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**COOPERATION IN THE FIELD OF INNOVATION,
ABSORPTIVE CAPACITY, PUBLIC FINANCIAL SUPPORT
AND DETERMINANTS OF THE INNOVATIVE
PERFORMANCE OF ENTERPRISE**

DULCINEIA CATARINA MOURA, MARIA JOSÉ MADEIRA
and FILIPE A. P. DUARTE*

AQ: Kindly
provide author
affiliation info.

**filipeduarte@ubi.pt*

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The aim of this paper is to better understand whether cooperation, absorptive capacity and public financial support for innovation activities, how they influence the innovative performance of Portuguese enterprise. The literature review focuses the importance of these three factors both drivers as the limiters process of business innovation, influencing the innovative performance of enterprise. Based on a review of the literature, hypotheses are formulated, which are tested with secondary data resources from the Community Innovation Survey 2010. This questionnaire was implemented under the supervision of EUROSTAT. The method used is the logistic regression model. The results obtained confirm that the implementation of cooperation with partners belonging to internal sources of business has a significant influence on the innovations achieved at the level of both products and processes.

Keywords: Innovation; cooperation; absorption capacity; public financial support; CIS.

*Corresponding author.

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1 **Introduction**

3 In the context of globalization, innovation assumes great importance, with an
5 impact on all sectors of activity and at the level of society in general, being seen as
7 the key factor in the competitiveness of companies and even nations. In this sense
9 Hirsch-Kreinsen *et al.* (2008, p. 3) refer “as the European Union evolves into a
11 knowledge society, the ability to generate, use, diffuse and absorb new knowledge
13 is increasingly viewed as critical to economic success and societal development.
Sustainable competitive advantages depend increasingly on the innovation
capacity of a company and consequently are reflected in its innovative performance.
Accordingly, it becomes necessary to gain a deeper knowledge of the
innovation process, focusing mainly on the factors that drive and limit business
innovation.

15 The innovative performance varies from company to company and is deter-
17 mined by a vast and complex combination of factors, both drivers of and limiters
to the process of business innovation. The explanatory factors of innovation
mentioned here are not exhaustive, and in this work we consider cooperation,
absorptive capacity and public financial support for innovation activities.

19 Thus, this research aims to identify the determinants of innovation that influ-
21 ence the innovative performance of Portuguese enterprise. The present study, as its
23 theoretical framework of reference, adopts different approaches to business
25 innovation, namely the systemic approach to innovation, networks, resources and
27 capabilities and the open innovation approach. Whereas the innovation process
between the company and its surroundings is not linear, evolutionary, complex
and interactive, this study aims to develop theoretical support based on the current
approaches, corroborated by empirical support; that is, it intends fundamentally to
identify and analyze the factors that influence and stimulate the activity and the
innovation performance of companies.

29 To test the hypotheses formulated, secondary data belonging to the Community
31 Innovation Survey 2010 are used (CIS, 2010). This questionnaire has been
implemented in several countries in Europe under the supervision of EUROSTAT.
The method used is the logistic regression model.

33 It is expected that the results will contribute to deeper knowledge of the theme
35 and fill some gaps both at the level of theoretical contributions and at the empirical
level. In addition, the study intends to generate knowledge and propose guidelines
37 to assist public and private entities in the formulation of measures aimed at the
opening of companies by sharing knowledge to boost innovation and the pro-
motion of innovative performance.

39 After this first introductory section, the chapter is composed of four sections.
Section 2 presents a review of the literature regarding the determinants of

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1 innovation. Section 3 sets out the methodology, describes the sample and the data
2 used in the empirical study and subsequently presents the regression models used.
3 Section 4 performs an analysis of the results, and the main conclusions appear in
4 the last section.

7 **Review of the Literature**

9 Compared with the current scenario of intense competition and immense com-
10 petitiveness, entrepreneurs probably have only one path to follow: innovation.
11 Innovation, in addition to the desire of entrepreneurs, involves costs and needs a
12 considerable amount of time and changes in the structure of the company to make
13 it flexible enough to accommodate the changes that must be imposed. All changes
14 are a reflection of a vast and complex collection of factors, both drivers of and
15 limiters to the process of business innovation, influencing the innovation perfor-
16 mance of companies. Given the diversity of explanatory factors of innovation, this
17 work considers: cooperation, absorptive capacity and public financial support.
18 Thus, the literature review focuses the importance of these three factors both
19 drivers as the limiters process of business innovation, influencing the innovative
20 performance of enterprise.

23 **Innovative performance**

24 Companies need to innovate not only to grow in a favorable manner but also to
25 survive and resist the current market (Cefis and Marsili, 2006). The innovative
26 performance and/or the innovative capacity of companies has already been the
27 object of analysis in previous studies, in particular Roberts and Amit (2003), Silva
28 *et al.* (2005) and Berchicci (2013). The present study considers the innovative
29 performance of a company as something that integrates the various components
30 resulting from its process of innovation; this research work highlights product and
31 process innovation.

32 Product innovation is the introduction of a new, or significantly improved, good
33 or service, taking into account its characteristics or uses. It also includes
34 improvements in technical specifications, components and materials, embedded
35 software, easier use and other functional characteristics (OECD, 2005). Therefore,
36 innovations in products synthesize the use of new knowledge or new technologies
37 and new uses as well as combinations of already-existing knowledge and tech-
38 nologies (OECD, 2005). In accordance with the CIS 2010, product innovation
39 allows better performance of a good or service as well as an increase in its
applications. Thus, attempts to improve the quality of goods and to increase the

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1 efficiency and/or the speed of services are the main objectives mentioned by
2 Conceição and Ávila (2001) and OECD (2005) that serve as motivation for
3 product innovation.

4 Process innovation is ‘the implementation of a production process or a distri-
5 bution method or an activity of support for their goods and services, new or
6 significantly improved, or an activity to support their goods or services also new or
7 significantly improved’ (CIS, 2010, p. 5). The result of process innovation can
8 have a significant impact on production, logistics, delivery or distribution or even
9 support activities, and whether the innovation was originally developed by the
10 company or another is not relevant (CIS, 2010).

11 Thus, in this research we adopt the term innovative performance of the com-
12 pany to consider the two components resulting from the process of innovation in a
13 company, namely product innovation and process innovation.

