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Bivariate Probit Models for Analysing how "Knowledge" Affects Innovation and Performance in Small and Medium Sized Firms

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Discussion Paper 120

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Abstract

This paper examines the determinants of innovation and its effects on small- and medium-sized firms We use the data from the OPIS databank, which provides a survey on a representative sample of firms from a province of the Southern Italy. We want to study whether small and medium sized firms can have a competitive advantage using their innovative capabilities, regardless of their sectoral and size limits. The main factor influencing the likelihood of innovation is knowledge, which is acquired through different ways. The econometric methodology consists of two bivariate models in order to estimate the probability of increased sales conditioned to the probability of innovation. We found that knowledge positively influences the probability of innovation; at the same time, knowledge has also a positive indirect effect on the increase of sales through innovation.

Keywords: innovation, small and medium sized firms, human capital, networks, bivariate probit

JEL Classification: O31; L1; C24; C25

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Introduction

Innovation is an important argument in economic theory; previous researchers have focused on the determinants and the effects of innovation, which is usually expected to generate a competitive advantage in the innovating firms and to boost the dynamism of the sectors the firms belong to (Schumpeter, 1934; Nelson, Winter 1982; Dosi 1988; Freeman and Soete 1987). Driven by the same interest of the relevant literature, in this paper we examine what influences innovation. The dominant literature links innovation mainly to technological sectors and to bigger firms; instead we concentrate the analysis on small and medium sized firms (SMEs) in traditional sectors.

To provide evidence on innovation in SMEs we accept from the literature a wider definition of innovation (Schumpeter, 1934; Baregheh et al, 2009) and new determinants, that are most relevant to the economic system characterized by SMEs. According to this approach, innovation consists of new ideas that create an advantage for the firm (Rogers, 1998).

Prior scholars note that the origins of innovation lie in a firm's ability to acquire and manage existing and new knowledge (Cohen, Levinthal 1989; Waarts et al. 2002).

The knowledge based view (Grant, 1996; Hodgson, 1997) assumes that knowledge "is the critical input in production and primary source of value (Grant, 1996 p. 112) and most explicit and all tacit knowledge is stored within individuals (Grant, 1996 p. 111). There is not a unanimous definition of knowledge, but many agree that it is related to human capital (Grant, 1996; Hodgson, 1998; Prahalad, Hamel, 1990).

To this extent it is crucial how individuals integrate themselves in order to exploit knowledge within the firm. Due to the high cost of coordinating knowledge dispersed among individuals (Hodgson, 1997) the capability to exploit knowledge of the firm are closely related to the skills of their founder/entrepreneur (Colombo, Grilli, 1995).

The theory of industrial districts and the new economic geography (Becattini, 1989; Krugman, 1995), underline the importance of networks and socio-economic relations in defined territories in spreading knowledge among firms. Thus the creation of knowledge and the adoption of innovation depends also on the relations the firm has with the outside world; Cohen, Levinthal (1989) tested the effects of the relations with competitors, while Waarts et al (2002) studied the case of the relations with the suppliers.

Thus knowledge (and then innovation) is linked to the manner in which the firms are organised, interact among themselves and internally circulate ideas and information.

Starting form this literature we analyze the relation between knowledge and innovation. We use as proxies for knowledge human capital of the entrepreneur[1] and employees within the firm, and also internal and external networks.

This definition of innovation allows us to broaden its sources and overcome the limitations in R&D expenditures and other traditional indicators that have hindered previous efforts to investigate the innovation potential of SMEs.

Another frequent discussion point refers to the results of innovation. Many scholars attempted to investigate the effects of innovation and the role of technology within firms. The results of their studies are generally positive (Griliches 1995; Hall, Mairesse 1995; Loof, Heshmati 2001).

We thus investigate the results of the introduction of innovation in terms of a better performance of the firm measured in terms of an increase in the revenues. On the other side an increase in performance of the firms has a positive impact on the probability to innovate.

We are able to make these investigations thanks to an ad hoc survey that investigates small and medium firms from the province of Salerno in Southern Italy (OPIS[2] database).

[1] Because we analyse small and medium sized firms, we do not distinguish between management and ownership, as the manager and the owner are almost always the same person.

Specifically, we utilised a survey on a sample of 469 manufacturing firms from the province of Salerno (Italy) and interviewed during the 1998-1999[3]. The sample is representative at both the territorial and sectoral level[4]. The questionnaire has nine sections and approximately 200 questions that cover all aspects of each firm (Coppola, Farace, Giordano, Mazzotta, 1999)
From an empirical view we use two bivariate probit model to estimate the probability of increased sales and the probability of innovate, taking in account the correlation or the link between them.
The paper is organised as follows. Section 1 defines the innovation and knowledge as principal determinants of the innovation. In section 2 we outline the theoretical framework. Section 3 follows with a description of data, variables and the econometric model that we propose to use in analyzing innovation and performance in SMEs. In Section 4, we present and discuss the empirical outcomes of the econometric estimates. Finally, Section 5 concludes the paper by summarising the main findings.

1. Definition of innovation and the determinants of knowledge

One of the primary problems is the definition of innovation. Schumpeter (1934) defined five types of innovation: new product, new process, new market, new source of raw materials, and a change in the industrial organization. More recently, one of the most commonly adopted definition of innovation provided by the OECD in the "Oslo Manual" defines two types of innovation: product and process. Product innovation occurs if a firm introduces a new or improved product that differs from the previous generations of the product. Process innovation can result in "new or significantly improved production methods, including methods of product delivery" (OECD 1997 p.49). However, innovation remains complex because even though it "is studied in many disciplines and has been defined from many perspectives" (Damanpour, Schneider 2006, p. 216), a consensual definition of innovation still does not exist (Baregheh et al. 2009).
Because "the term innovation is notoriously ambiguous and lacks either a single definition or measure" (Adams et al. 2006, p. 22) and because many definitions exist, we approach this problem from a more general perspective and define innovation as new ideas that are introduced in the firm in many ways and that allow the firm to get an advantage (Rogers, 1998).
An important aspect of this approach is that innovation is something new or an improvement that applies to a firm; consequently if innovation is adopted at firm level, it should be studied and analysed at that level. In other word something that is "new" for the firm could be "not new" for the sector, but in our approach it is always an innovation.
Additionally, innovations often assume different forms depending on the size of the innovating firms. Bigger firms usually have more financial resources, a better codified organisation and a R&D department/function. Oftentimes, larger firms use their market power to increase the advantages of their superior innovative capacities. At the same time, these firms innovate to maintain and/or increase their market power. As a result, the outcome of an innovation activity in a large firm is usually a product innovation (Mansfield, 1981; Pavitt et al., 1987; Dorfman, 1987).

[2] The OPIS project (Permanent Observatory on Enterprises in the province of Salerno) consists of the implementation and empirical application of a statistical methodology used to analyse an economic system characterized mainly by the presence of small- and medium-sized enterprises (SMEs) in a province in Southern Italy.
[3] We exclude the firms which introduced innovations more than six years before the survey.
[4] The OPIS dataset adopts a weighting procedure that relates the sample of the interviewed firms to the entire population (i.e., the firms from the province of Salerno). The weight in OPIS indicates the inverse of the probability that the observation is sampled.

Small firms suffer from limited financial resources and an inability to diversify their risks. Consequently, these firms usually prefer to acquire technologies embodied in new machinery. For small firms, technology acquisition (TA) is the primary source of innovation, and their innovation activities usually generate process innovations (Freeman, 1982; Freeman, Soete 1987; Conte, Vivarelli, 2005). Thus, small firms usually acquire technologies that are compatible with their organisation rather than risk investing in research programs whose expected results carry a considerable risk of failure.

There are similar results when we consider innovation at the sectorial level. Firms within traditional sectors often generate process innovations by acquiring new machinery and the technologies embodied in this machinery. In high-technology sectors, the firms invest more resources into research programs and activities and frequently generate product innovations (Pavitt, 1984). Because high-technology sectors are generally more dynamic, these sectors are considered more innovative than others (Pavitt, 1984; Freeman 1982).

Other types of innovation in addition to process and product innovations are also important (Schumpeter, 1934), such as, organisational or managerial innovations that refer to new and improved organisational and management-related strategies (OECD 1997). Innovation can be seen also as new form of organisation or a better way to manage the company; besides organizational/managerial innovation, which can be described as a better configuration of a company's existing structure, is related to entrepreneur's level of education (Colombo, Grilli 2005; Prahalad, Hamel 1990) much more than a process and product innovations.

In our survey, we decided to adopt a wider definition of innovation; together with product and process we asked for a third one that refers top all changes the firm introduced in organization and management[5]. It is important to underline that innovation is something new that allows an advantage for the firm, so that we look at the expected result of innovation in terms of a bigger competitiveness.

All types of innovation are difficult to measure, as finding a univocal set of parameters that can measure innovation or the innovative capabilities of firms is a challenging task[6]. One possible strategy is to use the result(s) of innovation as a proxy for the innovation capabilities of firms because the definition of innovation implies that new ideas create value for the firm (Rogers, 1998). Hence, it is possible to join together the definition of innovation and its results since two are strictly interrelated.

Some scholars have underlined the importance of information related to research activities. These researchers have argued that "R&D not only generates new information, but also enhances the firm's ability to assimilate and exploit existing information" and that innovation depends on "the firms' ability to identify, assimilate and exploit knowledge from the environment - what we call a firm's 'learning' or 'absorptive' capacity". (Cohen, Levinthal, 1989 p. 569).

