RESEARCH SPIN-OFFS AND SCIENCE PARKS:

AN EMPIRICAL INVESTIGATION ON ITALY

PRELIMINARY VERSION, PLEASE DO NOT QUOTE

Ilaria MARIOTTI[1], Elisa SALVADOR[2]*

ABSTRACT

The literature on research spin-off firms has flourished in the last decade (Mustar *et al*., 2006). Spin-off firms are recognized as an important opportunity for universities. Regions hosting them are hoping that spin-off firms will strengthen the local economy and increase their innovation activities. Furthermore, spin-offs may build up links to other regional firms, thus contributing to spill over of new knowledge into the regional economy (Capello, 1999).
Several analyses and empirical investigations have been published on this field in recent years. Notwithstanding, information on several aspects of the activities of a research spin-off firm is missing and, besides, most of the data is fragmentary. In this context, the debate on the geographical location issue and the proximity to the parent institute and the science park/incubator is still open. Most literature on spin-offs investigates why research spin-offs cluster around the location of their parent institution and linked structures (see, among others, Chiesa, Piccaluga, 2000, and Salvador, Rolfo, 2011 for Italy; Egeln *et al*., 2004 for Germany; Mustar, 1997 for France). The following main motivations are identified: (i) proximity reduces transaction costs and facilitates collaboration in research and the flow of tacit knowledge (Audretsch, Feldman, 1996); (ii) researchers who establish their own enterprise might attempt to keep a formal relation (i.e. cooperation in research projects, subcontracting in research, etc.) with their university of research organization, in order to reduce the risk of a business venture; (iii) spin-offs are often confronted with a lack of funds when starting businesses, and being close to the parent company provides them with infrastructures, facilities as well as young researchers and students (Saxenian, 1991); (iv) spin-offs' founders might prefer to stay in the region in which they have worked so far.
Within this context, the present paper aims at investigating the characteristics of spin offs located inside the science parks-incubators in Italy. The empirical analysis focuses on the results of a questionnaire investigation undertaken between January

[1] Politecnico di Milano – DiAP, piazza L. da Vinci, 32 20133 Milano, ilaria.mariotti@polimi.it.
[2] *ESCP Europe* Business School, 79 Avenue de la République, 75543 Paris Cedex 11, elisa.posta@libero.it, **corresponding author.*

and June 2008. The response rate was 39.5%: 155 spin-offs accepted to answer to the questionnaire. The results of the descriptive statistics are corroborated by means of discrete choice modelling.
The paper is structured into five sections. The introduction is followed by a literature review (sections 2, 3 and 4) and the research hypotheses to be tested. Section 5 focuses on data and methodology. Descriptive statistics and econometric analysis are described in sections 6 and 7, respectively. Conclusions follow.

1 Introduction

In recent years we have assisted to a greater emphasis on the research spin-off phenomenon. Spin-off firms can be considered as one of the main tools for the external transmission of knowledge realized in the university. Nonetheless, several are the problems surrounding this particular kind of firms. Research spin-offs are an example of entrepreneurship, but they come from the university world. Therefore, they are linked to university rules and procedures. Furthermore, spin-off founders are scientists and not managers. Gaps of finance and management competence as well as of credibility on the market emerged.

Several analyses and empirical investigations have been published on this field. Notwithstanding, information on several aspects of the activities of a research spin-off firm is missing and, besides, most of the data are fragmentary (Shane, 2004; Mustar *et al.*, 2006). Furthermore, even if the commercialisation of university discoveries and the creation of research spin-offs is an interesting subject, with potentially important consequences, it is still not investigated enough (Lockett *et al.*, 2003; Shane, 2004; Lockett, Wright, 2005). Besides, one of aspects still open also in Italy is the effectiveness of incubators and science parks for this particular kind of firms (Colombo, Delmastro, 2002; Barbieri *et al.*, 2008; Salvador, Rolfo, 2011).

Within this context, the aim of the present paper is to investigate the characteristics of Italian on-park spin-offs (firms located in a science park or an incubator) and off-park spin-offs (firms located outside a science park or an incubator), where research spin-off firms are defined as those firms coming from the research world with or without a university share and a patent, but established by current or former university/research centre members (professors, technical and administrative staff, PhD candidates). Italy provides a good setting for the analysis of research spin-offs. Several initiatives have been carried out in recent years in order to improve the conditions for the establishment of this kind of firms: (i) many Italian universities, since 2002, issued spin-off regulations following the Legislative Decree n. 297/1999 (Salvador, 2009); (ii) Technology Transfer Offices (TTOs), and Industrial Liaison Offices (ILOs) have been created following the law 262/2004 (Nosella, Grimaldi, 2009); (iii) specific attention has been devoted to science park and incubator structures.

