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Barriers to innovation activities as determinants of ongoing activities or abandoned

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Abstract

Purpose – This paper aims to analyse barriers as a determinant of ongoing or abandoned innovation activities. The literature exploits barriers as the nature of innovation and its influence on firm's. The main focus is the Portuguese SMEs and the impacts that act as barriers in the development of innovation activities.

Design/methodology/approach – The database was obtained through the Community Innovation Survey 2010 (CIS 2010) that was coordinated by EUROSTAT. In this sense, a logistic regression model is proposed, which makes it possible to analyse the relations between three or more variables, depending on whether the relationship is one of dependence or interdependence, thus allowing the application of distinct statistical techniques, using 6,160 firms

Findings – There are several sources of information that are associated with the development of innovation projects.

Practical implications – The importance of barriers to the development of innovation activities, as well as it being a decisive factor in the impediment to and abandon of the same, was noted.

Originality/value – This study also demonstrated that each case is different and that a barrier in one firm can at the same time be a window of opportunity for another firm.

Keywords SMEs, Barriers, Innovation activities, Abandoned activities, Ongoing activities

Paper type Research paper

1. Introduction

It is known that, to succeed, innovations depend on the ability of organizations to combine several factors that, consequently, generate challenges and obstacles and often result in failure, because innovation is seen as something positive for them. This is despite the fact that the activities of innovation often involve risk, with uncertain costs and without concrete guarantees in terms of returns (Koellinger, 2008; Ceccagnoli, 2009).

For these reasons, firms experience constant pressure, and with regard to innovation, the pressure is even higher, because the results have to appear as quickly as possible and with a high level of success. This is the only way in which firms become able to achieve growth and accompany the evolution of the market (Cainelli *et al.*, 2004, 2006). When an innovation is developed, it is necessary to be aware that this is a process that entails risks and uncertainties, as firms are exposed to obstacles, both internal and external, throughout the process. Accordingly, firms must not ignore these barriers but must manage them in the best way possible (Keizer *et al.*, 2002). Because the process of innovation is complex, owing to the



uncertainties and barriers, and requires a certain set of competencies, it is no surprise that many innovation projects are abandoned or placed on standby.

It can be noted that SMEs face greater barriers than other firms, requiring them to obtain more technological and external resources, making their search more intense than that of large firms owing to the interactivity that innovation instigates between SMEs (Rothwell, 1991). There is no easy way to identify the barriers. Sosna *et al.* (2010) believed that the templates for business innovation are a mechanism of renewal for firms in response to the changes that occur in environments outside their boundaries. Furthermore, Chesbrough (2010) related the templates for business innovation to the classical models of innovation, thus allowing the identification of opportunities and barriers to innovation.

For this reason, the responsiveness of firms to the challenges that they face differs from case to case. Thus, for the same or similar challenges, some enter routines instead of seeking solutions and others seek new solutions, new products or new technologies by investing in R&D, but they fail, as they do not evaluate and supersede the results in the most appropriate way. Normally this happens owing to their inability to distinguish between the different types of barriers and challenges that businesses face and evaluating them in the wrong way (D'Este *et al.*, 2012).

This article, using the data from the CIS (2010), intends to relate the existence of barriers to non-abandoned activities and justify why not all projects reach their conclusion and produce the results desired at their onset by conducting a statistical analysis.

After this brief presentation of the theme, the theoretical concepts and adequate literature on the topic will be reviewed. Then data from the CIS will be used to substantiate and justify the hypotheses presented, referring, in the end, to the conclusions obtained. This article provides a broad view of the reasons that lead to abandoned activities, allowing the identification of SMEs' greatest difficulties and, in this way, enabling them to improve their approach to their participation in innovation projects. There are no known earlier works examining the object of study presented in this research. Most of the works study barriers, but not as a determinant of ongoing or abandoned innovation activities. In other words, which are the main factors that influence the process of innovation on the Portuguese SMEs.

2. Literature review

One of the main issues encountered when investigating the theme of innovation, which is of great importance to the managers of top firms, is the barriers. For this reason, it is necessary to study the origin, the nature and the importance of each barrier. In addition, the influence, the consequences and the effects of each barrier in the process of innovation must be taken into account. Thus, these barriers can be classified in several ways, one of the most commonly used being to differentiate between internal barriers and external barriers in relation to organizations, in other words endogenous and exogenous barriers (Piatier, 1984).

The barriers may occur in one or several points of the innovation process. Different levels of implementation of innovation may have varying levels of results in this process. For example, financial difficulties will normally create more problems in the implementation phase of innovation. The assumption in the approach to the theme of barriers is that, from the moment that they are identified, the objective is to understand them, fight them and, if possible, eliminate them, so that innovation can follow its normal course (Tidd *et al.*, 1997).

In terms of the empirical literature on innovation, as happens with the CIS, which exploits the nature of innovation and its influence on firms, it is extensive and well consolidated. Two points have been emphasized in relation to the role of barriers in innovation: they may focus on the factors that affect the perception of the importance of barriers (Mohnen and Rosa, 2000; Baldwin and Lin, 2002; Iammarino *et al.*, 2009) or the influence of a barrier on

innovation and the intensity of innovation (Tourigny and Le, 2004; Mohnen and Röller, 2005; Mancusi and Vezzulli, 2010). Although these two points ultimately converge, the truth is that both fail to identify the nature of barriers to innovation in relation to how they are revealed and can dissuade, as well as the context in which barriers can coexist with innovation. In the majority of the available investigations, these tend to submit their data from a financial perspective, to the detriment of non-financial barriers, and do not always provide evidence for the obstacles that include non-financial issues, such as marketing and knowledge, which are central in the context of innovation policies and management (D'Este *et al.*, 2012).