With an absorptive capacity a firm may acquire outside knowledge and R&D activities enable firms to develop this ability. R&D plays a key role because it allows firms to develop a capability to manage information such that the firms can obtain advantages from information both inside and outside them. In this case, the firm's process of knowledge formation is based on the firm's prior acquisition of knowledge according to a cumulative process.

Although this assumption is generally true, such an approach captures only a part of the phenomenon, especially in those territories in which SMEs are predominant and in which the firms specialise in traditional and, thus, less innovative industries. Starting from

[5] The questionnaire provides also a brief description of the innovation the firm introduced.

[6] Different indicators are used to measure innovation. These measures are classified as input and output indicators. The first group (i.e., R&D expenses, R&D employees, and TA measures) measures a firm's innovative effort, whereas the second group (i.e., patents, trademarks, and others) measures the results. Both types of indicators have some limits (see OECD, 1989).

existing literature (Grant, 1996; Hodgson, 1998) we argue that in particular for SMEs the firm's ability to obtain and exploit information not only depends on the firm's R&D activities but is also positively linked to the firm's human capital, coordination with the firm. Furthermore the relations inside and outside the firm are another important source of knowledge (Becattini, 1989; Becattini et al, 2009).
We underline the role of networks in enabling a firm to develop new knowledge and to exploit its existing knowledge in a different and more efficient manner. More generally, a firm attempts to acquire knowledge from all possible sources. These sources may vary from one firm to another, especially if the firms' size or sectors are different.
At the end, a firm may derive knowledge from its workers, suppliers and competitors.

2. The theoretical framework

As Grant (1996) points out knowledge is a critical input in production and a primary source of value, and we think that in SMEs knowledge is strategic for the introduction of innovation.
The larger the stock of knowledge is, the higher the probability that the firm will innovate.
Firms can innovate in many different ways. In addition to acquiring the technologies embodied in new machinery in order to generate process innovations, small firms can play a strategic role by collecting information, interpreting this information, increasing their knowledge and introducing new and better ways to do things.
Following Adams et al (2006) and Gibbons et al (1994), we broaden the boundaries of innovation and we consider three types of innovation:

- product
- process
- organizational/managerial

The first two types of innovation are categories well known in the prevailing literature (Schumpeter, 1934; OECD, 1997), changes in organisation and management are relatively rare. We approach organisational and management innovation in order to complete and wider the definition of innovation by considering improvements in existing routines and activities so that at the end the firm gets an advantage. Changes in organisation and/or management involve the same product/process than before, while the firm does those things "better" than before, thanks those changes.
This implies an improvement which at the end represent and advantage to the firm[7]. So the category organisation and management innovation is often not related with technology that usually characterizes new product/process; we are aware of changes in organisation and management because we also look at their results in terms of performance.
On the other side, we accept the definition of innovation that looks at the firm; innovation is thus something new introduced in the firm (OECD, 1997; Rogers, 1998). At the end the firm can use a technology (or produce a new product) that is already used (produced) by other firms but that is new for the first one.
Defining a firm's stock of knowledge at any given period can be difficult, as knowledge can be acquired through a variety of methods. In our framework, there are three main sources of knowledge within a firm (See Figure 1):

[7] We are able to study organisational and management innovation thanks to the survey and the structure of the questionnaire in which, in the section that refers to innovation, we specifically questioned the firm about that.

- Technology (Cohen, Levinthal, 1989)
- Human capital (Grant, 1996; Hodgson, 1998)
- Networks (Becattini, 1989; Becattini et al, 2009)

When we refer to human capital, we consider the entrepreneur's[8] and the employees' educational levels and previous experiences. The entrepreneur's level of education and competence open his or her mind to the importance of human capital and the experiences of his or her workers, whose participation in the firm's strategy should be welcomed and encouraged.
Thus, human capital is an important source of knowledge for SMEs. The role of human capital is also important because human capital leads firms to construct internal networks such that the relation between the owners/entrepreneurs and the workers is reinforced. By doing so, the firm develops greater opportunities to build its knowledge (Grant, 1996).
Furthermore, a firm's stock of knowledge is contingent on the availability of information, which, in turn, depends on the relationships and the networks that the firm, whether big or small, has established both within the firm and with the outside world.

[8] See note 1.

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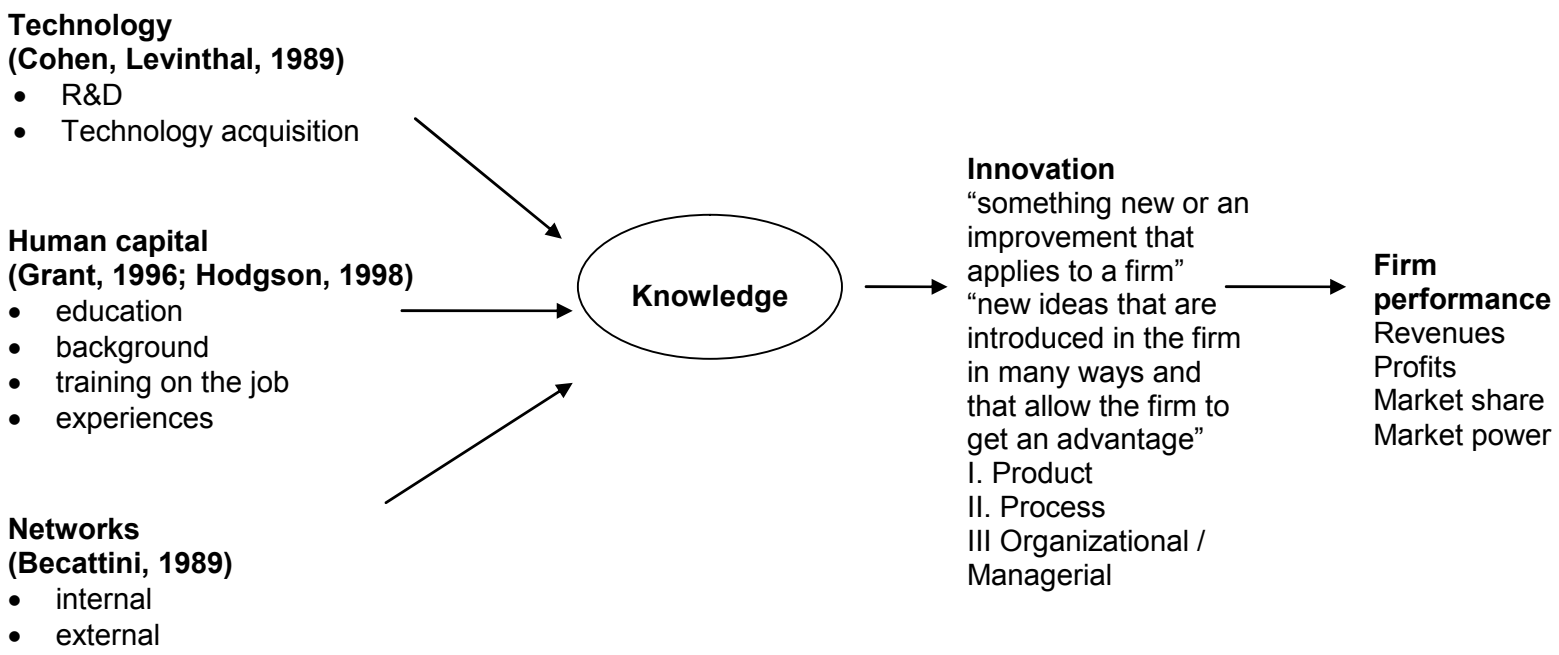

Figure 1 – A framework of the innovative capability of the firms

This approach underlines the positive role played by networks, which can be both formal and informal, in the innovation process. In the case of a big firm, these relationships mainly exist between the firm and the scientific world (e.g., universities and research centres). In the case of small or medium sized firms, the network is mainly informal and involves the firm's links to the surrounding environment. These types of networks generally produce positive externalities à la Marshall (Becattini, 1989; Audretsch, Feldman, 1999) and sometimes involve industrial districts (Jacobs, 1969; Sforzi, 1995; Becattini, 1989; Becattini et al, 2009).
The networks utilised by small and medium sized firms have different origins and can relate to the firms' relationships with various actors, such as suppliers, buyers, and customers. A firm's links to other social and economic networks can help the firm to resolve strategic issues during the innovation process.
Another important network is the one inside the firm. In some cases, the entrepreneur continually interacts with his or her employees. As a result, if these employees participate in the firm's strategic decisions, then they may enhance the firm's stock of knowledge and thereby facilitate innovation.
Looking at the expected results of innovation, we find that innovation enhances the firms' competitiveness and, thus, induces better firm performances. We can measure the improvements in the firms' performances in many different ways, such as increased revenues, profits, market share and market power. In any case, innovation and its effects are interrelated and it's impossible to deny a reciprocal correlation: the better performances of the firms depend on innovation and also the innovation activity may depends on the actual or expected performances.
Our theoretical model could be synthesized as follow:

$$FATT = f(INN, T, H, N) \qquad [1]$$

$$INN = g(FATT, T, H, N) \qquad [2]$$

Where INN is the innovation, FATT is a measure of better performance of the firms, T technology, H human capital and N networks. We expect that all these variables positively influence both the propensity of innovation and a good performance of the firms, through the positive link with the knowledge.
Based on the literature and in order to verify our assumption, we considered three groups of variables:

1) firm-specific characteristics;

2) entrepreneur-specific characteristics;

3) network characteristics.