15

Cooperation

17 Cooperation is a theme that has aroused the interest of many researchers, as
18 stressed by the literature review. Cooperation is an important factor for the creation
19 of technological skills (Schoenmakers and Duysters, 2006) and is a viable solution
20 to a problem common to many companies: resources and capabilities are not
21 always available within the company and are difficult to obtain efficiently on the
22 market (Tsai, 2009). It is expected that cooperation will provide other benefits,
23 such as the achievement of economies of scale, reducing uncertainty and risk
24 and gaining access to new markets and new additional knowledge (Miotti and
25 Sachwald, 2003).

26 Cooperation for innovation, according to the CIS (2010, p. 10), refers to “active
27 participation in innovation projects with other companies or non-commercial
28 institutions. The cooperation agreement does not imply that both partners with-
29 draw trade benefits. The simple hiring abroad, without any active collaboration of
30 the company, is not considered cooperation.” The importance of cooperation for
31 innovation has been increasing due to technological progress, increased costs and
32 the sharing of risky economic activities, among other factors that promote inno-
33 vation.

34 The role of cooperation in R&D has become increasingly important in the midst
35 of business life, and many authors have addressed the topic, including issues such
36 as whether innovative activities with other companies or institutions are oppor-
37 tunities to gain access to complementary technological resources and to enable
38 faster development and better access to the market in addition to allowing
39 diversification and the sharing of the cost and risk (Hagedoorn, 2002; Silva, 2003;
Robin and Schubert, 2013).

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1 In a study carried out in Portugal, which used the database of the “Portuguese
2 Third Community Innovation Survey”, Silva and Leitão (2009) affirmed that
3 companies that establish relationships of cooperation with universities and other
4 educational institutions have a greater propensity to achieve groundbreaking
5 advancements. They also emphasized that companies that establish relationships
6 with customers, suppliers or groups of companies have a greater propensity to
7 innovate than firms that do not cooperate. When confronted with the facts pre-
8 sented, it is evident that cooperation in the field of innovation significantly
9 influences the innovative process of enterprises and provides several benefits to
10 those companies. The role of suppliers and customers in the innovation process is
11 also emphasized: the first because they are in permanent contact with the custo-
12 mers’ needs and have to introduce amendments and innovations to be able to
13 continue to meet their needs; and the second because they are constantly looking
14 for new products and require companies that differentiate themselves by inno-
15 vating. However, the surrounding environment of companies also influences their
16 innovative capacity. Examples of this are the local public administration, business
17 associations, banks, regional agencies or professional schools that provide com-
18 panies with support in the form of financial resources and qualifications of the
19 labor force and reinforce the innovation capacity of the local industry (Schmitz and
20 Musyck, 1994).

21 Networking is seen today as fundamental for all companies, institutions or even
22 people on an individual basis. It is networks that often build the solution to many
23 of the problems of businesses, from supplying new markets to new forms and
24 methods of production. “The networks increase the value of the individual and the
25 individual increases the value of networks”; closeness, the human scale and con-
26 fidence are forces of cohesion that ensure a network (Gouveia, 2012, p. 98). It is
27 perceived that firms do not innovate in isolation from their surrounding environ-
28 ment and that innovation is influenced by both internal and external factors (Silva,
29 2003; De Faria *et al.*, 2010).

30 Cooperation in the field of innovation established with partners from the
31 surrounding environment means that companies must, from the outset, monitor all
32 their sources of information, removing each one necessary to remain competitive
33 and make their products more attractive to the market. Thus, it is imperative that
34 companies are alert to their surroundings and have the ability to anticipate change,
35 always keeping one step ahead of the competition. The connection to research
36 centers and universities has decreased the need for business investment in inno-
37 vation and has proved to be an attractive and decisive factor to ensure innovative
38 capacity in new ways.

39 In this work, innovation is seen as the result of an interactive learning process,
involving the interactions between users and producers (Lundvall, 1992), the

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1 interactions between companies and other institutions providing knowledge and
training (universities and institutions of higher education, consultants, commercial
3 laboratories and centers of research and development (R&D), state laboratories
and governmental R&D institutes) or the interactions between other partners
5 (Lundvall, 1992; Kaufmann and Tödtling, 2000, 2001; Silva, 2003; De Faria *et al.*,
2010).

7 According to Drucker (1985), the sources of innovation can be internal or
external to the organization. Chesbrough (2003) reported, regarding the control in
9 intramural innovation, the characteristic of a closed innovation, which, being
confined to the company's own organizational culture, has underlying internal
11 cooperation between the various elements that constitute it. In this type of inno-
vation, the whole process is generated internally without interaction with the
13 outside world; that is, from the generation of the idea to its marketing, all the tasks
are performed by the organization itself. However, one of the criticisms to high-
15 light is that the ideas and existing technologies may not be accessible or may not
have the required quality (Herzog, 2011).

17 In the closed innovation model, the innovation is always dependent on the
human resources of the company and their competences and skills in obtaining
19 new ideas, emerging as a cycle of innovation within the organization, the
investments of which are processes at the level of human resources and design and
21 development. In this type of culture, there is a conviction that the competitive
advantage over the competition comes from the pioneering role in the market. In
23 this way, it generates a virtuous cycle, leading to the profits made being reinvested
to improve and generate new ideas. The intellectual property is thus protected,
25 restricting or even preventing competitors from profiting and exploiting inno-
vations and emerging technologies (Chesbrough, 2003).

27 Open innovation comes from the use of input and output of knowledge flows
that allow the acceleration of the domestic innovation and the expansion of the
29 market for external use. This paradigm assumes that, to advance their technolo-
gies, companies can and must use both external and internal ideas as well as
31 following internal and external paths to the market. These are the intellectual
property of innovations according to their origin and may take different forms,
33 such as licensing contracts (Chesbrough, 2003). In this way, both internal and
external ideas appear with the same level of importance as the distribution
35 channels that are internal or external to the organization (Chesbrough, 2006). The
open innovation model of Chesbrough (2007), as well as Chesbrough *et al.* (2006)
37 and Berchicci (2013), relates the importance of external sources of technology
from partners as determinants of the final result of the innovative performance of
39 the company.

