



Self-employment and innovation. Exploring the determinants of innovative behavior in small businesses

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ABSTRACT

This paper explores the determinants of innovation in small businesses from a survey of more than 700 self-employed workers in Andalusia (Spain). Self-employed people running businesses with and without employees were included in the study and two types of innovation – product and process innovation – were differentiated.

The theoretical framework adopted distinguishes between three levels of factors affecting the innovative activities of the self-employed: (1) the personal characteristics of the self-employed – such as their motivations and their educational and professional background. (2) The organization characteristics – such as the sector, the number of employees, the dependence on suppliers or clients and the management styles. (3) The characteristics of the external environment.

Education appears as a key factor whose impact on innovation comes through two main sources: its effect on self-employed motivations and its influence on the management style of small businesses. Also previous experience as an employee and the comparative level of income in the area where the business is located are shown to be influential factors explaining innovation. Though firm size favors innovation, it does not play a determining role. Furthermore, results show significant differences between the factors explaining product and process innovation. The determinants for innovation in small businesses also vary substantially across sectors.

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1. Introduction

In recent decades the self-employed component of the national labor-force has been gaining relevance in many developed economies and notable public efforts have been made to support entrepreneurship and innovation in small and medium-sized enterprises (SMEs). Nevertheless, relevant gaps in knowledge still exist regarding the factors boosting innovation in small businesses and, consequently, regarding the most effective strategy to efficiently support this type of firms in their attempts at innovation. The aim of this work is to shed some additional light on these key issues.

This paper studies the determinant of innovation in small businesses from the perspective of self-employment and doing so represents an unusual approach. The concept of ‘self-employment’ – despite the habitual use of this term – is rather elusive due to its mixed nature. On the one hand, it can be defined as the residual and heterogeneous category made up of paid employees not remunerated by a wage (Carrasco, 1999). On the other hand,

self-employed people can be seemed as entrepreneurs who start up and/or run self-owned businesses. However, not all the self-employed are necessarily entrepreneurs (Robinson and Sexton, 1994), given that in many cases they run businesses that they did not found and carry out a conservative and unadventurous management. It is also convenient to distinguish between the category of self-employed people and business owners. The difference lies in the fact that business owners are not necessarily involved in the day-to-day operations of their company, since they can opt for hiring a professional manager and have other sources of income, such as paid-employees in other companies. So, from this perspective, all the self-employed people – even in the case of mere professionals without employees – are conceptually business owners, whereas business owners do not necessarily have to be self-employed workers.

Moreover, the self-employed can run businesses with or without employees. In the first case, the resulting businesses are in the great majority small businesses, though there could be the case of medium or large companies owned and managed by self-employed people. In addition, not all the small businesses are necessarily led by self-employed people. On the contrary, small firms are in some cases part of large corporations or are headed by managers working as paid-employees.

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All these conceptual considerations are frequently neglected in research about SMEs and, specifically, about small businesses. This literature generally assumes the hypothesis that the SME's organization, management and performance are significantly influenced by the personal characteristics of the entrepreneur (in many cases not clearly defining what is exactly meant by entrepreneur). However, research in this field is very often based on surveys carried out among managers or business owners. This design of the empirical work could lead to some bias, in line with the considerations previously presented.

This paper exclusively focuses on small businesses driven by the self-employed, hence many of those problems can be avoided. Throughout this article, self-employment is considered to be the category made up of people who draw their income from self-owned small businesses (with or without employees) that they operate personally. Therefore, under this definition the self-employed assume a triple role in their businesses: they are workers, managers and business owners.

This conceptual delimitation is consistent with the empirical definition employed in the second part of the paper. Self-employed people will be identified then based on the Social Security Administration regulation. According to the Spanish Social Security regulation, a self-employed status is applicable to the “individuals who carry out, on a regular basis, personally, directly, by themselves and outside the scope of another person's management and organization, an economic or professional activity for profit, giving or not employment to other workers.” (Spanish Institute of Social Security, 2007). In this respect, the paper explores the determinants of innovation in small businesses – differentiating between product and process innovation – from a survey of about 750 self-employed workers in Andalusia, a region in the south of Spain.

The paper is organized as follows. The second section reviews the literature about innovation in small businesses and presents the analytical framework adopted in this work to study the determinants of innovation activities by self-employed people. This theoretical framework gathers the main aspects influencing innovation activities in small businesses, distinguishing between three levels of factors: the personal characteristics of the self-employed people, the characteristics of their organizations and the characteristics of the external environment. The third section is devoted to the empirical analysis. The determinants of the innovative activities of the self-employed in the sample are investigated by means of estimating several logistic regressions. The last section puts forward the main conclusions and discusses some relevant policy implications.

2. Literature review and conceptual framework

A wide range of literature exists dealing with the factors which condition firm innovation and, in particular, innovation in small businesses. From these works it is possible to identify three levels of key factors influencing innovation in small businesses: the personal characteristics of the self-employed individual, the characteristics of the organization and, lastly, the characteristics of the external environment. As shown in Fig. 1, these three levels of factors are not independent, but interrelated dimensions. On the one hand, the personal characteristics of the self-employed have a direct and crucial influence on the small businesses' organization and management. On the other hand, the external environment influences the individual characteristics of the self-employed within an area and the organization and management of their businesses.

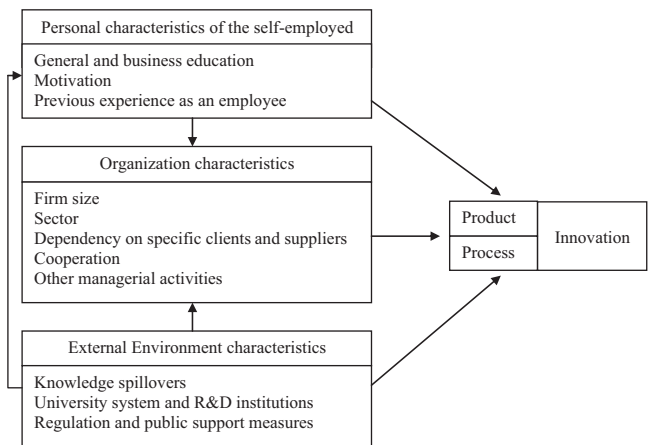


Fig. 1. Factors influencing innovation in SMEs.

2.1. Personal characteristics

The activity and characteristics of small businesses, especially in the stage of their creation and the early phases of their development, are directly linked to the characteristics of the entrepreneur. Therefore, when studying the SMEs' innovative behavior, it is essential to consider the repercussions of certain personal characteristics of the self-employed.

In this respect, education has been pointed out as a key aspect for the economic success of the self-employed (Robinson and Sexton, 1994; Kangasharju and Pekkala, 2002). Since knowledge is a fundamental factor in the innovation and assimilation of new technologies (Von Hippel, 1988; Hoffman et al., 1998), individual training plays an important role contributing to the internal learning and the generation of new ideas within the business (Damanpour, 1991; Nonaka and Takeuchi, 1995; Galende and De la Fuente, 2003). The educational background of the managers, business owners and entrepreneurs has been found to be an important factor explaining innovation in small businesses (Koellinger, 2008). Self-employed people with stronger educational backgrounds can carry out a more professional and efficient management and organization of their businesses and, in this way, can be more successful implementing innovations. However, not all the studies reach this conclusion. For instance, Keizer et al. (2002) did not find a significant effect of the managers' or business owners' education on innovation in a study of SMEs in the mechanical and electrical engineering sector in The Netherlands.