The first group refers to the firm and includes useful variables for keeping the effect of traditional determinants of the propensity for being innovative as: dimension of firms in number of employees; the sector (according to the ATECO classification); the age of the firm; information related to the founder and the dynamism of the firms measured in terms of whether the firm sells products to the local, regional, national, or international markets and whether the firm has conducted professional training activities in the last three years.
The second group of variables allows us to define knowledge linked to the cultural background of the entrepreneur/owner. The variables in this group consist of the following: the entrepreneur's level of education, age, former occupation before starting the firm, and number of experiences working as an entrepreneur.
The third group considers the firm's relationship to the external environment. We analyse this relationship from multiple perspectives. On the one hand, we consider whether the firm is participating in a consortium or has other relationships with other firms. On the other hand, we analyse the firm's general relationship with its surrounding environment (external networks). Besides we consider the workers' participation in the firm's strategic decision-making process. We aim to determine whether the firm has a much broader relationship with the territory in different ways, to identify the level of this relation and

ascertain whether the firm can obtain new knowledge through this relation (internal networks).

3. Datasets and explanatory variables

3.1 Description of datasets

The data used in this study comes from the OPIS[9] database, a survey on a sample of 469 manufacturing firms from the province of Salerno (Italy) and interviewed during the 1998/1999 with a face to face technique[10]. The sample is significant at both the territorial and sectoral level. The questionnaire has nine sections and approximately 200 questions that cover all aspects of each firm (Coppola, Farace, Giordano, Mazzotta, 1999). The first section describes the factors influencing the birth of the firm and the firm's life in general. There is also information about the firm owner's previous occupation and her/his level of education. An important section was devoted to collecting information on the type (i.e., process, product and organizational/managerial) and the timing of the firm's innovations, their effectiveness and the sources through which the firm acquires information on the innovations. The subsequent sections analysed some managerial aspects, such as the markets in which the firms purchase and sell goods. Additionally, the survey examined each firm's number of workers, social environment, and relations with not only the local community but also other enterprises in the area. One specific section of the questionnaire was called "innovation", in which we point out all the activities, conditions and results of the firms' innovations (Coppola et al 1999).
Our sample[11] is composed of 415 firms and preliminary descriptive statistics show that the average size of the firms in the Province of Salerno is quite small (9.54 employees). The 42.76% (196 firms) of the firms in our sample introduce at least one innovation. Of these innovations, the majority are process innovations (61.88%).

Innovation	N. 415
	%
No	57.24.
Yes	42.76
Total	100.00

Table 1 - Innovation Frequencies
Source: Own elaborations using OPIS data

Type of Innovation	N. 177
	%
Product Innovation	49.05
Process Innovation	61.88
Organizational/Managerial Innovation	15.78

Table 2 - Type of innovation
Source: Own elaborations using OPIS data

[9] See note 2.
[10] We exclude the firms which introduced innovations more than six years before the survey.
[11] These firms are not missing with respect to the variables used in this study.

Among the innovative firms the 43.4% gains an increase of sales during the last three years. Among the firms not innovative the percentage of the firms that increase their sales is of only 26.9%.

Innovation	Increased sales		Total	
	Yes	No		Conditional probability
Yes	85 20.5%	111 26.7%	196 47.2%	43.4% (FATT=1|INN=1)
No	59 14.2%	160 38.6%	219 52.8%	26.9% (FATT=1|INN=0)
Total	144 34.7%	271 65.3%	415 100.0%	
Conditional probability	59.0%	41.0%		
	(INN=1|FATT=1)	(INN=1|FATT=0)		

Table 3 - Relative frequencies of increased sales while introducing or not innovation process according to the OPIS database, in the Province of Salerno
Source: Own elaborations using OPIS data

In the sample (Tab 4), most of all firms (i.e., more than 60 percent) operate in the traditional sector, the one of the “supplier dominated” according to Pavitt’s taxonomy. In addition, most of the firms are founded by the actual owner approximately 21 years before the survey, have links to the local area, produce goods for a final market, have 9 employees on average. Innovative firms are bigger than the average since they have usually more employees than other firms (16.45 number of employees).

Dependent Variables	Mean Entire sample (n. 415)	Mean Innovative firms (n. 196)	Mean Firms with increased sales (n. 144)
Innovation (Yes 1/0)	42.75%	100.00%	55.46%
N. innovation	0.701	1.64	0.95
Market Performance (increased sales) (Yes 1/0)	32.80%	42.54%	100.00%
Characteristics of the firms			
Legal Form			
Sole proprietorship (Yes 1/0)	50.3%	30.35%	40.27%
Private company (Yes 1/0) $	49.7%	69.65%	
Pavitt Sector			
Science-based sectors/firms (Yes 1/0)	6.4%	6.4%	3.26%
Scale- intensive sectors/firms (Yes 1/0)	22.1%	26.8%	21.79%
Specialized equipment sectors/firms (Yes 1/0)	11.5%	12.8%	16.07%
Supplier-dominated sectors/firms (Yes 1/0) $	60.1%	54.0%	%
Economic sector			
Food, drink and tobacco industries (Yes 1/0)	22.0%	26.4%	22.57%
Textiles and leather industries (Yes 1/0)	12.6%	9.6%	9.70%
Wood and metal products industries (Yes 1/0)	24.2%	12.3%	21.9%
Manufacturers of paper pulp, paper, cardboard and paper products; printing and publishing industries (Yes 1/0)	5.4%	8.7%	5.08%
Manufacturers of chemical products and synthetic and artificial fibres and rubber (Yes 1/0)	3.1%	4.9%	2.97%
Manufacturers of products based on non-metallic minerals (Yes 1/0)	7.9%	10.0%	9.41%
Manufacturers of machinery, equipment and other products (Yes 1/0)$	24.8%	28.1%	28.37%
Dimension of the firm			
Total number of employees	9.54	16.45	14.8
Founder of the firm			
Actual owner (Yes 1/0)	70.1%	66.5%	74.45%
Previous generation (Yes 1/0)	24.0%	24.9%	20.46%
Other (Yes 1/0)$	5.9%	8.6%	5.09%
Age of the firm			
Number of years	20.70	22.08	21.9
Type of products			
Intermediate commodities (Yes 1/0)	10.6%	12.0%	9.39%
Final products (Yes 1/0)	77.7%	71.9%	71.50%
Intermediate and final products (Yes 1/0)$	11.7%	16.1%	19.11%
$ Excluded variables			

Table 4 - Descriptive statistics
(continues)

Dependent Variables	Mean Entire sample (n. 415)	Mean Innovative firms (n. 196)	Mean Firms with increased sales (n. 144
The firms also or only sell in non-local markets (Yes 1/0)	33.7%	46.2%	47.28%
Training during the last three years (Yes 1/0)	31.3%	45.3%	
Employee participation levels			
None (Yes 1/0)$	30.4%	11.5%	22.13%
High (Yes 1/0)	13.1%	19.6%	17.07%
Medium (Yes 1/0)	28.2%	34.7%	34.05%
Low (Yes 1/0)$	8.2%	10.9%	8.82%
Characteristics of the entrepreneur			
Education			
Less than upper secondary school (Yes 1/0)	42.9%	26.1%	33.38%
Upper secondary school (Yes 1/0)	43.2%	50.6%	55.89%
Tertiary school or university (Yes 1/0)$	13.9%	23.3%	10.73%
Age	43.12	42.48	41.50
Previous occupation			
Employees (Yes 1/0)	40.2%	32.7%	42.67%
Student or unemployed (Yes 1/0)$	25.8%	24.5%	25.6%
Self-employed (Yes 1/0)	5.0%	4.2%	8.0%
Entrepreneur (Yes 1/0)	27.9%	35.9%	21.5%
Other or housewife (Yes 1/0)$	1.1%	2.6%	%
Years of experience as an entrepreneur (total)	23.69	28.07	24.7
Number of employees by education level			
Less than upper secondary school	7.07	10.38	10.55
Upper secondary school	3.85	6.47	5.16
Professional school (three years)	0.46	0.52	0.26
Tertiary school or university	0.60	0.97	0.73
Network			
Consortium (Yes 1/0)	7.4%	12.1%	10.18%
Partnership (Yes 1/0)	4.3%	7.8%	4.9%
Link with the territory (Yes 1/0)	82.0%	78.0%	81.7%
Importance of link to other firms (Yes 1/0)	16.0%	22.2%	17.01%
Affiliation with a district (Yes 1/0)	29.3%	33.0%	35.62%

$ Excluded variables

Table 4 - Descriptive statistics (continued)
Source: Own elaborations using OPIS data

According to Table 5A, approximately 64.2% of the companies introduce at least one innovation. With respect to Pavitt's taxonomy, 56.3% of the scale-intensive firms have at least one innovation. With regard to the entrepreneur's educational level, 75.2% of the companies led by an entrepreneur with a tertiary/university degree are innovative and among the firms affiliated with a consortium 73. 6% have at least one innovation.
In Table 5B we can see that firms with a positive performance in the market' sales are not characterized by any of the variables considered. Only among the ones that sell both semi-finished and finished products firms that have increased sales prevail on others (56.0%).

