

Public Funding and Innovation – NITEC: The Portuguese case

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Abstract: The topic of innovation and of economic development is unavoidable in national and international policies, as those are also fundamental to the daily life of firms and universities, as well as for each one of us as an element of change. To modern economies, innovation is crucial for the firms' performance. Therefore, governmental entities have built and endorsed initiatives and programs to promote innovation in firms. The European Innovation Scoreboard (European Commission, 2022) states that EU Innovation performance has increased by "about 10%-points since 2015 and there has been noticeable progress in the EU's global position". Public funding is ultimately a political instrument to increase the number of resources allocated to innovation activities. Financial subsidies have been the main instrument used by most of OECD countries to stimulate research and development activities (Gonsáles & Pasó, 2008). In this sense the aim of this paper is to understand what the outputs of an innovation incentive instrument in Portuguese firms were, considering internal innovation processes. Moreover, after the pandemic crisis, innovation became even more a critical topic, since the technological transformation has accelerated and from those derived transformations in human capital, technology, and technological access, to name a few. According to the Global Competitiveness Report 2020 countries should "expand public investments in R&D", as well as "create incentives that favour patient investments in research, innovation and invention" (Schwab, Klaus, Sahidi, 2020, p.6). It is important to consider the impact of political strategies and orientations have on the promotion of firms' innovation capacity and the way it is translated into innovation. In the scope of this study, it was select an incentive program to innovation, translated into the establishment of research and technologic development nuclei (NITEC- Núcleos de Investigação e Desenvolvimento Tecnológico – NITEC) on firms. This paper attempts to highlight the need to different and more qualitative approaches on the impact of public funding on innovation in private firms. It investigates the Portuguese case, since it was here that the RDI (research, development and innovation) norm was created and has a direct link with public funding strategies.

Keywords/Phrases: Innovation Systems, Public Funding, Innovation Ecosystems, Knowledge

1. Introduction

According to the Global Competitiveness Report 2013-2014 (Schwab, 2014) there is a close relation between the level of complexity of the firm's management system and the level of development and innovation of a country. It seems clear that more sophisticated business and management practices produce a higher efficiency in the production of goods and services. The sophistication of businesses and management systems concerns not only the comprehensiveness of a countries business networks, but also the individual quality of a firms' strategy and operation. In that report, competitiveness is defined as the sum of institutions and factors that determine a country level of productivity. The mechanisms that determine the potential growth of a country were also considered, namely: education and training, technological progress, macroeconomic stability, governance, firms' sophistication, and market efficiency, among others. Public funding is ultimately a political instrument to increase the number of resources allocated to innovation activities. Financial subsidies have been the main instrument used by most of OECD countries to stimulate research and development activities (Gonsáles & Pasó, 2008). Studies suggest that being granted with any type of direct help increases firms probability of conduction innovation activities (Huergo & Moreno, 2017). The way innovation support systems are design tend to promote more sophisticated management processes and firm's internal innovation systems (Sabala-Iturriagoitia, Voigt, Gutiérrez-Gracia, & Jiménez-Sáes, 2007). In this sense we try to understand what the outputs of an innovation incentive instrument in Portuguese firms were considering internal innovation processes.

The Portuguese economy is classified as an economy based on innovation (Schwab, 2017), being so, it is imperative that the investment on innovation systems is accomplished, as well as the stimuli to the creation of innovation and business networks, and the liaison to universities. The Portuguese economy is recognised as innovative and emphasises the importance of investing in innovation systems, fostering innovation networks, and connecting with universities. Portugal, as an EU member, has received substantial financial support through various frameworks since 1989, totaling over 107.7 billion euros by 2017. An additional 23 billion euros will be added through the Portugal 2030 framework. The earlier frameworks concentrated on economic infrastructure, human resource development, competitiveness, agriculture, rural and industrial development, and regional

potential. Subsequent frameworks integrated goals like human resource qualification, competitive factors, social cohesion, and sustainability and more importantly enhanced the investment on innovation. The most recent frameworks, including Portugal 2020 and Portugal 2030, prioritise intelligent, sustainable, and inclusive growth, digital and green transition, and investment in innovation.

From both the perspectives of Portuguese government and the European Commission, it is important to consider the impact that those political strategies and orientations have on the promotion of firms' innovation capacity and the way it is translated into innovation. In the scope of this study, NITEC program was selected as the incentive program to innovation to be analysed, which was translated into the establishment of research and technologic development nuclei (NITEC) on firms.