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1 The role of cooperation in companies' innovative process has been increasing
2 due to technological progress as well as the sharing of costs and risk. Several
3 authors have affirmed that innovative activities with other companies or institu-
4 tions are opportunities to gain access to additional technological resources and
5 allow more rapid development and improved market access (Cassiman and
6 Veugelers, 2002; Hagedoorn, 2002).

7 The recognition of the importance of the sources of information and coopera-
8 tion for the activities of product innovation and process has gained importance
9 over the last few years (Gomes *et al.*, 2012). In this context, there were several
10 authors who stated that the internal and external sources of information and co-
11 operation are complementary and not substitutes (Cassiman and Veugelers, 2002).

12 In this research, taking the CIS, 2010 as a basis, the sources of information and
13 cooperation for the activities of product innovation and process are grouped into
14 four variables, following other empirical investigations (Loureiro, 2011; Mention,
15 2011). Thus, the variables tested in the study are internal sources (Fint), market
16 sources (Fmerc), institutional sources (Finst) and other sources (FOtras).

17 Each of the sources of information and cooperation is associated with a theo-
18 retical hypothesis, with the aim of obtaining knowledge about the influences that
19 these forms of cooperation exert on the innovative performance and the level of
20 innovation in products and processes. Thus, the study establishes the following
21 relationship between cooperation in the context of innovation and innovative
22 performance:

23 **Hypothesis 1:** *The realization of cooperation with partners in the context of*
24 *innovation positively influences the propensity to innovate.*

25 On the basis of the generic hypothesis related to the partners establishing
26 cooperation in the field of innovation and with the typology presented in the
27 Innovation Survey CIS 2010, the following four specific assumptions are for-
28 mulated in this context:

29 **Hypothesis 1.1:** *The realization of cooperation with partners belonging to in-*
30 *ternal sources of the company is positively related to its propensity to innovate.*

31 **Hypothesis 1.2:** *The realization of cooperation with partners belonging to the*
32 *sources of the market is positively associated with the propensity to innovate.*

33 **Hypothesis 1.3:** *The realization of cooperation with partners belonging to the*
34 *institutional sources is positively associated with the propensity to innovate.*

35 **Hypothesis 1.4:** *The realization of cooperation with partners belonging to other*
36 *sources is positively associated with the propensity to innovate.*

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1 In this follow-up, innovation is the result of an interactive process between the
company and its surrounding environment as a result of the collaboration between
3 a wide range of stakeholders, both inside and outside the company (Silva, 2003);
that is, innovation can occur through internal or external factors. Thus arises the
5 term cooperation, which is considered as a stimulus for innovation and is expected
to generate several benefits from the perspective of open innovation. In addition to
7 cooperation, the literature has also emphasized the influence of absorptive capacity
and public financial support.

9

11 **Absorptive capacity**

The concept of absorptive capacity has assumed importance over time due to the
13 system dynamic capacity in the process of business innovation (Cohen and
Levinthal, 1994; Zahra and George, 2002; Lane, Koka and Pathak, 2006; Camisón
15 and Forés, 2010; Chang and Tzeng, 2010; Sun and Anderson, 2010; Patterson and
Ambrosini, 2015).

17 Absorptive capacity is the ability to identify and use external knowledge that is
relevant to internal innovative activities (Cohen and Levinthal, 1989, 1990). In this
19 way, absorptive capacity involves not only the ability to identify and assimilate
new external knowledge but also the ability to apply such knowledge for a
21 business purpose (Cohen and Levinthal, 1990).

In accordance with Cohen and Levinthal (1989), innovative capabilities depend
23 on the ability to exploit external knowledge and the R&D effort of the internal
market. Powell and Brantley (1992) and Powell *et al.* (1996) referred to the
25 internal capacities and external collaboration not superseding each other but rather
complementing each other. The internal capacity enables the assessment of
27 research that comes from outside, while external collaboration provides access to
new features that may not be developed internally.

29 Zahra and George (2002) considered absorptive capacity as a dynamic capacity,
through which the company acquires, assimilates, transforms and explores external
31 information. These authors considered absorptive capacity to be required for the
development of innovation processes.

33 The study by Zahra and George (2002) extended the concept originally defined
by Cohen and Levinthal (1990), referring to absorptive capacity as a group of
35 routines and organizational processes through which companies acquire, assimilate,
transform and exploit knowledge to produce a dynamic organizational capacity.
37 For these authors, absorptive capacity provides a competitive advantage to
the company, a level of strategic flexibility, innovation and performance. In this
39 context, Tzokas *et al.* (2015) stated that the application and effective use of
knowledge on the part of the companies that purchase it require an ability

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1 that enhances companies strategically in the generation of new products and/or
services.

3 The literature review performed found a consensus that the absorptive capacity
of an enterprise promotes and facilitates its innovative performance. Thus, the
5 company, to cooperate with its partners, engages in the process of information
exchange, whereby it gains new ideas and shares knowledge with the aim of
7 acquiring, assimilating, transforming and exploiting knowledge (Zahra and
George, 2002), subsequently fostering the creation of a product or process, or the
9 significant improvement of the same, for the company and/or the market.

11 This research aims to determine whether companies that invest in better
structures, technologies and qualified personnel have evidenced a higher pro-
pensity to innovate. Thus, it establishes the following relationship between ab-
13 sorptive capacity and propensity to innovate:

15 **Hypothesis 2:** *A company's absorptive capacity is positively associated with its
propensity to innovate.*

17 The present research aims to establish whether companies that invest in inno-
vation activities, in particular in internal and external R&D and qualified staff,
19 have a greater propensity to innovate. On the basis of the generic hypothesis
related to the indicators that can measure companies' absorptive capacity, and
21 taking into account the data obtained through the innovation survey (CIS, 2010),
the study formulates the following three specific assumptions in this context:

23 **Hypothesis 2.1:** *The qualifications of a company's human resources are positively
25 associated with its propensity to innovate.*

27 **Hypothesis 2.2:** *An increase in the proportion of internal investments in R&D is
positively associated with the propensity of a company to innovate.*

29 **Hypothesis 2.3:** *An increase in the proportion of foreign investments in R&D is
positively associated with the propensity of a company to innovate.*

31 **Public financial support**

33 Public financial support appears as a factor in the promotion of the activities of
business innovation (Silva *et al.*, 2009). Despite not being considered as a strategic
35 factor, it emerges as one of the main constraints to the survival and development of
enterprises (Silva and Raposo, 1999; Silva *et al.*, 2012).