Previous experience is another conditioning factor in self-employment (Robinson and Sexton, 1994), which can significantly influence innovation in small businesses and start-ups. Innovation, as the result of a process of knowledge accumulation, benefits from previous experience in a particular field (Koellinger, 2008). A large part of the relevant knowledge for innovation is of a tacit and unspoken nature, and derives from experience (Arora and Gambardella, 1994). This non-codified and eminently practical knowledge (know-how) is especially important within the process of organizational learning (Dosi, 1988), the development phase of the innovation process (OECD, 2002), and the process of incremental innovation (Abernathy and Clark, 1985; Malerba and Orsenigo, 1995), particularly once the technology used is in a mature and standardized phase.

Furthermore, the motivation and personal attitude of the self-employed in carrying out their business activity has been considered as an influential factor on innovation and other energizing initiatives of SMEs. Innovation requires motivated individuals. Among the obstacles to a business' innovative behavior, the individual's aversion to new technologies and learning, their hostility to

taking on responsibilities or their voluntary isolation can be pointed out (Probst and Büchel, 1995). In order to foster innovation, the individual must be motivated and open to commitment and professional challenges. People decide to become entrepreneurs for a variety of reasons (Nooteboom, 1993), thus different taxonomies of entrepreneurial motivations have been proposed in the literature. One of the most usual ones differentiates between intrinsic and extrinsic motivations. An intrinsic entrepreneurial motivation poses the idea that entrepreneurs undertake their activity for the mere pleasure of carrying it out, that is, for vocational reasons or for the need of personal development. On the contrary, extrinsic entrepreneurial motivation implies that the entrepreneurs' activity is driven by the desire of gaining an economic reward or a material achievement. In this respect, Guzmán and Santos (2001) defended that those entrepreneurs with an extrinsic motivation might be less prone to the introduction of innovations, among other energizing business behaviors. Another relevant typology differentiates between 'necessity' and 'opportunity' motivation. Opportunity entrepreneurs start a business in order to pursue an opportunity in the market, while necessity entrepreneurs are pushed by unemployment situations or dissatisfaction with their previous jobs (Reynolds et al., 2002). In this sense, Block and Sandner (2009) have found, in a study for Germany, that opportunity entrepreneurs remain in self-employment longer than necessity entrepreneurs. However, after controlling for the entrepreneurs' education in the professional area where they start their business, this effect is no longer significant.

In addition, other entrepreneurs' psychological characteristics, such as tolerance to risks, innovativeness, positive affect or creativity, have been proposed by some researchers as factors positively related to firm-level innovation (Marcati et al., 2008; Baron and Tang, 2011).

2.2. Organization characteristics

The literature also includes certain traits of business organization as factors conditioning innovation in small businesses. In this sense, business size has been of special and continuing interest to those studying the innovative activity of SMEs (Acs and Audretsch, 1990; Vaona and Pianta, 2008). Firm size is related to the capabilities and resources available for innovation (including technical, human and financial resources). In this sense, the growth and turnover of the staff can also imply a continual renewal of the internal knowledge within the business (Nonaka and Takeuchi, 1995; Hurley and Hult, 1998). Size can affect both the process of internal generation and the transfer of scientific and technical knowledge from outside the organization. However, this supposed direct positive effect of firm size on innovation has been subject to continuing debate (Scherer, 1965; Soete, 1979). In this respect, another hypothesis proposes a non-linear relation between both variables (Martínez-Román et al., 2011).

On the other hand, certain sector characteristics condition the innovative path of small businesses. The technological opportunities within the sector (profits expected from innovations), the level of market concentration (number of competitors) and the conditions for accumulation and appropriation of technology are aspects typically considered when explaining the disparities among sectors in technological innovation (Dosi, 1988; Rosenberg, 1982; Malerba and Orsenigo, 1995). Models analyzing the generation and spread of innovations from a market-based perspective place an emphasis on the "demand pull" (Schmookler, 1966), in response to the "technology push" proposed in Schumpeter's works (Schumpeter, 1934). This "demand pull" results from the combination of needs and demand with the technological characteristics of the sector. Starting from the market focus, models of technological innovation have been perfected based on the concept of the technological

trajectory, generically categorized as market or technological trajectory models. According to this approach, the study of innovation should focus on the analysis of common characteristics detected in different industrial branches. This sectoral pattern has a significant influence on innovation since the business adapts its innovative processes to the technological models of the sector (Pavitt, 1984; Dosi et al., 1990).

Likewise, clients' and suppliers' power of negotiation is a factor which must be considered for its possible repercussions on the innovative activity of the SME. Porter's model of extended rivalry (1980) pointed out the effects of clients' and suppliers' power of negotiation on the competitiveness of the industrial sector. The current tendency is to view clients and suppliers as stakeholders rather than rivals of the business, thus effectively facilitating transactions and cooperation along the business chain. However, too much dependency on clients and suppliers can generate a weakness at the negotiating table and hence may constitute a strategic restriction affecting the competitive rivalry and innovative activity of small businesses (Guzmán-Cuevas et al., 2009). These dependent relationships are especially intense for those SMEs belonging to Global Value Chains (GVC) which are governed by large multinational corporations (OECD, 2008). In these cases, some authors maintain that the SMEs taking part in value chains could stimulate their processes of innovation and technological improvement by the spillover of knowledge and demands from larger organizations, while others consider that this possibility has been overestimated (Romero, 2009).

On the other hand, business cooperation can be an important route for the transmission of the knowledge and experience in the production network. This is even more important in the case of small businesses, because, in comparison to large companies, they have a reduced innovative autonomy and they do not usually collaborate with technological centers regarding Research and Development (R&D) activities (Dyer and Singh, 1998). Business cooperation in the technological field has been subject to numerous studies, as it is considered to be the intermediate step between internal development and the acquisition of technology (Hagedoorn et al., 2000; Fritsch and Lukas, 2001; Keizer et al., 2002). Cooperation between small businesses generally involves innovative projects of an incremental nature, developed by SMEs with complementary activities and with the goal of sharing resources and knowledge. The competitive advantage sought in this type of small scale cooperation is generally the differentiation of the product or service and its better adaptation to the needs of the client (Porter, 1990). The role of cooperation as a strategic support for innovation has been favored by the generalization of the state-of-the-art information technologies and the capacity of these technologies to receive and transmit information and knowledge. These cooperative relations may be of a formal nature-based on some form of contract- or may originate informal agreements. They may also be stable, periodic or even sporadic, and they may only affect very specific areas of the business. The informal exchange of know-how, if used selectively, is an effective solution for SMEs wishing to access to new technologies at a lower transaction cost than in formal agreements. However, its informal nature makes it difficult to study and, for this reason, researchers have normally focused on business relations of a formal nature (Von Hippel, 1988; Hagedoorn et al., 2000).

