RSI_{g,p}^{2004}$	[5]	0.004	0.009	0.006	0.049	1				
$HHI_{g,p}^{2004}$	[6]	0.051	0.066	0.044	0.048	0.194	1			
$KIBS_p^{2004}$	[7]	0.077	0.067	-0.040	-0.001	0.020	0.019	1		
$P\_KIBS_p^{2004}$	[8]	0.071	0.058	-0.043	-0.002	0.002	-0.033	0.996	1	
$T\_KIBS_p^{2004}$	[9]	0.083	0.075	-0.038	0.000	0.038	0.074	0.996	0.985	1