The creation of the NITEC initiative (was based on the Decree-Law 70-B/2000 of the 5th May and its specific regimentation on the regulation number 441/2003 of 28th of May, and it aims at the development of research and technological development (R&TD) units within firms.

A research and technological development (R&TD) unit was understood as a small team with permanent status, composed by three persons as a limit, exclusively dedicated to develop and endogenise technological skills within a company, and built in activities structured by projects that were translated into new products, processes or systems, or the introduction of significant improvements, with clear technologic upgrade, in products, processes or systems already existent¹.

Therefore, the main objectives of this unit were:

- To create internal R&TD activities within a firm, as well as to reinforce the drive to pursue these features.
- To promote technological knowledge endogenisation and improve firms' absorptive capacity.
- To allow an effective uprising of national companies through the marketing of technologically innovative products.

According to Gouveia (2005), in Portugal the effort to mobilise all agents of the education, science and technology systems had to be bigger so that the goals of Lisbon strategy could be met. During the last twenty years there has been a considerable growth of the education, science, and technological systems. Nevertheless, there is still the need to promote important changes in these systems so that it becomes more competitive and dynamic. There is an urgent need to engage it with organisations and firms that are responsible for economic growth and wealth. The development of R&TD units in firms has contributed to promote a closer collaboration between organisations of the science and technology system and firms.

Also, it contributed not just to the rising of a research and innovation activities, but also to a bigger demand of highly qualified jobs by firms, which led to significantly increase of private supported research, development, and innovation.

2. Methodology

The study was designed to capture the variety of changes that happened in the firms financed by NITEC funding. Information was collected on a significant number of instances: firms, university, and intermediary entities by interviewing participant-informants. Using theory-driven sampling (Eisenhardt, 2007), respondent were selected from the group of firms that were pioneers in applying for NITEC. Within these firms the firm's owners, CEO or the persons responsible for innovation process were elected.

The interview protocol was initially designed based on the literature analysis performed. The interviews check list was constructed based on previous studies, namely the study of Silvia Massa and Stefania Testa (Massa & Testa, 2008) on Italian Small and Medium Enterprises; the study of Garcia-Quevedo (García-Quevedo, 2004) on the relationship between public funding on R&D and private R&D expenditure; the study Becheikh, Landry and Amara (Becheikh, Landry, & Amara, 2006) on innovation processes and the internal and contextual factors driving it; and the study of Bougrain and Haudeville (2002) on SMEs' internal research capacities to exploit external scientific and technical knowledge and to use networks of innovators.

¹ <http://www.adi.pt/nitec.htm>

The main goal was to enable interviewees to express their opinion regarding the different topics raised by the questions, but also to discuss other issues that he/she may considered relevant for the study. All the interviews were recorded and later transcribed (*verbatim* transcription). For the interpretation of data, transcripts of interviews were entirely used, but also the information exchanged before and after recording. All these data enabled a greater understanding of key issues. Using the method of Miles, Huberman, & Saldaña (2014), we reduce raw data in structured and quantifiable data. The treatment of data by the cataloguing of the answers, identification of units of thought and frequency of response was used by authors as Noblet, Simon, & Parent (2011), Valkokari, Paasi, & Rantala (2012) and Hermans & Castiaux (2017).

In this case, it was identified key words in the answers collected which enabled the assessment of frequency of citation, keyword, or related words. Thus, it was possible to present and analyse the data quantitatively. Throughout this accounting, some phrases were selected that were relevant due to objectivity of content and because they sign a personal or common point of view with other entrepreneurs. So, we also present qualitative data for a better understanding of the issue.

The universe of research was a group of 68 companies unevenly distributed throughout the Portuguese territory. A non-disclosure agreement was signed with all respondents to ensure the confidentiality of the information provided.

Some measures to ensure validity were adopted. Issues of external validity were partially addressed by closely following the grounded theory approach, and by concentrating in the problem of internal validity and reliability and by cross-referencing the qualitative data with other sources, like NITEC final reports, results of the European Innovation Scoreboard, other studies about the outputs of public funding on firms' innovation systems. This triangulation approach increased confidence that the qualitative data were accurate, and that interpretation was true to the intentions of the interviewees.

