UNRAVELLING THE EFFECTS OF SCIENCE PARKS ON THE INNOVATION PERFORMANCE OF NTBFs

Abstract

In spite of the extensive presence of Science Parks in developed countries, it is still unclear whether they have been successful in fostering the innovation performance of new technology-based firms (NTBFs). The aim of this paper is to help answer this question. Using an unbalanced panel of 7,691 observations associated with 1933 Spanish NTBFs (2007-2013), located both on-park and off-park, our empirical results show no evidence of a direct relationship between being located on a Science Park and the innovation performance of the NTBFs. However, our findings reveal that Science Parks play a positive selection role by attracting NTBFs with high technological capabilities (indirect effect). Moreover, our results also indicate that the decision to locate in a Science Park may enhance the innovation performance of NTBFs that collaborate and jointly export (moderating effect). This paper offers new explanations that help provide a better understanding of the effects of Science Parks on innovation performance and also outlines several practical implications.

Keywords: Science Park, NTBF, Innovation

JEL classification: D62, L52, O32

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1. Introduction

Science Parks have been argued to play a key role in the development of new technology-based firms (NTBFs) since these firms base their competitiveness mainly on technologies involving science and/or engineering knowledge (Granstrand 1998). In fact, since the 1980s a large number of Science Parks[1] have been established in order to create a supportive environment for these firms (Storey and Tether 1998; Colombo and Delmastro 2002), one that creates a bridge between research and industry (Quintas et al. 1992, Squicciarini 2008), encourages the creation of knowledge based firms and transfers technologies and skills (Liberati et al. 2016, p. 695). Science Parks provide not only physical facilities but also an important network resource for NTBFs (Löfsten and Lindelöf 2002), such as a pool of specialized labor, availability of capital, legal services, knowledge flows between firms and local research institutions, and the so-called image effect (Ferguson and Oloffson 2004), among others.

Due to the advantages of Science Parks, policy makers in most developed countries, and recently also those in developing economies, concerned about improving the innovation capacity of their firms, have increasingly chosen these parks as a tool to promote innovation and growth (Audretsch et al. 2014). This has led to an extensive and growing literature on science parks emerging over the last three decades, as Hobbs et al. (2016) summarize. However, empirical evidence has shown inconsistent results about whether they have been successful in supporting firms (e.g. Chan and Lau, 2005; Lamperti et al. 2015; Vasquez-Urriago et al. 2016). A number of studies confirm differences between on-park firms and their off-park counterparts with regard to survival (e.g. Ferguson and Olofsson 2004 for Swedish firms; Westhead and Cowling 1995 for British firms), growth rates (e.g. Löfsten and Lindelöf 2002, 2003 for Sweden; Colombo and Delmastro 2002 for Italy; Yang et al. 2009 for Taiwan), and different innovation measures (e.g. Felsenstein 1994 for Israel; Siegel et al. 2003a and Phan et al. 2005 for the UK; Lindelöf and Loftsen 2004 for Sweden, Squicciarini 2008 for Finland; Huang et al.

[1] According to Link and Scott (2007, 2015), the term Science Park is more prevalent in Europe, while the term Research Park is more commonly used in the United States, and the term Technology Park is found in Asia.

2012 for Taiwan; Lamperti et al. 2015 for Italy). However, several studies find no statistical differences between on-park and off-park firms in relation to the “return” for being located on a science park (Siegel et al. 2003b). In particular, Science Parks have not been found to be more effective for their tenants when it comes to innovation performance as measured by the number of patents (e.g. Westhead and Storey 1994 for the UK; Colombo and Delmastro 2002 and Liberati et al. 2016 for Italy; Lindelöf and Löfsten 2003 for Sweden), the number of new products and services (e.g. Westhead 1997 for the UK; Lindelöf and Löfsten 2003 for Sweden), R&D intensity (e.g. Westhead 1997 for the UK; Colombo and Delmastro 2002 for Italy), or sales of new innovations (e.g., Chan et al. 2010 for South Africa), among other measures and countries studied[2].

In order to provide some plausible explanations for these inconclusive results, the paper looks in more depth at this relationship by exploring whether or not, and how, being located on a Science Park fosters the innovation performance of NTBFs. With this aim, and unlike in previous studies, we firstly propose that Science Parks have an indirect effect on the innovation performance of NTBFs, rather than a direct effect, through an advantageous selection of on-park NTBFs. In other words, the effect of the parks comes from NTBFs with better technological capabilities clustering in them. Recently, Liberati et al. (2016) could not conclude that science parks are effective in improving the innovation capacity of their firms and given that the results of on-park firms are better than those of off-park firms, they deduce that parks are able to attract the best firms. However, our analysis allows us to confirm this. Secondly, we propose that Science Parks moderate the effect of the NTBFs’ exporting and/or collaborating strategies (individual and joint effects) on their innovation performance. The benefits of the park also depend on each firm’s strategic decisions. As a result, the strategies related to how and where firms grow require special consideration in the research. Moreover, given the extensive involvement of governments in Science Parks (UNCTAD 2015), as well as the concern about the collaborations and exporting of the NTBFs (Nieto and Santamaría 2010), there is academic and public policy interest in gaining a better understanding of how the effect of these strategies on the performance of NTBFs is moderated by the location strategy chosen (on-park *versus* off-park).

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[2] Eveleens et al. (2016) presented a broad review of how network-based incubations influence start-up performance and they also obtained inconclusive results.

Our study contributes to, and complements, the existing research in several ways. First, it identifies and explains the effect of Science Parks on the innovation performance of NTBFs, differentiating between direct, indirect and moderating effects. Second, it explores the idea of there being an advantageous selection of NTBFs located in the parks and the inclusion of individual and joint interactions between the firms' strategies (exporting and technological collaboration). Third, while many existing studies rely on regional populations of firms or cross-sectional surveys of firms across an entire country, our sample is larger, involving a panel with 7,691 observations (2007-2013). Finally, it covers the period 2007-2013, which corresponds to the economic crisis. This gives us a great opportunity to look in more depth at the relationship between Science Parks and the innovation performance of NTBFs in an unstable environment. Thus, we consider that this paper provides new theoretical and empirical explanations that contribute to a better understanding of the effects of Science Parks.

The paper is structured as follows. The next section presents the theoretical background that has inspired our hypotheses. Section 3 describes the data and methodology used in the analyses, after which we present and discuss the main results (section 4). The final section sets out the conclusions, limitations, and practical implications.

2. Hypotheses

Much of the literature suggests that Science Parks could act as facilitators and stimulators for the development of NTBFs (Lindelöf and Löfsten 2003). The rationale for this assumption can be synthesized as follows. Science Parks allow their tenants to benefit from access to a pool of specialized labor which favors the exchange of knowledge, ideas and information. They also provide access to the appropriate specialized goods and services which are particularly valuable when it comes to exploiting their knowledge-based business ideas and they also provide recognition (Ferguson and Olofsson 2004) since Science Parks are normally seen as prestigious locations. Furthermore, on-park NTBFs benefit from technology spillovers (Griliches 1992), which could make it easier for on-park firms to adopt new forms of technology, and from the formation and transmission of social capital, enhancing trust and promoting the sharing of vital information and stimulating on-park firms to increase innovation. The first source of these technological spillovers is proximity to university laboratories and other research centers (Lindelöf and Löfsten 2004; Link and Scott 2006). With some exceptions (e.g. Monck et al. 1988; Quintas et al. 1992; Malairaja and Zawdie 2008), there is a view that science parks promote the natural exchange of scientific expertise and research results with universities. The second source of knowledge externalities is associated with agglomeration economies (Chyi et al. 2012), that is, many NTBFs are clustered into a small area and this fosters the mutual exchange of knowledge. The final source is the Science Park's management team, which can provide advice on finance and marketing (Mian 1997).