Legal Form	**%**
Sole proprietorship (Yes 1/0)	**29.41%**
Company (Yes 1/0)	**64.18%**
Pavitt Sector	
Science-based sectors/firms (Yes 1/0)	**47.42%**
Scale-intensive sectors/firms (Yes 1/0)	**56.30%**
Specialized equipment sectors/firms (Yes 1/0)	**52.42%**
Supplier-dominated sectors/firms (Yes 1/0)	**42.78%**
Consortium	
Yes	**73,56%**
No	**45.00%**
Education	
Less than upper secondary school (Yes 1/0)	**29.64%**
Upper secondary school (Yes 1/0)	**57.78%**
Tertiary school or university (Yes 1/0)	**75.24%**

Table 5A Percentage of innovative firms by relevant characteristics

Legal Form	**%**
Sole proprietorship (Yes 1/0)	**27.88%**
Company (Yes 1/0)	**41.55%**
Pavitt Sector	
Science-based sectors/firms (Yes 1/0)	**18.52%**
Scale- intensive sectors/firms (Yes 1/0)	**34.07%**
Specialized equipment sectors/firms (Yes 1/0)	**47.92%**
Supplier-dominated sectors/firms (Yes 1/0)	**34.14%**
Consortium	
Yes	**33.59%**
No	**48.39%**
Education	
Less than upper secondary school (Yes 1/0)	**27.12%**
Upper secondary school (Yes 1/0)	**44.44%**
Tertiary school or university (Yes 1/0)	**26.32%**
Also or only sells in non-local markets	
No	**27.47%**
Yes	**48.23%**
Producer of intermediate commodities and final products	
No	**40.00%**
Yes	**56.00%**

Table 5B Percentage of firms with increased sales by relevant characteristics
Source: Own elaborations using OPIS data

When we examine the mean of the number of innovations (Table 6), we see that the science-based companies generate the highest number of innovations. In addition, we find that the higher is the mean of the number of innovations, the higher the owner's educational level.

Legal Form	**Mean**
Sole proprietorship (Yes 1/0)	1.409
Company (Yes 1/0)	1.734
Pavitt Sector	
Science-based sectors/firms (Yes 1/0)	2.360
Scale-intensive sectors/firms (Yes 1/0)	1.662
Specialized equipment sectors/firms (Yes 1/0)	1.483
Supplier-dominated sectors/firms (Yes 1/0)	0.572
Consortium	
Yes	1.604
No	1.861
Education	
Less than upper secondary school (Yes 1/0)	1.364
Upper secondary school (Yes 1/0)	1.728
Tertiary school or university (Yes 1/0)	1.738

Table 6 Number of innovations (mean) by relevant characteristics
Source: Own elaborations using OPIS data

3.2 Econometric models and explanatory variables

As indicated in the theoretical framework, we want to analyse the relation between some determinants of "knowledge", the decision to innovate and the improvements in the firms' performances. A good performance of the firms depends from innovation and, through it, from the "knowledge", but depends from the determinants of "knowledge" directly even if we net out the effect of innovation. Then is important in order to separate the results of innovation from its determinants on the economic performance of SMEs. For instance some economic factors (such as education) could significantly influence the probability of innovation and could influence "indirectly" through the innovation the likelihood of increased sales. At the same time the level of education can also influence "directly" by itself the probability to increased sales and these effects (direct and indirect could go in different directions). Finally it is impossible to deny that innovation is correlated to the actual or expected performance of the firm.
Therefore, the best model should be one that considers the correlation between market trends and the introduction of innovations. The econometric model should be a structural model containing one equations for innovation and one for performance of firm:

$$FATT^* = \alpha_1 INN^* + X_1\beta_1 + e_1 \qquad [3]$$

$$INN^* = \alpha_2 FATT^* + X_2\beta_2 + e_2 \qquad [4]$$

FATT* and INN* are endogenous latent variables reflecting respectively the firms's propensity for increasing sales and for being innovative. FATT* and INN* are simultaneously determined. X1 includes the covariates usually found as determinants of sales increase and X2 includes the covariates usually found as determinants of propensity to innovate (i.e., firm characteristics, entrepreneur characteristics and network characteristics). Note the underlying latent structural variables in the two equation and not the observed binary variables. This model is identified and it can be consistently estimated with a two step methods but it's hard to interpret (Greene, 1998; Maddala,

1983). Therefore we decide to follow two alternatives strategies. The first is to estimate the reduced-form of equations [3] and [4], that is:

$$FATT = X_1\Pi_1 + u_1 \qquad [3a]$$

$$INN = X_2\Pi_2 + u_2 \qquad [4a]$$

FATT =1 if the firm's sales increase during the last three years in at least one of its sales markets and 0 otherwise.
INN =1 if the firm introduces at least one innovation during the last six years and 0 otherwise.
Where X1 and X2 contain all the exogenous variables [12].
We estimate equations [3a] and [4a] by using standard bivariate probit techniques, as shown by the following:

$$y_j = \begin{cases} 1 \quad if \quad y_j^* > 0 \\ 0 \quad if \quad y_j^* \le 0 \end{cases}$$

where j=1, 2 and reduced–form disturbance covariance Cov $(u_1, u_2) \neq 0$. To verify whether the two outcomes are really correlated, we test the significance of ρ, which represents the correlation between the errors in the two probit models. The dependent variables are INN and FATT[13].
The second empirical strategies consist of consider two equation in which the endogenous "innovation" (INN) variable is among the explanatory variable in the "increased sales" (FATT) equation. On the other hand, "increased sales" does not appear in the "innovation" equation. Hence a recursive simultaneous equation model (Maddala, 1983; Holly et al., 1998; Greene, 2003) is obtained. The "innovation" equation is modelled as reduced-form equation instead the "increased sales" is a structural equation with the innovation variable as explanatory variable, then we can call this model a semi-structural model:

$$FATT^* = \alpha_1 INN + X_1\beta_1 + e_1 \qquad [5]$$

$$INN^* = X_2\beta_2 + e_2 \qquad [6]$$

This model is identified and it can be consistently and efficiently estimated by full information maximum likelihood (FIML) estimation treated as a bivariate probit model, ignoring the simultaneity (Greene, 2003). The estimated equations are:

$$FATT = \alpha_1 INN + X_1\Pi_1 + u_1 \qquad [5a]$$

$$INN = X_2\Pi_2 + u_2 \qquad [6a]$$

[12] We can use the same independent variables in each probit model. Additionally, we can estimate a seemingly unrelated version of the bivariate probit model by using two different independent variables. We choose this second option. We include the legal form variable in our estimated probability of innovation, but we exclude this variable from our estimated probability of increased sales.
[13] Another model may consider the potential endogeneity of the innovation variables. Instead of analysing a biunivocal relation between the two probabilities (i.e., innovation and increased sales), this model may consider the direct dependency of the probability of increased sales (FATT) on the probability of innovation (INN). The potential endogeneity of innovation could be a choice variable that is correlated with unobservables relegated to the error term. For this analysis, we used a probit model with dummy endogenous variables or a probit regression model with endogenous switching (Heckman, 1978; Miranda, Rabe-Hesketh, 2006). The results of this model were not convincing. This model was not stable and presents difficulties in the convergences.

The estimation of a recursive multivariate probit model requires some consideration for the identification of the model parameters. Maddala (cf. 1983, p. 123) shows that at least one of the reduced-form exogenous variables is not included in the structural equations as explanatory variables. Wilde (2000) states that Maddala concentrates on the special case where the constant terms are only exogenous variables and that the suggestion is valid only for this case. Consequently, the parameters of the model are identified if there exists at least one varying exogenous regressor. According to Wilde, there is sufficient variation in the data to identify the parameters even in this simple case. In our model, we follow the Maddala approach and impose exclusion restrictions. All exclusions were decided by first including the variables in both equations and omitting then from the equation(s) in which they were insignificant. We decide to include the legal form of the firm and the professional training variables in our estimated probability of innovation, but we exclude these variables from our estimated probability of increased sales. These two exclusions can also be justified theoretically because the legal form and the training activities can influence the increasing sales indirectly through the innovation process.
About the dependent variables, in our questionnaire, we acquired information on the firms' revenues over the last three years[14]. We think this can be a good proxy for the actual and expected performance in the market sales and the innovations introduced over the last six years[15]; then it is impossible to exclude a reciprocal link or dependence of the probability to innovate and the firms' revenues.
The explanatory variables we use in our empirical model can be divided into three groups:

1) Firm-specific characteristics:
- Legal form;
- Economic sector;
- Total number of employees;
- Founder of the firm;
- Age of the firms (i.e., the number of years since the firm's inception);
- Firms' output (i.e., intermediate products, final products or both);
- Firms' market (i.e., local markets, non-local markets, or both[16]);
- Training activities during the last three years.

2) Entrepreneur-specific characteristics:
- Highest educational level of the owner/entrepreneur[17];
- Owner's age (average age if we have more than one owner/entrepreneur);
- Owner's previous occupation[18];
- Years of experience as an entrepreneur (the sum of experience's if we have more than one owner/entrepreneur).

3) Network characteristics:
- Degree of Workers' participation in a firm's decisions;
- Educational levels of the workers;
- Affiliation with a consortium or other corporate link;
- Sense of belonging to the local community;

[14] The revenues concern sales of both final products and intermediate commodities.
[15] The question in the questionnaire is: The interviewer (entrepreneur or other managing director) may indicate up to 3 innovations introduced during the life of the firm? For innovation we mean any change that the company introduced independently from their results.
[16] The local markets in our study are the province of Salerno, the Campania region and the South of Italy.
[17] If there is more than one entrepreneur, then we consider the highest level of education among the entrepreneurs.
[18] If we have more than one entrepreneur/partner we consider the prevalently (more frequent) activity among them. If there isn't a prevalently activities we consider the previous activities of the first partner.