Firms from the Porto, Aveiro and Viseu region that were granted funding by the NITEC program were part of the sample. These locations were selected not only because of its strong entrepreneurial activity, but also due to the close functional and administrative relationships, and convenience for data collection.

Besides the interviews, data from the NITEC final reports that were issued by the National Innovation Agency (ANI) was gathered, as a way of complementing the information amassed during the interviews. These reports also allowed to have information regarding the level of investment of firms, and the level of funding comprehended for each firm involved.

All data was analysed using NVivo software² that allowed a detailed analysis of specific topics, once all the information was encoded, and provided a systematic process in data analysis and research, increasing validity and reliability of the study.

3. Measuring innovation – indicators used by firms

The perception of what innovation is, and what it implies, is usually connect to the way their outcomes are measured. In this case, it is relevant to investigate what are firms' most used innovation indicators, as well as for funding agencies.

In the case of funding agencies, several innovation indicators are used to assess projects and their eligibility, that range from the quality of the project presented to its contribution to regional development. On the one hand, there are a set of indicators related to the project proposal's quality and feasibility, and to the ability of the firm to describe the existing state of the art using a technological and scientific language, and to clearly translate the mapping made of the several stages and outcomes of the project submitted. These set of indicators rely on the existing knowledge and human resources of the firm, as well as on the current status of R&D department or experience. In smaller firms this fact could appear as a barrier to innovation, as pointed out in the study of Massa and Testa (2008), since SMEs tend to have less available resources that can allocate time to measure the outputs and outcomes of innovation or that have the level of knowledge necessary to make it.

The degree of novelty related to the object of the proposal is also assessed and it is dependent of the context where it will be adopted, such as the firm itself, the national or international markets, which highlight the

² NVivo 12.1.0 (3068), QSR Internacional

concern that project's results should exceed the firm level, not only being able to reach the national market but also the international one.

On the other hand, there is a set of indicators that assess the impact of the project at both the firm level, and at regional and national economy level. More specifically, funding agencies look for projects that are able not just to improve firm's competitiveness, but also are able to contribute to the national economic development, as well as the development of the regions where the firms are located through the dissemination of knowledge, creation of jobs and human capital development. Also, if the project has impact on more than one region it receives a higher rate.

In the case of firms, and considering the answers of the interviewees, four different types of indicators were identified as being used by firms to measure innovation: *financial*, *innovation process*, *market* and *knowledge/know-how*. Also, most respondent firms have their innovation systems certified by the NP 4457 norm which implies that those firms have already implemented a set of indicators that are frequently used to measure its innovation activities.

The NP 4457 is a Portuguese norm, issued in 2007, that sets the management system requirements for research, management, and innovation (RDI). This norm has into consideration the recommendations of the Oslo Manual, the Kline and Rosenberg chain-linked model (Becheikh et al., 2006), and it is meant to be applied in all types of economic activities (industry and services). This model sees the company as an open system strongly connected to its surrounding environment, which implies that the model is attentive to the interactions inside the company and desires to stimulate them so that all innovation possibilities are taken into consideration. Innovation management is also about interface management, which represent the ability to communicate inside and outside the firm, to have the nuclear skills to innovate and learn to create a new innovation cycle (Iso, 2007). The interfaces are technological vigilance, technological cooperation, technological forecast, new customers/clients, internal and external analysis, intellectual property, internal creativity, organisation capability to conceive innovation structures and knowledge management (Iso, 2005). As stated by (Rocha, Lima, Amorim, Romero, & Crus-Cunha (2022, p.2) this standard defines the requirements of a research, development and innovation system (R&D+I) and is supported by the standard NP4458 that defines the requirements of an R&D+I project. NP4458 is meant to facilitate the systematisation of R&D+I project and improve its management. This standard is used as a reference to identify the project characteristics and ensure its planning, documentation, realisation and evaluation, and certified companies under NP4457, are expected to have more mature and defined project management practices, when compared to noncertified companies".

The *financial type indicators* are used as a barometer of the firm's innovation activity, which is then used to assess the level of investment to be made in the internal innovation processes. Regardless of the level of sophistication of the firm's internal innovation system, several respondent firms have a return-on-investment type of indicator, like new products' sales, gains of efficiency or savings."