In addition to business cooperation, the development of other invigorating activities has sometimes been cited as a factor favoring innovation in small businesses. In this sense, the stimulus of continued personnel training encourages innovation because it contributes to learning and stimulates the creativity of individuals (Damanpour, 1991; Nonaka and Takeuchi, 1995). Therefore, the

existence of training systems is a factor which favors innovation (Johnson et al., 1996; Freel, 2005), as it allows new knowledge to be shared and incorporated into the organization and helps individuals to learn and become more competent. Likewise, activities related to the systematic search for new markets and business opportunities, participation in conferences or trade fairs related to the sector and the development of planning, control and risk management activities have been considered examples of invigorating behaviors in the activity of an SME (Guzmán and Santos, 2001). These activities are usually associated with the most proactive and innovative entrepreneurs.

2.3. External environment characteristics

Innovation is a complex, dynamic and interactive process conditioned by the characteristics of the business environment (Rosenberg, 1982; Porter and Stern, 2001; Koellinger, 2008). However, the relationship between the SMEs' performance regarding innovation and the external environment has remained underdeveloped in the literature (Edwards et al., 2005).

The influence of external conditions comes from different sources. On the one hand, physical proximity facilitates the personal contact between individuals working in businesses and research institutions, favoring the exchange and spread of knowledge within the region (Jaffe et al., 1993; Murray, 2004; Singh, 2005). Thus, small businesses can benefit from their proximity to universities and research centers, incorporating them into their innovation networks (Keizer et al., 2002).

In this respect, the knowledge-spillover theory of entrepreneurship (Audretsch, 1995) postulates that small and new firms are able to innovate without assuming large investments in R&D by exploiting knowledge created in universities and large corporations. Thus, entrepreneurship can act as a key source for knowledge spillovers and innovation by taking knowledge created within the context of one organization or incumbent firm as a basis for starting a new firm (Audretsch and Lehmann, 2005; Audretsch and Keilbach, 2008). According to these authors, these knowledge spillovers would be geographically bounded and localized within a spatial proximity to the knowledge source.

The set of cultural values in a particular region can also favor innovation. In this sense, the degree of interpersonal trust conditions the ease and fluidity of contact needed to share and transmit knowledge (Tsai and Ghoshal, 1998). In those spatial contexts where a culture of trust among individuals exists, it is more probable for cooperative relationships among businesses to be successfully developed. Furthermore, the characteristic of the entrepreneurial culture in an area influences the motivations and decisions for self-employment and the entrepreneurial orientation of the small businesses.

The characteristics of the institutional framework also determine the small businesses' attempts at innovation. The legal regulation and the administrative environment can exert an important influence on innovation processes at a local, regional and national level (Edquist and Johnson, 1997; Porter and Stern, 2001). Certain studies have shown that industries tend to be concentrated in regions and even cities of a country, given the fact that administrative decentralization in some countries has produced distinctive characteristics among its different regions (Porter, 1990; Cooke et al., 1997). Since, as was previously mentioned, education is an important factor for innovation, the strength of the educational system has to be outlined as a crucial factor favoring innovation. Moreover, the development of decentralized policy initiatives to stimulate innovation introduces relevant differences among the local and regional business environments directly, influencing the small businesses' innovation strategies (Keizer et al., 2002).

3. Empirical analysis

This section puts forward an empirical study which explores the determinants of innovation in SMEs within the analytical framework proposed in Fig. 1.

3.1. Data collection, variables and method

Data for this study come from a survey conducted in the last quarter of 2007 among Andalusian people registered in the Spanish Social Security system as self-employed workers. The stratified sample – with quotas for sectors and provinces – was representative of the self-employed population in Andalusia (470,163 self-employed workers in 2007) with an error of $\pm 3.5\%$ at a confidence level of 95%. For the aim of this paper, only self-employed people running small businesses without employees or with up to 100 employees have been considered, so the final dataset is made up of 747 observations.

The questionnaire included queries about the innovative activities of the small businesses and about different possible explanatory variables for them. The *dependent variables* in this empirical exercise are the indicators for innovation. The self-employed people interviewed were asked whether in the previous three years they had carried out any product innovation-including radical, incremental and small improvements in the firm's products – and any process innovation – including radical, incremental and an adaptation or mere incorporation of existing technology. Thus, the three following dummy variables are considered in this paper to capture innovation:

1. *Product innovation* (proc.inn): this binary variable takes the value 1 if the firm undertook any product innovation in the previous three years, and 0 in the negative case.
2. *Process innovation* (prod.inn): this binary variable takes the value 1 if the firm undertook any process innovation in the previous three years, and 0 in the negative case.
3. *Product and process innovation* (both.inn): this binary variable takes value 1 if the firm undertook both product and process innovations in the previous three years.

The following 18 *explanatory* or *independent variables* are included in this study-classified into three groups:

- A. *Personal characteristics of the self-employed*: indicators for educational background, previous experience and motivations to become a self-employed worker are considered in this group as follows.
 1. *Tertiary education* (ter.edu): this variable takes the value 1 for those self-employed workers who had a university degree or higher professional training (after secondary studies), and 0 for the rest of those interviewed.
 2. *Business education* (bus.edu): this variable takes the value 1 for those self-employed people who had attended any course about entrepreneurship, management, business administration or specific topics related to their business activity and 0 in the negative case.
 3. *Previous experience as an employee* (exp): this variable takes the value 1 for those interviewed who had previously worked as an employee.
 4. *Intrinsic motivation* (int.mot): the self-employed people interviewed were asked about their level of agreement with the following statement: "I am a self-employed person because this is the best option for my personal and professional development". The answers were coded as an ordinal variable which

takes values from 1 to 7 – 7 meaning full agreement and 1 complete disagreement.

5. *Extrinsic motivation* (ext_mot): the self-employed people interviewed were asked about their level of agreement with the following statement: “I am a self-employed person because this way I earn more money than working as an employee”. The answers were coded again as an ordinal variable taking values from 1 to 7 – 7 meaning full agreement and 1 complete disagreement.
6. *Necessity motivation* (nec_mot): the self-employed interviewed were asked about their level of agreement with the following statement: “I became a self-employed person because I did not have another option (I was unemployed)”. Again, the corresponding ordinal variable takes values from 1 to 7 – 7 meaning full agreement and 1 complete disagreement.

Other personal characteristics – such as age or gender – were initially considered as factors possibly influencing innovation. However, statistically significant results were not obtained for them and, consequently, these variables were removed from the analysis presented here.