Schumpeter (1934) began by developing the idea that entrepreneurs are agents of destructive creation by introducing new products. Later he indicated that, while the imperfections of capital markets favour large firms, SMEs are discouraged from innovating owing to the high costs and the barriers to entry (Schumpeter, 1942). Ortega-Argiles *et al.* (2009) reinforced this idea by stating that, comparing SMEs with large firms, the first have a gap in terms of financial assets, have weak powers and reduced capabilities, and are not able to benefit from economies of scale. On the other hand, they have many advantages, as they have greater flexibility, dynamism, efficiency and proximity to the market (Hewitt-Dundas, 2006). If we combine the sector size of SMEs, regardless of the economy, with the importance of the growth of innovation, we can observe that it is central to innovation in SMEs. The factors that cause delays and dropouts in SMEs deserve special attention, because, owing to the fact that their resources and capacities are limited, they may in turn further degrade these delays and cause abandonment of projects (Hewitt-Dundas, 2006). Tepic *et al.* (2013) argue that proficiency of innovation process execution, as well as the synergy between the firm resources and capabilities and the requirements of the innovation, is important for high innovation performance. Shepherd and Ahmed (2000) refer that the success of product and process innovation is warmly welcomed by a company to enhance their competitive advantage. Nicholas *et al.* (2011) affirm that one of the challenge that firms faced is that they currently lack a structure to integrate sustainability into business. Lack of financial resources, time, staff, technical expertise and organizational structures are barriers that SME owners typically to take on sustainability.

Panayides (2006) stated that instilling an innovation culture requires the investment of resources, especially managerial time, manifested by encouraging and targeting more frequent introduction of products and services in the marketplace, although, outcomes may not be readily apparent. Actually, intensive cooperation with partners was shown to enhance knowledge sharing and the creation of new knowledge that may be useful to all parties in the development of valuable innovations.

There are few studies about the failures of the determinant factors of innovation. Mohnen *et al.* (2008) analysed the influence of financial constraints on firms that decide to abandon innovation, stop prematurely, encounter difficulties or do not even start their innovation projects. In this work, the authors reported that the constraints on the financial level have a positive effect on a premature stop, a slowdown or the start of the project but do not have the same effect on the abandon of innovation projects. Another similar work is by Landry *et al.* (2008), who analysed failure in innovation. They studied a number of determinants of the failure of innovation projects, including variables related to the creation of knowledge based on R&D, the strategy of the firm's, external sources of knowledge, financing, obstacles to innovation, vulnerability and the degree of novelty of innovation. Of these variables, the authors reached the conclusion that the issues of funding and the development of innovation are the main obstacles to innovation. In terms of management and technology policies, the literature addressing the theme of R&D identifies several factors that justify why firms participate in R&D cooperation:

- the sharing of costs and risks;
- opportunities to complement and to share capacity;
- factors related to the absorption capacity; and
- the size of firms and experience in projects of joint research (Schartinger *et al.*, 2001; Veugelers and Cassiman, 2005; Okamuro, 2007; Lópes, 2008).

Becker and Dietz (2004) concluded that cooperation in R&D is used to complement internal resources in the innovation process, allowing a greater probability of developing new products.

Many researchers, such as Mohnen and Rosa (2000), Baldwin and Lin (2002) and Galia and Legros (2004), have taken account of several characteristics and variables of enterprises in work related to barriers to innovation. These characteristics are, among others, the size, sector, age, competitive environment and variables related to the activities of innovation, which include technological intensity, financial support for innovation, externalization of R&D activities, R&D expenses, introduction of technological innovation and novelties of innovation, among others. The firms that face problems in innovation, such as (among others) the size of the firm (Dahl and Moreau, 2002), activities related to R&D (Santamaria *et al.*, 2009), uncertain costs and lack of warranties of return on investment (Ceccagnoli, 2009), need, in most cases, to acquire skills and techniques through their customers and suppliers to overcome their shortcomings regarding their technological capabilities (Miotti and Sachwald, 2003). Hall and Martin (2005) and Hall *et al.* (2011) described the possible causes of the existence of barriers relating to technological issues, the commercial area, the organizational area and the social uncertainty, which normally originate from environmental changes such that the dynamics of firms or those of the markets into which they are inserted are obliged to follow (Barreto, 2010). In terms of consensual conclusions, there is the fact that firm's need to take into account the perception of a heterogeneous range of characteristics and variables, and in this way, assess the obstacles to innovation properly.

Mohnen and Röller (2005) and Löf and Heshmati (2006) analysed the influence that the obstacles to innovation have on their own innovation. In these works, these obstacles were measured through R&D, innovation activities or the results of innovation, noting that the obstacles to innovation have a positive effect on their own innovation. However, these results cannot be considered conclusive, because there are common factors that affect either the innovation or the obstacles to innovation. Savignac (2008), Tiwari *et al.* (2008), Hajivassiliou and Savignac (2011) and Blanchard *et al.* (2013) focused their work on the effect of limitations to financing and observed that these obstacles have a negative effect on innovation. Some of these studies focused on markets close to Portugal, as they tackled the French and European markets. Brancati (2015) stated that the literature addressing the theme on the financial constraints to innovations is vast but inconclusive. The question of financing is important when talking about barriers, because, in the absence of financial resources, firms begin a process of rationing of resources that leads to the various types of barriers being weighted (Brancati, 2015). Koziot *et al.* (2015) stressed the importance of customers and other participants at the market level in relation to cooperation aimed at the creation of innovations. Villareal and Calvo (2015) highlighted the importance of sources of funding, technical assistance and support to the establishment of businesses as determinants of success while creating an environment that is conducive to innovation.

Hueske *et al.* (2015), in their work, concluded that the environments in which firms are situated can be a factor of barriers to innovation. For example, owing to the financial crisis that emerged some years ago, product development processes involve high costs; in particular, the technological and commercial barriers are factors that hinder innovation, as

well as issues concerning the financial capacity of the undertakings themselves (Deeds, 2001; Hall and Martin, 2005; Kranich, 2008). In addition to financial matters, Hueske *et al.* (2015) concluded that the lack of capacity of human resources is a barrier that firms cannot always overcome. Issues such as emerging industries and social uncertainties were also pointed out as being deterrents to innovation. This means that factors that are external to the enterprise can be one of the greatest obstacles to innovation projects in progress and may even lead to their abandon.

