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Do Firms in Incubation Innovate Too? Evidence from Portugal

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Abstract

This article examines innovation in micro- and small firms in incubation in Portugal. The research set out to identify patterns of innovative activity toward a sustainable development. A conceptual study was developed, based on the literature and empirical studies, to help understanding of the factors determining innovation in small businesses in incubation facilities. Two conclusions can be drawn from the findings. On the one hand, businesses in incubation units see innovation as an essential, continuing activity with interrelated dimensions. These firms tend to introduce new products, innovate in processes and implement changes in the organization and exploration of new markets. On the other hand the research showed that some areas of innovation depend on the type of origin of the firm, and its size.

Key Words: *Determinants of innovation, Small firms, Business incubators and Sustainable environment.*

Introduction

Over recent decades, the generation of micro- and small businesses has been regarded as a critical factor in the industrial restructuring required by the disappearance of traditional firms and industries, and in the local creation of jobs and wealth (Rothwell, 1992). The awareness that entrepreneurship and innovation are key factors throughout this process is spreading and becoming increasingly widely accepted, by national governments, companies and academics (Bruin & Dupuis, 2003).
This dynamic has led to the birth in Portugal, and in many other countries, of many facilities to support entrepreneurship. Business incubators are among these facilities. These new organizational units are sustainable environments sponsored by universities, science and technology parks, business groups and local and regional governments. They offer special conditions to support entrepreneurs who want to overcome obstacles and start their own business. Such innovation is therefore intrinsically linked to the business incubation movement worldwide, providing favourable and sustainable environments for economic development (Aerts et al, 2007; Marques et al, 2010). This study understands the concept of business incubator as all the facilities needed to provide special conditions to help start-up firms in their earliest stages, at low cost OECD (1997).

The purpose of this research was to explore some internal characteristics of firms in incubation facilities and see to what extent they affect innovation. Four determinants of innovation were tested, using data gathered from a survey: firm's origin; economic sector; firm's size, and R&D carried out. Several studies have been carried out in these areas but they and the results of the empirical tests are often contradictory and inconclusive. One of the main reasons for the apparent inconsistencies in the literature is that the theories presented and the empirical tests often attempt to establish general patterns, whereas in fact firms tend to follow specific patterns of innovation specific to a particular sector (Malerba & Orsenigo, 1995; Tether, 2002).

The research was based on a study of micro- and small businesses in incubation facilities. There were three main reasons why it was decided to look at Portuguese firms based in incubators. First, business incubation has been found to greatly favour the creation of new firms and the promotion of enterprise development by governments, universities and business groups (Carayannis & Zedwitz, 2005; Hackett & Dilts, 2004). Second, micro- and small enterprises are held to be essential for economic development and are an integral part of all market economies (Hoffman *et al*, 1998; Rothwell & Dodgson, 2001). There is evidence that micro- and small businesses in incubation are particularly important in the information and communication technology (ICT) and biotechnology (Rothaermel & Thursby, 2005) sectors. Third, it has been suggested that in medium-sized countries business incubators act as a catalyst for economic development, the creation of wealth and jobs (Sofouli & Vonortas, 2007). They are seen as a route for regional and local economies to achieve sustainable economic growth, especially in lower-growth regions that tend to drive new investment (Laranja, 2009).

This article is organised as follows. Section 2 explains the conceptual structure and presents a literature review related to the concept of innovation and its determinants. Section 3 explains the approach used. The results of the survey are presented and discussed in section 4, and the last section states the conclusions and explains the implications for management and suggests areas for future research.