- Importance of the firm's relationships with other firms in the area;
- Affiliation with a district area[19].

We decide to impute the missing values of the following fundamental variables: the year of the firm's inception, the founder of the firm, the degree to which the employees participate in the firm's decision-making process and the employees' educational levels. The variables used for the imputation are the firm's legal form, the firm's economic sector and whether the firm has produced at least one innovation.
We use the Imputation by Chained Equations (ICE) approach, which is based on each variable's conditional density given the presence of other variables. We include the variables to be imputed and those to be used only for the purpose of imputing other variables (Royston, 2009; Royston, Carlin, White, 2009).

4. The results

By examining table 7 and table 8, we determine the probability that a firm will innovate and the probability of increased sales. We consider three models:

I) First, we estimate the simple univariate probit model, without control for the correlation or simultaneity;
II) Second, we estimated the reduced form equations with the bivariate probit model
III) Third, we estimate a semi-structural model with a recursive simultaneous equation model[20].

To check the robustness of the results, in the second specification we try to excludes some variables that can be correlated with the entrepreneur's education level as: owner's previous occupation, years of experience as an entrepreneur and economic sector of the firm.
With regard the estimates of ρ, its values is positive (+ 0.21) in the reduced – form model (II) and negative in the semi- structural model (III) (-0.64) (table 7 and 8) and it is significant then the null hypothesis that $\rho=0$ is rejected. We are reassured that our recursive model provides more reliable than a single equation model. The negative ρ estimate which, at first, seems counter-intuitive given that the coefficient on innovation is positive, is in fact of the expected sign.
It implies that once "innovativeness" is controlled for in Equation 1 (*FATT)* unobserved characteristics that make a firm more likely to increase sales, also make them less likely or "necessary" to introduce innovation. We think that the best model is the recursive bivariate model because it is more informative (provides direct and indirect effects) but there aren't great differences in the results of the three models.

[19] This Industrial District (ID) includes 15 municipalities from the Province of Salerno: Angri; Baronissi; Bracigliano; Castel San Giorgio; Mercato San Severino; Nocera Inferiore; Nocera Superiore; Pagani; Roccapiemonte; San Marzano sul Sarno; San Valentino Torio; Sant'Egidio del Monte Albino; Sarno; Scafati; Tramonti.. The ID specialises in tomatoes production of other canned foods.
[20] In the recursive bivariate probit model, the computation of marginal effects is complicated by the fact that the explanatory variables appearing in the equation for the endogenous dummy have an indirect effect (through the endogenous dummy) on the outcome of the primary interest as well as a direct effect if they also appear in the first equation. The marginal effects in these paper are building following the formula in Greene (1998) modified in Baslevent and El-hamidi (2009). We highlight that the formulation of marginal effect could be applied to binary explanatory variables especially if we are is interested in decomposing the total effect into its direct and indirect components. However a more accurate definition for total marginal effect of binary could be applied and it's an impact difference effect of the binary variable (1/0) on the joint probability. We report the marginal effect that can be considered the derivative of the joint probability respect to the an explanatory variables. The effect of introduce an innovation can be evaluated by the difference between the conditional probabilities of increased sales when innovation is introduced or not. Another way to evaluate the influence of innovation is by calculating its effect on the probability of the marginal distribution. (Kassouf, Hoffmann, 2005).

With regard to the estimates of the probability of innovation (table 7) the variables that are statistically significant for all of the specifications are the following: the economic sector, where the wood and metal products industries have lower probabilities of innovations (-23 percentage points), while increases by 24 percentage points for the manufacturers operating in the paper, printing and publishing industries in comparison with the manufacturers of machinery, equipment and other products.
Because printers and lithographers have to constantly adopt new technologies aimed at improving the quality of their products (e.g., multimedia printing), the paper, printing and manufacturing companies are highly innovative. As predicted by the traditional models, the probability of innovation increases as the size of the firms increase. This result is confirmed by the sign and the significance of the coefficient of the number of employees who have less than secondary school. This result is caused by a strong positive relation between innovation and the dimensions of the firms; we consider the number of low educated workers as a proxy for the dimensions of the firms.
Furthermore, our hypothesis of the positive link between firm's knowledge, which was measured by the educational level, experiences and networks (Destefanis, 2001), and firm innovation is confirmed because the probability of innovation increases if the firm is led by an entrepreneur with a high education level (+26.1), if the firm invests in professional training (+18.4), if the previous occupation of the entrepreneur was being an entrepreneur (+15.6) and if the firm's workers participate in the firm's decision-making process to a high degree (+20.4). The networks external to the firm are irrelevant to the firm's probability of innovation.

	Univariate probit (I model)				Recursive bivariate probit- Marginal probability (III model)				Bivariate probit-conditional probability (II model first specification)				Bivariate probit conditional probability (II model second specification)			
Dependent variable: Innovation (1/0)	**Marginal effect**	**Robust Standard Error**	**z**		**Marginal effect**	**Robust Standard Error**	**z**		**Marginal effect**	**Robust Standard Error**	**z**		**Marginal effect**	**Robust Standard Error**	**z**	
Legal form: sole proprietorship (1/0)	-0.109	0.083	-1.30		-0.122	0.076	-1.600		-0.165	0.076	-2.19	**	-0.103	0.086	-1.20	
Food, drink and tobacco industries (1/0)	-0.030	0.101	-0.29		-0.032	0.099	-0.330						-0.010	0.106	-0.10	
Textiles and leather industries (1/0)	-0.145	0.090	-1.51		-0.140	0.087	-1.600	*					-0.134	0.102	-1.31	
Wood and metal products industries (1/0)	-0.225	0.091	-2.25	**	-0.231	0.089	-2.590	**					-0.225	0.102	-2.20	**
Manufacturers of paper pulp, paper, cardboard and paper products; printing and publishing industries (1/0)	0.219	0.113	1.88	*	0.196	0.111	1.770	*					0.245	0.101	2.43	**
Manufacturers of chemical products and synthetic and artificial fibres and rubber (1/0)	0.037	0.134	0.27		0.035	0.129	0.270						0.063	0.139	0.46	
Manufacturers of products based on non-metallic minerals (1/0)	0.026	0.115	0.23		0.021	0.119	0.170						0.040	0.120	0.33	
Founder of the firm: actual owner (1/0)	-0.100	0.142	-0.71		-0.091	0.140	-0.650		-0.119	0.141	-0.85		-0.129	0.152	-0.85	
Founder of the firm: previous generation (1/0)	-0.035	0.140	-0.25		-0.027	0.140	-0.200		-0.087	0.143	-0.61		-0.045	0.151	-0.30	
Age of the firm	-0.004	0.005	-0.79		-0.003	0.005	-0.750		-0.002	0.004	-0.54		-0.004	0.005	-0.86	
Squared age of the firm	0.000	0.000	0.43		0.000	0.000	0.450		0.000	0.000	0.26		0.000	0.000	0.30	
Producer of intermediate commodities (Yes 1/0)	-0.053	0.119	-0.44		-0.063	0.115	-0.550		-0.009	0.123	-0.08		-0.017	0.127	-0.13	
Producer of final products (Yes 1/0)	-0.018	0.093	-0.19		-0.044	0.096	-0.460		-0.015	0.094	-0.16		0.015	0.098	0.15	
Also or only sells in non-local markets (1/0)	0.076	0.070	1.08		0.077	0.068	1.130		0.074	0.069	1.08		0.050	0.072	0.70	
Participation of workers: high (1/0)	0.228	0.110	2.02	**	0.204	0.113	1.800	*	0.244	0.093	2.64	***	0.219	0.101	2.16	**
Participation of workers: medium (Yes 1/0)	0.090	0.086	1.05		0.067	0.087	0.770		0.068	0.084	0.81		0.091	0.087	1.04	
Participation of workers: low (1/0)	0.133	0.124	1.07		0.100	0.120	0.830		0.095	0.116	0.82		0.158	0.118	1.34	

Table 7 - Estimated probabilities of innovation
*legend: * p<.1; ** p<.05; *** p<.01*
Source: Own elaborations using OPIS data (continues)