These theoretical benefits of Science Parks underlie the argument in much of the management literature that NTBFs in Science Parks should perform better than their off-park counterparts.

However, are these benefits really a direct effect of being located in a Science Park? If the effect of the park on the innovative performance of the firms were direct, all on-parks firms would perform better than off-parks firms. However, many of the empirical results are critical of the effectiveness of Science Parks, even taking into account different countries and using different innovation and performance variables and measures (e.g. Westhead and Storey 1994; Westhead 1997; Colombo and Delmastro 2002; Lindelöf and Löfsten 2003; Liberati et al. 2016; among others).

One possible explanation is that Science Parks provide an innovation-generating environment in which tenants benefit each other since they are enclaves of innovation (Felsenstein, 1994). However, as Lindelöf and Löfsten (2003) and Löfsten and Lindelöf (2001, 2002, 2003) suggest, the success of Science Parks is actually due to the characteristics their tenants already possess, such as entrepreneurial orientation, motivation and firm capabilities (with respect to innovation and other strategy issues). A more motivated firm will be more involved in cooperation with other firms and research institutions as a channel for transferring knowledge that can be translated into innovation. As a result, Science Parks probably attract more motivated firms than off-park locations (Lindelöf and Löfsten 2003; Löfsten and Lindelöf 2001, 2002, 2003)[3]. Moreover, these authors state that "*it is also "clear" that, in terms of NTBF performance, whether or not*

[3] In contrast, Westhead (1997) and Fukugawa (2006) claim that some park managers have relaxed the standards for selecting tenants to maintain rental income.

a firm is in the high technology sector is maybe of greater importance than whether or not it is located in a Science Park" (Löfsten and Lindelöf 2002, p. 863).

These arguments and results allow us to question the direct effect of Science Parks on the innovation performance of NTBFs.

So, we present our first hypothesis as follows:

H1a: Being located in a Science Park has no direct effect on the innovation performance of NTBFs.

Instead, we propose that the positive effect of the Park on innovation performance is indirect and is due to an advantageous selection of NTBFs located in the parks.

Fukugawa (2006 p. 388), in line with Monck et al. (1988) and Westhead and Storey (1994), states that "*R&D-inactive firms choose Science Parks simply because they are prestigious in the business community*", reflecting the presence of adverse selection[4] in Science Park NTBFs. This paper adopts the opposite perspective (advantageous *versus* adverse selection). This is due to some of the literature suggesting that NTBFs with higher specific capacities[5] to benefit from shared resources have an incentive to enter Science Parks (e.g. Löfsten and Lindelöf 2001, 2002, 2003, Lindelöf and Löfsten 2003, Yang et al. 2009; Liberati et al 2016).

Science Parks provide a favorable environment for innovation in which NTBFs can build networks with customers, suppliers, researchers and other businesses/organizations (Löfsten and Lindelöf 2003). However, networks are not instantaneous phenomena: time and effort are needed to transform an interaction into successful cooperation. In addition, the effectiveness of networks is linked to particular combinations of partnerships. In other words, NTBFs that devote few resources to promoting innovation are less likely to achieve learning from their cooperation partners and, as a result, less likely to take advantage of the opportunity to develop innovations and obtain economic benefits. So their incentive to locate in a particular place (a Science Park) that does not bring any added value is lower. In contrast, NTBFs with more resources to invest in R&D will be more proactive in innovation activities. The more financial and human resources NTBFs

[4] The classic models of asymmetric information pioneered by Akerlof (1970) in his "market for lemons" would assume that potential entrants have private information regarding their specific capabilities.

[5] Following Eveleens et al. (2016), these specific capabilities would include absorptive capacity, network capacity and the relational capability of managing shared resources.

invest in R&D, the greater their absorptive capacity, that is, their ability to assimilate and exploit commercially the available knowledge spillovers in Science Parks (Cohen and Levinthal 1990; Cassiman and Veugelers 2002). As these firms are likely to take advantage of the Science Park location, their expected future profit from knowledge-networks increases, as does their predisposition to locate in a Science Park.

Moreover, NTBFs with a strong cognitive ability may be more likely to use the information flows and knowledge networks, but they may also be more knowledgeable about potential innovation risks. Specifically, considering two NTBFs with different cognitive abilities, the high-cognitive ability NTBF may have better technological knowledge, but it may also have a greater awareness of the possible lack of appropriability of an innovation. In contrast, the one with low cognitive ability thinks there will be no appropriability problems beyond those already experienced. Since Science Parks have traditionally been designed to enhance the appropriability of R&D investment, the first NTBF may be more likely to join a Science Park than the second, therefore leading to advantageous selection.

Finally, Science Parks may provide an environment conducive to the development of prestige for firms (e.g. Monck et al. 1988; Felsenstein 1994; Fukugawa 2006; Sofouli and Vonortas 2007; Salvador, 2011), providing an advantage for the NTBFs that cluster in them. However, the reputation of a Science Park is not independent of its tenants; in fact, the presence of other NTBFs, firms and laboratories in a Science Park could be the best indicator of the desirability of that locality for other NTBFs (Appold 1991). If this were the case, we could expect the location choice of NTBFs to be based on their technological capabilities, with NTBFs that have more technological resources and capabilities tending to cluster. Therefore:

H1b: NTBFs with high technological capabilities tend to cluster in Science Parks

In addition to this indirect effect of Science Parks, we also argue that being located in a Science Park might have a moderating effect on the strategies and innovation performance of some NTBFs. In particular, and as a result of the international competition faced by NTBFs due to the dynamic evolution of technology, export and technology collaboration strategies deserve special attention.

Given the global nature of technology, global markets appear for the newly developed products and processes (Bengtsson and Löwegren 2001). Many studies have argued that NTBFs can acquire an important competitive advantage by becoming international, serving their customers on a global scale (Coeurderoy et al. 2012). Internationalization provides new market opportunities for selling product innovations and for obtaining new useful knowledge to build new value-creating skills. This learning by exporting can facilitate technology diffusion and transfer (Filatotchev et al. 2011).

However, it is widely accepted that when NTBFs enter and establish themselves in international markets they face greater obstacles and constraints than other firms in terms of a lack of finances, marketing, entrepreneurial knowledge and other resources (Storey and Tether, 1998). These firms suffer from “liabilities of newness”, which relate to a new firm’s inability to access the critical resources needed to develop and launch new products, particularly in the first years after market entry (Stinchcombe 1965; Hannan and Freeman 1984).

Science Parks could provide their tenants with a good environment - support organizations for the park management, park tenants, and community services (Gibson et al., 2013)- which helps NTBFs to access the required resources and overcome the constraints to developing international activities (Bengtsson and Löwegren 2001). For example, the institutions in parks can offer information, advice and training services relating to overseas markets (Storey and Tether 1998; Löfsten and Lindelöf 2001). In this line, a case study of a specific Science Park, AvePark in Portugal, shows the need to complement the physical infrastructure with softer investments and services such as a plan to foster the internationalization of the park and its tenants (Carvalho, 2009).