Conceptual Structure

The Concept of Innovation

Although innovation has been thoroughly studied there is no way of measuring the innovation that has been generally accepted. Some research is based on R&D expenditure and on information about patents (Breschi, 1999; Malerba & Orsenigo, 1995), and other work relies on measurements derived from detailed surveys of companies (Avermaete *et al*, 2003). Innovation is a very broad concept and so various classifications have been developed and used in the literature (Abernathy & Clark, 1985; Cumming, 1998; Johannessen *et al*., 2001). Most researchers have focused on technology-related innovation, such as the introduction of products that need radical changes in the production process. The concept of innovation, however, can be seen as extending beyond the drastic innovation of technology-based products. It can be taken as something that brings improvements to products and processes, changes to organizational structures and efforts to explore new markets. This idea is reflected by Lundvall (1992, p. 8), when he refers to it as "on-going processes of learning, searching and exploring, which result in new products, new techniques, new forms of organization and new markets".

Innovation is often the outcome of simultaneous changes in different areas, where interrelations stand out (Caraça *et al*, 2009), as explained next.

Product innovation can be a good, service or idea that is viewed by someone as being new (Lundvall, 1992; Caraça *et al*, 2009). One person or organization can thus regard a product as an innovation while another does not (Johannessen *et al*., 2001). Product innovation can be prompted by changes in a firm's organizational structure. For example, when the quality of products is improved by a more efficient organization of internal controls. Furthermore, new products can appear when new market segments are explored. For instance, new market segments have been introduced in recent decades by the ICT industries and involved items from personal computers to GPS systems (Tidd *et al*, 1997). But product innovation is basically associated with change in processes.

Innovation in processes includes adapting existing production lines, installing completely new infrastructure, and implementing new technologies. On the whole, process innovation enables the creation of new products. But process innovation may be necessary as part of a company's reorganization or in order to explore new markets (Jenssen & Aasheim, 2010).

Organizational innovation concerns changes in authority relationships, in organizational structure, in job allocation, in remuneration systems, in communication systems and other aspects of formal interaction between the people in the organization (Slappendel, 1996). Although there are not very many studies on organizational innovation it has been gaining importance in all industrial sectors. We can look at the success of standard ISO 9000, for example, which establishes rules for making processes transparent, documented, reproducible and controlled (Tidd *et al*, 1997).

The last innovation domain concerns market innovation, which involves exploring new territorial markets and penetrating new market segments in the context of the current strategy. As an example, recent development in the biotechnology sector show that market innovation is strongly interlinked with product and organizational innovation, and less strongly to process innovation (Khilji *et al*, 2006).

Innovation Determinants

A number of factors that determine innovation have been identified, ranging from microeconomics characteristics and links between firms to macroeconomic performance (Becheikh *et al*, 2006; Cooke *et al*., 1997; Nooteboom, 1999; Palmberg, 2006; Shefer & Frenkel, 2005). In this article the impact of four variables is analysed:

- Firm origin
- Economic sector
- Firm size
- R&D activities

The literature on the relations between the origin of the company and innovation is quite limited. Studies in this area include Schumpeter (1934), who is regarded as the founder of the theory of dynamic innovation (Malerba & Orsenigo, 1995). Schumpeter (1934) examined the industrial structure of Europe at the end of the 19th century, which was then dominated by small enterprises. He found that entry tended to be easy for firms that were using new technologies and stressed the role of new firms as drivers of innovation. New entrepreneurs started out with fresh ideas, fresh products and fresh processes. Here, current production methods, organization and distribution are interrupted and the quasi-rents associated with previous innovations are wiped out. This dynamic is known as creative destruction or Schumpeter's Mark I innovation model (1934). Other authors have studied the performance of spin-off firms in a scattered way, examining innovative activity in their relations with universities and R&D laboratories (Carayannis *et al*, 1998; Dahlstrand, 1997; Gonzalez *et al*, 2012) and underscoring the high-tech nature of the technology used. But, in an incubation environment, there are very few studies that assess the impact of the origin of a firm on its innovation.