	Univariate probit (I model)				Recursive bivariate probability (III model)				Bivariate probit-conditional probability (II model first specification)				Bivariate probit conditional probability (II model second specification)			
Dependent variable: Innovation (1/0)	**Marginal effect**	**Robust Standard Error**	**z**		**Marginal effect**	**Robust Standard Error**	**z**		**Marginal effect**	**Robust Standard Error**	**z**		**Marginal effect**	**Robust Standard Error**	**z**	
Training during the last three years Yes 1/0)	0.168	0.071	2.35	**	0.184	0.063	2.91	***	0.135	0.071	1.89	*	0.151	0.073	2.09	**
Owner's education: less than upper secondary school (Yes 1/0)	-0.262	0.102	-2.44	**	-0.261	0.102	-2.55	***	-0.278	0.104	-2.68	***	-0.302	0.107	-2.82	***
Owner's education: upper secondary school (Yes 1/0)	-0.189	0.090	-2.04	**	-0.168	0.092	-1.83	*	-0.196	0.093	-2.11	**	-0.236	0.092	-2.56	**
Age	0.003	0.008	0.31		0.002	0.009	0.20		-0.002	0.009	-0.28		0.001	0.009	0.07	
Squared Age	0.000	0.000	-0.40		0.000	0.000	-0.19		0.000	0.000	0.33		0.000	0.000	-0.09	
Previous occupation of the entrepreneur: Employee (Yes 1/0)	0.077	0.081	0.95		0.069	0.077	0.89						0.061	0.082	0.74	
Self-employed (Yes 1/0)	-0.047	0.135	-0.34		-0.046	0.141	-0.33						-0.092	0.144	-0.64	
Entrepreneur (Yes 1/0)	0.164	0.089	1.85	*	0.156	0.089	1.75	*					0.175	0.086	2.04	**
Years of experience as an entrepreneur (total)	0.003	0.002	1.47		0.003	0.002	1.29						0.003	0.002	1.51	
Number of employees who did not graduate from upper secondary school	0.006	0.003	1.98	**	0.005	0.003	2.00	**	0.004	0.003	1.52		0.005	0.003	1.63	
Number of employees who graduated from upper secondary school	0.003	0.004	0.68		0.001	0.004	0.28		0.004	0.004	0.96		0.003	0.005	0.76	
Number of employees with professional qualifications (less than three years)	-0.018	0.012	-1.54		-0.018	0.011	-1.59		-0.021	0.012	-1.70	*	-0.013	0.013	-1.01	
Number of employees with tertiary education	-0.003	0.008	-0.41		-0.001	0.007	-0.17		0.002	0.007	0.34		-0.006	0.008	-0.68	
Consortium (Yes 1/0)	0.051	0.126	0.41		0.043	0.124	0.35		0.104	0.120	0.86		0.036	0.132	0.27	
Partnership (Yes 1/0)	0.141	0.155	0.91		0.135	0.147	0.91		0.096	0.156	0.62		0.150	0.145	1.03	
Link with the territory (Yes 1/0)	-0.055	0.078	-0.70		-0.051	0.079	-0.64		-0.081	0.080	-1.01		-0.070	0.081	-0.87	
Importance of link to other firms (Yes 1/0)	0.091	0.092	1.00		0.088	0.089	0.99		0.112	0.089	1.26		0.095	0.092	1.03	
Affiliated with a district (1/0)	0.064	0.077	0.84		0.075	0.076	0.99		0.022	0.073	0.30		0.049	0.077	0.63	
Nobs	415				415				415				415			
Wald chi	110.0				294.09				158.09				203.68			
Pseudo R2	0.2441															
Rho£					-0.635	Chi2(1)=3.321	P>chi2=0.068	*	0.154	2.120	0.15		0.213	4.041	0.044	**
LL					-8582.36								-8601.38			

Table 7 - Estimated probabilities of innovation (continued)
*legend: * p<.1; ** p<.05; *** p<.01 £for rho we present the chi2 test*
Source: Own elaborations using OPIS data

	Univariate probit (I model)				Recursive bivariate probit- Marginal probability (III model)				Bivariate probit-conditional probability (II model first specification)				Bivariate probit conditional probability (II model second specification)			
Dependent variable: Increased sales (1/0)	**Marginal effect**	**Robust Standard Error**	**z**		**Direct effect**	**Indirect effect**	**Total effect**	Sig	**Marginal effect**	**Robust Standard Error**	**z**		**Marginal effect**	**Robust Standard Error**	**z**	
Legal form: sole proprietorship (1/0)	-					-0.066	-0.066									
Innovation (1/0)					0.537		0.537	***								
Food, drink and tobacco industries (1/0)	-0.106	0.078	-1.29		-0.094	-0.017	-0.111						-0.112	0.088	-1.27	
Textiles and leather industries (1/0)	-0.133	0.073	-1.65	*	-0.071	-0.079	-0.150						-0.131	0.086	-1.52	
Wood and metal products industries (1/0)	-0.093	0.087	-1.02		-0.003	-0.132	-0.135						-0.068	0.101	-0.67	
Manufacturer of paper pulp, paper, cardboard and paper products; printing and publishing industries (1/0)	-0.142	0.075	-1.65	*	-0.259*	0.104	-0.155	**					-0.182	0.086	-2.11	*
Manufacturer of chemical products and synthetic and artificial fibres and rubber (1/0)	-0.138	0.089	-1.33		-0.167	0.019	-0.148						-0.160	0.106	-1.50	
Manufacturer of products based on non-metallic minerals (1/0)	-0.076	0.088	-0.82		-0.093	0.011	-0.082						-0.085	0.102	-0.84	
Founder of the firm: actual owner (1/0)	0.098	0.114	0.83		0.164	-0.049	0.115		0.144	0.127	1.13		0.132	0.134	0.98	
Founder of the firm: previous generation (1/0)	0.015	0.133	0.11		0.046	-0.015	0.031		-0.001	0.143	-0.01		0.031	0.151	0.21	
Age of the firm	0.000	0.004	0.09		0.002	-0.002	0.000		0.001	0.004	0.17		0.001	0.005	0.13	
Squared age of the firm	0.000	0.000	0.83		0.00002	0.0000	0.000		0.000	0.000	0.74		0.000	0.000	0.79	
Producer of intermediate commodities (Yes 1/0)	-0.151	0.084	-1.55		-0.161	-0.035	-0.196		-0.161	0.096	-1.68	*	-0.172	0.098	-1.75	*
Producer of final products (Yes 1/0)	-0.155	0.085	-1.87	*	-0.141	-0.024	-0.165		-0.119	0.092	-1.30		-0.165	0.091	-1.81	*
Also or only sells in non-local markets (Yes 1/0)	0.173	0.065	2.72	***	0.126	0.041	0.167	*	0.157	0.067	2.34	**	0.176	0.067	2.62	***
Participation of workers: high (Yes 1/0)	0.067	0.092	0.75		-0.031	0.108	0.077		0.090	0.099	0.91		0.042	0.097	0.43	
Participation of workers: medium (Yes 1/0)	0.037	0.071	0.52		-0.002	0.036	0.034		0.056	0.078	0.72		0.029	0.078	0.38	
Participation of workers: low (1/0)	-0.067	0.087	-0.74		-0.137	0.053	-0.084		-0.065	0.0943	-0.69		-0.093	0.097	-0.96	

Table 8 - Estimated probabilities of increased sales
*legend: * p<.1; ** p<.05; *** p<.01*
Source: Own elaborations using OPIS data
(continues)

	Univariate probit (I model)				Recursive bivariate probability (III model)				Bivariate probit-Marginal probability (II model first specification)				Bivariate probit conditional probability (II model second specification)			
Dependent variable: Increasing sales (1/0)	**Marginal effect**	**Robust Standard Error**	**z**		**Direct effect**	**Indirect effect**	**Total effect**	Sig	**Marginal effect**	**Robust Standard Error**	**z**		**Marginal effect**	**Robust Standard Error**	**z**	
Training during the last three years (Yes 1/0)	0.097	0.067	1.47			0.098	0.098		0.085	0.072	1.19		0.079	0.072	1.09	
Owner's education: less than upper secondary school (Yes 1/0)	0.143	0.104	1.38		0.282	-0.144	0.138	***	0.163	0.109	1.49		0.192	0.111	1.73	*
Owner's education: upper secondary school (Yes 1/0)	0.186	0.094	1.98	**	0.272	-0.092	0.180	***	0.201	0.099	2.02	**	0.229	0.101	2.27	**
Age	0.015	0.007	2.13	**	0.015	0.0009	0.016	*	0.018	0.008	2.46	**	0.016	0.008	1.99	**
Squared Age	-0.000	0.000	-2.52	**	-0.0002	-0.00001	0.000	**	-0.000	0.000	-2.79	***	-0.000	0.000	-2.38	**
Previous occupation of the entrepreneur: Employees (Yes 1/0)	0.117	0.074	1.60		0.093	0.037	0.130						0.115	0.079	1.46	
Self-employed (Yes 1/0)	0.303	0.138	2.19	**	0.320	-0.025	0.295	**					0.314	0.135	2.32	*
Entrepreneur (Yes 1/0)	-0.031	0.077	-0.39		-0.086	0.083	-0.003						-0.059	0.082	-0.73	
Years of experience as an entrepreneur (total)	0.001	0.002	0.63		-0.0008	0.002	0.001						0.001	0.002	0.37	
Number of employees who did not graduate from upper secondary school	0.005	0.002	2.05	**	0.003	0.003	0.006		0.004	0.003	1.66	*	0.005	0.003	1.70	*
Number of employees who graduated from upper secondary school	0.001	0.003	0.38		0.002	0.001	0.003		0.001	0.003	0.21		0.001	0.003	0.25	
Number of employees with professional qualifications (less than three years)	-0.032	0.010	-3.22	***	-0.027	-0.010	-0.037	***	-0.031	0.011	-2.86	***	-0.033	0.011	-2.91	***
Number of employees with tertiary education	0.007	0.007	0.99		0.009	-0.006	0.003		0.004	0.007	0.59		0.008	0.007	1.11	
Consortium (Yes 1/0)	0.099	0.103	1.00		0.067	0.023	0.090		0.085	0.111	0.77		0.104	0.110	0.94	
Partnership (Yes 1/0)	-0.045	0.119	-0.36		-0.093	0.011	-0.082		-0.059	0.126	-0.47		-0.062	0.131	-0.48	
Link with the territory (Yes 1/0)	0.067	0.068	0.95		0.087	-0.027	0.060		0.080	0.076	1.06		0.080	0.077	1.04	
Importance of link to other firms (Yes 1/0)	-0.007	0.082	-0.09		-0.049	0.047	-0.002		-0.014	0.087	-0.16		-0.016	0.090	-0.18	
Affiliation with a district (1/0)	0.071	0.069	1.05		0.049	0.040	0.089		0.049	0.0692	0.71		0.069	0.074	0.94	
Nobs	415				415				415				415			
Wald chi	70.08				294.09				158.09				203.68			
Pseudo R2	0.1517															
Rho£					-0.635	Chi2(1)=3.321	>chi2=0.068	*	0.154	2.120	0.15		0.213	4.041	0.044	**
LL					-8582.36								-8601.38			