Moreover, since geographical proximity accelerates the dissemination of knowledge among firms (Chan and Lau 2005), especially tacit knowledge which is more difficult to share (Bell and Zaheer, 2007), the development of synergies and links among exporting firms clustered in a location such as a Science Park is likely. Taking into account that most of the knowledge shared locally has a high tacit content (Vedovello, 1997; Bakouros et al. 2002), these relationships among firms and between firms and other institutions could provide firms with resources and access to important information about international markets. However, there may also be disadvantages associated with being in a park (Link and Scott, 2015). When a park attracts many exporting NTBFs, which then have access to the same technologies, those exporting NTBFs may expect greater competition in the use of those technologies. They may have to compete over the limited space available in a Science Park, over a highly specialized workforce and over shared services (Bakouros et al. 2002).

Science Parks also help their tenants to identify export opportunities, understand and compare the market access requirements arising from regulations (Bergek and Norrman 2008), and communicate to potential customers the meaning and value of their new ideas and/or products. Their institutions are expected to manage the information flow about foreign markets and international activities. Universities and research institutes located in a Science Park also provide support through offering staff training and scientific research.

Additionally, Science Parks provide NTBFs with a positive image gained from their location (Ferguson and Olofsson 2004) which may enhance their legitimacy in international markets, helping them to win new customers and develop international networks of foreign partners. This could be expected to happen even if the park's management is not particularly active (Albahari et al. 2017).

Thus, being located in a Science Park is likely to make it easier for NTBFs to export, having a positive impact on their success in introducing new products. Based on these arguments, we suggest the following hypothesis:

H2a: The effect of exporting on the innovation performance of NTBFs is moderated by the location strategy chosen (on-park versus off-park). This effect will be strongest for NTBFs located on a Science Park.

NTBFs base their competitive advantage largely on technological resources and innovation (Bengtsson and Löwegren 2001). Therefore, the development of innovation capacity may indeed enhance the success of NTBFs in launching new products. This innovation capacity could be internally developed by relying on internal R&D or externally acquired by buying it in the market or establishing technological collaborations with other R&D partners.

Technological collaboration is designed to provide participating firms with opportunities to acquire technological resources and capabilities such as capital, knowledge, innovation and consultancy in the field of high technology (Löfsten and Lindelöf 2005) from external sources, and enable the sharing of complementary resources among firms, making synergy creation possible in order to develop new technologies or improve innovation performance. As a consequence, firms may be more motivated to invest in R&D to exploit these technological opportunities (Fukugawa 2013). However, although technological collaborations are necessary to produce technological innovation, they are rarely sufficient to ensure its commercial benefits (Lindelöf and Löfsten 2004). To increase the commercial benefits of technological innovation the firm needs access to other resources that are complementary to its innovation assets (Teece 1986).

Science Parks could collaborate in fostering agreements and in improving the innovation performance derived from technological collaboration between firms and research and technology organizations (Vasques-Urriago et al. 2016). The geographical proximity of these agglomerations of organizations provides opportunities for formal and informal contacts and links which allow knowledge exchange (Bakouros et al. 2002; Colombo and Delmastro 2002) and may lead to joint projects developing among their tenants (Fukugawa 2006) who gain access to mutual exchanges of resources (Westhead and Storey 1994). The partner's search costs and uncertainty decrease due to the fact that the information about partners can be obtained face to face. This environment favors communication and repeated contact between partners, reducing the cost of each future interaction by generating routines and procedures (Dahl and Pedersen 2004), developing mutual understanding among partners and reducing the risk of failure, resulting in more stable and longer collaborative links that allow trust to be built. A high level of trust not only reduces the transaction costs involved in knowledge interactions but also contributes to sharing more valuable knowledge and to developing non-transferable common knowledge because decision makers do not feel that they have to protect themselves from their partner's opportunistic behavior (Inkpen and Pien 2006). As a consequence, innovation output improves.

The potential for and success of technological collaboration depends on the institutions and organizations which create a favorable innovation environment. Science Parks provide NTBFs with a more appropriate technological infrastructure than is available to firms in off-park locations, encouraging them to establish their technological collaborations (Westhead 1997) and stimulating research productivity among on-park firms (Siegel et al. 2003a).

Moreover, technological knowledge flows more easily locally than over great distances, favoring the generation of more knowledge spillovers (Baptista and Swann

1998) which on-park firms can transform into valuable new products, services or processes (Westhead 1997; Löfsten and Lindelöf 2005) in a timely manner, making commercial control over an innovation output both easier and faster (Baptista and Swann 1998). Additionally, Science Parks offer firms several general and specialized services such as financial and marketing support to help them succeed in the commercialization of their new products (Díez-Vial and Fernández-Olmos, 2015).

In summary, Science Parks help their tenants with knowledge creation, technology diffusion and commercialization and intermediation among firms and knowledge institutions. Thus, we suggest that NTBFs located in a Science Park and establishing technological collaborations may be more able to benefit and produce successful new products than other NTBFs. Thus, we offer the following hypothesis:

H2b: The effect of technological collaboration on the innovation performance of NTBFs is moderated by the location strategy chosen (on-park *versus* off-park). This effect will be strongest for NTBFs located in a Science Park.

We expect that engaging in both exporting and technological collaboration activities may help NTBFs located in Science Parks to develop additional competitive advantages, which may be reflected in their subsequent innovation performance.

As we have mentioned earlier, Science Parks offer a wide range of general and professional services that promote and support the activities of their tenants. By providing access to experienced business consultants with international networks and/or foreign partners, technological collaboration can lower the barriers that prevent NTBFs from competing successfully in international markets. This could be a very valuable service for the internationalization of NTBFs, which usually lack personnel with international experience (Bengtsson and Löwegren 2001). In the case of NTBFs located in a Science Park, this effect is reinforced because this physical location offers a collaborative environment that supports and promotes collaboration between private firms and scientific-technological organizations, providing them with information, relationships and useful contacts to promote the transfer of technology and knowledge flows into new products for international markets (Löfsten and Lindelöf 2002).

Technological collaboration would also increase the ability of NTBFs to innovate new products and processes, which acts as an important driver of successful exporting. In this sense, innovative NTBFs will have a greater tendency to expand their existing products into new markets to foster sales growth and achieve increasing returns on innovation investment. Accordingly, international markets become increasingly important for NTBFs in their efforts to exploit the technological progress acquired through technological collaborations and thereby enhance their success when introducing new products. We suggest that this knowledge exchange, which may result in new products for international markets, will be more effective for NTBFs concentrated geographically in a Science Park. Since new product development is a process of problem solving and knowledge creation and integration, effective tacit knowledge exchange has been identified as a key component in the development of successful new products (Goffin and Koners 2011).

Lastly, reducing response times is becoming indispensable for successful innovation in the technology sector. For NTBFs, technological collaborations are crucial not only to drive more innovation in their products and services, but also so that they can innovate rapidly. With the development of innovation accelerating in response to changes in demand in international markets, NTBFs establishing technological collaborations take an early global market position that could provide them with an important international competitive advantage, and therefore the capacity to innovate successfully. Science Parks contribute to technological collaborations that increase the ability to capitalize quickly on international market opportunities. By promoting the development of trust (due to geographic proximity) in collaborations (Wennberg and Lindqvist 2010), less time is spent on monitoring and the transaction costs involved in the knowledge interaction are lower.