The relations between the sector of economic activity and innovation have been studied more often. The literature mentions in general that the high-tech sectors are more inclined to post higher rates of innovation than the more traditional ones (Acs & Audretsch, 1988; Frenkel *et al*, 2001; Hoffman *et al*, 1998; Shefer & Frenkel, 2005). Attention is drawn to the existence of differing innovation patterns between sectors, which is why inter-sectoral studies have led to apparent contradictions in the results. So this study looks at the kinds of innovation in firms in incubation facilities by dividing the sample into three groups according to their technological character. The first and second groups include mostly high-tech sectors, like 1- ICT and 2- Biotechnology and health. The third group contains mostly low-tech sectors, designated 3- Other sectors. This classification generally reflects the sectoral pattern of Portuguese incubators and, therefore, of the firms in incubation units.
The study of the relationship between the firm's size and innovation also goes back to Schumpeter (1942). He believed that large firms are more likely to innovate than small ones. With knowledge built up in specific technological areas, with greater expertise in R&D projects, and in production and distribution on a

large scale, plus access to resources, large companies set up barriers to the entry of new entrepreneurs (Greve, 2003). This is Schumpeter's Mark II innovation model.

Following Schumpeter the relation between firm size and innovation has been studied exhaustively (Bertschek & Entorf, 1996; Breschi, 1999; Greve, 2003; Malerba & Orsenigo, 1995; Shefer & Frenkel, 2005). But more than half a century after his work the discussion about this issue goes on. These empirical studies came to apparently contradictory conclusions. This is basically due to the use of different measures of innovation (Grunert *et al*, 1997; Shefer & Frenkel, 2005) and of different sampling methods, in which a lot of studies collect data in industries to try and arrive at a general conclusion instead of discerning specific innovation patterns of each industry. In addition, the size distribution of firms in the samples differs.

Finally, many studies have been carried out on the relation between R&D activities and innovation. Among them, Hall & Bagch-Sem (2002), Parthasarthy & Hammond (2002) and Shefer & Frenkel (2005) report that engaging in R&D activities is an important input into the innovation process but stress that there are some limitations since not all innovations come from R&D. Furthermore, it should be noted those studies tend to favor large companies to the detriment of small ones.

Although it is clear that the internal characteristics of firms, such as their origin, sector of activity, size and R&D carried out, have an impact on their innovative behaviour, studies have often focused on the environment in which innovation occurs. This is where business incubators emerge as particularly favourable environments from the technological, institutional and regional point of view (Cooke *et al*, 1997). From this standpoint, governments, universities and R&D laboratories, business associations and networks of other kinds, all contribute to companies' innovative behaviour (Breschi, 1999; Laranja, 2009).

Methodology

Companies' innovative activity was initially assessed by means of a survey of firms in the 11 incubator units of Portuguese companies that agreed to take part in the study. The sample of firms in incubation as of 31 December 2008 comprised 158 micro- and small enterprises. It was decided to study 50% of the firms in each incubator by means of a stratified sample, using two strata: Year of incubation of the firm, and Sector of economic activity. The final sample of firms interviewed comprised 79 micro- and small businesses, 38 from the ICT sector, 7 from the biotechnology sector and 34 from other sectors. All the firms in the sample were less than 3 years old.

A pilot interview was conducted in May 2009 and the final one took place between June and September 2009. The managers or owners of the firms were interviewed in person. Each interview lasted about 1 hour. The survey focused on four innovation indicators. The first was product innovation. The entrepreneurs were asked about whether they had introduced any product innovation, defined as a new or substantially modified product, in the last 3 years. The second was process innovation, taken to be the introduction of a new process or substantial improvement of existing ones in the last 3 years. The third was organizational innovation, which was the introduction or major improvement of organizational methods or systems in the last 3 years. The implementation of standard ISO 9000 was of particular interest, since this would imply a radical effort at changing the organization. The fourth is market innovation, which is defined as entry into new geographic markets or new client segments. These four indicators were treated as areas of analysis and coded zero or one.