Table 8 - Estimated probabilities of increased sales (continued)
*legend: * p<.1; ** p<.05; *** p<.01; £for rho we present the chi2 test*
Source: Own elaborations using OPIS data

Looking at the results of the probability of increased sales (Table 8) first of all the variable innovation is positive and significant (marginal effect is +54 percentage point).
Regarding the net effects we find that the paper, publishing and printing industries suffered a crisis from 1995-1998 given that the direct and total effect are negative, even if the effect through the innovation (indirect effect) is positive. Additionally, firms led by older owners/entrepreneurs do good, but only if the owners/entrepreneurs are less than 40 years old. As to markets if the firms that sell abroad, we can see the two effects (direct and indirect) go in same direction (positive).
The probability of increased sales is higher if the entrepreneur is self-employed before starting the firm (+ 29.5 percent point – net/total effect). Instead, the firms' performance levels decrease as the number of the workers with only professional qualifications increases (-0,037) .
With respect to our theoretical hypothesis, the results are particularly interesting. According to the data, an entrepreneur with only a secondary education exhibited the strongest performances. In general, entrepreneurs with lower educational levels were more likely to experience increased sales than entrepreneurs who graduated from a tertiary school. To control the robustness of the results, we exclude variables that can explain these results. For example, we control for the sectoral classification, the entrepreneurs' previous occupations and the number of years spent working as an entrepreneur. The results are the same. Thus, we are not able to explain why less educated entrepreneurs exhibit superior market sales.
If we look at the direct and indirect effect, we can see that the two results have quite often opposite sign. For instance, with regard to the entrepreneur's educational level the direct effect is positive, while the indirect effect is negative, and we can argue that the entrepreneur with lower educational levels, have higher performance but lower likelihood of innovate. In each case the direct effect dominates, and so the net effect turn be positive.
We also calculated the value predicted by the three different levels of educations. We held the following covariates constant: sole proprietorship; paper, printing and publishing sectors; selling the final product; selling to local markets; lack of professional training; the high participation rates of employees in the firm's decisions; the entrepreneur's previous activities in entrepreneurship; lack of affiliation with a consortium; and lack of connections to the local area and other firms. The continuous variables are equal to the corresponding means. Additionally, we repeat this calculation with all of the variables at the mean.
Finally, we repeat this calculation for the two last models (bivariate probit and recursive bivariate probit) and we let vary the innovation and set it equal to 1, then to 0 and finally to estimated mean. As can be seen in table 9, the higher the educational level of the entrepreneur is, the higher the probability that the firm will innovate. In particular, this probability conditioned to the increased sales is 96.9% if the owner/entrepreneur graduated from a tertiary school, 90% if the owner/entrepreneur only graduated from a secondary school, and 87.6% if the owner/entrepreneur did not graduate from secondary school.
Our results also show that entrepreneurs with tertiary levels of education have lower estimated probabilities of increased sales (6.8% if they innovate and 2.4% if they don't), compared to an entrepreneurs with lower educational levels.
With respect to the table 10A (results of recursive bivariate probit model), we can see that the results are very different; the conditional probability of increased sales is lower if we consider to have/ extract potentially innovative firms and higher if we extract potentially not innovative firms (this results depend from the negative sign of ρ). If we look at the conditional mean, it seems that introducing innovation decreases the probability of increased sales. Looking more deeply at this result the firms more likely to innovate are the ones that have a smaller probability to increase sales.

The firms where the entrepreneur has a university degree are the firms which have more need to innovate in order to increase their competitiveness to raise their revenue and catch up other firms. The economic reason of this result is not explained by our data but it probably depends by an unobservable variable describing any characteristic of entrepreneur as quality of education or other professional experiences, or some variables pertinent to the markets where the firms is involved.
Finally, if it could be possible for the firms to sign an agreement to not innovate, then the differences among them will decrease. This finding shows that innovation makes firms more competitive and increases the differences among the firms. However, because the probability of increased sales declines for all of the firms, this result is not efficient for the system as a whole. Without this agreement, firms had to innovate to maximise their competitiveness.
In any case the impact effect of the innovation on the probability of increased sales is positive and equal to 23 percentage point for lower educated entrepreneur and 8.7 percentage point for entrepreneur with university degree (calculated on the marginal probability Table 10B). Besides, looking at the table 10C where we highlight also the joint probability of increased sales estimated at the average of the probability of innovation. Entrepreneur with the tertiary school manage to recover positions compared with less educated entrepreneur (the difference is only 3 percentage point to less than secondary and 6 percentage point to the entrepreneur with upper secondary school). Entrepreneur with upper secondary school have the best position in terms of increased revenues.

Bivariate probit&
Less than upper secondary education

	Increase in Sales		Total		
Innovation	Yes	No			
Yes	10.6	65.4	76	**13.9**	Conditional Prob FATT=1|INN=1
No	1.5	22.4	23.9	**6.3**	Conditional Prob FATT=1|INN=0
Total	12.1	87.8	100	-	
Conditional Prob. Inn=1	**87.6**	**74.5**			

Upper secondary education

	Increase in Sales		Total		Conditional Prob. Fatt=1
Innovation	Yes	No			
Yes	13.2	68.1	81.3	**16.2**	Conditional Prob FATT=1|INN=1
No	1.4	17.3	18.7	**7.5**	Conditional Prob FATT=1|INN=0
Total	14.6	85.4	100	-	
Conditional Prob. Inn=1	**90.4**	**79.7**			

Tertiary education

	Increase in Sales		Total		Conditional Prob. Fatt=1
Innovation	Yes	No			
Yes	6.2	85.4	91.6	**6.8**	Conditional Prob FATT=1|INN=1
No	0.2	8.1	8.3	**2.4**	Conditional Prob FATT=1|INN=0
Total	6.4	93.5	100	-	
Conditional Prob. Inn=1	**96.9**	**91.3**			

Total

	Increase in Sales		Total		Conditional Prob. Fatt=1
Innovation	Yes	No			
Yes	11	68.9	79.9	**13.8**	Conditional Prob FATT=1|INN=1
No	1.3	18.8	20.1	**6.5**	Conditional Prob FATT=1|INN=0
Total	12.3	87.7	100	-	
Conditional Prob. Inn=1	**89.4**	**78.6**			

Bivariate probit$
Less than upper secondary education

	Increase in Sales		Total		Conditional Prob. Fatt=1
Innovation	Yes	No			
Yes	9.02	16.7	25.72	**35.1**	Conditional Prob FATT=1|INN=1
No	16.6	57.7	74.3	**22.3**	Conditional Prob FATT=1|INN=0
Total	25.62	74.4	100	-	
Conditional Prob. Inn=1	**35.2**	**22.4**			

Upper secondary education

	Increase in Sales		Total		Conditional Prob. Fatt=1
Innovation	Yes	No			
Yes	25.9	23.7	49.6	**52.2**	Conditional Prob FATT=1|INN=1
No	16.6	33.8	50.4	**32.9**	Conditional Prob FATT=1|INN=0
Total	42.5	57.5	100	-	
Conditional Prob. Inn=1	**60.9**	**41.2**			

Tertiary education

	Increase in Sales		Total		Conditional Prob. Fatt=1
Innovation	Yes	No			
Yes	20.7	51.3	72	**28.8**	Conditional Prob FATT=1|INN=1
No	4.5	23.5	28	**16.1**	Conditional Prob FATT=1|INN=0
Total	25.2	74.8	100	-	
Conditional Prob. Inn=1	**82.1**	**68.6**			

Total

	Increase in Sales		Total		Conditional Prob. Fatt=1
Innovation	Yes	No			
Yes	17.9	24.6	42.5	**42.1**	Conditional Prob FATT=1|INN=1
No	14.9	42.6	57.5	**25.9**	Conditional Prob FATT=1|INN=0
Total	32.8	67.2	100		
Conditional Prob. Inn=1	**54.6**	**36.6**			

Table 9 - Jointly, marginal and conditional probability (in%) of increase in firm's sales, in the estimated bivariate probit model & holds constant the following covariates: sole proprietorship; paper, printing and publishing sectors; selling the final product; selling in local markets; lack of training; high participation rate of employees in firm decisions; entrepreneur's previous activities in entrepreneurship; lack of affiliation with a consortium; and lack of connections to the local area and other firms. The continuous variables are equal to the corresponding means. $ All of the covariates at the mean.
Source: Own elaborations using OPIS data