To reach the goal, a large data sample, resulting from a questionnaire investigation on the universe of Italian research spin-offs, has been adopted. The present paper starting from the descriptive evidence developed by Salvador and Rolfo (2011) aims to investigate the characteristics of Italian research spin-offs by means of a probit estimation relating the probability to be either on-park or off-park.

Specifically, the analysis highlights that on-park research spin-offs are more willing to be located in the North west of Italy, they are more oriented to work for the international market, and are specialised in the biopharmaceutical sector. Besides, the analysis shows that on-park spin-offs are less willing to develop patents.

The paper is structured into eight sections. The Introduction is followed by an overview of the Italian economic scenario in order to understand the country' strengths and weaknesses. Section 3 defines science parks and incubators. Section 4 provides a literature review on similarities and differences of on-park and off-park spin-offs and frames the hypotheses to be tested. Data and methodology are described in section 5, while the descriptive statistics is presented in section 6. The results of discrete choice modelling are presented and discussed in section 7; the concluding remarks follow.

2 The Italian economic scenario and the emergence of the research spin-off phenomenon

With a total population of nearly 60 million of habitants subdivided in 20 Regions[3], Italy shows several structural problems that hinder the innovation potential and the economic performance. Burocracy, political instability and a marked delay in fostering and supporting the new information and communication technologies (Colombo, Delmastro, 2001, 2002; Bassanetti *et al.*, 2004; Finlombarda, 2006; Bianchi *et al.*, 2010), are affecting the Italian context[4]. These factors have a pivotal consequence on the performance of the business world and in particular on the establishment, survival and growth of a very particular kind of firm like the research spin-off one.

According to the Inno-Policy TrendChart (2008, 2009), the Italian economic scenario is presently characterised by economic uncertainty and stagnation as well as severe financial constraints. The Italian economy is still affected by a problem of low growth. Special factors such as low-skilled workers entering the labour market, weak investments on R&D, firms specialising in traditional sectors and the prevalence of small family businesses which are less prone to innovate (Bianchi *et al.*, 2010; Balderi *et al.*, 2007), and insufficient product market competition, can have contributed to depress measured productivity growth. Since the 1990s, Italy's performance has substantially lagged behind that of other main European Union economies. In Italy in 2007 growth came in below expected at 1.5%, little more than half the euro zone average of 2.7% (Inno-Policy TrendChart, 2008). The country suffers from weak productivity performance, as a consequence of a dearth of innovation. The Italian structural problems reduce the ability to take advantage of the innovative technologies spread throughout the world in recent years (Fondazione Rosselli, 2007; 2008; Bassanetti *et al.*, 2004). In

[3] About 45% of the total population is concentrated in the North of the country, that is the core area.

spite of a widespread entrepreneurship oriented towards traditional/mature sectors, Italy is behind in promoting the creation of new technology-based firms (Colombo, Delmastro, 2001, 2002; Finlombarda, 2006). Notwithstanding some positive signals of revival in 2006 and 2007, the Italian scenario is still anaemic in terms of growth rates. Furthermore, the worsening of the international macroeconomic scenario are all pointing to the downside. Notwithstanding, it is worth noting the repositioning of Italian exports towards medium-high tech exports. By the end of 2007, Italy was the second exporting country towards extra-EU countries after Germany. The Technological Balance of Payments, chronically in deficit, showed for the first time a positive sign in 2006 (Inno-Policy TrendChart, 2008; Fondazione Rosselli, 2007; 2008).

From these considerations, we can assume that Italian firms have the potentialities to respond to major constraints. Although these signals in terms of innovation performance Italy is still considerably behind its main European partners even if its overall performance has marginally increased over the past years. Italy is in the group of "moderate innovators", with a performance below EU average but above the group of "catching up" countries (Inno-Policy TrendChart, 2008, 2009), while according to Fondazione Rosselli (2007; 2008) Italy is in the group of "scarcely innovative countries". Poor innovation performance can be traced back to deficiencies of the tertiary education system. Another main problem is that funds for innovative SMEs from private banks and venture capital are rather scarce in Italy. The market of early-stage and venture capital funding is relatively young and underdeveloped; nevertheless, it has started to show signs of improvement (Inno-Policy TrendChart, 2009). The OECD ST&I Scoreboard 2007 ranked Italy in 17th position (out of 19th) in terms of availability of venture capital funds as a percentage of the GDP (Inno-Policy TrendChart, 2008).