In addition to knowing whether any of the four types of innovation relating to product, process, organization and market was present or not, the questionnaire was designed to gather information that would measure the influence of four variables as determinants of innovation. The first is the firm's origin,

to see if it was a spin-off from a university, a spin-off from another company, a new firm established on individual initiative, an already-existing firm, a subsidiary of another, existing, company or some other situation. The second, economic sector, denotes the activity in accordance with its technological character. The first and second groups included mostly high-tech sectors, e.g.: 1- ICT (communications, computer and electronic hardware and software), 2- Biotechnology and health (medical, health, genetic engineering and molecular biology products and services). The third group contains mostly low-tech sectors, designated 3- Other sectors (energy, consumer products, industrial products and other goods and services). The third variable concerns the size of the company measured in terms of employees (up to 3, from 4 to 10, from 11 to 15, from 16 to 25, from 26 to 50 and more than 50). The last variable measured R&D activities: 1 – none; 2 – full-time R&D, and 3 – part-time R&D.
SPSS was used to process the results. An independent t-test and chi-square test (χ^2) adjusted by the Fisher coefficient for a small number of firms, for 95% significance, were used to find associations. Whenever possible the association was measured using Cramer's V coefficient.

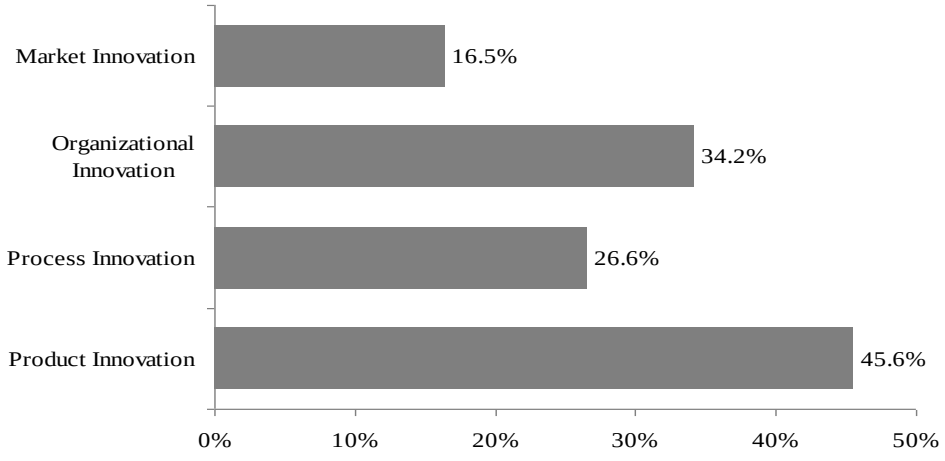
Results

The empirical analysis of the sample is divided into five parts: first, a summary of general findings; second, the results of the analysis of relations between firms' origins and their innovative activity; third, the relations between the sector of activity and types of innovation; the effect of firm size on innovation is analysed in the fourth part. Finally, the effect of R&D as a determinant of innovation is also discussed.

General Results

The results of the general analysis highlight the importance of innovation to micro- and small firms based in business incubators. All the 79 said they had introduced at least one of the four kinds of innovation discussed above.
The chart below (Figure 1) shows the research results for the four innovation indicators. In the last three years, or since they were based in business incubators, 36 respondents have introduced a product innovation and 21 have implemented a process innovation. 27 firms said they have started procedures to obtain the ISO 9000 certification (organizational innovation). The decision to enter new market segments or create new niches was indicated by 13 firms.

Figure 1 - General results of innovation in micro and small firms based in business incubators (n=79).



Source: Personal research on Portuguese firms in incubation in 2009

The analysis also confirms the interrelations and interdependence between the various domains of innovation (Lundvall, 1992; Caraça *et al*, 2009), where the development or adoption of a product innovation often involves the adoption of improvements in the processes, in the functioning of the organization and in market innovations. 41 of the 79 firms said they have innovated in terms of product and process, 34 have developed a product and organizational innovation and 42 have a product and market innovation.

The p values are significant ($p<0.001$), showing strong interrelations between the innovation domains. In addition 8 firms (10%) have developed all four types of innovation at the same time, with 6 of these firms being in the ICT sector and undertaking R&D on a part-time basis. This shows that high-tech companies tend to engage more in innovative activity, with a chain of interrelations in all the firm's domains (Caraça *et al*, 2009).