The exporting activity of NTBFs may also provide them with the stimulus and capacity to establish successful technological collaborations, which may positively affect the launch of their new products. By exporting, NTBFs move closer to their customers and find new ways to engage with them. This valuable information can then be used in the technological collaboration process to innovate by creating new products and services that meet those demands (Salomon and Shaver 2005). In this regard, Science Parks are broadly considered to be an essential environment when it comes to explaining the ability of NTBFs to absorb this international knowledge through collaboration. Additionally, being exposed to international markets may serve as a way for NTBFs to access new potential partners with whom to develop international collaborations and projects which allow them to develop new products or services in sectors with future potential (Guadix et al. 2016) . Exporting NTBFs are interested in finding counterparts who are worthy collaboration partners and they might gain a better reputation and more legitimacy by being located in a Science Park (Ferguson and Olofsson 2004).

Overall, NTBFs are characterized by not having stable business relationships and not having a reputation. They need time to gain legitimacy in international markets. Therefore, they need to demonstrate to the international market that they are reliable and trustworthy business partners. In this case, Science Parks could be used by NTBFs as a platform to overcome the liabilities of "newness" (Ferguson and Olofsson 2004; Sofouli and Vonortas 2007) and "foreignness" associated with exporting, working as "good brand names" (Salvador 2011) for their tenants and promoting the development of technological collaborations which result in new products being sold in international markets. Similarly, a Science Park could allow them to take advantage of the opportunities available from successful exporting operations through technological collaborations that rapidly transform international knowledge into new products.

Therefore, we propose the following hypothesis:

H2c: The effect of both exporting and technological collaboration on the innovation performance of NTBFs is moderated by the location strategy chosen (on-park *versus* off-park). This effect will be strongest for NTBFs located in a Science Park.

The theoretical framework is summarized in figure 1.

INSERT FIGURE 1

3. Empirical analysis

3.1 Data source and presentation of the variables

In order to test the hypotheses we use microdata from the Spanish Technological Innovation Panel (PITEC), which is an annual survey of the innovation activities of firms (e.g. types of innovation, innovation expenditure, innovation objectives, etc.)[6]. The data

[6] The data, questionnaire and a description of each variable are available online http://icono.fecyt.es/PITEC/Paginas/descarga_bbdd.aspx. This database provides some anonymized data in order to provide individual level information and to maintain the confidentiality required by data protection

are compiled by the Spanish National Institute of Statistics (INE), with the support of several official institutions: the Spanish Foundation for Science and Technology (FECYT) and the COTEC Foundation, based on the Community Innovation Survey (CIS) type questionnaire. The main advantages of PITEC over the majority of datasets are that there is no need to worry about sample-selection issues and its longitudinal nature, which ensures a consistent representation of the Spanish business structure over time[7]. Moreover, this is the only database that contains information on the export and collaboration activities of NTBFs located in Science Parks. The main limitation of this survey lies in the fact that it does not allow us to explore heterogeneity among the different types of Science Park because the only information that it provides is whether or not the firm is located in a Science Park (it does not provide the name of the Park or its characteristics).

This database has largely been used to analyze different objectives related to innovation such as the effect of collaboration on innovation performance (e.g. Belderbos et al. 2015, González-Pernía et al. 2015) or the effect of Science Parks (e.g. Fariñas and López 2007, Díez-Vial and Fernández-Olmos 2015, Vásquez-Urriago et al. 2016, Albahari et al. 2017[8]), among others.

Although PITEC offers panel data from 2003, our study covers the period 2007-2013 because 2007 is the first year of the panel with information about whether or not a firm is located in a Science Park. The most recent year available is 2013. This period corresponds to the economic crisis that particularly affected developed countries, giving us a unique opportunity to look in more depth at the relationship between Science Parks and the innovation performance of NTBFs. This differentiates this research from most previous studies on this topic which were conducted in periods of economic growth. As Chan and Lau (2005) pointed out, it is important to consider the macro context in which the benefits of Science Parks are analyzed. Although parks are always important in terms

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laws. López (2011) describes the procedure applied at the PITEC and demonstrates that the use of anonymized data from PITEC instead of original data produces reliable results.

[7] The survey methodology follows the Guidelines proposed by the OECD for the collection and interpretation of data on innovation (Oslo Manual). The sampling design tries to minimize the sampling errors in the different phases and there are controls that guarantee a suitable quality level for the whole process. Finally, this survey is designed to deal more accurately with the innovation behavior of Spanish firms longitudinally.

[8] Vásquez-Urriago et al. (2016) extracted data from the 2007 Spanish Survey of Technological Innovation in Companies and Albahari et al. (2017) used the Spanish CIS database. In both cases, the source of information is the same as in PITEC.

of the support they provide to firms, they may be especially important in periods of crisis when the probability that firms will fail to survive increases[9].

Spanish Science Parks, as is the case for other Science Parks, have often been established through a partnership between national and local authorities, private firms and local universities or research centers. They are generally associated with a physical space and their objective is to promote the creation and/or growth of firms, especially knowledge-based firms, and the transfer of technology, and to foster innovation between the organizations located in the park. Their development in Spain was clearly initially based on the success of experience in the United States. The number of parks in Spain has grown rapidly since the first initiatives in the late 1980s, increasing from 6 to 67 during this period. Nowadays, the 67 functioning Science Parks in Spain are home to a total of 6,300 companies with a turnover of €20 billion. They provide employment for 150,000 people and around 20% of the jobs are in Research and Development. This makes Spain one of the world's leading countries in the establishment of such Parks (see the Spanish Association of Science and Technology Parks -APTE[10]). Moreover, as UNCTAD (2015) states, Science Parks in Spain have similar characteristics to those in other European countries such as France, Greece, Italy and Portugal.

From PITEC, we select those firms that are new technology-based firms (NTBFs). We focus on NTBFs because they have received growing attention in the literature and in particular because of how important it is for them to be located in a park. Although there is no unique and unambiguous definition of NTBFs in the literature (Nieto and Santamaría 2010), Cooper's (1971, p. 3) definition remains the most commonly used: "*a firm that emphasizes research and development or that places major emphasis on exploiting new technical knowledge*". However, it is Little's (1977) definition that allows us to better identify a NTBF. Taking this as a starting point and complementing it with the size characteristic established by Butchart (1987), we classify NTBFs as those firms with the following characteristics: a) they invest in internal R&D (e.g. Fariñas and López 2007); b) they have been operating for less than 25 years (e.g. Löfsten and Lindelöf 2002); c) they have been created by a group of individuals, i.e., not as a subsidiary of an established company (e.g. Löfsten and Lindelöf 2003); and d) their size is no larger than

[9] Unfortunately, with the available information we cannot compare our results with those obtained in a period of economic growth.
[10] www.apte.org.es

200 employees (e.g. Fariñas and López 2007). This definition of an NTBF is in line with previous studies that consider a specific combination of the criteria of age, size, independence and technology. There are 1933 NTBFs that fit these characteristics during the period being studied. Thus, our final sample is an unbalanced panel of 7,691 observations (905 on-park and 6786 off-park observations).

We have established the measures of our variables by following previous research on the park effect (Table 1). The dependent variable is *Innovation Performance*. We choose to operationalize this through sales of new products (new to the firm and new to the market) because the ultimate purpose of firms located on parks is to launch new products and enter new markets (Löfsten and Lindelöf 2003). This also reflects the extent to which customers perceive a product innovation not only as new but as superior to existing products, and the extent to which this leads to purchasing intentions (Grunert and Traill 2012). This is measured as the percentage of total firm sales accounted for by new product sales. Various authors have recently used this instead of patents (e.g., Cassiman and Veugerlers 2006; Díez-Vial and Fernández-Olmos 2015) since the propensity to patent varies by firm, sector and country (Löfsten and Lindelöf 2002), not all innovations are patented (Fukugawa, 2016) and it is difficult to identify the influence of patents on final revenue (Guadix et al. 2016). *Park* is a dummy variable for being located in a Science Park. This equals 1 if a firm is located in a Science Park, and zero otherwise. *Export* is also a dummy equal to one when the firm exports and zero otherwise. The independent variable *collaboration* is operationalized using a dummy that equals 1 if the company participates in technological collaboration networks in the period t-2 to t and zero otherwise. This variable includes all types of collaboration partner (suppliers, customers, competitors, consultants, universities, public firms and/or technology centers) without differentiating between them in order to analyze the effect of any technological collaboration on the NTBF's innovation performance.