Hueske *et al.* (2015) mentioned in their work that if firms manage, in terms of their organization, to identify the barriers in good time, they have more chances of facing them and finding solutions capable of overcoming them, implementing greater dynamics in the process. These authors also reported that limiting the analysis in terms of strategy, structure and resources disregards and negatively influences the organizational level, the level of learning or the cultural level of the organization. Hence, it is fundamental that firms that have better innovation have a greater capacity to identify the barriers and thereby to achieve better preparations (Silva *et al.*, 2008). Silva *et al.* (2008) highlighted in their work that the barriers such as the high cost of innovation, lack of funding, organizational rigidity, lack of qualified personnel, lack of market information, government regulations and lack of customer response are variables that hinder and restrict the development of innovation activities, implying that firms feel less impelled to innovate. Bowers and Khorakian, (2014) studied the market of Iran and concluded by the interviewees from all of the companies studied, as all agreed, that innovation always entails risk. Some of them recognised a need to manage risk more explicitly. Companies also refer that when various actions are undertaken that are consistent with good risk management, these actions typically involve resolving specific technical problems rather than considering project risk management in a systematic manner. With regard to the work of Ortt *et al.* (2008), we can see that a disadvantage of contextual innovation may be that having different approaches to innovation management within a single company may make innovation processes within that company more difficult. An example of that is when a lead customer-driven approach (e.g. business units of Philips operating in business markets) is incompatible with a technology push (e.g. incubators at Philips).

More recent studies have provided evidence of barriers that explain why firms are unable to put the ideas that they conceive into practice, namely, the lack of capacity in terms of internal efficiency, technical support, protection of innovation and lack of ability of human resources (Najda-Janoszka and Kopera, 2014; Meijer, 2015). The question of the lack of investment in R&D concerns the technological level, in that the level of human resources is caused mainly by a lack of financing, a lack of knowledge or the relationship between the size of the firm and the development of innovation, which does not always correspond to reality (Song and Oh, 2015; Yu *et al.*, 2015).

With regard to the work of Hadjimanolis (1999) and Barrau (2000), we can see the set of barriers to innovation that exist and the number of obstacles that deter firms from continuing with their innovation projects.

Next a summary table is presented showing the main types of barriers to innovation, which complements what is advocated by several authors, as well as dividing the barriers into internal barriers (endogenous) and external barriers (exogenous), as the resources and capacities of undertakings are a pivotal factor in acquiring a competitive advantage (Avermaete *et al.*, 2003; Silva, 2003; Barbosa, 2006).

Thus, based on the literature review performed on the data in CIS 2010, the hypotheses were formulated and are presented in the following tables, and also presented the relation between each factor/variable and authors (Tables I-III).

| Factors/variables | Authors |
|---|---|
| <i>Economic factors</i> | |
| Lack of funds within your enterprise or group | Schumpeter (1942), Ortega-Argiles <i>et al.</i> (2009), Mohnen <i>et al.</i> (2008), Landry <i>et al.</i> (2008), Mohnen and Rosa (2000), Baldwin and Lin (2002), Galia and Legros (2004), Silva <i>et al.</i> (2008), Najda-Janoszka and Kopera (2014), and Meijer 2015 |
| Lack of finance from sources outside your enterprise | Schumpeter (1942), Ortega-Argiles <i>et al.</i> (2009), Mohnen <i>et al.</i> (2008), Landry <i>et al.</i> (2008), Savignac (2008), Tiwari <i>et al.</i> (2008), Hajivassiliou and Savignac (2011), and Blanchard <i>et al.</i> (2013) |
| Innovation costs too high | Schumpeter (1942), Ortega-Argiles <i>et al.</i> (2009), Mohnen <i>et al.</i> (2008), Landry <i>et al.</i> (2008), Brancati (2015), Silva <i>et al.</i> (2008), Ceccagnoli (2009), and Okamuro (2007) |
| <i>Knowledge factors</i> | |
| Lack of qualified personnel | D'Este <i>et al.</i> (2012), Baldwin and Lin (2002), Galia and Legros (2004), and Silva <i>et al.</i> (2008) |
| Lack of information on technology | D'Este <i>et al.</i> (2012), Nicholas <i>et al.</i> (2011), Mohnen and Rosa (2000), Baldwin and Lin (2002), Galia and Legros (2004), Hueske <i>et al.</i> (2015), Deeds (2001), Hall and Martin (2005); Kranich (2008), and Okamuro (2007) |
| Lack of information on markets | D'Este <i>et al.</i> (2012), Hall and Martin (2005), Hall <i>et al.</i> (2011), Barreto (2010), and Silva <i>et al.</i> (2008) |
| Difficulty in finding cooperation partners for innovation | Panayides (2006), Landry <i>et al.</i> (2008), Najda-Janoszka and Kopera (2014), Meijer (2015), Villareal and Calvo (2015), Koziot <i>et al.</i> (2015), and Okamuro (2007) |
| <i>Market factors</i> | |
| Market dominated by established enterprises | Hewitt-Dundas (2006), Nicholas <i>et al.</i> (2011), Panayides (2006), Hall and Martin (2005), Hall <i>et al.</i> (2011), and Barreto (2010) |
| Uncertain demand for innovative goods or services | D'Este <i>et al.</i> (2012), Hewitt-Dundas (2006), Shepherd and Ahmed (2000), Panayides (2006), Hall and Martin (2005), Hall <i>et al.</i> (2011), Barreto (2010), Mohnen and Röller (2005), and Löf and Heshmati (2006) |
| <i>Reasons to innovate</i> | |
| No need due to prior innovations by your enterprise | Schumpeter (1934), Tepic <i>et al.</i> (2013), Mohnen and Rosa (2000), Baldwin and Lin (2002), Galia and Legro (2004), Hall and Martin (2005), Hall <i>et al.</i> (2011), Barreto (2010), Hueske <i>et al.</i> (2015), Najda-Janoszka and Kopera (2014), Meijer (2015), Song and Oh (2015), Yu <i>et al.</i> (2015), Hadjimanolis (1999), and Barrau (2000) |
| No need because of no demand for innovations | Schumpeter (1934), Tepic <i>et al.</i> (2013), Mohnen and Rosa (2000), Baldwin and Lin (2002), Galia and Legros (2004), Hall and Martin (2005), Hall <i>et al.</i> (2011), Barreto (2010), Hueske <i>et al.</i> (2015), Hadjimanolis (1999), and Barrau (2000) |

Table I.
Barriers to innovation

3. Research design

3.1 Sample and questionnaire

This work was carried out with the support of the CIS (2010), as it is the main statistical survey on innovation in enterprises and is mandatory in the member states of the EU (CIS methodological, 2010). These data are the most complete survey about the Portuguese firms, not only because it is mandatory but also because it is the one that encompasses most variables of barriers and allows a study to be more complete. Otherwise, it would be very difficult to obtain such a complete data of Portuguese SMEs. The operations of the CIS are based on a conceptual framework laid down in the *Oslo Manual* and Eurostat's methodological recommendations (CIS Methodological, 2010).