The analysis developed by Fondazione Rosselli (2007; 2008) to measure and compare the innovation potential of 19 major industrialised countries, ranks Italy in the last positions in many of the 28 innovation indicators assessed in the report, such as technical scientific knowledge, new ICT exploitation, human capital, financial support to R&D activities. The study compares Italy with other 18 developed countries and registers the lowest indicators for the efficiency in technology transfer processes between universities and enterprises, investments in ICT, population with university degrees, number of researchers, private expenditure in R&D, venture capital funds availability, diffusion of broadband infrastructure. Technology transfer is one of the fields where an improvement is observable, in particular in terms of spin-off firms (Fondazione Rosselli, 2007; 2008). The spin-off of high-tech business ideas is gradually increasing as a new strategic orientation of Italian universities. In this context a pivotal initiative has been undertaken by Italian universities since 2001 for research spin-off firms. Their increasing numbers over the past few years have prompted many Italian universities to establish rules to control the spin-off process and address related issues systematically.

[4] "*A major change is now expected with the launch of the E-government 2012 plan that, starting from an intervention for ICT diffusion in public administration, should act as a major instrument to stimulate economic recovery*", Inno-Policy TrendChart (2009), p. 9.

The inspiration for the issuing of spin-off regulations was the Legislative Decree No 297/1999, which is concerned with the 'reorganization of the discipline and streamlining of the procedures for the support of scientific and technological research, for the diffusion of technologies, for researchers' mobility'. The Ministerial Decree of 8 August 2000, No 593, sets out 'procedures for giving support according to Legislative Decree n. 297/1999' (Salvador, 2009).

Given this general context, it is important to stress also the main changes in the regional governance system occurred in recent years. Since 2005, the contribution of Italian regions to the innovation policy formulation process and the management of measures favouring R&D and innovation increased due to the reform of Title V of the Constitution in 2001 and its implementation through the Law 131/2003. Thanking to the new power acquired by the Regions in the field of scientific research and technological innovation policy, R&D and innovation regional policy initiatives have been developed. Several regions provided specific instruments whose application has been launched at local level. Measures to support the creation of spin-offs from research centres and universities, like FIXO[5] in many regions and voucher spin-off[6] in Puglia, may be considered interesting measures. Nevertheless, the duality between the central government and the regional actors' intervention is still affecting the Italian system and more coordination between the two levels would be useful in order to better define industrial policy objectives and territorial balancing as well as to establish responsibilities and areas of intervention (Inno-Policy TrendChart, 2008, 2009). The increased responsibilities of regions should have been accompanied by enough transfer of resources from the central government and by an improvement of internal technical skills and competencies. Only some of the most advanced Italian regional systems have undertaken such a process. Many other regions are still weak in the acquisition of more autonomy and in the definition and implementation of effective local development policies.

We can say that the Italian governance system has been characterised by the presence of many policymaking entities undertaking innovation policy tasks that are sometimes fragmented, uncoordinated and conflicting. A strong fragmentation of instruments and measures, often conceived as short term or even *una-tantum* initiatives, has characterised till now research and innovation policy intervention in Italy (Inno-Policy TrendChart, 2008, 2009). According to Bianchi *et al.* (2010), globalisation has made necessary the modernisation of Italy and the elimination of many structural delays. Main challenges for the Italian system are given by the improvement of technology transfer mechanisms to reduce the existing gap between research and the market, by innovation financing, in particular venture capital, and by mobility of talents, especially brain drain. Yet, several policy interventions had been introduced in order to address these challenges. To the aim of the present

[5] The program FIXO (Training and Innovation for Employment) has the aim of developing a relationship between universities and firms. One of the actions of this program is related to promote and support spin-off initiatives by young researchers.

[6] This support action assigns a "voucher", which means a financial contribution in order to support the start-up and the growth stages of firms.

analysis it is important to highlight that Italy has not yet adopted a specific support policy in favour of innovative start-ups (Colombo, Delmastro, 2002). Notwithstanding the lack of a policy specifically focused on supporting high-tech start-ups, several support instruments at national and regional levels are available. According to the Inno-Policy TrendChart (2008), Italian regions located in the North have first focused on the problem of the financial gap faced by innovative start-ups.

All these recent initiatives are key signals of the importance of the research spin-off phenomenon in Italy. There has been a wave of research spin-offs in Italy in recent years. Nonetheless, the context of Italian research spin-offs is still limited and the results in terms of growth are not rapid. The scenario described above can justify and explain the main difficulties encountered by this kind of firms. Furthermore, the confusion surrounding the research spin-off world in Italy and the absence of a clear and focused policy at national and/or regional level are deep problems that delays the potential of this kind of firms (Salvador, 2011a).

3 Science park and incubator: a definition

There is no uniformly accepted definition of a science park (Lofsten, Lindelof, 2005; Dettwiler *et al.*, 2006). Nonetheless, we can say that the term "science park" [7] is usually used to describe a property based initiative that has formal and working links with a university or other higher education institution or research centre. A science park is a business support and technology transfer initiative that encourages and supports the start up, incubation and development of innovation led, high growth, knowledge based businesses, provides an environment where larger and international businesses may develop specific and close interactions with a particular centre of knowledge creation for their mutual benefit (Parry, Russell, 2000; Ferguson, Olofsson, 2004).