37 In Portugal, in the context of financing, there is a high number of inefficiencies
that matter (Silva, 2003), in particular a lack of connection, coordination and
39 linkage between elements of the innovation system, revealed by the poor con-
nection between companies and institutions that conduct research and promote

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1 innovation (Oliveira, 2001). There is also poor use of the potential for the creation
of partnerships between universities, laboratories and state enterprises (Stern,
3 2001), among other weaknesses in the system.

Other studies claim that governmental policies should support technological
5 development, public investment policies, and support to innovation and cooper-
ation with universities or national laboratories (Escribá and Murgui, 2009; Albors-
7 Garrigos and Barrera, 2011; Doh and Kim, 2014; Bock *et al.*, 2018).

From this perspective, community financial support has been a central issue in
9 the political agendas of the European Union. Regardless of the country, each
government is responsible for regional and local factors that affect innovation
11 (Doh and Kim, 2014), as well as for policies that improve access of companies to
funds for infrastructure and information. They are also responsible for providing
13 legal and financial bases to companies in favor of entrepreneurship and growth
(Lee *et al.*, 2010). In this way, companies aggregate participants, dynamics, and
15 opportunities that promote innovation, providing sources for new jobs, growth in
exports and productivity. In short, the public policies for supporting innovation are
17 tools that promote the activities of the companies.

Public financial support includes tax benefits, subsidies, low-interest loans, or
19 bank guarantees. According to Lecerf (2012), Albors-Garrigos and Barrera (2011)
and Bock *et al.* (2018), financial support is considered a fundamental prerequisite
21 for the innovation projects of companies. It is one of the keys to improve the
innovation of companies and regions, or the territories to which they belong.
23 However, innovation can only occur if the ability to innovate exists in the com-
panies, through the availability of resources, collaboration structures, and pro-
25 cesses to solve problems. In the context of small-and medium-sized companies,
the available resources are mainly related to financial factors and skilled workforce
27 (Laforet, 2011). The capital is one of the resources that companies need to start,
operate or grow, achieve an appropriate level of financing, it is a prerequisite for
29 innovation activities (Xie *et al.*, 2013).

In accordance with Tourigny and Le (2004), the financial aid can reduce the
31 obstacles that companies face in relation to innovation. In this way, it is important
to examine how the public financing influences the development of innovation
33 activities and consequently the innovative performance. Indeed, it is of utmost
importance to study the impact of public financial support provided by state en-
35 tities on innovation activities performed by Portuguese companies, in order to
analyze their influence on business innovation activities. To do this, it presents the
37 following hypothesis:

39 **Hypothesis 3:** *A company that benefits from public financial support has a greater
propensity to innovate.*

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1 used in this inquiry is described in the *OECD Oslo Manual* and adopted across
2 Europe through EUROSTAT (OECD, 2005). The CIS 2010 questionnaire pro-
3 vides detailed general data about companies, namely their sector of activity,
4 number of employees, training and qualification of personnel, investments and
5 expenditure on R&D activities, turnover, cooperation and public financial support.

6 Although some of the limitations associated with the questionnaire CIS, such as
7 the lack of access to certain variables, the balance of the use of CIS 2010 is very
8 positive, due to the quality and reliability of the information, as well as access to a
9 large amount of data. These facts are corroborated by Laursen and Salter, (2006,
10 p. 137): “the interpretability, reliability, and validity of the survey were established
11 by extensive piloting and pre-testing before implementation within different
12 European countries and across firms from a variety of industrial sectors, including
13 services, construction and manufacturing”.

14 In accordance with the methodological notes of the DGEEC (2012), the period
15 of data collection occurred between July 2011 and April 2012, while the reference
16 period was between 2008 and 2010. The consultancy GPEARI/MCTES, through
17 authorization delegated by the National Institute of Statistics (INE), coordinated
18 the process of inquiry with companies, collecting, treating and analyzing data
19 related to innovation in Portugal.

20 The sample obtained after correction by the results of the examination consisted
21 of 8,189 companies. In this sample, 6160 companies replied to the questionnaire,
22 corresponding, therefore, to a response rate of 76% (GPEARI, 2010). This sample
23 was composed of companies with at least 10 people in the service, and, when a
24 company had 250 or more persons, it was subject to a thorough inquiry. The
25 sample was constructed by the National Institute of Statistics (INE) in accordance
26 with the methodological specifications of EUROSTAT. The sample was stratified
27 by Classification of Economic Activity (CAE) to 2 digits by size (considering the
28 age of persons in the service) and by regional distribution (NUTS II).

29

31 **Variables**

32 The dependent variable used in this study is the “innovative performance” of the
33 company (DI), following the operationalization of the variables used in the studies
34 conducted by Silva (2003); Escribano *et al.* (2009); Kostopoulos *et al.* (2011) and
35 Berchicci (2013). Innovative performance is measured through a binary variable
36 that examines whether the company introduced innovative products or processes
37 between 2008 and 2010; that is, it is equal to 1 if the company introduced products
38 or processes that are new or significantly improved and 0 if the company did not
39 introduce any type of product or process innovation.

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1 This research uses as independent variables those variables associated with
 2 three factors: (i) cooperation in the field of innovation; (ii) absorptive capacity; and
 3 (iii) public financial support. The first independent variable used in this research is
 4 cooperation in the innovation framework of a company. Cooperation shows the
 5 relationships that the company could accomplish with its partners in the field of
 6 innovation. In this research, cooperation in the field of innovation is measured
 7 through a variable that identifies whether the company, between 2008 and 2010,
 8 cooperated with some partners belonging to various sources of information and
 9 cooperation. The data are obtained through question 6.1, which asks about the
 10 “sources of information and cooperation for the activities of product innovation
 11 and process”. These variables are measured according to their intensity or im-
 12 portance; therefore, cooperation is measured on a scale from 0 to 3, on which
 13 companies classify its importance as: 0 = not used; 1 = low; 2 = average; or
 14 3 = high. This approach has already been adopted in other studies (Escribano
 15 *et al.*, 2009; Kostopoulos *et al.*, 2011).