To obtain the sample from the CIS (2010), 9,245 inquiries were sent to the total of 24,772 universe firms. In this work, 6,160 firms were considered, covering the entire available data. The

Table II.
Hypotheses to
abandoned innovation
activities

| Hypothesis | Explanatory variables | Code | Dependent variable |
|---|---|---------|-------------------------------------|
| <i>H1A.</i> The lack of funds within your enterprise or group is negatively related with the propensity of the firm not to abandon the activities of innovation | Lack of funds within your enterprise or group | Hfent1 | Innovation activities not abandoned |
| <i>H1B.</i> The lack of finance from sources outside your enterprise is negatively related with the propensity of the firm not to abandon the activities of innovation | Lack of finance from sources outside your enterprise | Hfout1 | |
| <i>H1C.</i> The Innovation costs too high are negatively related with the propensity of the firm not to abandon the activities of innovation | Innovation costs too high | Hcost1 | |
| <i>H1D.</i> The lack of qualified personnel is negatively related with the propensity of the firm not to abandon the activities of innovation | Lack of qualified personnel | Hper1 | |
| <i>H1E.</i> The lack of information on technology is negatively related with the propensity of the firm not to abandon the activities of innovation | Lack of information on technology | Htec1 | |
| <i>H1F.</i> The lack of information on markets is negatively related with the propensity of the firm not to abandon the activities of innovation | Lack of information on markets | Hinf1 | |
| <i>H1G.</i> The difficulty in finding cooperation partners for innovation is negatively related with the propensity of the firm not to abandon the activities of innovation | Difficulty in finding cooperation partners for innovation | Hpar1 | |
| <i>H1H.</i> The market dominated by established enterprises is negatively related with the propensity of the firm not to abandon the activities of innovation | Market dominated by established enterprises | Hdom1 | |
| <i>H1I.</i> The uncertain demand for innovative goods or services is negatively related with the propensity of the firm not to abandon the activities of innovation | Uncertain demand for innovative goods or services | Hdem1 | |
| <i>H1J.</i> No need due to prior innovations by your enterprise is negatively related with the propensity of the firm not to abandon the activities of innovation | No need due to prior innovations by your enterprise | Hprior1 | |
| <i>H1K.</i> No need because of no demand for innovations is negatively related with the propensity of the firm not to abandon the activities of innovation | No need because of no demand for innovations | Hmar1 | |

target population, in which this work relates, includes the companies located in the Portuguese territory, with the minimum of ten persons employed, for sectors of industry and services. It should be noted that six in every ten companies, performed activities of innovation, being respectively 67 and 56.4 per cent in the services sector and industry of all firms (CIS Methodological, 2010). Two variables were used as control variables: CAE (CAE2_COD) and SIZE (SIZE_COD). These control variables were chosen owing to the fact that, regardless of the CAE (sector of activity), innovation is a factor of differentiation that all firms aim to explore; as for size (scale), the choice of this control variable relates to the fact that, in addition to being one of the most used in terms of innovation studies, the work itself focuses on national SMEs. In relation to missing values, where no answers were provided, the procedure adopted was to regard them as “irrelevant” responses.

Concerning the inquiry of the CIS (2010), this work took into account Question 4.1, relating to ongoing activities or abandoned in product and process innovation, and Question 8.1, regarding the degree of importance of the factors that prevented innovation activities or projects.

| Hypothesis | Explanatory variables | Code | Dependent variable |
|--|---|---------|-------------------------------|
| H2A. The lack of funds within your enterprise or group is negatively related with the propensity of the firm to maintain ongoing innovation activities | Lack of funds within your enterprise or group | Hfent1 | Ongoing innovation activities |
| H2B. The lack of finance from sources outside your enterprise is negatively related with propensity of the firm to maintain ongoing innovation activities | Lack of finance from sources outside your enterprise | Hfo ut1 | |
| H2C. The Innovation costs too high are negatively related with the propensity of the firm to maintain ongoing innovation activities | Innovation costs too high | Hcost1 | |
| H2D. The lack of qualified personnel is negatively related with the propensity of the firm to maintain ongoing innovation activities | Lack of qualified personnel | Hper1 | |
| H2E. The lack of information on technology is negatively related with the propensity of the firm to maintain ongoing innovation activities | Lack of information on technology | Htec1 | |
| H2F. The lack of information on markets is negatively related with the propensity of the firm to maintain ongoing innovation activities | Lack of information on markets | Hinf1 | |
| H2G. The difficulty in finding cooperation partners for innovation is negatively related with the propensity of the firm to maintain ongoing innovation activities | Difficulty in finding cooperation partners for innovation | Hpar1 | |
| H2H. The market dominated by established enterprises is negatively related with the propensity of the firm to maintain ongoing innovation activities | Market dominated by established enterprises | Hdom1 | |
| H2I. The uncertain demand for innovative goods or services is negatively related with the propensity of the firm to maintain ongoing innovation activities | Uncertain demand for innovative goods or services | Hdem1 | |
| H2J. No need due to prior innovations by your enterprise is negatively related with the propensity of the firm to maintain ongoing innovation activities | No need due to prior innovations by your enterprise | Hprior1 | |
| H2K. No need because of no demand for innovations is negatively related with the propensity of the firm to maintain ongoing innovation activities | No need because of no demand for innovations | Hmar1 | |

Table III.
Hypotheses to ongoing innovation activities

Tables IV and V present abandoned activities and ongoing activities, briefly describing all the variables that enter the process of analysis used to test the hypothesis formulated.