Firm Origin

As in the previous analysis, independent t-test was calculated to ascertain the impact of a firm's origin on innovation. It was found that the origin does determine process, organizational and market innovation. But an association between the origin of the company and innovation was not confirmed. Table 1 shows that university spin-offs and subsidiaries of already-existing companies are responsible for the associations found. Of the 7 university spin-offs, 57.1% implemented process innovations (χ^2 =8.017; p=0.042) and 85.7% implemented some organizational change (χ^2=11.359; p=0.006).

Market innovation was found simultaneously in university spin-offs (57.1%) and in the only firm that was a subsidiary of an already-existing company (100%) (χ^2=14.646; p=0.002). Cramer's V coefficient revealed moderate associations with process and organizational innovation and a relatively strong association with market innovation (V=0.469).

Economic Sector of Firm

Testing for associations between the economic sector and innovation domains showed that in no instance did the sector of activity determine any kind of innovation to any significant extent. Three conclusions emerge. First, the biotechnology and health firms innovate most in terms of product (71.4%) and least in terms of process (14.3%). Second, the ICT firms innovate less than might be expected in terms of product (50.0%), given their high-tech nature. Third, innovation with respect to new market segments was poor for all sectors of activity, with only 16.1% of the firms in the sample implementing action in this aspect. This could indicate inadequate intervention of the incubator in relation to offering strategy guidance to firms.

Firm Size

The size of a firm did not affect process and market innovation. But size was related to product and organizational innovation. The 25 firms with 4 to 10 employees (66.7%), and the 8 with up to 3 employees (25.8%) were found to be associated with product innovation, which was a lower number than expected (χ^2=15.812; p=0.001). But the degree of association is strong (V=0.453), so it may be supposed that the more employees that enterprises in incubation have the higher their rate of product innovation. Table 1 shows that the percentage of firms implementing organizational innovation increases with the number of employees, since the level of significance was much lower than 0.05 where the firms accounting for this association are those with 24 to 50 employees and over 50 employees (χ^2=10.74; p=0.018), with a moderate association (V=0.381).

Table 1 Characteristics of firms in incubation by type of innovation

		Type of innovation							
		Product (n=36)		*Process (n=21)*		*Organizational (n=27)*		*Market (n=13)*	
		n	%	n	%	n	%	n	%
Origin	University spin-off (n=7)	6	85.7	4	57.1	6	85.7	4	57.1
	Company spin-off (n=6)	3	50.0	2	33.3	2	33.3	1	16.7
	New firm (n=63)	25	39.7	13	20.6	17	27.0	6	9.5
	Already-existing firm (n=2)	1	50.0	1	50.0	1	50.0	1	50.0
	Subsid. or existing firm (n=1)	1	100.0	1	100.0	1	100.0	1	100.0
	p-value	*.087*		*.042*		*.006*		*.002*	
Economic sector	ICT (n=38)	19	50.0	10	26.3	12	31.6	9	23.7
	Biotechnology & health (n=7)	5	71.4	1	14.3	3	42.9	1	14.3
	Other sectors (n=34)	12	35.3	10	29.4	12	35.3	3	8.8
	p-value	*.159*		*.749*		*.777*		*.213*	
Size	Up to 3 employees (n=31)	8	25.8	5	16.1	6	19.4	2	6.5
	4 to 10 employees (n=39)	25	64.1	15	38.5	18	46.2	10	25.6
	11 to 15 employees (n=4)	0	0.0	0	0.0	0	0.0	0	0.0
	16 to 25 employees (n=3)	2	66.7	0	0.0	1	33.3	0	0.0
	26 to 50 employees (n=1)	0	0.0	0	0.0	1	100.0	0	0.0
	Over 50 employees (n=1)	1	100.0	1	100.0	1	100.0	1	100.0
	p-value	*.001*		*.065*		*.018*		*.082*	
R&D activity	No R&D (n=24)	8	33.3	3	12.5	4	16.7	2	8.3
	Full-time R&D (n=7)	5	71.4	2	28.6	4	57.1	2	28.6
	Part-time R&D (n=48)	23	47.9	16	33.3	19	39.6	9	18.8
	p-value	*.187*		*.176*		*.051*		*.248*	

Source: Personal research on Portuguese firms in incubation in 2009.