16 In the empirical research, the ten sources of information and cooperation,
 17 presented earlier in Table 1, are grouped into four variables by means of factorial
 18 analysis. Thus, the variables tested in the study are internal sources, market
 19 sources, institutional sources and other sources. The internal sources are consid-
 20 ered to be the internal partners, respectively, within one’s own company or the
 21 group to which it belongs (SENTG). The sources market is considered to contain
 22 external partners, encompassing customers (SCLI), suppliers (SSUP) and com-
 23 petitors (SCOM). The institutional sources include universities and other institu-
 24 tions of higher education (SUNI), consultants, technology centers or other private
 25 institutions of I&D (SING) and state laboratories or other public services (SGMT).
 26 Other sources include conferences, trade fairs, exhibitions (SCON), scientific
 27 journals and technical/professional/commercial publications (SJOU) and profes-
 28 sional associations and businesses (SPRO).

29
 30
 31 Table 1. Sources of information and cooperation for the activities of product and process
 32 innovation.

| Internal sources | Market sources | Institutional sources | Other sources |
|--|--|---|---|
| <ul style="list-style-type: none"> • Within the com- pany itself or within the same group | <ul style="list-style-type: none"> • Suppliers • Clients or consumers • Competitors • Consultants or pri- vate companies | <ul style="list-style-type: none"> • Educational institutions • Public services for R&D | <ul style="list-style-type: none"> • Conferences and exhibitions • Scientific journals and technical books • Professional asso- ciations or business |

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 Source: Own elaboration based on the methodological document CIS 2010.

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1 The existing literature has adopted various ways to measure absorptive
2 capacity, but in any case we can state that there is supremacy in relation to other
3 forms of measurement (Escribano *et al.*, 2009). The following approaches can be
4 used to measure absorptive capacity: (1) quantitative, as referenced by several
5 studies (Cohen and Levinthal, 1990; Tsai, 2001; Cassiman and Veugelers, 2002;
6 Escribano *et al.*, 2009; Kostopoulos *et al.*, 2011); or (2) qualitative, as, for
7 example, used in the study conducted by Lichtenthaler (2009).

8 Due to the abundance of investigations and the lack of consensus on the method
9 to be used in the measurement of absorptive capacity, this empirical study con-
10 siders three variables from the data from the CIS 2010: (1) qualifications of human
11 resources in the company (EMPUD), which is measured by question 12.3 –
12 approximate percentage of people with higher education in 2010, represented by
13 seven steps; (2) internal investments in R&D (Intra_cat) – this indicator is obtained
14 by the ratio between the investment and internal R&D expenses and the total
15 amount of investments and expenditure on innovation activities; and (3) foreign
16 investments in R&D (Extra_cat) – this indicator is obtained through the ratio
17 between the investment and R&D expenses and the total amount of investments
18 and expenditure on activities of innovation. For more specific information, these
19 variable ratios are categorical variables of seven levels, corresponding to the seven
20 steps already used by the CIS 2010 to represent the variable qualification of human
21 resources in the company (EMPUD). It should be noted that the calculation of
22 indicators does not completely follow the studies of Escribano *et al.* (2009) and
23 Kostopoulos *et al.* (2011), since it was not possible to obtain the information
24 needed by the GPEARI/MCTES about the number of employees with a degree in
25 business.

26 Finally, with respect to public financial support, we use a dichotomous variable
27 to identify whether the company benefited from public funding for innovation
28 activities. Thus, it assumes the value “1” in the case of a company that earned
29 public financial support and the value “0” in the opposite case. The same variable
30 was also used in the studies by Silva (2003), Hu and Mathews (2009), Madrid-
31 Guijarro *et al.* (2009) and Silva and Leitão (2009). To measure public financial
32 support, we use the following independent variables: public financial support from
33 the local and regional administration (FUNLOC), public financial support from the
34 central administration (FUNGMT) and public financial support from the European
35 Union (FUNEU).

37

Method

39 Given the complexity of the phenomena under study and taking into account that
their underlying explanation has a varied set of factors, it is necessary to carry out

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1 modeling of the data and statistical inference. Data modeling aims to provide
information about the point estimates of the parameters of the model to gain an
3 understanding of the relationship between the variables as well as information for
the hypothesis testing (Gujarati, 2008). In turn, statistical inference corresponds to
5 a technique that allows conclusions to be drawn about the population from the
results of the sample (Malhotra and Birks, 2007).

7 In this follow-up, to achieve the objectives proposed, the study resorted to
multivariate statistical analysis, which, according to Hair, Anderson, Tatham and
9 Black (1998); (Hill and Hill, 2009), enables the simultaneous analysis of relations
between three or more variables, which may be applied by different statistical
11 techniques, as the relationship in question is dependent or interdependent.

13 In the present investigation, the dependent variables are dichotomous, and the
analysis of dependence can be effected by means of logistic regression. Second,
15 Pestana and Gageiro (2008) presented the most suitable modeling technique to
estimate the probability of occurrence of one of the achievements of the classes of
17 variables. Thus, logistic regression is a technique that seeks to understand what
distinguishes two groups of cases, that is, what differentiates the two levels of a
dependent dichotomous variable.

19 The theoretical review of the literature performed showed that the innovative
performance of an enterprise is a complex phenomenon influenced by a wide
21 range of factors. Therefore, it is necessary to explore the relationship between
these factors and the innovative capacity; more specifically, we intend to examine
23 the statistical relationship of a binary dependent variable with more than one
explanatory variable, and it is therefore appropriate to use the logistic regression
25 model (logit model). This model has been widely applied in other empirical studies
(Conceição and Heitor, 2001; Fritsch and Lukas, 2001; Kaufmann and Tödtling,
27 2001; Nassimbeni, 2001; Silva, 2003; Silva and Leitão, 2007, 2009; Moreira,
2010; Mention, 2011; Arora *et al.*, 2016; Parrilli and Heras, 2016).

29 It is also an appropriate method for models that include a categorical dependent
variable (binary or dichotomous) and several categorical independent variables
31 (Hair *et al.*, 1998). This binary variable is the propensity for the company to
innovate at the product or process level, that is, the propensity for the company to
33 achieve an innovative performance. In this sense, two logistic regression models
are estimated, which contain as independent variables those related to the im-
35 plementation of cooperation, absorptive capacity and public financial support.