INSERT TABLE 1

In keeping with the existing literature, we also added some control variables. First, we take into account the firm's *R&D intensity* by capturing the R&D commitment of the firm. Greater R&D intensity is expected to improve a firm's performance (Yang et al. 2009). The traditionally used measure, still the most popular, is the ratio of R&D expenditure to turnover (in percentage terms). Second, we include firm *size* as the natural logarithm of the number of employees (e.g. Belderbos et al. 2004), due to its relevance for the firm's innovation behavior and performance. Third, we control for *age*. A firm's performance might vary over its lifetime, but the effect is not clear. While older and more experienced firms may be more likely to grow because they have learned how to do things better, younger firms might benefit from fewer organizational rigidities and less inertia, characteristics that are brought about by age (Díez-Vial and Fernández-Olmos 2015). Age is measured by the natural logarithm of the number of years (plus one) elapsed since the year of establishment (Fukugawa 2006)[11]. Finally, we control for industry effects by including a *low-tech* dummy that takes a value of one if the firms belongs to a low-tech industry (based on the industry classification provided by the Organization for Economic Cooperation and Development, OECD) and zero otherwise. Given that the OECD's classification of sectors is based on the sector's average share of R&D spending, being in a low-tech sector is expected to have a negative relationship with innovation performance.

3.2 Descriptive analysis

Before assessing the effects of belonging to a Science Park on the innovation performance of NTBFs, we checked for heterogeneity between on-park and off-park NTBFs. Several two-group t-tests were conducted to compare the results of both groups. Table 2 presents the sample characteristic and the results of the t-test analysis.

As preliminary results, we confirm the existence of statistical differences between on-park and off-park NTBFs for all variables with the exception of export propensity and size. In particular, on-park NTBFs are younger, have a higher percentage of sales of new products (22.02%) than their off-park counterparts (16.30%); and a higher R&D intensity (53.06% versus 21.22%). Moreover, a larger proportion of on-park NTBFs are involved in some level of technological collaboration. In contrast, as we expected, a larger proportion of off-park NTBFs belong to low-technology sectors.

INSERT TABLE 2

Table 3 provides the correlation matrix (Spearman) and the variance inflation factors (VIFs). The maximum VIF obtained is 1.27, which is substantially less than the

[11]We add one year to avoid ages of zero (Fukugawa 2006). Moreover, we use this variable in logarithmic form because one year might be insignificant to a middle aged firm but could be of great importance to a newly-established firm.

conservative cut-off of 10 for multiple regression models (Hair et al. 1998). These results lead us to conclude that no strong correlation among variables has been observed.

INSERT TABLE 3

Table 4 shows the evolution of on- and off-park NTBFs from 2007 to 2013 in PITEC, taking into account not only their exporting and collaborating activities, but also their innovation performance. The total number of NTBFs in the sample decreases during the period, perhaps due to the economic crisis. However, the percentage of NTBFs located in a Science Park increases during the period. While 1.63% of all NTBFs were located in a Science Park in 2007, this percentage had risen to 12.97% by 2013.

INSERT TABLE 4

Overall, the number of exporting NTBFs increased during this period. This increase is sharper among on-park NTBFs (almost three times greater). Specifically, the percentage of on-park NTBFs involved in exporting grew from 25.81% in 2007 to 63.46% in 2013. The increased participation in exporting was especially intense up to 2008, remaining somewhat stable during 2009-2011 and increasing again after that. In spite of this, the average percentage of NTBFs exporting during the period is higher in those located off-park, although the difference is not large (47.29% *versus* 48.67%).

On-park NTBFs tended to engage in technological collaboration agreements and introduced new products more frequently than off-park NTBFs during the period 2007-2013, although collaborations increase in both sub-samples.

3.3 Models and Methodology

We use several models and methodologies to test our hypotheses. For the first hypothesis (H1a), that states that an NTBF being located in a Science Park has no direct effect on its innovation performance, we use the entire sample of NTBFs and the model includes all the variables[12], as specified below:

$$Innovation\_performance_{it} = \beta_0 + \beta_1 Park + \beta_2 Export_{it} + \beta_3 Collaboration_{it} + \beta_4 Export_{it} x Collaboration_{it} + \beta_5 R\&Dintensity_{it} + \beta_6 Size_{it} + + \beta_7 Age_{it} + \beta_8 Low\_tech_{it} + \mu_{it} \quad (1)$$

[12] With the exception of the binary variables, which should have the possible values of 0 and 1, we mean centered the predictor variables in all the regression models to minimize multicollinearity (Aiken and West 1991).

To estimate equation (1) we apply the general Dynamic Tobit model to the panel data, since the distribution of the dependent variable exhibits censoring at zero.

The hypothesis H1b establishes that NTBFs with advanced technological capabilities tend to cluster in Science Parks because they have more innovation capabilities and, as a result, they expect to benefit more from being located in a Science Park than NTBFs with reduced technological capabilities, which leads to advantageous selection.

Therefore, we consider that locating NTBFs in a Park is an endogenous decision. In order to deal with this, we split the sample into on-park and off-park NTBFs and we employ a panel data sample selection model (Heckman Model) because it allows us to correct potential selection bias and identify the existence of advantageous selection[13]. This approach involves the estimation of a binary choice model for selection, followed by the insertion of a selectivity factor (the inverse Mills ratio) calculated from the first model into the second model of interest.

In the first stage, a probit model is used to examine the decision of whether or not to enter the Science Park. The variables that could influence this decision are those found in the literature (e.g. Yang et al. 2009): R&D intensity, collaboration in technology, size, age and industry. These are included in the model as follows:

$$Park_{it} = \alpha_0 + \alpha_1 R\&Dintensity_{it} + \alpha_2 Collaboration_{it} + \alpha_3 Size_{it} + \alpha_4 Age_{it} + \alpha_5 Low\_tech_{it} + \mu_{it} \quad (2)$$

This equation (2) is estimated using the maximum likelihood method.

In the second stage, we also include the export variable and the multiplicative variable: Export x Collaboration. Moreover, as required, we add the inverse Mills ratio (λ), as shown in equation 3, for both subsamples.

$$Innovation\_performance_{it} = \beta_0 + \beta_1 Export_{it} + \beta_2 Collaboration_{it} + \beta_3 Export_{it} x\ Collaboration_{it} + \beta_4 R\&Dintensity_{it} + \beta_5 Size_{it} + \beta_6 Age_{it} + \beta_7 Low\_tech_{it} + \beta_8 \lambda_{it} + \mu_{it} \quad (3)$$

As with Equation (1), we apply a general Dynamic Tobit to each panel (on-park

[13] The use of matched samples is another approach widely used in the literature (e.g. Westhead and Storey 1994; Löfsten and Lindelöf 2002; Fukugawa 2006). However, it has important limitations, especially for the objectives of our study. There is no reliable and cost-effective way to identify an adequate comparison group (Mian 1997); it provokes a sample bias; and as Ferguson and Olofsson (2004, p. 9) stated, "*It is difficult to know whether observed differences between the groups being compared are associated with the issue being studied, or a result of different samplings*".

and off-park).