B. Organization characteristics

7. *Number of employees* (emp): firm size, measured by the number of employees is included in the analysis as a continuous variable.
8. *Square number of employees* (emp_2): also defined as a continuous variable which tries to capture the possible quadratic effect of firm size.
9. *Sector*: three main sectors have been distinguished in order to investigate whether the factors determining innovation in small business are specific for each economic activity. These sectors are industry – including the building industry – the knowledge-intensive services sector, and the trade and the rest of the services sector. The knowledge-intensive services have been identified following the European Commission classification (Eurostat, 2005).
10. *Dependency on specific clients* (ford_dep): the self-employed people interviewed were asked what approximate percentage of their sales came from their most important client. They had to select one of the following six options: less than 10%, between 10 and 25%, between 25 and 50%, between 50 and 75%, between 75 and 100% or 100%. The answer was treated as an ordinal variable.
11. *Dependency on specific suppliers* (back_dep): the self-employed people interviewed were asked what approximate percentage of their purchase came from their most important supplier. They had also to choose between one of the following six options: less than 10%, between 10 and 25%, between 25 and 50%, between 50 and 75%, between 75 and 100% or 100%. The answer was also coded again as an ordinal variable.
12. *Cooperation* (coop): the self-employed workers interviewed were asked whether they had ever undertaken any cooperation activity with other firms. In this respect, both formal agreements and informal relationships regarding production, R&D, marketing or other aspects of business activity were considered. The answers were coded as a dummy variable (1 for cooperative firms and 0 for non-cooperative ones).

In addition, five more variables were included in the analysis to explore the possible effect of different management practices on the innovative behavior of small businesses:

13. Participation in trade fairs and conferences related to their business (manag_1).
14. Formal business planning of the different management areas (finance, marketing, logistics, human resources, etc.) (manag_2).
15. Activities for the control and forecast of the firm's results (manag_3).
16. Alertness and identification of new markets and business opportunities (manag_4).
17. Support for workers' training and education (manag_5).

All these five variables (manag_x) were treated as dummy variables which take value 1 for those self-employed people who undertook the respective tasks or activities in their business, and 0 in the negative case.

C. External environment characteristics

18. *Provincial level of income* (prov_inc): this paper has a focus on the personal characteristics of the self-employed and the characteristics of the small businesses they carried out. Nevertheless, the inclusion of a control variable to capture external effects associated with the characteristics of the external environment was considered necessary to guarantee more consistent empirical results. In this respect, as a general hypothesis, in highly developed areas with high per capita income, one might expect to find more efficient suppliers of inputs, more and better qualified workers and managers, more public support for self-employment and entrepreneurship or stronger R&D systems (universities, public and private research centers, etc.). In this sense, Koellinger (2008) has found that highly developed countries (in terms of GNP per capita) exhibit higher shares of innovative nascent entrepreneurs. Relevant internal differences exist in Andalusia among the eight provinces that make up the region. So, a proxy variable was defined classifying these provinces into two groups: those with high per capita incomes – Almería, Seville, Huelva and Cádiz – and those with low ones – Málaga, Granada, Córdoba and Jaén. The resulting dummy variable takes value 1 for those self-employed people operating in any of the provinces with a high per capita income and 0 for those operating in any of those with low per capita incomes.

A list with all these variables is shown in Table 1 and some descriptive indicators for them are presented in Table 2. As can be observed, 39.9% of the self-employed interviewed had introduced product innovations, 46.2% had brought in process innovations and 32.8% had innovated both regarding their products and their processes. Table 2 also shows some basic features of the self-employed people who took part in the survey. The majority of them had a university degree or higher professional training and benefited from previous experience as paid-employees. Regarding their motivations, an intrinsic motivation seems to be as strong as an extrinsic one, necessity being the least important motivation among the participants in the survey, who mainly run microenterprises – with an average of 3.1 employees – in the services sector.

Logistic regressions are used in this paper to test the influences of the independent variables on the dichotomous innovation variables. The logistic regression model can be presented as follows:

$$\ln \left(\frac{p}{1-p} \right) = z = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \dots + \beta_k x_k \quad (1)$$

where p is the probability that $y = 1$; y alternatively represents the innovation dummies (prod_inn, proc_inn or both_inn); x_j are the independent variables ($j = 1, \dots, k$) and β_j denote the regression coefficients ($j = 1, \dots, k$).

Table 1
Summary of variables.

Description	Label	Type	Dimension
<i>Dependent variables</i>			
Product innovation	prod.inn	Dichotomous	Innovation
Process innovation	proc.inn	Dichotomous	Innovation
Both types of innovation	both.inn	Dichotomous	Innovation
<i>Explanatory and control variables</i>			
Tertiary education	ter.edu	Dichotomous	Personal characteristics
Business education	bus.edu	Dichotomous	Personal characteristics
Previous experience as an employee	exp	Dichotomous	Personal characteristics
Intrinsic motivation	int.mot	Ordinal	Personal characteristics
Extrinsic motivation	ext.mot	Ordinal	Personal characteristics
Necessity motivation	nec.mot	Ordinal	Personal characteristics
Number of employees	emp	Continuum	Business characteristics
Square number of employees	emp.2	Continuum	Business characteristics
Sector	sector	Categorical	Business characteristics
Dependency on specific clients	ford.dep	Ordinal	Business characteristics
Dependency on specific suppliers	back.dep	Ordinal	Business characteristics
Cooperation	coop	Dichotomous	Business characteristics
Participation in trade fairs and conferences	manag.1	Dichotomous	Business characteristics
Formal business planning	manag.2	Dichotomous	Business characteristics
Control and forecast of results	manag.3	Dichotomous	Business characteristics
Alertness and identification of new markets and business opportunities	manag.4	Dichotomous	Business characteristics
Workers' training and education	manag.5	Dichotomous	Business characteristics
Provincial per capita income	prov.inc	Dichotomous	Territory characteristics

So the probability of an innovative behavior – product innovation, process innovation or both types of innovation simultaneously – for a given value of x_j will be given by the following expression:

$$p = \frac{\exp(\beta_0 + \sum_j \beta_j x_j)}{1 + \exp(\beta_0 + \sum_j \beta_j x_j)} \quad (2)$$

This logistic regression model is estimated using the maximum likelihood method.

3.2. Results

Appendix A displays the correlations among the variables included in the analysis. As can be seen, many correlation coefficients among the variables are statistically significant. Particularly, as shown in Fig. 1, the personal characteristics of the self-employed, such as the educational background, previous work experience and the nature and strength of their entrepreneurial motivations have a direct influence on their management style and the characteristics of their businesses. Nevertheless, the coefficients among the explanatory variables are always below 0.5 (with the exception of the correlation between the number of employees and the square number of employees) and the variance inflation factors (VIF) are in all the cases below 10 (the highest VIF observed is 4.0), indicating that multicollinearity is not a concern. Logistic regressions were firstly estimated using all the observations and later separately for each sector – industry, knowledge – intensive services, and trade and the rest of the services.

The results for the overall estimations are shown in Table 3 – for product innovation – Table 4 – for process innovation – and Table 5 – for both types of innovations together. Firstly, a baseline model is presented in each case which includes only some of the explanatory variables (model 1). This model itself reasonably fits the data, as the percentage of correct predictions – higher than 70% for the three dependent variables for innovation – shows (71.2% for product innovation, 70.7 for process innovation and 76.0% for both types of innovation together). Next, a second estimation is put forward which also includes the motivation variables as regressors (model 2). After this, the cooperation dummy and the rest of the variables capturing the managerial practices were also included (model 3). All these additions improve the goodness of fit of the estimations.