37 **Data analysis and discussion of the results**

39 The 3,406 companies selected for this study are subjected to a factorial analysis to
group cooperation partners for innovation. This statistical analysis allows the

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1 Table 2. Factorial analysis of cooperation within the framework of the innovation factor for the
2 fields of cooperation.

| | Component | | | | Commonalities | |
|----|--|-----------------------|---------------|----------------|------------------|-------|
| | F1 | F2 | F3 | F4 | | |
| 3 | | | | | | |
| 5 | SGMT (state laboratories, public services) | 0.855 | | | 0.796 | |
| 7 | SUNI (universities) | 0.836 | | | 0.776 | |
| 9 | SINS (consultants, technology centres, other inst. private R&D) | 0.712 | | | 0.630 | |
| 11 | SJOU (scientific journals and technical publications/professionals/businesses) | | 0.822 | | 0.793 | |
| 13 | SCON (conferences, trade fairs, exhibitions) | | 0.814 | | 0.741 | |
| 15 | SPRO (professional associations and businesses) | | 0.690 | | 0.617 | |
| 17 | SCOM (competitors) | | | 0.837 | 0.794 | |
| | SCLI (customers) | | | 0.782 | 0.721 | |
| 19 | SSUP (suppliers) | | | 0.438 | 0.426 | |
| | SENTG (interns) | | | 0.922 | 0.901 | |
| 21 | | Institutional sources | Other sources | Market sources | Internal sources | Total |
| 23 | Percentage variance explained | 22.1 | 21 | 17.2 | 11.6 | 71.9 |
| 25 | KMO | 0.847 | | | | |

27 identification of new variables, called factors, which are fewer in number than the
28 initial set of variables, thus condensing the information contained in the initial
29 variables into a smaller set. Table 2 presents the factorial analysis for cooperation
30 in the field of innovation for the sample.

31 An analysis of Table 2 enables us to identify four factors, specifically factor 1
32 (with 22.1% of the explained variance), called institutional sources, which covers
33 the variables state laboratories and public financial support, universities and other
34 academic institutions and even consultants, technology centers and other private
35 R&D institutions; factor 2 (with 21% of the explained variance), called other
36 sources, which includes scientific journals and technical/professional/trade pub-
37 lications, conferences, fairs and exhibitions and professional associations and
38 businesses; factor 3 (with 17.2% of the explained variance), referred to as market
39 sources, which comprises the variables competitors, customers and suppliers; and,
finally, factor 4 (with 11.6% of the variance explained), which includes only the

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1 variable relating to internal sources of cooperation. The grouping of the variables
obtained through the factorial analysis is in line, in large part, with the grouping
3 underlying the methodological document CIS 2010, systematized in Table 1. The
only change is the variable consultants or market undertakings, which was in-
5 cluded in the market sources. However, the factorial analysis covers institutional
sources in factor 1, which seems to have some logic, because it is known that
7 many services of this nature are obtained interchangeably with institutional
sources or consultants/private companies of which the core business is R&D
9 activities. Based on the literature review and the grouping of variables and factors,
systematized in the previous table, the logistic regression models for innovation in
11 products and processes are formalized. After the implementation of the logistic
regression models for all the observations available, 3,406 companies, the models
13 that are obtained are presented in Table 3.

The results of the logistic regression models for product and process innovation
15 are presented in Table 3. It shows that the predictive ability of the product in-
novation model is 70.6%, a value that is the result of the comparison between the
17 values of the response variable predicted by the model and the observed values.
The chi-square statistic has the value of 357.25, with an evidential value that is
19 below the significance level of 0.05. The log-likelihood statistic, with the value of
3779.20, confirms the overall significance of the model compared with the null
21 model. In turn, the process innovation model presents a predictive capacity of
83.6%, a value that is the result of the comparison between the values of the
23 response variable predicted by the model and the observed values. The chi-square
statistic has a value of 355.72, with an evidential value that is below the signifi-
25 cance level of 0.05. The log-likelihood statistic, with a value of 298,870, also
ratifies the global significance of the model compared with the null model.

27 Having used the Wald statistic as a test statistic, it is observed that the majority
of the estimates of the parameters of the product innovation regression model are
29 statistically significant at the level of 5%, while in the model of product innovation
only four are statistically significant. Then an analysis of the estimates of the
31 models is performed and, at the same time, the research hypotheses are tested.

The first hypothesis argues that the propensity of a company to innovate is
33 related to the implementation of cooperation with partners belonging to its internal
sources – H1.1. The results show that the cooperation undertaken with partners
35 from internal sources of information, that is, from the company itself or the group
to which it belongs, has a positive and significant effect on innovation, both
37 product and process. These facts are proved by the result of the estimation of the
associated parameters (0.199 and 0.101) as well as by the analysis of why an
39 advantage is associated with the variable: 1.221 for product innovation and 1.107
for process innovation. In this way, an increase in cooperation with partners inside

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Table 3. Logistic regression model of the determinants of product and process innovation.

| | Product innovation | | | | Process innovation | | | |
|---|--------------------|---------|--------|---------|--------------------|-------|--------|--------|
| | B | S.E. | Sig. | Exp (B) | B | S.E. | Sig. | Exp(B) |
| Cooperation for innovation | | | | | | | | |
| Internal sources | 0.199 | 0.041 | 0.000* | 1.221 | 0.101 | 0.049 | 0.037* | 1.107 |
| Market sources | 0.235 | 0.039 | 0.000* | 1.265 | 0.049 | 0.046 | 0.290 | 1.050 |
| Institutional sources | -0.056 | 0.043 | 0.197 | 0.946 | 0.006 | 0.052 | 0.906 | 1.006 |
| Other sources | 0.158 | 0.040 | 0.000* | 1.171 | 0.122 | 0.047 | 0.010* | 1.130 |
| Absorptive capacity | | | | | | | | |
| Qualification of personnel | 0.024 | 0.025 | 0.344 | 1.024 | 0.031 | 0.029 | 0.293 | 0.970 |
| Internal invest. in R&D | 0.166 | 0.016 | 0.000* | 1.181 | 0.026 | 0.018 | 0.150 | 1.027 |
| External invest. in R&D | 0.078 | 0.019 | 0.000* | 1.081 | 0.083 | 0.024 | 0.001* | 1.086 |
| Public financial support | | | | | | | | |
| PFS from local and regional administ (FUNLOC) | 0.209 | 0.262 | 0.425 | 1.232 | 0.036 | 0.311 | 0.907 | 1.037 |
| PFS from central administ (FUNGMT) | 0.335 | 0.107 | 0.002* | 1.398 | 0.359 | 0.130 | 0.006* | 1.431 |
| PFS from the European Union (FUNEU) | 0.108 | 0.160 | 0.500 | 1.114 | 0.296 | 0.199 | 0.137 | 1.345 |
| Constant | 0.295 | 0.081 | 0.000* | 1.343 | 1.471 | 0.098 | 0.000* | 4.354 |
| Quality of adjustment of the model | | | | | | | | |
| Predicted correctly (%) | | 70.6% | | | 83.6% | | | |
| Chi square | | 357.25 | 0.000 | | 355.72 | 0.000 | | |
| Log likelihood | | 3799.20 | | | 2988.70 | | | |
| Number of cases | | 3 406 | | | 3 406 | | | |