With equation (3) we also test the hypotheses H2a, H2b and H2c that deal with the positive moderating effect of being located in a Science Park and the joint effect of exporting and collaborating on the innovation performance of NTBFs.

When analyzing the relationship between export and collaboration decisions and innovation performance, we allow for the existence of individual effects. As is common with panel data, these effects are potentially correlated with the right-hand side regressors as $\mu_{it}=v_t+\varepsilon_{it}$, where v_t is a firm-specific effect that varies across firms but not within a firm over time, and the term ε_{it} is a white noise error. We employ the robust Hausman test to judge which technique, fixed effect (FE) or random effect (RE), is most appropriate for eliminating the individual effects.

4. Results and Discussion

Table 5 presents the results of the estimations of the regressions derived from equations (1) and (3). The Wald tests suggest that all the models are congruent given that the estimated parameters are jointly significantly different from zero (Prob> χ^2= 0.000). Likewise, the F values correspond to the robust Hausman tests on the random-effect versus fixed-effect models. As these F values are smaller than the values of the 1% critical level, the estimates shown in Table 5 are obtained from the random effect model.

The first column shows the regression analysis for all sampled firms (Equation 1). As a first result, we see that the park term is not significant, meaning that, as we predicted in hypothesis H1a, Science Parks do not directly improve the innovation performance of NTBFs in the form of new products in the market. So if NTBFs were to decide to locate in a park based only on this expected direct effect, their performance would probably not be improved.

INSERT TABLE 5

In order to test whether the effect of the Science Park on the innovation performance of NTBFs could be indirect through advantageous selection for on-park NTBF, as predicted in H1b, we estimate the panel data sample selection model for on-park and off-park NTBFs. The estimates for both subsamples are shown in columns (2) and (3). However, equation (2) has first been estimated obtaining the following marginal effects.

Park= 0.007***R&D + 0.604***Collaboration + 0.404***Size - 2.565***Age – 9.621**Low-tech
(0.002) (0.149) (0.109) (0.572) (0.760)

According to these empirical results from the first-stage probit model, the probability of becoming a member of a Science Park significantly increases with R&D intensity and collaboration. This result is in line with those reported in the literature (e.g. Yang et al. 2009).

In Table 5, we can also see that the inverse Mills ratio (λ) is significant and positive only in the on-park subsample. In the off-park subsample this term was not included in the final model, since during testing it was found that it was not significant. There is thus no selection bias in the off-park sample. However, the significance of the Mills term for the on-park subsample suggests that the non-observable characteristics that positively affect the NTBFs located in a park also have a positive effect on their innovation performance. Therefore, NTBFs with relatively higher innovation capabilities (as derived from equation 2) are located in the Science Parks and are therefore expected to have a better innovation performance. This result corroborates the idea of advantageous selection in Science Parks, as predicted in hypothesis H1b, which assumes that the NTBFs that enter Science Parks do so because they have better capabilities prior to entry.

The rest of the hypotheses establish that Science Parks moderate the effect of the NTBFs exporting or/and collaborating strategies (H2a, H2b, and H2c).

The export coefficient is not statistically significant in any of the regressions. These results do not support a "learning-by-exporting" effect caused by exposure to superior foreign technology and knowledge in any subsample of NTBFs, or in the sample as a whole. We cannot therefore confirm whether on-park exporting NTBFs have better innovation performance than off-park exporting NTBFs, rejecting hypothesis H2a.

In contrast, we find a positive and statistically significant coefficient for the collaboration variable in both subsamples and also in the sample as a whole. In order to investigate the role of collaboration in the better innovation performance of on-park NTBFs, a coefficient-equality test is performed to examine possible differences in coefficients between on-park and off-park NTBFs. One frequently applied hypothesis test is $= b_1 - b_2/\partial_{b_1-b_2}$, where $\partial_{b_1-b_2}$ equals the estimated standard error of the difference. The z test for the difference between the two collaboration regression coefficients is z=2.078, failing to reject the null hypothesis that $b_1=b_2$. Thus, the effect of technological collaboration is no different for NTBFs located inside a park and those located outside. In other words, technological collaboration always has a positive impact on the innovation performance of NTBFs. This confirms the contribution of technological collaboration in internalizing knowledge spillovers and eliminating the disincentive effect of spillovers on R&D, which in turn leads to greater innovation success (Belderbos et al. 2004). We do not thus find support for hypothesis 2b.

Finally, the export x collaboration interaction term is significant and positive only for the on-park NTBFs sample. However, the corroboration of hypotheses 2c is not as straightforward as analyzing the significance of the coefficient β_3 export x collaboration. It can be interpreted as the average difference in innovation performance between exporting and non-exporting NTBFs when collaborating changes from 0 to 1, and similarly (because interactions are symmetric), as the average difference in innovation performance between collaborating and non-collaborating NTBFs when exporting changes from 0 to 1. It is important to note that the interpretation of the interaction coefficient β_3 alone is not sufficient to corroborate hypothesis 2c (Wiersema and Bowen 2009). The coefficient of the product term β_3 indicates the magnitude of the change in the export effect, but does not address the question of whether the export effect is stronger when collaborating is 0 or 1, and the same is true for collaboration when exporting is 0 or 1. For this reason, and in accordance with the recommendation from Aiken and West (1991), we compute the simple slope for the independent variable. The simple slope is the partial derivative of the dependent variable with respect to the independent variable, which in our case would be:

$$\frac{\partial Innovation\ Performance}{\partial Collaboration} = \beta_1 + \beta_3 Export$$

The common approach taken to explore the meaning of the simple slope is to calculate the effect of the independent collaboration variable on the dependent variable when the export variable is set at one standard deviation unit above (*high export*) and below (low export) its mean. These two values allow us to test hypothesis 2c. Thus, to facilitate the interpretation of the interaction effect we use the procedure established by Aiken and West (1991) and plot the interaction for each subsample of NTBFs, on-park and off-park, as seen in figure 2.

The interaction between collaboration and exporting in figure 2 (2.a) shows that for on-park NTBFs which collaborate there is a strong positive relationship between export and innovation performance. In fact, the interaction plotted demonstrates that on-park NTBFs which export and collaborate outperform those on-park NTBFs that do not collaborate regardless of their export activity. The second insignificant interaction effect between collaboration and export for off-park NTBFs is shown in figure 2 (2.b). The plot demonstrates that collaborating off-park NTBFs outperform non-collaborating off-park NTBFs regardless of their export activity. These findings support hypothesis 2c.

INSERT FIGURE 2

Thus, although we have not found differences in the individual effect of the export strategy (insignificant effect) between on-park and off-park NTBFs, or in the collaboration strategy (positive effect) between both samples, we do show that on-park NTBFs are able to develop more successful new products than other NTBFs when they engage in both exporting and collaboration activities. So one of the important sources of innovation performance differences between on-park and off-park firms is related to their engagement in both exporting and collaboration strategies.