However, as can be observed in Tables 3–5, the effect of the tertiary education (ter.edu) – which is highly significant in regression 1 – has a lower statistical significance in regression 2, and is not statistically significant in regression 3. This is due to the fact that ter.edu is correlated with the motivation variables and with the variables for cooperation (coop) and managerial practices (manag.x) (see the correlation matrix in Appendix A). Those self-employed workers with tertiary education show more intense intrinsic and extrinsic motivations and a lower necessity motivation (as can be observed in Fig. 2). They are also more cooperative and more frequently undertake the managerial practices considered in this paper (see Fig. 3). Among all these variables, only the one capturing the actions to foster workers' training and education is not significantly correlated with tertiary education. Thus, the influence of tertiary education on innovation comes basically

Table 2
Descriptive indicators.

Variable	Value	Variable	Value	Variable	Value	Variable	Value
prod.inn ^a	39.9	ter.edu ^a	58.1	emp ^b	3.1	coop ^a	49.9
		bus.edu ^a	60.0	industry ^a	28.6	manag.1 ^a	37.5
proc.inn ^a	46.2	exp ^a	69.3	k-i. services ^a	43.3	manag.2 ^a	44.7
		int.mot ^b	4.7	trade and other serv. ^a	28.1	manag.3 ^a	64.6
both.inn ^a	32.8	ext.mot ^b	4.7			manag.4 ^a	52.5
		nec.mot ^b	3.3	ford.dep ^b	1.5	manag.5 ^a	34.3
				back.dep ^b	2.2	prov.inc ^a	52.5

^a Percentage of 1 (affirmative answers).

^b Mean value.

Table 3
Logistic regression for product innovation.

Variables	(1)		(2)		(3)		(4)	
	β	S.E.	β	S.E.	β	S.E.	β	S.E.
ter_edu	0.462 **	(0.183)	0.394 **	(0.187)	0.198	(0.200)		
bus_edu	0.930 ***	(0.186)	0.869 ***	(0.189)	0.567 ***	(0.203)	0.624 ***	(0.198)
exp	0.622 ***	(0.190)	0.620 ***	(0.191)	0.475 **	(0.201)	0.476 **	(0.199)
emp	0.172 ***	(0.034)	0.151 ***	(0.035)	0.104 ***	(0.038)	0.115 ***	(0.038)
emp_2	−0.003 ***	(0.001)	−0.003 ***	(0.001)	−0.002 **	(0.001)	−0.002 **	(0.001)
ford_dep	−0.188 **	(0.081)	−0.194 **	(0.082)	−0.181 **	(0.086)	−0.192 **	(0.087)
back_dep	−0.060	(0.057)	−0.058	(0.058)	−0.092	(0.060)	−0.104 *	(0.059)
prov_inc	0.509 ***	(0.181)	0.551 ***	(0.184)	0.468 **	(0.194)	0.454 **	(0.193)
int_mot			0.058	(0.049)	0.039	(0.053)	0.040	(0.052)
ext_mot			0.034	(0.046)	−0.007	(0.049)	−0.014	(0.049)
nec_mot			−0.057	(0.039)	−0.047	(0.041)	−0.046	(0.040)
coop					0.290	(0.189)	0.378 **	(0.186)
manag_1					0.496 ***	(0.191)	0.468 **	(0.190)
manag_2					0.364 *	(0.207)	0.381 *	(0.205)
manag_3					0.791 ***	(0.222)	0.793 ***	(0.220)
manag_4					0.416 **	(0.198)	0.436 **	(0.197)
manag_5					−0.199	(0.204)	−0.206	(0.202)
constant	−2.054 ***	(0.299)	−2.194 ***	(0.416)	−2.536 ***	(0.443)	−2.426 ***	(0.437)
−2 Log likelihood	841.830		836.074		782.932		795.252	
Chi-square	156.080 ***		161.835 ***		214.798		227.925 ***	
Nagelkerke R Square	0.256		0.264		0.339		0.350	
% correct predictions	71.2		71.8		74.0		74.2	

* Differences statistically significant at the 0.10 level.

** Differences statistically significant at the 0.05 level.

*** Differences statistically significant at the 0.01 level.

from its effect on the motivations and the management style of self-employed people. Once these influences are captured in the regressions by the specific variables, the residual effect of tertiary education is not significant and the *ter_edu* variable can be neglected without significantly deteriorating the regressions' results.

So, finally, model 4 was also estimated, including all the independent variables with the only exception of *ter_edu*. As can be seen, this exclusion improves the goodness of fit in the three regressions given by the Nagelkerke *R* Square and the percentages of correct predictions. The odd ratios for the regression coefficients in the final model 4 are presented in [Appendix B](#).

As can be seen in [Tables 3–5](#), six variables are common, statistically significant factors explaining product innovation and process innovation in model 4: business education (*bus_edu*), previous experience as an employee (*exp*), number of employees (*emp*), square number of employees (*emp_2*), provincial level of per capita income (*prov_inc*), and cooperation (*coop*). However, certain differences can also be observed between the determinants of product and process innovations. Thus, the variables for the dependency on the main client and the main supplier (*for_dep* and *back_dep*) and the managerial practices (*manag_x*) are significant for product innovation, but not for process innovation (with the exception of *manag_5*, which is neither significant for product innovation, nor

Table 4
Logistic regression for process innovation.

Variables	(1)		(2)		(3)		(4)	
	β	S.E.	β	S.E.	β	S.E.	β	S.E.
ter_edu	0.406 **	(0.177)	0.300 *	(0.183)	0.187	(0.192)		
bus_edu	0.689 ***	(0.178)	0.630 ***	(0.182)	0.382 **	(0.194)	0.432 **	(0.189)
exp	0.639 ***	(0.183)	0.668 ***	(0.186)	0.568 ***	(0.192)	0.569 ***	(0.190)
emp	0.192 ***	(0.035)	0.159 ***	(0.037)	0.107 ***	(0.039)	0.118 ***	(0.039)
emp_2	−0.004 ***	(0.001)	−0.003 ***	(0.001)	−0.003 **	(0.001)	−0.003 ***	(0.001)
ford_dep	−0.065	(0.072)	−0.089	(0.073)	−0.098	(0.076)	−0.106	(0.076)
back_dep	0.031	(0.054)	0.021	(0.055)	0.000	(0.056)	−0.010	(0.056)
prov_inc	0.815 ***	(0.174)	0.957 ***	(0.180)	0.950 ***	(0.188)	0.942 ***	(0.187)
int_mot			0.119 **	(0.048)	0.099 **	(0.050)	0.100 **	(0.049)
ext_mot			0.120 ***	(0.045)	0.104 **	(0.047)	0.098 **	(0.047)
nec_mot			0.027	(0.038)	0.044	(0.039)	0.044	(0.039)
coop					0.321 *	(0.182)	0.397 **	(0.179)
manag_1					0.327 *	(0.190)	0.304	(0.189)
manag_2					0.299	(0.204)	0.315	(0.203)
manag_3					0.309	(0.210)	0.313	(0.208)
manag_4					0.268	(0.193)	0.289	(0.191)
manag_5					0.266	(0.200)	0.258	(0.198)
constant	−2.126 ***	(0.288)	−3.207 ***	(0.423)	−3.468 ***	(0.433)	−3.372 ***	(0.437)
−2 Log likelihood	871.516		852.720		823.051		833.689	
Chi-square	157.664 ***		176.460 ***		206.128 ***		217.088 ***	
Nagelkerke R Square	0.254		0.281		0.322		0.331	
% correct predictions	70.7		71.9		72.8		72.8	

* Differences statistically significant at the 0.10 level.