The *innovation process* type of indicator is closely linked to the existence of a formal internal innovation process, and it aims at measuring the efficiency of the innovation process itself. Some indicators arise from the innovation process, like the total number of ideas, number of ideas that turn into a new product or process, number of new products launched in the market, turnover associated with new products commercialised. There is a clear effort to settle a typology of quantitatively measurable indicators, that help to support not only the end results of the innovation system, but also the different steps of the processes as well.

Time-to-market, customer satisfaction and the level of engagement are indicators highlighted by the interviewees as *market related indicators*. Market acceptance is seen as the ultimate indicator of a firm's ability to thrive in their innovation process. Market acceptance is also used to measure the level of novelty of the innovations produced. By comparing its product, process, or service with what is already presented in the market, firms can assess its position in the market, and thus define the strategy of releasing new products accordingly. The number of new markets added to the firm's area of operations, as well as the strengthening position on previous market segments and channels were also referred as related to the perception of the firm's innovative capacity.

Finally, the *know-how* that has generated inside the firm's innovations process is considered as an intangible resource worth measuring, according to the interviewees. Once again, the ability to create knowledge and transform it into new products, processes or even a new business area is underline as one of the capabilities that is boosted by internal innovation processes.

4. Main outputs that NITEC project had on firms.

From the 21 studied firms, only in one case the NITEC unit was discontinued, in the other cases the R&D units persist until today imbedded within the organisational culture, firms' procedures, and ways of doing. Nevertheless, comparing the initial structure of those units with what currently exists, only in three cases the units were restructured into an independent business area, since innovation and development services are presented to other firms as outsourcing. This type of innovation outsourced service represents an evolution of firm's internal innovation processes. Thus, the *creation of an innovation unit or department* was one of the main outcomes of NITEC program, along with the definition and establishment of internal innovation processes and innovation teams. This has led to some kind of *organisational innovation* since new organisational structure and culture were developed. Besides the development of a new department responsible for innovation, firms were able to hire qualified personnel which also improved firms' absorptive capacity.

Moreover, the development of *internal innovation systems* was key to improve a firm's innovation capacity. On the one hand, firms have put in place several strategies to gather innovation ideas from employees. On the other hand, the certification of the innovation process was considered relevant. As already mentioned, 14 of the firms that participated in our study are certified by the NP 4457 norm, and one more follows COTEC suggestions. The norm played an important role in what idea management, partnership and networks management, employees' involvement and innovation process mapping are concerned. As Dietrich (2018) noticed, organisational innovations are the result of the interactions between actors in firms structures. Organising the interactions and the knowledge that is born within is extremely important to reinforce the absorptive capacity of the firm (Acs, Braunerhjelm, Audretsch, & Carlsson, 2008). Besides the enhancement of the absorptive capacity of firms, firms that are involved in R&D and innovation activities are more prone in identifying innovation barriers and in overcoming it (D'Este, Iammarino, Savona, & Von Tunzelmann, 2012).

Those innovation systems also consider practices of open innovation, to make them more dynamic, faster, and creative. On the one hand, *partnerships with customers and suppliers* have been identified by interviewees as sources of innovation, thus playing an important role as innovation partners. These findings seem to go in accordance with the study of Massa & Testa (2008). Italian entrepreneurs do think that customers and suppliers are important in their innovation process, and that "innovation can emerge from disorderly interaction processes that can occur everywhere and among everyone" (Massa & Testa, 2008, p. 401). Agencies are also seen as a resource for innovation and market access since agencies belong to privileged networks of knowledge and project database.

5. NITEC program and innovation barriers

Apart from the impact on the development of different types of innovations, based on the interviews, it was possible to identify the effect of NITEC project on five different levels of the firms, mainly: *i) knowledge pool; ii) networks and partnerships; iii) internal innovation processes; iv) organisational culture; and v) market access*. Authors like Grabowski, Pamukcu, Szczygielski, & Tandogan (2015) and Bronsini & Piselli (2016) point out that public incentives may change firms innovation behaviour, namely through the establishment of collaboration projects with different context actors, and the increase of the propensity to cooperate, and the improvement of firms' innovation activities.

In the case of *knowledge*, it refers to the know-how and competences that were generated and improved within the firm during the timeframe of NITEC project. Several firms stretched the importance of this intangible output as a strategic resource.