Finally, with respect to the control variables, the results are in line with previous results, except for the size variable which is significant in the subsample of on-park NTBFs but not in the subsample of off-park NTBFs. The rest of the control variables are highly significant in both groups. In addition, the R&D intensity and low-tech variables have the expected signs: positive for R&D intensity and negative for low-tech. In other words, ceteris paribus, the innovation performance of NTBFs depends on their innovation efforts. Likewise, young firms tend to be more innovative. This could be related to the fact that age has a negative effect on cognitive skills, such as creativity, which are essential for innovation activities. Summing up, our results indicate that being located in a Science Park does not appear to be a main way for NTBFs to improve their innovation performance, that is, its effect is not direct. The explanation for this absence of a direct effect is twofold. First, NTBFs are not randomly located in a Science Park; instead, NTBFs with greater technological resources and capabilities have an incentive to locate in a Science Park, leading to what has been called “advantageous selection”. Second, we assume that not all NTBFs benefit to the same extent from local externalities in Science Parks; that is, the benefits of Science Parks depend on the strategies that their tenants adopt. Along with this indirect Science Park effect, we also identify moderating effects when NTBFs are engaged jointly in exporting and collaborating.

5. Conclusions, policy implications and further research

In response to increasing global competition, institutions in developed countries have introduced a range of policy measures to encourage the development of technology and an innovation culture. It is common wisdom among policy makers that new technology-based firms are a key element in national and regional economic development given their contribution to technological innovation. Governments have also assumed that Science Parks provide an appropriate environment to stimulate innovation in NTBFs. This belief arose, in part, from the initial success of the Silicon Valley Science Park. As a result, over the last three decades successive governments have actively encouraged their development. However, the debate is ongoing with regard to whether or not they have been successful in supporting NTBFs.

The objective of this paper is to examine the way in which Science Parks contribute to the innovation of the NTBFs located in them. This work differs from prior research on this issue in several regards. First, a more comprehensive set of effects of Science Parks are studied. While the existing empirical literature has tended to directly address the role of Science Parks on the performance of firms, we contribute by also looking at the indirect (advantageous selection) and moderating effects (of strategies for jointly exporting and collaborating) of Science Parks on the innovation performance of NTBFs. Finally, we have analyzed a firm-level panel of data from the Spanish Innovation Survey which covers a representative sample of Spanish NTBFs for the period 2007-2013. In this unfavorable macroeconomic climate, characterized by high levels of unemployment and the failure of firms, Spanish Science Parks have been receiving increasing attention from policy makers as one of the main innovation policy initiatives implemented in Spain (Vásquez-Urriago et al. 2016). Given these circumstances, one would expect Science Parks to play a relatively important role in supporting the innovation of NTBFs, and this would help to justify government intervention in this area.

The results of our paper do not support the theory-based assumption that Science Parks directly increase the innovation of the NTBFs located in them. That is, on the basis of the NTBFs analyzed, there is no evidence of a direct relationship between being located in a Science Park and innovation. However, the findings do show indirect and moderating effects. First, Spanish Science Parks have been rather successful in attracting NTBFs with strong technological capabilities, therefore playing a positive selection role (i.e., they have an indirect effect). Second, from a resource-based view the strategic choice of locating in a Science Park may provide access to resources that strengthen the joint effects of the exporting and collaboration activities of NTBFs, which in turn will positively influence subsequent innovation by NTBFs. In other words, the decision to locate in a Science Park may enhance access to resources for NTBFs that jointly export and collaborate and so may promote innovation. Hence, a Science Park can be considered to be an environment that may provide greater incentives for NTBFs to jointly export and collaborate, and as a result of pursuing these strategies in this location they will increase their innovation (i.e., moderating effect).

Overall, our analysis leads to a better understanding of the effects of Science Parks on the innovation of NTBFs. While the existing research has tended to investigate whether being located in a Science Park makes firms more innovative, without addressing the fact that firms with the greatest technological capabilities may cluster in Science Parks, we have examined the direction of causality between the innovation of NTBFs and their being located in a Science Park. Likewise, the results presented in this paper provide further support for the argument in much of the Science Park literature to the effect that the benefits of a Science Park depend not only on access to scientific expertise and research results through their proximity to university laboratories and other research centers, but also on the technological resources and strategies of each NTBF.

Our analyses raise several important policy implications in terms of the resources being devoted to Science Parks. We use a large Spanish NTBF longitudinal data set to show that being located in a Science Park has no direct impact on the innovation of NTBFs. This result may disappoint supporters of Science Parks. It would, however, be dangerous to infer from the evidence presented that Science Parks are not good for NTBFs. The extent to which Science Parks can help NTBFs to innovate depends partly on the ability of their image to attract firms with the best technological skills, and partly on the strategies developed by NTBFs in Science Parks. Hence, public support programs that indiscriminately protect Science Parks may slow down the selection effect of market competition, thus negatively affecting economic efficiency. Policy makers can play a key role within contemporary societies if they build Science Parks containing firms, universities and research laboratories that are seen as highly prestigious and with a good reputation for innovation, because this will help Science Parks to operate better. Likewise, managers should be aware that innovation performance is more easily enhanced by on-Park NTBFs combining collaboration and exporting activities. Similarly, these positive synergies should be taken into account when designing public policies for the development of Science Parks. In particular, Spanish technology policies could be aimed at promoting both collaboration and exporting activities in Science Parks.

This paper has limitations that suggest interesting avenues for future research. Although we believe that our sample of Spanish NTBFs from PITEC is appropriate for studying the innovation of Spanish firms over time, this approach limits our research into the effect of Science Parks to one developed country. Science Parks from other countries (e.g., emerging countries) may show regional differences in the management approach they take. Therefore, further research should be carried out using longitudinal databases that cover Science Parks in multiple countries. Moreover, the period under study covers the years of the economic crisis, so our results could be affected by this circumstance. However, at the moment the information required for a comparison with non-crisis periods is not available. Therefore, future research in this area is necessary. Finally, our study only investigates the effect of technological collaboration on the innovation performance of NTBFs without differentiating between the different types of collaboration (e.g. vertical, horizontal, institutional, etc.). Further research should therefore be conducted to look in more depth at this topic, identifying differences on the basis of partners as they might affect innovation in different ways.

Despite these limitations, we are confident that this study represents a useful step on the path to understanding the effects of Science Parks on the innovation performance of NTBFs.