AQ: Kindly provide Table 4 citation in text.

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Table 4. Summary of the outcome of the hypotheses.

| | Cooperation for innovation | Product innovation | Process innovation |
|----|---|--------------------|--------------------|
| 3 | Internal sources | ✓ | ✓ |
| | Market sources | ✓ | |
| 5 | Institutional sources | | |
| | Other sources | ✓ | ✓ |
| 7 | Absorptive capacity | | |
| | Qualifications of personnel | | |
| 9 | Internal investments in R&D | ✓ | |
| | External investments in R&D | ✓ | ✓ |
| | Public financial support | | |
| 11 | PFS from the local and regional administration (FUNLOC) | | |
| 13 | PFS from the central administration (FUNGMT) | ✓ | ✓ |
| | PFS from the European Union (FUNEU) | | |

the company also increases the propensity of the company to innovate in products and in processes, showing an advantage of 1.221 and 1.107, respectively, compared with companies that do not cooperate with this type of partners. The results corroborate the study by Evangelista (2006), which shows that companies rely on internal sources of information.

As regards the second hypothesis, it is intended to test whether the implementation of cooperation with partners belonging to the market sources is associated with the propensity for a company to innovate – H1.2: The realization of cooperation with partners belonging to the sources of the market is positively associated with the propensity to innovate. In relation to the propensity to innovate in processes, nothing can be concluded about the effect of this factor, given that the results obtained show that the achievement of cooperation with partners belonging to the market sources has no statistical significance in the model of process innovation.

Concerning the model of product innovation, the results show that the achievement of cooperation with partners belonging to the market sources has a positive and significant effect on the propensity to innovate at the level of products. Thus, the greater the intensity of cooperation with these partners, the greater the propensity of the company to innovate in products. The ratio of the associated advantage is 1.265 compared with companies that do not cooperate, so we can reject the null hypothesis of the non-existence of a relationship between the variables considered. In this way, hypothesis H1.2 confirms this model at the level of the propensity to innovate in products. It is also worth noting that the cooperation undertaken by the partners of the sources of information from the market,

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1 in particular customers, suppliers or consumers, positively influences product in-
novation, thus reinforcing the results of the study by Tether (2005). The results
3 obtained from research conducted in Canada (Baldwin *et al.*, 1998) also empha-
sized the importance of these external sources as influential factors in the pro-
5 propensity to innovate.

The third hypothesis associates the propensity of a company to innovate with
7 the realization of cooperation with partners belonging to institutional sources –
H1.3. This is not statistically significant. The results show that the variable im-
9 plementation of cooperation with this type of partners has no statistical signifi-
cance in the models of innovation for products and processes; therefore, nothing
11 can be concluded about the effect of this factor on innovation performance.

The fourth hypothesis establishes the relationship between the propensity to
13 innovate and established cooperation with partners from other sources – H1.4: The
realization of cooperation with partners belonging to other sources is positively
15 associated with the propensity to innovate. The cooperation undertaken with
partners from other sources of information, particularly those from scientific
17 journals and technical publications/professionals/businesses, conferences, trade
fairs and exhibitions, professional associations and business consultants, positively
19 influences the propensity for the company to innovate at the level of products and
processes. These facts are associated with the result of the ad hoc estimation of
21 parameters (0.158; 0.122) as well as that of the analysis of why an advantage is
associated with the variable (1.171; 1.130). Thus, depending on whether there is
23 an increase in cooperation with partners from other sources, it also increases the
propensity for the company to innovate in products and processes, showing an
25 advantage compared with companies that do not cooperate with this type of
partners. Mothe and Nguyen (2008) also obtained results that confirm the im-
27 portance of consultants, laboratories or private R&D institutions as fundamental
sources that contribute to the propensity to innovate.

29 The fifth hypothesis to be tested associates the propensity of a company to
innovate with the qualifications of its personnel – H2.1: The qualifications of a
31 company's human resources are positively associated with its propensity to
innovate. The results show that the variable qualification of human resources has
33 no statistical significance in the models of innovation in products and processes, so
no conclusions can be reached about the effect of this factor on innovation
35 performance.

The sixth hypothesis is formulated as follows – H2.2: An increase in the
37 proportion of internal investments in R&D is positively associated with a com-
pany's propensity to innovate. In relation to the model of process innovation,
39 nothing can be concluded about this variable, since it has no statistical signifi-
cance. However, it is noted that companies that make this type of investment have

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1 a higher propensity to innovate at the level of products, evidencing an advantage
of 1.181 compared with companies that do not perform internal investments in
3 R&D, thus corroborating the results of the study by Silva *et al.* (2010). Given these
results, it is notable that the greater the achievement of internal investments in
5 R&D in larger enterprises, the higher the propensity to innovate at the product
level. Thus, we can reject the null hypothesis of the non-existence of a relationship
7 between the variables; therefore, hypothesis H2.2 is accepted in this model.

9 The seventh hypothesis formulated is designated H2.3: An increase in the
proportion of foreign investments in R&D is positively associated with a com-
pany's propensity to innovate. The results show that external investments in R&D
11 have a positive and significant effect on the propensity to innovate of a company,
at both the product and the process level, proving these facts by examining the
13 ratio of advantage (1.081) and (1.086), respectively, and reinforcing the results of
the study by Paranhos and Hasenclever (2011), which shows that innovative
15 companies invest in R&D. The study by Boone (2000) also shows that companies
that acquire R&D more efficiently are more innovative.