** Differences statistically significant at the 0.05 level.

*** Differences statistically significant at the 0.01 level.

Table 5

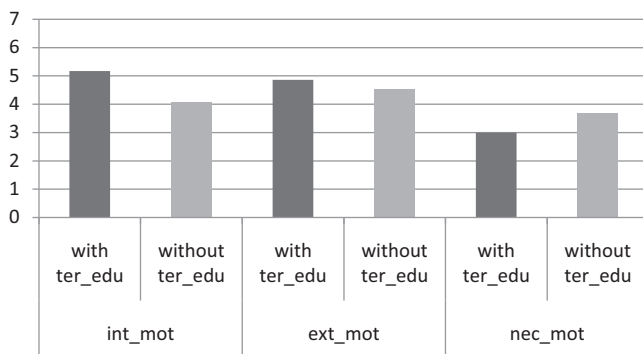
Logistic regression for product and process innovation together.

Variables	(1)		(2)		(3)		(4)	
	β	S.E.	β	S.E.	β	S.E.	β	S.E.
ter_edu	0.575 ***	(0.200)	0.424 **	(0.206)	0.217	(0.219)		
bus_edu	0.828 ***	(0.204)	0.699 ***	(0.209)	0.410 *	(0.225)	0.466 **	(0.218)
exp	0.766 ***	(0.208)	0.786 ***	(0.212)	0.644 ***	(0.221)	0.634 ***	(0.218)
emp	0.182 ***	(0.036)	0.139 ***	(0.037)	0.087 **	(0.039)	0.099 **	(0.390)
emp_2	−0.004 ***	(0.001)	−0.003 ***	(0.001)	−0.002 *	(0.001)	−0.002 **	(0.001)
ford_dep	−0.164 *	(0.089)	−0.178 **	(0.090)	−0.174 *	(0.094)	−0.190 **	(0.095)
back_dep	−0.050	(0.063)	−0.051	(0.064)	−0.081	(0.066)	−0.096	(0.065)
prov_inc	0.788 ***	(0.196)	0.899 ***	(0.203)	0.804 ***	(0.213)	0.775 ***	(0.211)
int_mot			0.151 ***	(0.055)	0.128 **	(0.058)	0.125 **	(0.056)
ext_mot			0.099 *	(0.051)	0.061	(0.053)	0.052	(0.053)
nec_mot			−0.089 **	(0.043)	−0.076 *	(0.045)	−0.074 *	(0.044)
coop					0.503 **	(0.203)	0.607 ***	(0.199)
manag_1					0.369 *	(0.204)	0.330	(0.202)
manag_2					0.379 *	(0.220)	0.393 *	(0.218)
manag_3					0.698 ***	(0.250)	0.706 ***	(0.246)
manag_4					0.354	(0.215)	0.371 *	(0.213)
manag_5					−0.067	(0.217)	−0.072	(0.213)
constant	−2.805 ***	(0.338)	−3.514 ***	(0.482)	−3.877 ***	(0.514)	−3.702 ***	(0.501)
−2 Log likelihood	761.766		738.018		696.045		711.872	
Chi-square	170.138 ***		193.885 ***		235.858 ***		250.304 ***	
Nagelkerke R Square	0.286		0.321		0.380		0.391	
% correct predictions	76.0		77.2		78.7		78.8	

* Differences statistically significant at the 0.10 level.

** Differences statistically significant at the 0.05 level.

*** Differences statistically significant at the 0.01 level.

**Fig. 2.** Educational level of self-employed people and motivations.

for process innovation). On the contrary, the strength of intrinsic (int_mot) and extrinsic motivation (ext_mot) are significant variables for process innovation, but not for product innovation.

Next, let us concentrate on those innovative-oriented self-employed who introduced both product and process innovations (see Table 5). The explanatory variables which have a statistically

significant effect on the innovative behavior at the confidence levels either of 0.05 or 0.01 are the following ones: business education (bus_edu), previous experience as an employee (exp), number of employees (emp), square firm size (emp_2) – with a negative sign, dependency on the main client (ford_dep) – with a negative sign, provincial level of per capita income (prov_inc), intrinsic motivation (int_mot), cooperation (coop) and undertaking of activities for the control and forecast of the firm's results (manag_3). Also, necessity motivation (nec_mot) – with a negative sign, formal business planning (manag_2) and alertness and identification of new markets and business opportunities (manag_4) are marginally significant factors explaining innovation activities by those self-employed interviewed (with a level of confidence of 0.10). Among them, the larger β coefficients and odds ratios are those for the level of provincial per capita income (prov_inc), undertaking of activities for control and forecast of the firm's results (manag_3), the previous experience as an employee (exp), the cooperation activities (coop) and the business education (bus_edu).

These overall results provide a general picture which, however, hides very different sectoral patterns regarding the determinants of innovation in small businesses. Table 6 shows the results of the regression model 4 for the self-employed who introduced both product and process innovations, estimating separate models for industry, knowledge-intensive services, and trade and the rest of the services (the odds ratios can be observed in Appendix B). In this respect, business size (emp) is the only variable which is a statistically significant factor determining innovation in the three sectors. Nevertheless, this positive effect decreases as the number of employees increases in the case of the knowledge-intensive services, and trade and the rest of the services, as the negative coefficient for the square number of employees (emp_2) reveals. In the case of industry, the rest of the statistically significant effects are associated with extrinsic motivation (ext_mot), cooperation (coop) and the activities for the control and forecast of the firm's results (manag_3). In the case of the knowledge-intensive services, those self-employed, with previous experience (exp) and extrinsic motivation (ext_mot), with business education (bus_edu) and alert to new markets and business opportunities (manag_4) seem to introduce more innovations. Finally, in the case of trade and the rest

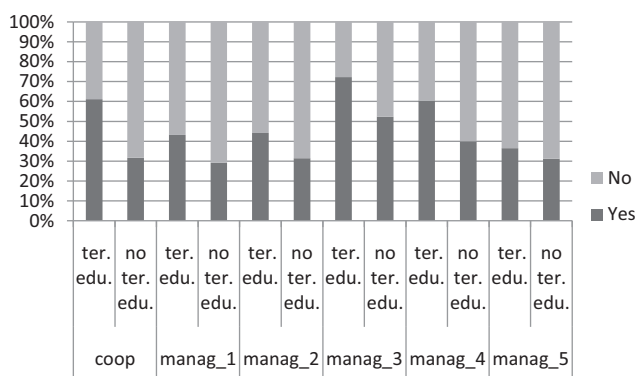
**Fig. 3.** Educational level of self-employed people and managerial practices.