	Innovation Variable =1			
Less than upper secondary education	**Conditional Probability**		***Impact***	***Difference with terziary***
	Prob(INN=1|FATT=1)	43.7	**15.0**	-16.5
	Prob(INN=1|FATT=0)	80.1		-11.4
	Prob(FATT=1|INN=1)	16.1		**9.8**
	Prob(FATT=1|INN=0)	50.0		**17.5**
	Innovation Variable =1			
Upper secondary education	**Conditional Probability**			
	Prob(INN=1|FATT=1)	53.8	**16.1**	-6.5
	Prob(INN=1|FATT=0)	86.6		-4.9
	Prob(FATT=1|INN=1)	17.3		**11.0**
	Prob(FATT=1|INN=0)	53.9		**21.5**
	Innovation Variable =1			
Tertiary education	**Conditional Probability**			
	Prob(INN=1|FATT=1)	60.2	**5.9**	
	Prob(INN=1|FATT=0)	91.5		
	Prob(FATT=1|INN=1)	6.3		
	Prob(FATT=1|INN=0)	32.5		
	Innovation Variable =0			
Less than upper secondary education	**Conditional Probability**			***Difference with terziary***
	Prob(INN=1|FATT=1)	28.6		-28.6
	Prob(INN=1|FATT=0)	71.8		-17.0
	Prob(FATT=1|INN=1)	1.1		**0.7**
	Prob(FATT=1|INN=0)	6.8		**4.2**
	Innovation Variable =0			
Upper secondary education	**Conditional Probability**			
	Prob(INN=1|FATT=1)	33.3		-23.8
	Prob(INN=1|FATT=0)	79.5		-9.4
	Prob(FATT=1|INN=1)	1.3		**0.8**
	Prob(FATT=1|INN=0)	9.1		**6.5**
	Innovation Variable =0			
Tertiary education	**Conditional Probability**			
	Prob(INN=1|FATT=1)	57.1		
	Prob(INN=1|FATT=0)	88.8		
	Prob(FATT=1|INN=1)	0.5		

Table 10A - Conditional Probability (in%) of increase in firm's sales while introducing or not an innovation, in the estimated recursive bivariate probit model & & holds constant the following covariates: sole proprietorship; paper, printing and publishing sectors; selling the final product; selling in local markets; lack of training; high participation rate of employees in firm decisions; entrepreneur's previous activities in entrepreneurship; lack of affiliation with a consortium; and lack of connections to the local area and other firms. The continuous variables are equal to the corresponding means.
Source: Own elaborations using OPIS data

Recursive Bivariate probit&				
	Innovation Variable =1			
Less than upper secondary education	Marginal probability		*Impact of innovation*	*Difference with terziary*
	Innovate	67.7	**0.0**	**-19.8**
	Increased sales	26.1	**23.3**	**16.8**
	Innovation Variable =1			
Upper secondary education	Marginal probability			
	Innovate	76.1	**0.0**	**-11.3**
	Increased sales	25.3	**22.6**	**16.0**
	Innovation Variable =1			
Tertiary education	Marginal probability			
	Innovate	87.5	**0.0**	
	Increased sales	9.3	**8.7**	

Recursive Bivariate probit&			
	Innovation=0.6766055		
Less than Uppersecondary education	Marginal probability		*Difference with terziary*
	Innovate	67.7	**-19.8**
	Increased sales	14.4	**7.5**
	Innovation=0.7613845		
Upper secondary education	Marginal probability		
	Innovate	76.1	**-11.3**
	Increased sales	16.4	**9.5**
	Innovation=0.8745913		
Tertiary education	Marginal probability		
	Innovate	87.5	
	Increased sales	6.9	

	Innovation Variable =0		
Less than upper secondary education	Marginal probability		*Difference with terziary*
	Innovate	67.7	**-19.8**
	Increased sales	2.8	**2.2**
	Innovation Variable =0		
Upper secondary education	Marginal probability		
	Innovate	76.1	**-11.3**
	Increased sales	2.7	**2.0**
	Innovation Variable =0		
Tertiary education	Marginal probability		
	Innovate	87.5	
	Increased sales	0.6	

Table 10B - Marginal Probability (in%) of increase in firm's sales and innovate in the estimated recursive bivariate probit model & holds constant the following covariates: sole proprietorship; paper, printing and publishing sectors; selling the final product; selling in local markets; lack of training; high participation rate of employees in firm decisions; entrepreneur's previous activities in entrepreneurship; lack of affiliation with a consortium; and lack of connections to the local area and other firms. The continuous variables are equal to the corresponding means.
Source: Own elaborations using OPIS data

Innovation at estimated mean
Recursive bivariate probit&
Less than upper secondary education

Innovation	Increase in Sales: Yes	Increase in Sales: No	Total	Conditional Prob.		***Difference with terziary***
Yes	5.3	65.4	70.7	**7.5**	Fatt=1|Inn=1	***3.0***
No	9.2	20.2	29.4	**31.3**	Fatt=1|Inn=1	***5.9***
Total	14.5	85.6	100	-		
Conditional Prob. Inn=1	**36.6**	**76.4**				

Upper secondary education

Innovation	Increase in Sales: Yes	Increase in Sales: No	Total	Conditional Prob. Fatt=1		
Yes	7.9	70.4	78.3	**10.1**	Fatt=1|Inn=1	***5.6***
No	8.5	13.1	21.6	**39.4**	Fatt=1|Inn=1	***13.9***
Total	16.4	83.5	100	-		
Conditional Prob. Inn=1	**48.2**	**84.3**				

Tertiary education

Innovation	Increase in Sales: Yes	Increase in Sales: No	Total	Conditional Prob. Fatt=1	
Yes	4	84.6	88.6	**4.5**	Fatt=1|Inn=1
No	2.9	8.5	11.4	**25.4**	Fatt=1|Inn=1
Total	6.9	93.1	100	-	
Conditional Prob. Inn=1	**58.0**	**90.9**			

Total

Innovation	Increase in Sales: Yes	Increase in Sales: No	Total	Conditional Prob. Fatt=1	
Yes	6.2	69.6	75.8	**8.2**	Fatt=1|Inn=1
No	8.5	15.7	24.2	**35.1**	Fatt=1|Inn=1
Total	14.7	85.3	100	-	
Conditional Prob. Inn=1	**42.2**	**81.6**			

Table 10C - Jointly, marginal and conditional probability (in%) of increase in firm's sales, in the estimated recursive bivariate probit model - Innovation is set at estimated mean & holds constant the following covariates: sole proprietorship; paper, printing and publishing sectors; selling the final product; selling in local markets; lack of training; high participation rate of employees in firm decisions; entrepreneur's previous activities in entrepreneurship; lack of affiliation with a consortium; and lack of connections to the local area and other firms. The continuous variables are equal to the corresponding means.
Source: Own elaborations using OPIS data

5. Conclusions

In this paper we have studied the relation between knowledge and innovation looking at the possible results of innovation. We believe that innovation depends on firm's ability to assimilate and exploit existing information and on the firms' ability to identify, assimilate and exploit knowledge from the environment.

The first source of knowledge is the R&D that helps the firm in developing an absorptive capacity (Cohen, Levinthal, 1989). However, in the case of small and medium sized firms, which do not have institutional R&D functions or activities, this channel of knowledge is unavailable.

Knowledge in SMEs depends by human capital (Grant, 1996; Hodgson, 1998) and networks (Becattini, 1989). When we refer to human capital, we consider the entrepreneur's (Colombo, Grilli, 2005) educational level and previous experiences, and the employees' educational levels. Furthermore, if the firm's stock of knowledge is contingent on the availability of information, this information depends on the relationships and the networks that the firm, whether big or small, establishes both within it and with the external environment. These types of networks generally produce positive externalities à la Marshall. The networks utilised by SMEs have different origins and can relate to the firms' participation in consortiums and the firms' relationships with various actors, such as suppliers, buyers, and customers. In the case of SMEs, this network is mainly informal (De Devitiis et al. 2009).

We have studied the determinants and the results of innovation on a territory characterised by the presence of small and medium sized firms. As we noted previously, these types of firms are limited by size and sector in their pursuit of innovation. We accepted a broader definition of innovation as a "new or significantly improved production methods, including methods of product delivery" (OECD 1997 p.49) and "something new or an improvement that applies to a firm". We define innovation as new ideas that are introduced in the firm in many ways and that allow the firm to get an advantage (Baregheh et al, 2009; Rogers, 1996). Then innovation is defined at firm level and the expected results consist in an advantage for the firm that is a better performance.

Due to the relations we have considered among knowledge, innovation and its results we have used two different bivariate models.

Looking at the results, we have found that human capital plays a positive role on innovation; innovation is also positively influenced by the dimension of the firm[21], training and workers participation in the strategic decision.

On the other side, those elements are not significant for the probability of increased sales. The probability of increased sales is positively influenced by owner's/entrepreneur's characteristics such as a higher age and previous working experience as self-employed; the probability is also influenced positively if the firm sells in market other than Southern Italy.

Innovation is a key resource for some of the firms interviewed; in fact, those which are less likely to increase sales are pushed to innovate in order to catch up the other and get a positive result from innovation. Something similar happens when the entrepreneur has a high level of education; in this case if we net out the effects of innovation the firm has a worse performance than the other ones, so that innovation is a key element in the effort of catching up competitors.

Some of the results we have found may depend by an unobservable variable, that is probably refers to some characteristics of entrepreneur as quality of education or other professional experiences or to the fact that the entrepreneur works effectively in the firm, but we do not have information about that.

[21] Measured in term of employees per firm.

We suggest a reflection on some policy implication that can be helpful for SMEs in traditional sectors as we have analyzed in this paper; the first one bases on the positive results of innovation and we suggest to reinforce the incentives to innovate, but also to enrich, enlarge and render more effective the relations within and between the firms (Grant, 1996) and enhance human capital in the firm. Another important implication refers to a system of support to extend the market sales outside the Souther area of Italy. In this case enlarging the market the firm will face a stronger competition but at the same time it can have more information to process about its sector; this can generate an awareness of the necessity of innovation to better face competition.

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