Firm's R&D

Product, process, organizational and market innovation are independent variables of the R&D activities of firms in incubation. But one interesting result concerns the fact that firms engaging in R&D full-time innovate more at product, organization and market level than firms whose R&D activity is part-time, leading to the supposition that the importance of R&D to companies' innovating activity, but showing with a significance higher than 0.05, so they were not considered relevant.

Conclusions

This paper has examined the determinants of innovation in micro- and small firms, using a database built up through a survey of 79 enterprises based in Portuguese incubators. The results show the importance of innovation to the great majority of these micro-and small firms. Though largely limited in terms of scale,

these firms seem to innovate continuously and on an interrelated basis. The survey shows that all the firms had developed some type of innovation in the last three years, and tended to have done so in more than two areas simultaneously. The incubation as a sustainable environment certainly drove this high level of innovation, which confirms previous studies that found that incubators encourage entrepreneurship and innovation (Hackett & Dilts, 2004). Of the factors studied, neither the economic sector nor R&D activity determined innovation. The biotechnology sector innovated comparatively more than ICT. Full-time R&D contributed more to product, process and organizational innovation than part-time R&D, which confirms previous studies in non-incubator environments (Shefer & Frenkel, 2005).

Our study shows that firm origin and size significantly influenced innovation. In terms of origin, university spin-off firms determine the level of process, organizational and market innovation, while subsidiaries of existing companies only affect market innovation. The findings do not confirm the widespread view that innovation from spin-off companies is largely based on high-tech product innovation (Carayannis *et al*, 1998). The incubation environment may make a positive contribution to reversing the situation by helping to encourage product innovation.

Firm size has an influence on product and organizational innovation. Firms with up to 10 employees mostly innovate at product level and those with more than 26 employees essentially innovate at organizational level. But it was found that the more employees the greater the implementation of product and organizational innovation, which confirms the findings of other studies (Shefer & Frenkel, 2005). This supports the idea that micro- and small businesses can play an important role in innovation activities in their localities.

Practical Implications for Management

The literature on innovation in micro- and small enterprises in incubation facilities is fairly scarce. The entrepreneurs involved are usually operating on the basis of their experience, the successes and weaknesses of similar firms and on the support of the incubator when it comes to strategic decisions on innovation at the critical start-up phase. There are two implications for policy.

First, incubators, seen as a tool to facilitate entrepreneurship and innovation and dynamic in terms of adapting to change, are undoubtedly a good medium for stimulating the innovative activity of start-ups in all sectors, and especially firms in high-tech sectors such as ICT and biotechnology and health.

This research has shown that firms in incubation innovate in all realms, and that they are interdependent. It further shows that there is a need for an appropriate tool to measure innovation in particularly favorable environments where links to innovating networks are facilitated. Greater focus on these aspects could help to boost the product innovation rates of university spin-offs. Here, too, attention is drawn to the part played by incubator managers in helping and giving strategic guidance to businesses. This could lead to increasing market innovation.

Second, from an economic standpoint, the incentive to innovation provided by business incubators can be seen as a strategy to stimulate sustainable regional and national growth. The study also showed that R&D based innovation does not significantly determine innovative activity. Perhaps firms rely heavily on information from other sources like customers, suppliers, the incubator's management and the university associated with it. This is where governments can really help to strengthen relations between incubating firms, universities and other economic and social actors, and thereby stimulate innovation.

Future Research

The study was based on enterprises in Portuguese incubators without a defined sectoral orientation. It would be useful to extend the analysis to other European regions and undertake comparative studies to

pinpoint specific regional patterns of innovation. Such cross-country analyses would also enable conclusions to be drawn for European innovation policy regarding firms in incubation.

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