Table 6

Logistic regressions for both product and process innovation together by sector. Model 4.

Variables	Industry		Knowledge-intensive services		Trade and rest of services	
	B	S.E.	B	S.E.	β	S.E.
bus_edu	−0.252	(0.409)	0.740*	(0.446)	1.276***	(0.394)
exp	0.214	(0.446)	0.790**	(0.371)	0.722*	(0.424)
emp	0.112*	(0.065)	0.251**	(0.119)	0.328*	(0.169)
emp_2	−0.002	(0.001)	−0.015**	(0.008)	−0.029*	(0.017)
ford_dep	−0.205	(0.188)	−0.035	(0.161)	−0.319*	(0.192)
back_dep	−0.196	(0.124)	−0.067	(0.120)	−0.054	(0.120)
prov_inc	0.457	(0.423)	−0.150	(0.392)	2.067***	(0.421)
int_mot	0.014	(0.110)	−0.001	(0.114)	0.208***	(0.102)
ext_mot	0.193*	(0.144)	0.177*	(0.098)	−0.129	(0.092)
nec_mot	−0.081	(0.083)	0.035	(0.082)	−0.102	(0.085)
coop	0.937**	(0.410)	0.002	(0.359)	1.117**	(0.372)
manag_1	0.004	(0.391)	0.498	(0.348)	0.383	(0.420)
manag_2	0.538	(0.401)	0.614	(0.408)	−0.005	(0.449)
manag_3	1.072**	(0.496)	0.366	(0.480)	0.824*	(0.441)
manag_4	0.572	(0.470)	0.632*	(0.379)	0.179	(0.406)
manag_5	−0.210	(0.408)	0.047	(0.359)	0.023	(0.445)
constant	−3.259***	(0.986)	−4.071***	(1.007)	−5.164***	(0.924)
−2 Log likelihood	199.717		226.993		218.554	
Chi-square	79.900***		50.830***		170.725***	
Nagelkerke R Square	0.427		0.292		0.584	
% correct predictions	80.8		71.7		86.0	
n	214		212		328	

* Differences statistically significant at the 0.10 level.

** Differences statistically significant at the 0.05 level.

*** Differences statistically significant at the 0.01 level.

of the services, business education (bus_edu), previous experience (exp) and intrinsic motivation (int_mot) appear as characteristic personal traits of the more innovative self-employed. Furthermore, in this sector, forward dependence on specific clients (ford_dep) seems to have a negative effect on innovation, whereas the level of per capita provincial income (prov_inc), cooperation (coop) and the activities for the control and forecast of the firm's results (manag_3) represent positive factors influencing innovation.

4. Discussion and policy implications

Though many works have addressed the determinants of innovation in SMEs, the conclusions are not completely consistent and some aspects are still a matter of controversy. When studying SMEs and, especially, small businesses, the personal characteristics of the entrepreneur are generally assumed to play a primary role in the firm's performance. However, some conceptual and practical problems – when carrying out empirical research – arise regarding the delimitation of the entrepreneur/business owner/manager, as has been discussed in the introduction of this paper. In this respect, the current article adopts an original approach investigating the factors determining the innovative activities of self-employed people running small businesses. In this way, the problems mentioned are overcome, since it is easier to conceptually and empirically delimitate and identify the figure of the self-employed. From a conceptual perspective, the self-employed simultaneously assume three roles: they are business owners, managers and workers in the same firm. From an empirical perspective, the legal status represents a clear criterion to identify the self-employed.

When considering innovation in this research, the classical distinction between product and process innovation is employed in order to check whether there might be differences in the factors behind these two types of innovations. The paper proposes an integrated framework to analyze innovation in small businesses, gathering those variables which have been more frequently considered in the literature and some others whose influence has been usually neglected. In this respect, three levels of explanatory factors for the innovation activities of small businesses are

considered: the personal characteristics of the self-employed people, the organization characteristics and the characteristics of the external environment (though the paper focuses on the first two dimensions).

Regarding the personal characteristics of the self-employed workers, the paper makes a contribution by studying the effect on innovation due to different types of motivations. To our knowledge, this factor have not been considered – or not thoroughly so – in previous studies about innovation activities in small businesses. In this respect, those self-employed who are moved by a sound intrinsic motivation have a higher probability of introducing innovations. Furthermore, the strength of extrinsic motivation is also shown to have a positive effect on innovation activities in the case of process innovations. On the contrary, those self-employed workers with a necessity motivation who start up a business as an alternative to escape from unemployment are less innovative than the rest.

Another explanatory factor that has not merited sufficient attention in previous studies is the dependency of small businesses on special clients and suppliers. In this respect, on the one hand, dependency on the most important clients – due to a high concentration of the sales with them – is observed as negatively affecting the innovation behavior of self-employed workers, specifically regarding product innovation. The expression 'false self-employed workers' has been applied to this type of situation, in which certain firms externalize some activities hiring the services of self-employed workers who are completely dependent on the main firm. The objective in these cases is to avoid the obligation of paying social contributions or to escape from the applying of the labor laws. The results put forward in this paper seem to indicate that these self-employed workers have frequently no autonomy to change the characteristics of the goods or services they produce and they are often also poorly motivated to introduce innovations.

Nevertheless, the empirical analysis carried out here points out education – both general and specific business education programs – as the major factor explaining the innovative behavior of self-employed people. Regarding this, the paper delves into the sources through which the general education level of the self-employed people affects the innovation activities in small businesses. This effect comes mainly from two channels: the personal motiva-

tions of self-employed people and their management style. In this respect, this study shows that those self-employed people with tertiary studies (university degree or formal high professional training) are more strongly motivated towards entrepreneurship and innovation. In addition, these self-employed people with a better educational background also develop an entrepreneurially oriented style of management, undertaking different energizing initiatives which boost innovation. Moreover, taking part in courses, seminars or other educational initiatives regarding entrepreneurship, management or issues especially connected with the activity that the self-employed workers develop also appears as a highly relevant issue favoring innovation behavior.

Previous experience as an employee appears as well as a major determinant of innovation in small firms, regardless of this experience being obtained in the same or in a different sector. Furthermore, the results of this paper show that a management style which gives importance to cooperation, business planning and the control and forecasting of the firm's performance significantly favors innovation in small businesses.

Firm size (in terms of number of employees) has a significant positive effect on innovation in small businesses too. However, this factor does not seem to play a determining role. Thus, the coefficients and the odd ratios for this variable are the smallest among the statistically significant explanatory variables for innovation and this 'size' effect diminishes as the number of employees increases. The latter is shown by the negative β coefficient for the square number of employees, which is also a statistically significant variable in the model.