3.2 Measures and method: logistic regression

It was decided to use multivariate statistical analysis, which makes it possible to analyse the relations between three or more variables, depending on whether the relationship is one of dependence or interdependence, thus allowing the application of distinct statistical techniques (Hair *et al.*, 2006; Hill and Hill, 2009).

Regardless of the analysis presented, it concerns the presence of dichotomous variables, which induce the use of logistic regression analysis, because the objective is to study a dependent variable in relation to more than one explanatory variable (Murteira, 1993; Pestana and Gageiro, 2003). Hill and Hill (2009, p. 208) referred to logistic regression as a technique that enables researchers to:

| Model 1 | Variables | Code | Measures | Type | Hypotheses |
|----------------------|---|---------|--|---------------------|------------|
| Dependent variable | Abandoned Activities | AA | Binary: 1 = The firm has not abandoned the activities in innovation 0 = The firm has abandoned the activities in innovation | Dichotomic | |
| Independent variable | Lack of funds within your enterprise or group | Hfent1 | 1 = The firm percept barriers in the development of its activities of innovation 0 = The firm don't percept barriers in the development of its activities of innovation | Discrete/ binary | <i>H1A</i> |
| | Lack of finance from sources outside your enterprise | Hfout1 | | | <i>H1B</i> |
| | Innovation costs too high | Hcost1 | | <i>H1C</i> | |
| | Lack of qualified personnel | Hper1 | | <i>H1D</i> | |
| | Lack of information on technology | Htec1 | | <i>H1E</i> | |
| | Lack of information on markets | Hinf1 | | <i>H1F</i> | |
| | Difficulty in finding cooperation partners for innovation | Hpar1 | | <i>H1G</i> | |
| | Market dominated by established enterprises | Hdom1 | | <i>H1H</i> | |
| | Uncertain demand for innovative goods or services | Hdem1 | | <i>H1I</i> | |
| | No need due to prior innovations by your enterprise | Hprior1 | | <i>H1J</i> | |
| | No need because of no demand for innovations | Hmar1 | | <i>H1K</i> | |

Table IV.
Variables and hypothesis of the model to abandoned innovation activities

[...] realize what differentiates two groups of cases, i.e. what differentiates the two levels of a dependent variable of the dichotomy, on the basis of a set of independent variables.

According to that which has been previously defined, variable is binary, which assumes a value equal to 1, if the firm not abandoned innovation activity, or a value equal to 0, if the firm has abandoned innovation activities. The binary data are very common among the several types of categorical data, and their modelling is part of the linear regression models' category (McCullagh and Nelder, 1989). The logistic regression model is the most common one (Ferrão, 2003), in terms of the way it facilitates the substantive interpretation of parameters. Thus, logit regression is an approach used in studies of innovation capability factors (Kaufmann and Tödting, 2000, 2001; Silva, 2003; Silva *et al.*, 2005). In this sense, a logistic regression model for innovative advances is proposed, using dichotomic independent variables, where ε_i represents the residual term. The estimation process is based on the maximum likelihood procedure and takes into consideration the following model specification.

For this work we considered as dependent variables the variable "ongoing activity" and the variable "activities not abandoned", which will be represented by the letter "A". The data come

| Model 1 | Variables | Code | Measures | Type | Hypotheses |
|----------------------|---|---------|---|---------------------|------------|
| Dependent Variable | Ongoing activities | AC | <i>Binary</i> : 1 = The Firm maintained ongoing activities in innovation 0 = The firm has not kept in progress in innovation activities | Dichotomic | |
| Independent variable | Lack of funds within your enterprise or group | Hfent1 | 1 = The firm percept barriers in the development of its activities of innovation | Discrete/ binary | H2A |
| | Lack of finance from sources outside your enterprise | Hfout1 | 0 = The firm don't percept barriers in the development of its activities of innovation | | H2B |
| | Innovation costs too high | Hcost1 | | | H2C |
| | Lack of qualified personnel | Hper1 | | | H2D |
| | Lack of information on technology | Htec1 | | | H2E |
| | Lack of information on markets | Hinf1 | | | H2F |
| | Difficulty in finding cooperation partners for innovation | Hpar1 | | | H2G |
| | Market dominated by established enterprises | Hdom1 | | | H2H |
| | Uncertain demand for innovative goods or services | Hdem1 | | | H2I |
| | No need due to prior innovations by your enterprise | Hprior1 | | | H2J |
| | No need because of no demand for innovations | Hmar1 | | | H2K |

Table V.
Variables and hypothesis of the model to ongoing innovation activities

from a stratified sample. Also considered in the model were the variables' dimensions – size – and sector of activity – CAE. The introduction of these variables was intended to check whether the explanatory variables kept the same behaviour in terms of both the magnitude of the point estimate of parameters and the significance. The independent variables related to the barriers were denoted in the model by the letter “B”.

In this way, the following was built to present the logistic regression model:

$$A_i = \beta_0 + \beta_1 B_1 + \beta_2 B_2 + \beta_3 B_3 + \beta_4 B_4 + \beta_5 B_5 + \beta_6 B_6 + \beta_7 B_7 + \beta_8 B_8 + \beta_9 B_9 \\ + \beta_{10} B_{10} + \beta_{11} B_{11} + \varepsilon_i$$

Where:

- A_i = type of activity;
- β = coefficient;
- B_i = barrier; and
- ε_i = residuum.

In this work, the statistical software that served as the basis for the statistical analysis of the data was the SPSS (Statistical Package for the Social Sciences) in version 20.0 for Windows, because, according to Quivy and Campenhoudt (1992), it is the most recommended software to use in the study of correlations between phenomena.

The estimation procedure followed in this work was the maximum verisimilitude, not only because it is the most used and the most important method (Garthwaite, 1995) but also because the “[...] estimators produced by it have the properties desired, namely: statistics, unbiased estimator consistency and efficiency [...]” (Garthwaite, 1995).