Creating and building new knowledge has been seen like co-creation process brought about by multiple sources. NITEC program encouraged firms to hire new employees dedicated to innovation activities which, in turn, brought with them a set of new skills and knowledge. As stated by Braunerhjelm, Ding and Thulin (2018) new insights are brought by knowledge that is embodied in individuals. New knowledge has also been developed by the unfolding of the innovation process, trial and error, new experiments on new products, and new ways of doing differently builds up knowledge that later could be transferred into other innovation projects or other departments. The relationship with universities and being part of a wider network of relationships has also been a source of new knowledge.

The ability to take a part in *networks and partnerships* was also referred by the respondent as another important outcome of NITEC project. Firms of smaller dimension underline the fact that before NITEC the opportunities to participate in networks or partnerships with universities was difficult or inexistent. In fact, the smaller firms had

no experience in networks prior to NITEC. As several interviewees affirm, the NITEC provided the opportunity to bring the business and university worlds together.

Also, several respondents highlighted the changes in terms of *innovation internal processes*, through the selection and implementation of key performance indicators to evaluate innovation outputs, restructuring of firm's internal departments and supplying it with dedicated personnel. Therefore, through the implementation of a dedicated innovation unit, firms have redesigned their internal organisation. Moreover, NITEC nurtured the implementation of formal innovation processes which then fostered the firm's ability to respond to market needs, to reduce time-to-market and improve the ability to offer a new products or services. As already mentioned, firms have established processes of open innovation, where the external environment is scanned for knowledge and technologies that could be incorporated in the firm's innovations (outside-in process), as well as to spot opportunities to commercialise technologies that were developed internally by the firm (inside-out processes).

Additionally, to the impact on internal processes, NITEC unit had an influence on the organisation, building awareness to the internal innovation processes and its competitive advantages, namely in terms of how the market perceives the firm.

Deeply linked to the organisational culture impact, *market access* was another impact pointed out by the participant firms. The respondents underline the fact that a dedicated innovation team fine-tunes the firm response to market needs, decreasing time-to-market of new products, and promoting a more accurate positioning of the firm's products within market segments and channels. According to some respondents, NITEC unit allowed the firm to enter a new market channel, and it improved the market awareness of the firm. Also, NITEC unit allowed the exploration of new market opportunities both nationally and internationally, through gaining market knowledge.

6. Conclusions

Public funding agencies have the objective of supporting projects that foresee the creation of radical innovations, which then could have a significant impact at both economic and social levels. Consequently, these agencies use a set of indicators related to the quality of the project proposal, as well as the impact of the project not only on firms' competitiveness, but also at local and national economy. In turn, firms are exclusively concerned with the development of innovations that would improve their market positioning, sales, and production efficiency. Thus, firms use a set of indicators that are related to firms' business sustainability and growth. In both cases, these types of indicators are aligned with what each organisation think innovation is and its main outputs. Nevertheless, this may be translated as a barrier when firms are applying for projects supported by public funding agencies since those may perceive that the expected project outputs may not fulfill their expectations in terms of innovation outputs.

In sum, through the participation in the NITEC program firms were able to create internally a new unit or department dedicated to innovation equipped with highly skilled personnel. Therefore, firms were able to structure their innovation processes based on open innovation principles, taking benefit from the establishment of partnerships with customers, suppliers, and universities. Those organisations were, on the one hand, sources of innovation ideas and, on the other hand, partners in the development of innovations that could meet new market opportunities. Also, firms have implemented mechanisms to promote the participation of their employees in the different steps of the innovation process, such as idea generation, opportunity identification, and idea implementation. The development of new innovations, such as product, process, organisational, and marketing types of innovation, was also a side-effect of the NITEC projects.

Adding to the conclusions stated on Barbieri, Bragoli, Cortelessi, & Marseguerra (2020, p.128) study on public funding and innovation on Italian SMES, "public funding for innovative expenditure is not only a factor influencing firms' decisions to undertake innovative activities, but it is also a factor that determines the firm's innovative strategic choice", findings suggest, in the case of Portuguese SMES, that public funding not only condition the decision of investing in innovation processes, but it enhances the establishment of organisational processes and systems that lift innovation.

This papers also highlights the relevance of taking into consideration more quantitative indicators when looking into innovation results and scoreboards, hence there are side effect results that have significant results on firms' performance. Moreover, taking into consideration qualitative indicators can impact on the design of innovation programs and systems of finance, turning it more flexible and adjusted to SMEs.

Acknowledgments

This work was supported by the UIDB/05105/2020 Program Contract, funded by national funds through the FCTI.P.

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