Finally, the external environment plays a crucial role in influencing innovation in small businesses. This factor has been introduced in this research just by means of a proxy variable related to the provincial level of per capita income. Hence, those self-employed workers in territories with high per capita income are associated with higher probabilities of being innovative. This conclusion is in line with a great part of the literature stressing the significance of the territorial dimension in innovation. However, the proxy variable used in this study is insufficient to identify the different types of spatial externalities through which the impact of this territorial dimension on innovation takes place.

Though the main determinants of product and process innovation are basically the same, there are also interesting differences regarding some influential factors which are specific for each type of innovation. Thus, personal motivations seem to matter significantly for process innovation, but have no effect on product

innovation. On the contrary, the variables regarding management practices exert a clear influence on product innovation, but are not relevant as determinants of process innovation. In addition, the firm's dependency on the most important client and/or supplier diminishes the probability of product innovations, but is irrelevant for process innovation. Likewise, the results indicate that the factors determining innovation in small businesses vary substantially across sectors.

These results have direct implications for SME policy, specifically, for those actions aiming at stimulating innovation in small businesses. In this respect, in accordance with the conclusions put forward here, efforts to improve the educational background of self-employed people might increase innovation and favor an entrepreneurial orientation in small businesses. This applies to general education, but also to specific business education programs. Moreover, when specific incentives for innovation are introduced, it is convenient to concentrate them on those self-employed with previous work experience, and with a strong intrinsic or extrinsic motivation (but not target the necessity-driven entrepreneurs). In addition, actions aiming at fostering innovation in small businesses should be designed specifically for each sector, taking into account the key factors conditioning innovation in each activity.

As mentioned before, a more thorough analysis of the external environment's influence on innovation activities in small businesses could be one possible extension of the analytical framework proposed in this paper. Also a more precise delimitation of different types of innovation might lead to relevant conclusions. In this respect, when considering product innovation, it could be interesting to differentiate between radical, incremental and small improvements in the firm's products. Similarly, regarding process innovation, it could be revealing to investigate the specific factors influencing this being radical, incremental or the mere adaptation or incorporation of existing technologies. Moreover, it could be interesting to distinguish between process innovations in the production, marketing, logistics, human resources or other functional areas of firm management.

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Appendix A. Correlation matrix

Variables	prod_inn	proc_inn	both_inn	Emp	emp_2	ford_dep	back_dep	prov_inc	ter_edu	bus_edu
prod_inn	1									
proc_inn	0.587***	1								
both_inn	0.856***	0.754***	1							
emp	0.189***	0.183***	0.206***	1						
emp_2	0.014	0.004	0.018	0.809***	1					
ford_dep	−0.103***	−0.055	−0.091**	−0.012	0.000	1				
back_dep	−0.124***	−0.066	−0.121***	−0.109***	−0.039	0.073**	1			
prov_inc	0.248***	0.306***	0.292***	0.264***	0.088**	−0.013	−0.095***	1		
ter_edu	0.221***	0.209***	0.235***	0.150***	0.056	0.022	−0.156***	0.169***	1	
bus_edu	0.285***	0.260***	0.269***	0.133***	0.053	0.017	−0.100***	0.257***	0.319***	1
exp	0.134***	0.135***	0.146***	0.037	0.029	−0.098***	−0.028	−0.011	0.076**	0.074**
int_mot	0.162***	0.205***	0.224***	0.157***	0.035	0.078**	−0.030	0.024	2.272***	0.207***
ext_mot	0.105***	0.167***	0.168***	0.142***	0.045	0.037	−0.021	−0.034	0.084**	0.066
nec_mot	−0.170***	−0.110***	−0.198***	−0.121***	−0.021	0.033	0.110***	−0.100***	−0.149***	−0.171***
coop	0.259***	0.270***	0.306***	0.215***	0.079**	0.030	−0.058	0.236***	0.288***	0.235***
manag_1	0.252***	0.216***	0.233***	0.175***	0.085**	−0.011	−0.052	0.084**	0.142***	0.307***
manag_2	0.319***	0.305***	0.330***	0.269***	0.091**	−0.022	−0.003	0.242***	0.211***	0.215***
manag_3	0.336***	0.270***	0.314***	0.207***	0.071	−0.068	−0.025	0.174***	0.205***	0.241***
manag_4	0.201***	0.253***	0.270***	0.155***	0.061	0.000	−0.004	0.119***	0.201***	0.246***
manag_5	0.121***	0.171***	0.125***	0.225***	0.097	0.102***	−0.027	0.029	0.055	0.159***
Variables	exp	int_mot	ext_mot	nec_mot	coop	manag_1	manag_2	manag_3	manag_4	manag_5
prod_inn										
proc_inn										
both_inn										
emp										
emp_2										
ford_dep										
back_dep										
prov_inc										
ter_edu										
bus_edu										
exp	1									
int_mot	−0.030	1								
ext_mot	0.055	0.381***	1							
nec_mot	−0.069	−0.178***	−0.213	1						
coop	0.118***	0.218***	0.170***	−0.161***	1					
manag_1	0.119***	0.125***	0.096	−0.140***	0.189***	1				
manag_2	0.026	0.242***	0.152***	−0.214***	0.268***	0.255***	1			
manag_3	0.133***	0.102***	0.156***	−0.137***	0.228***	0.196***	0.491***	1		
manag_4	0.090**	0.199	0.146***	−0.148***	0.277***	0.278***	0.394***	0.364***	1	
manag_5	−0.024	0.127***	0.055	−0.109***	0.110***	0.255***	0.286***	0.174***	0.309***	1

** Significant correlations at 0.05 level.

*** Significant correlations at 0.01 level.

Appendix B. Odds ratio (expβ) for model 4 (overall and sectoral results).

	prod_inn	proc_inn	both_inn	both_inn		
	All sectors			Industry	Knowledge-intensive services	Trade and rest of services
bus_edu	1.867	1.540	1.595	0.777	2.097	3.581
exp	1.610	1.767	1.885	1.238	2.203	2.058
emp	1.122	1.125	1.104	1.119	1.286	1.388
emp_2	0.998	0.997	0.998	0.998	0.985	0.972
ford_dep	0.825	0.899	0.827	0.815	0.965	0.727
back_dep	0.901	0.990	0.908	0.822	0.935	0.947
prov_inc	1.575	2.565	2.171	1.579	0.861	7.903
int_mot	1.041	1.105	1.133	1.014	0.999	1.323
ext_mot	0.987	1.103	1.054	1.213	1.193	0.879
nec_mot	0.955	1.045	0.928	0.922	1.035	0.903
coop	1.459	1.488	1.834	2.553	1.002	3.055
manag_1	1.597	1.355	1.390	1.004	1.645	1.466
manag_2	1.463	1.370	1.481	1.713	1.848	0.995
manag_3	2.210	1.368	2.025	2.922	1.442	2.280
manag_4	1.547	1.336	1.449	1.772	1.881	1.196
manag_5	0.814	1.294	0.930	0.811	1.048	1.023
constant	0.088	0.034	0.025	0.038	0.017	0.006

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