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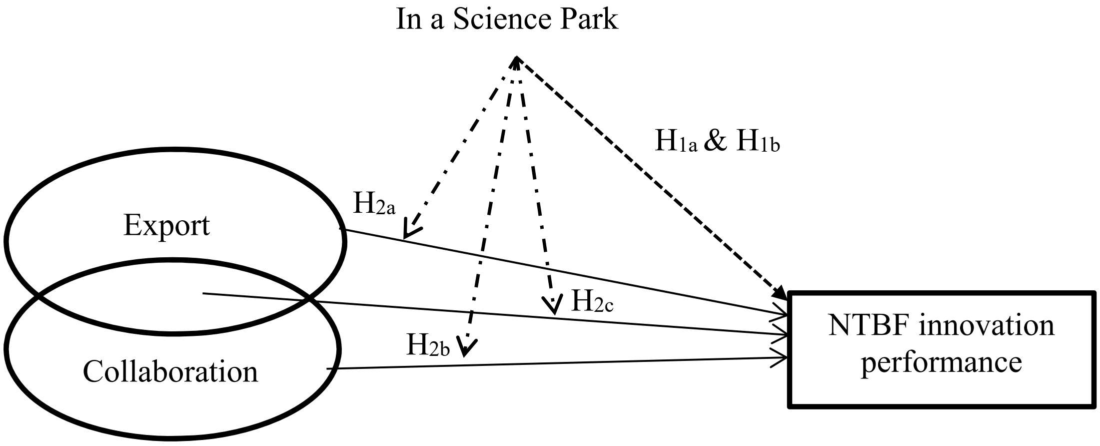
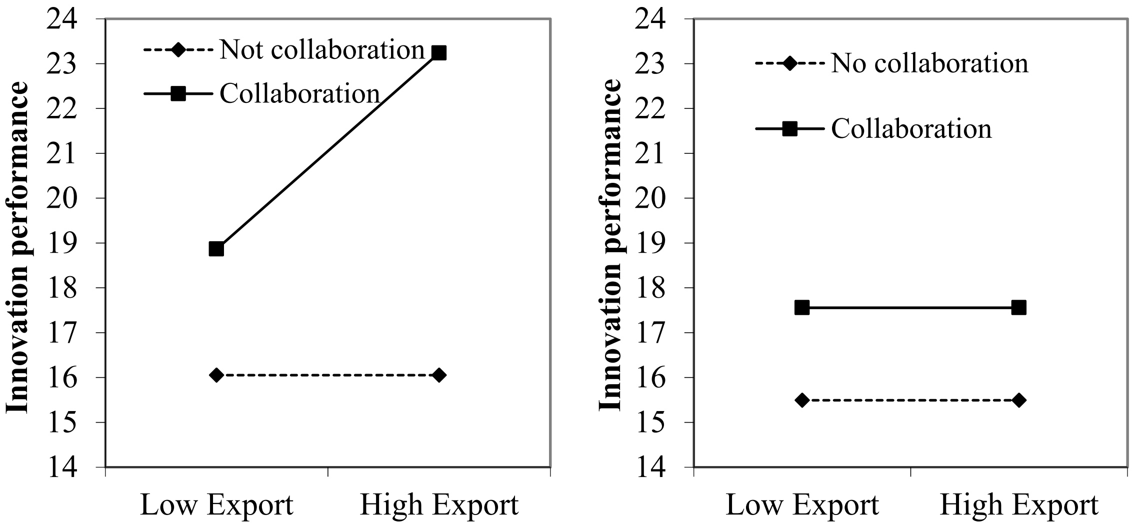
Figure 1: Research Model



Source: Own elaboration

Figure 2: Interaction effect for on-park NTBFs and off-park NTBFs subsamples.

2.a. Subsample of on-park NTBFs	2b. Subsample of off-park NTBFs



Low export: mean- 1 standard deviation   High export: mean + 1 standard deviation.
Source: own elaboration.

Table 1. Definition of variables included in the empirical analysis

Variables		Definition	References
Dependent	Innovation Performance	Percentage of new products sales (new to the firm and the market) over firm´s total sales.	Cassiman and Veugerlers (2006); Chan et al. (2010); Díez-Vial and Fernández-Olmos (2015)
Independent	Park	1 if the NTBF is located in a Science Park; 0 otherwise.	Colombo and Delmastro (2002); Siegel et al. (2003a); Ferguson and Olofsson (2004); Yang et al. (2009)
	Export	1 if the NTBF exports; 0 otherwise	
	Collaboration	1 the NTBF collaborates technologically during t-2 to t; 0 otherwise.	Montoro et al. (2011)
Control	R&D Intensity	Ratio between R&D expenditure and turnover.	Yang et al. (2009)
	Size	Logarithm of number of employees.	Belderbos et al. (2004); Huang et al. 2012
	Age	Logarithm of the number of years (plus one).	Fukugawa (2006)
	Low-tech	1 if the NTBF belongs to a low-technology sector.	OECD classification

Source: Own elaboration.

Table 2. Sample characteristics: means, standard deviations and t-tests

Variable (No. Observations)	All NTBFs (7,691)		On-park (905)		Off-park (6,786)		t-test
Innovation Performance	16.973	(27.675)	22.015	(30.847)	16.301	(27.156)	-5.847***
Export	0.485	(0.500)	0.473	(0.500)	0.487	(0.500)	0.780
Collaboration	0.438	(0.496)	0.657	(0.475)	0.408	(0.492)	-14.387***
R&D intensity	24.967	(36.745)	53.064	(53.066)	21.220	(32.183)	-25.502***
Size	2.909	(1.038)	2.938	(1.095)	2.905	(1.030)	-0.882
Age	2.890	(0.212)	2.818	(0.219)	2.900	(0.209)	11.066***
Low-tech	0.108	(0.310)	0.011	(0.105)	0.120	(0.326)	10.063***

Figures in parentheses are standard deviations. *** p-value< 0.01

Table 3: Correlation Matrix

	1	2	3	4	5	6	7	8	VIFS
Innovation Performance	1								
Park	0.059*	1							1.12
Export	0.053*	-0.009	1						1.05
Collaboration	0.120*	0.162*	0.002	1					1.08
R&D intensity	0.181*	0.257*	-0.159*	0.276*	1				1.27

Size	-0.014	0.004	0.198*	0.013	-0.389*	1			1.16
Age	-0.077*	-0.125*	0.134*	-0.093*	-0.287*	0.261*	1		1.12
Low-tech	-0.080*	-0.114*	0.078*	-0.047*	-0.277*	0.092*	0.024*	1	1.04

* p-value< 0.01

Table 4. Evolution of export and collaboration in on-park and off-park NTBFs

	2007	2008	2009	2010	2011	2012	2013
Total NTBFs in the sample	1469	1322	1205	1053	939	901	802
Number of on-park NTBFs, of which:	24	144	154	143	125	111	104
- Exporting NTBFs (%)	25.81	46.53	46.10	46.15	50.40	56.76	63.46
- Collaborating NTBFs (%)	60.48	61.11	70.13	76.22	65.60	59.46	64.42
Number of off-park NTBFs, of which:	1345	1178	1051	910	814	790	698
- Exporting NTBFs (%)	30.63	46.18	49.29	52.42	54.55	60.25	61.89
- Collaborating NTBFs (%)	37.70	39.64	39.87	43.85	41.65	42.41	43.55
Innovation performance on-park (%)	21.60	22.51	23.87	24.61	20.79	19.59	19.58
Innovation performance on off-park (%)	16.74	17.73	17.95	17.83	15.28	13.71	12.67

Source: Own elaboration.

Table 5. Marginal effects of Random Tobit. Dependent variable: Innovation performance.

Variable	All firms		On-park		Off-park[1]	
Park	3.390	(2.955)				
Export	3.396	(2.010)	-3.323	(6.906)	3.808	(2.098)
Collaboration	7.492***	(2.015)	2167.24**	(1008.09)	7.613***	(2.159)
Export x Collaboration	-0.473	(2.639)	17.317**	(7.875)	-2.735	(2.843)
R&D intensity	0.082 ***	(0.023)	24.928**	(11.587)	0.077***	(0.028)
Size	0.891	(1.048)	1452.468**	(673.57)	-0.134	(1.108)
Age	-24.283***	(5.765)	-9217.721**	(4282.37)	-22.881***	(6.030)
Low-tech	-13.614***	(3.702)	-34754.53**	(2808.97)	-12.995***	(3.700)
λ (inverse Mills ratio)			3629.648** (1692.122)			
Wald test χ^2	94.77***		40.65***		65.03***	
Robust Hausman test	Prob> F = 0.156		Prob>F = 1.000		Prob>F = 0.272	
Observations	7,691		905		6,786	

[1] The inverse Mills ratio is not statistically significant; this means there is no selection bias and, as a consequence, it is not necessary to include it in the model. Figures in parentheses are standard errors. *** p-value < 0.01 ** p-value < 0.05