4. Data analysis and discussion of the results

In this section, the independent variables take the form of dichotomous variables owing to the fact that the objective of the present study consists of the analysis of the influence on the abandon or the ongoing innovation activities. Thus, for this study, two groups of variables were formed: yes and no. The “yes” group encompasses three categories of importance, namely, high, medium and low. The “no” group contains the category irrelevant. Concerning the database, it emphasizes the fact that the study did not contemplate the classification into which the same are subdivided; that is, it did not take into account the fact that the independent variables are grouped into economic factors, factors of knowledge, market factors and reasons not to innovate, because the objective is to analyse the influence of each variable individually.

4.1 Abandoned activities

The study began by building the logistic regression model for the dependent variable innovation – activities not abandoned. The model was tested first only for the innovation activities not abandoned with the independent variables and then with the control variables size (size) and sector of activity (CAE) together. With regard to the discussion of the results, the analysis will refer first to the innovation activities not abandoned without the control variables and subsequently it will include the control variables. In relation to the results, and as this work concerns barriers to innovation activities not abandoned, they must be considered as barriers to the dependent variables with a positive signal.

Analysing the quality of the fit of the final model, first for the model without the control variables and then for the model with the control variables, determines that the predictive capacity of the model is 91.5 per cent (Table VI); that is, this value is the result of the comparison between the values of the response variable predicted by the model and the observed values.

Table VI notes that the chi-square test shows the value of 144.407 with a value of proof below the 5 per cent level of significance. Regarding the statistical log-verisimilitude, it has a value of 3,435.574, meaning that it corroborates the global significance of the model in comparison with the null model (Table VI). These data relate to the model of the innovation activities not abandoned without the control variables, as, after the introduction of the control variables (Model B), the conclusions are the same, only differing in the values of the chi-square and log-verisimilitude of, respectively, 415.792 and 3,164.189 (Table VI).

As observed in Table VI, the Wald test statistic was used at the significance level of 5 per cent. In the same framework, observing the estimates of the regression parameters for the model without the control variables, it can be noted that the variables: *Lack of funds within your enterprise or group* (Hfent1), *Lack of finance from sources outside your enterprise* (Hfout1), *Innovation costs too high* (Hcos1), *Difficulty in finding cooperation partners for innovation* (Hpar1) and *No need because of no demand for innovations* (Hmar1) are statistically significant. In terms of the weights of the variables in the model, respectively, the

| | Model A – Without control variables | | | Model B – With control variables | | |
|----------------------|-------------------------------------|-------------|---------|----------------------------------|-------------|---------|
| | Estimated coefficients | Value proof | EXP (B) | Estimated coefficients | Value proof | EXP (B) |
| Hfent1 | 0.498 | 0.010 | 1.645 | 0.542 | 0.006 | 1.720 |
| Hfout1 | -0.552 | 0.000 | 0.576 | -0.367 | 0.028 | 0.693 |
| Hcost1 | 0.978 | 0.000 | 2.660 | 0.812 | 0.001 | 2.253 |
| Hper1 | 0.203 | 0.339 | 1.225 | 0.195 | 0.377 | 1.215 |
| Htec1 | 0.328 | 0.155 | 1.389 | 0.395 | 0.104 | 1.485 |
| Hinf1 | 0.008 | 0.970 | 1.008 | -0.043 | 0.844 | 0.958 |
| Hpar1 | 0.312 | 0.038 | 1,366 | 0.230 | 0.140 | 1.258 |
| Hdom1 | 0.278 | 0.149 | 1.321 | 0.386 | 0.056 | 1.471 |
| Hdem1 | 0.146 | 0.479 | 1.158 | -0.012 | 0.954 | 0.988 |
| Hprior1 | -0.101 | 0.547 | 0,904 | -0.127 | 0.474 | 0.881 |
| Hmar1 | -0.418 | 0.016 | 0.658 | -0.309 | 0.092 | 0.734 |
| Constant | -3,873 | 0.000 | 0.021 | -4.189 | 0.000 | 0.015 |
| <i>Model summary</i> | | | | | | |
| Correct predict (%) | 91.5 | | | 91.5 | | |
| Chi-square | 144.407 | 0.000 | | 415.792 | 0.000 | |
| Log likelihood | 3,435.574 | | | 3,164.189 | | |
| Number of cases (n) | 6,160 | | | 6,133 | | |

Table VI. Results of the logistic regression for abandoned innovation activities

largest to the smallest weight, as evidenced by the value of Exp (B), are *Innovation costs too high* (Hcos1), *Lack of funds within your enterprise or group* (Hfent1), *Difficulty in finding cooperation partners for innovation* (Hpar1), *No need because of no demand for innovations* (Hmar1) and *Lack of finance from sources outside your enterprise* (Hfout1), with the respective values of 2.660, 1.645, 1.366, 0.658 and 0.576.

Of the five variables, three have a significant and positive effect: Hcos1, Hfent1 and Hpar1. That is, they reject the null hypotheses, therefore corroborating *H1C*, *H1A* and *H1G*. Respectively, the point estimates are 0.978, 0.498 and 0.312. In other words, *Innovation costs too high*, *Lack of funds within your enterprise or group* and difficulty in finding cooperation partners for innovation are factors that lead firms to abandon their innovation activities. On the other hand, with a significant but negative effect, there are the variables *No need because of no demand for innovations* (Hmar1) and *Lack of finance from sources outside your enterprise* (Hfout1), with the first having more weight in the model than the second, as, respectively, the values of the parameters Exp (b) are 0.658 and 0.576, and the point estimates are -0.418 and -0.552. This means that these variables that consider innovation *No need because of no demand for innovations* and *the lack of finance from sources outside your enterprise*, that are not barriers. These do not lead to the abandonment of innovation activities and therefore appear not as barriers to but as drivers of innovation. Thus, as they did not reject the null hypothesis, these variables did not confirm *H1K* and *H1B* (Table VI).