17 The eighth hypothesis to be tested is formulated in the following way – H3.1:
Public financial support from the local/regional administration is positively asso-
19 ciated with a company's propensity to innovate. The results show that this variable
is not statistically significant in the models of product and process innovation, so
21 no conclusions can be reached about the effect of this factor on innovation per-
formance.

23 The ninth hypothesis establishes the relationship between the propensity of a
company to innovate with PFS from the central administration – H3.2: Public
25 financial support from the central administration is positively associated with a
company's propensity to innovate. It is found that this variable has a positive and
27 significant effect on the propensity to innovate in products and in processes,
proving these facts through an analysis of the point estimation of the associated
29 parameters and the reason for an advantage associated with the variables of 1.398
and 1.431, corresponding, respectively, to the models of product and process
31 innovation. These results are corroborated by studies that relate to public financial
support appearing as a determinant factor in the promotion of innovation activities
33 (Tourigny and Le, 2004; Silva *et al.*, 2009; Moreira, 2010; Silva *et al.*, 2012).

35 The last hypothesis to be tested, it is formulated in the following way – H3.3:
The company that benefits from public financial support from the European Union
is positively associated with the propensity for the company to innovate. The
37 results show that this variable is not statistically significant in models of innovation
in product and process, so nothing can be concluded about the effect of this factor
39 in innovative performance.

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1 The following table summarizes the hypotheses for which it was possible to
2 reject the null hypothesis of non-existence of a relationship between each of the
3 variables with the innovative performance of the company, therefore confirming
4 the hypotheses associated with all the variables indicated.

5

7

Conclusion

9

This research aimed to analyze the determinants of innovation that influence the
10 innovative process in Portuguese companies and consequently their innovative
11 performance at the level of product and process innovation. The determining
12 factors referred to here are not exhaustive; however, in this study, we highlight
13 cooperation, absorptive capacity and public financial support.

15

In accordance with the objective of this research, hypotheses were formulated
14 and tested using logistic regression models, after having extracted the factors that
15 formed the variables of cooperation through a factorial analysis.

17

Based on the sample of 3406 companies, the total number of valid cases for
16 which information was available about the set of independent variables in this
17 study, most were of a small size (50.7% of the total sample), and a significant
18 number (50.4% of the total sample) have low-skilled human resources and even
19 resources without any qualifications (10.2% of the total sample). Few companies
20 have resorted to public financial support (PFS). Those that have resorted to public
21 financial support from local/regional innovation activities are almost negligible
22 (2.5%) compared with those that have appealed to the central administration
23 (23.4%) and even the EU (9.2%). In the global statement, nevertheless, the
24 demand for the PFS referred to remains low. The analysis of Table 3 also indicated
25 that more businesses innovate in processes (2,846) than in products (2,387).

27

29

The results obtained in the model confirm that the implementation of cooper-
28 ation with partners belonging to internal sources of business has a significant
29 influence on the innovations made both at the level of products and at the level of
30 processes. According to the theoretical framework, the implementation of coop-
31 eration with partners belonging to the company's internal sources is basic and
32 necessary for innovative performance at the level of both products and processes;
33 that is, cooperation of this type has a positive influence on the design and
34 development of new products or significant improvements in existing products as
35 well as the implementation of new processes, such as cooperation with partners
36 belonging to other sources. Companies that innovate through cooperation are
37 therefore more prone to develop innovations at the level of products and processes
38 than those that do not cooperate. As regards the effects of cooperation with
39 partners belonging to the sources of the market, in particular established

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1 relationships with customers, suppliers and competitors, it is noted that these
2 companies have a higher propensity to innovate in the accompanying products,
3 possibly because of the changes in perceptions and needs of customers, as well as
4 the evolution of market trends.

5 Regarding the purpose of the relation between innovative performance and
6 internal investments in R&D, it is noted that the implementation of this type of
7 investment in R&D is positively associated with the propensity for a company to
8 innovate at the product level. In relation to the realization of foreign investments in
9 R&D, it appears that companies that make foreign investments in R&D have
10 advantages in developing innovations at the product and the process level
11 compared with companies that do not perform this type of investment.

12 Based on the hypotheses tested, the results of the model suggest that PFS from
13 the central administration has a positive and significant effect on innovation at the
14 level of products and processes. The results suggest that companies that benefit
15 from this type of PFS are more prone to develop innovations in both than those
16 that do not benefit.

17 The results obtained suggest that new measures of orientation of public policies
18 aimed at businesses, especially micro and SMEs, which constitute the greater part
19 of the Portuguese business fabric, enable them to access innovation. In this way,
20 the determinant factors of innovation, analyzed in this chapter, may make a greater
21 contribution to the innovative performance of Portuguese companies not only
22 through the enhancement and upgrading of human resources, such as the pro-
23 tection of knowledge, but also through the encouragement of cooperation sup-
24 ported by networks and better availability of PFS, based on the implementation
25 and/or development of innovation systems.

26 The secondary data that we had access through a survey Community Innovation
27 Survey (CIS 2010) in Portugal, made available by INE (National Institute of
28 Statistics), proved to be insufficient for the construction of some variables. This
29 limitation of data, due to CIS 2010, made it impossible to use several variables,
30 such as the proxy for innovation, like the share of sales from innovative products,
31 among other proxy and, consequently, the respective enrichment of the empirical
32 analysis

33 As a research proposal for future work, we suggest that re-orientate the analysis
34 to that of the LMT firms and SME perspective, following the trajectory of
35 researchers such as Hirsch-Kreinsen and Jacobson (2008) this would make it
36 possible very rich analysis. It is also suggested the empirical research applied to
37 data from the CIS (2012, 2014), so as to enrich and complement the work un-
38 dertaken and allow an analysis of innovation in product and process a broader
39 horizon, or, still, repeat the research, based on only those data, thus obtaining the
40 most updated information, allowing the evaluation of evolutionary trends of

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1 innovation and the consequent impact of the determinant factors of innovation on
the innovative performance of Portuguese companies, the level of product and
3 process.

5

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7

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11

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