As observable in Table VI, to examine the estimates of the regression parameters for the model with the control variables, with the introduction of the variables size and sector of the firm, the results differ from the previous model, because only three variables are significant. Of these, two are positive, Hfent1 and Hcost1, and one has a negative signal, Hfout1; they are statistically significant at the 5 per cent level. The importance in terms of their weight in the final model is *Innovation costs too high* (Hcos1) (2,253), *Lack of funds within your enterprise or group* (Hfent1) (1,720) and *Lack of finance from sources outside your enterprise* (Hfout1) (0.693), respectively in terms of the point estimates of the associated parameters, they are, respectively, 0.812, 0.542 and -0.367. A level of significance with a positive signal means

| | Model A—Without control variables | | | Model B—With control variables | | |
|----------------------|-----------------------------------|-------------|---------|--------------------------------|-------------|---------|
| | Estimated coefficients | Value proof | EXP (B) | Estimated coefficients | Value proof | EXP (B) |
| Hfent1 | 0.199 | 0.105 | 1.220 | 0.295 | 0.025 | 1.343 |
| Hfout1 | -0.190 | 0.093 | 0.827 | -0.061 | 0.624 | 0.941 |
| Hcost1 | 0.914 | 0.000 | 2.494 | 0.762 | 0.000 | 2.143 |
| Hper1 | 0.355 | 0.007 | 1.427 | 0.382 | 0.008 | 1.465 |
| Htec1 | -0.379 | 0.010 | 0.685 | -0.349 | 0.028 | 0.706 |
| Hinfl | 0.301 | 0.030 | 1.352 | 0.316 | 0.033 | 1.372 |
| Hpar1 | 0.531 | 0.000 | 1.701 | 0.426 | 0.000 | 1.531 |
| Hdom1 | -0.353 | 0.003 | 0.703 | -0.254 | 0.045 | 0.776 |
| Hdem1 | 0.552 | 0.000 | 1.736 | 0.509 | 0.000 | 1.664 |
| Hprior1 | -0.237 | 0.029 | 0.789 | -0.338 | 0.004 | 0.713 |
| Hmar1 | -0.642 | 0.000 | 0.526 | -0.489 | 0.000 | 0.613 |
| Constant | -2.251 | 0.000 | 0.105 | -1.306 | 0.000 | 0.271 |
| <i>Model summary</i> | | | | | | |
| Correct predict (%) | 77.9 | | | 80.0 | | |
| Chi-square | 333.487 | 0.000 | | 1,046.599 | 0.000 | |
| Log likelihood | 6,165.100 | | | 5,451.987 | | |
| Number of cases (n) | 6,118 | | | 5,641 | | |

Table VII.
Results of the logistic regression for ongoing innovation activities

that costs of innovation are too high, and lack of funds within your enterprises or group is a factor that acts as a barrier and as such leads firms to abandon their innovation activities, leading to us rejecting the null hypothesis, and therefore corroborating *H1C* and *H1A*. On the other hand, lack of funding has the opposite signal, which means that it is not a barrier and as such does not motivate the abandon of innovation activities; consequently, we accept the null hypothesis, rejecting *H1B*.

4.2 Ongoing activities

With this information, the model of logistic regression was built for the dependent variable ongoing activity. The model for the activities in progress with only the independent variables was tested first and then the model with the control variables size (size) and sector of activity (CAE). With regard to the discussion of the results, the analysis will refer first to ongoing activities without the control variables and subsequently it will include the control variables.

With regard to Nunes (2008) and Silva *et al.* (2008), the results with negative parameters should be considered as barriers when the dependent variable is innovation. In relation to the results, concerning barriers to ongoing innovation activities, the dependent variables with a positive signal should be considered as barriers.

Analysing the quality of the fit of the final model verifies that the predictive capacity of the model is 77.9 and 80 per cent, respectively, without and with the control variables (Table VII); this value is the result of the comparison between the values of the response variable predicted by the model and the observed values.

Table VII notes that the chi-square test shows the value of 333.487 with a value of proof below the level of significance of 5 per cent. Regarding the statistical log-verisimilitude, it has a value of 66,165.100, corroborating the global significance of the model in comparison with the null model (Table VII). These data relate to the model, that is, ongoing activities without control variables, and after the introduction of the control variables, the conclusions are the

same, differing only in the values of chi-square and log-verisimilitude of, respectively, 1,046.599 and 5,451.987 (Table VII).

As test statistics, we used the Wald statistic, at the 5 per cent significance level (Table VII). It is observed through the estimates of the regression parameters for the model without the control variables that, with the exception of the variables Hfent1 – *Lack of funds within your enterprise or group* – and Hfout1 – *a lack of finance from sources outside your enterprise*, are all statistically significant. These, by order in terms of the weight of variables in the model, as evidenced by the value of Exp (B), are respectively from the largest to the smallest weight:

- *Innovation costs too high* (Hcos1) (2.494);
- *Uncertain demand for innovative goods or service* (Hdem1) (1.736);
- *Difficulty in finding cooperation partners for innovation* (Hpar1) (1.701);
- *Lack of qualified personnel* (Hper1) (1.427);
- *Lack of information on markets* (Hinf1) (1.352);
- *No need due to prior innovations by your enterprise* (Hprior1) (0.789);
- *Market dominated by established enterprises* (Hdom1) (0.703);
- *Lack of information on technology* (Htec1) (0.685); and
- *No need because of no demand for innovations* (Hmar1) (0.526).

Accordingly, it is verified that all the variables have a significant effect, some with a positive effect and some with a negative effect. The variables *Innovation costs too high* (Hcos1), *Uncertain demand for innovative goods or services* (Hdem1), *Difficulty in finding cooperation partners for innovation* (Hpar1), *Lack of qualified personnel* (Hper1) and *Lack of information on markets* (Hinf1) have a positive effect, which lead us to accept the null hypotheses, rejecting H2C, H2I, H2G, H2D and H2F. Respectively, the point estimates are 0.194, 0.552, 0.531, 0.355 and 0.301. These results indicate that these are the factors related to *Innovation costs too high*, *Uncertain demand for innovative goods or services*, *Lack of qualified personnel*, *Difficulties in finding cooperation partners for innovation* and *Lack of information on markets* that contribute more often to firms retaining their innovation activities. With a negative signal are the variables *No need due to prior innovations by your enterprise* (Hprior1), *Market dominated by established enterprises* (Hdom1), *Lack of information on technology* (Htec1) and *No need because of no demand for innovations* (Hmar1), respectively, with the estimates of -0.237 , -0.353 , -0.379 and -0.642 . These variables indicate that these factors are not obstructive to the maintenance of ongoing activities, that is, factors such as *No need due to prior innovations by your enterprise*, *Market dominated by established enterprises*, *Lack of information on technology* and the fact that *No need because of no demand for innovations*, lead to them not being considered as barriers to ongoing activities. Thus, we reject the null hypotheses, the provisional H2J, H2H, H2E and H2K, for these variables.

Observing the estimates of the regression parameters for the model with the control variables (Table VII), we note that the results are similar to those of the previous model without the control variables, only varying in the fact that, instead of there being five significant and positive variables, there are now six, of which the order in terms of weight in the final model, from the largest to the smallest, is *Innovation costs too high* (Hcos1) (2.143), *Uncertain demand for innovative goods or services* (Hdem1) (1.664), *Difficulty in finding cooperation partners for innovation* (Hpar1) (1.531), *Lack of qualified personnel* (Hper1) (1.465), *Lack of information on markets* (Hinf1) (1.372) and *Lack of funds within your*

enterprise or group (Hfent1) (1.343), with the estimates of, respectively, 0.762, 0.509, 0.426, 0.382, 0.316 and 0.295. Consequently, we can say that the factors that are included are *Innovation costs too high*, *Uncertain demand for innovative goods or services*, *Difficulties in finding cooperation partners for innovation*, *Lack of qualified personnel*, *Lack of information on markets* and *Lack of funds within your enterprise or group*. These contribute many times to firms not retaining their innovation activities. This analysis leads us to accept the null hypotheses, rejecting *H2C*, *H2I*, *H2G*, *H2D*, *H2F* and *H2A*. As regards the remaining variables that are statistically significant at the 5 per cent level and have a negative effect, they are the same as in the model without the influence of the control variables size and CAE, varying only in the order and in the weight that each one has in the model. Thus, from more influence to less influence, they are *Market dominated by established enterprises* (Hdom1) (0.776), *No need due to prior innovations by your enterprise* (Hprior1) (0.713), *Lack of information on technology* (Htec1) (0.706) and *No need because of no demand for innovations* (Hmar1) (0.613), with the estimates of -0.254 , -0.338 , -0.349 and -0.489 , respectively. In this way, we can reject the null hypotheses, meaning that we cannot confirm *H2H*, *H2J*, *H2E* and *H2K* for these variables. This indicates that these variables do not obstruct the maintenance of ongoing activities; that is, factors such as the *Market dominated by established enterprises*, *No need due to prior innovations by your enterprise*, *Lack of information on technology* and *No need because of no demand for innovations*, lead to ongoing activities being maintained.

4.3 Synthesis and discussion of the results

This research proposed a logistic regression model based on two dependent variables that are related to 11 independent variables concerning the factors that hamper innovation activities, in other words, obstacles to innovation that prevent firms from maintaining their progress or that have been the reason for which SMEs have abandoned their innovation projects. To achieve this goal, the data were obtained through the database CIS (2010 (CIS, 2010) and analysed statistically. Thus, in a very brief summary, we present the main conclusions below.

The results obtained by means of the logistic regression model indicate that firms abandon their projects particularly for two reasons: *Lack of funds within your enterprise or group* and *Innovation costs too high*. As the factors causing firm's retaining their ongoing activities are *Innovation costs too high*, the *Uncertain demand for innovative goods or services*, *Difficulties in finding cooperation partners for innovation*, *Lack of qualified personnel*, *Lack of information on markets* and the *Lack of funds within your enterprise or group*.

Because there are no known earlier works examining the object of study presented in this research, it is difficult to present works that have performed the same type of testing and validation and obtained results on the matter investigated in this work. Notwithstanding this fact, there are studies that have discussed the theme in question, although from different perspectives. It may be observed that the results in some way corroborate those obtained here, such as those of Nunes (2008), who concluded that the lack of financing from external sources is a barrier to innovation; Silva *et al.* (2008), who claimed that the high costs of innovation and the lack of funding sources are barriers to firm's ability to innovate; García-Vega and Lopes (2010), who stated that the factors related to the lack of funding, market factors and factors of knowledge are the main factors that preclude the development of innovations; and Radas and Bozic (2013), who argued that the low level of resources and capacities contributes to the development of problems, which lead to the creation of barriers,

giving as examples the lack of financial resources and financing as well as the high costs of innovation.

5. Conclusion

This research generally supports the literature presented. The importance of barriers to the development of innovation activities was noted, as well as being a decisive factor in the impediment to and abandon of the same. This study also demonstrated that each case is different and that a barrier in one firm can at the same time be a window of opportunity in another firm.

The results obtained indicate that firms abandon their projects particularly for two reasons:

- (1) *Lack of funds within your enterprise or group.*
- (2) *Innovation costs too high.*

As the factors causing firm's retaining their ongoing activities are *Innovation costs too high*, the *Uncertain demand for innovative goods or services*, *Difficulties in finding cooperation partners for innovation*, *Lack of qualified personnel*, a *Lack of information on markets* and the *Lack of funds within your enterprise or group*. In another words, the main problems are related with financial issues, market demand, R&D and human resources.

We compared the results obtained with similar studies. As these similar studies do not have the same target in terms of research, it is necessary for this to be taken into account when comparing the final results. Also, we highlight that the results must considered that there are studies that have discussed the theme in question, although from different perspectives.

The main limitation of this study is the fact that it was not possible, owing to the limitation of the database, to include all or at least a sample of all businesses in all sectors that constitute the national market. Another important feature was the non-inclusion of case studies, which was related to the time limitation, as well as the fact that we did not perform a comparison with other years to observe the development of SMEs.

As suggestions for future investigations, following the exposed limitations, future work could include more variables and make comparisons with other years to achieve ratios of comparability between years and even between sectors of activity and/or size. It would also be interesting to perform case studies, in which it is possible to observe the attestation of the obtained data in loco.

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