It is widely acknowledged that the earliest parks were established in North America in the 1950s (Cesaroni, Gambardella, 1999; Colombo, Delmastro, 2002; Sofouli, Vonortas, 2007; Link, Scott, 2003; Wessner, 2009; Bellavista, Sanz, 2009). Park formations increased sharply in the late 1970s and early 1980s in all countries also under the stimulus of the Bayh-Dole Act and the passage of several technology initiatives in the early 1980s (Link, Scott, 2007, 2006, 2003). Silicon Valley with its Stanford Research Park and Route 128 in Massachussets were the first successful initiatives. In Europe, science parks are concentrated in France and the United Kingdom. In Italy the first science parks were established in the 1980s: Area Science Park of Trieste, which is the most important and the largest science park in Italy (Bigliardi *et al*., 2006), in 1982 and Tecnopolis Novus Ortus of Bari in 1985. Several other examples followed in the coming years due to national (in Southern Italy) and

[7] The term "science park" is more prevalent in Europe, while the term "research park" is more prevalent in the United States and the term "technology park" is more prevalent in Asia (Link, Scott, 2007, p. 661).

regional initiatives. Since the end of the 1990s, almost every Italian Region has at least a science park (Sancin, 1999).

In the absence of an agreed and clear policy, the Italian science parks context is characterized by particularities such that every science park denotes distinctive and almost unique characteristics, not only due to regional needs. Diversity is an important characteristic of science parks well underlined in the literature (Wessner, 2009). According to Link and Scott (2003, p. 1325) and to Link and Link (2003, p. 81), "*the definition of a research or science park differs almost as widely as the individual parks themselves*". In Italy it is, therefore, possible to find science parks of huge dimensions, like the Bioindustry Park of Canavese and the Environment Park of Turin, as well as less consolidated structures, in particular in the South of Italy. Notwithstanding their dimension and heterogeneity, the rationale for the creation of science parks may be considered proximity to university laboratories and research centres, the presence of an incubator, the creation of networking opportunities, the role of bridging institution providing tenant firms with suitable accommodations and technical and business services (Colombo, Delmastro, 2002; Link, Scott, 2003, 2006, 2007).

The presence of an incubator is a pivotal factor. Since the 1960s (Hackett, Dilts, 2004), structures providing a supportive environment and shared facilities for helping the establishment of young firms as well as their development and maximization of their growth and rate of survival, were established in the industrialized countries. These structures are referred to as "incubators"[8]. The incubator model is frequently developed within a science park structure, of which an incubator is an important cornerstone.

The concept of incubation evolved over the years and there are currently three generations of incubators, characterized by differences in the business support services. The first generation incubators provided physical space and basic shared facilities. The second generation provided more specialized business support services, like counselling. The third generation, referred to as networked knowledge incubators, appeared at the end of the 1990s, with availability of networking for the sharing of knowhow and the promotion of best practices among entrepreneurs. Networking, face-to-face interaction and trust in an incubator have been investigated in recent years (Cooper *et al.*, 2010). The incubation process was accelerated by the Internet revolution and its positive feedback on high-tech businesses. Thanking to the ICT revolution and the diffusion of Internet (Benghozi *et al.*, 2009), incubator projects began spreading first in the US and second in Europe. As underlined by Salvador and Rolfo (2011), in principle, incubators and science parks alike should be considered as a means to reduce the so called "liability of newness" (Ferguson, Olofsson, 2004; Gilbert *et al.*, 2006; Sofouli, Vonortas, 2007; Schwartz, 2009; Schwartz, Hornych, 2010). Liability of newness relates to the high failure risk young firms face in the first years of their life. Start-ups and young firms do not have stable business relationships and they do not possess any reputation and need some time to gain

[8] An extensive review of the literature on incubators and a list of definitions culled from the literature is provided by Hackett, Dilts (2004).

legitimacy in the market (Schwartz, 2009). Incubators and science parks are perceived as useful solutions: they can work as a network of positive and favourable associations for tenant companies willing to grow. Their function is linked to the necessity to create a stable and effective network of contacts in terms of potential financers, clients, suppliers.

Science parks and incubators have a key role to play in the first years of life of newly established companies. The actual question is whether the potentialities of these structures are translated in concrete effectiveness. The admission criteria are usually very selective in order to filter good entrepreneurial projects, but the potential success of these business ideas cannot be given for granted. Therefore, the question whether science parks and incubators are really effective in supporting young firms is still without an agreed answer[9]. Furthermore, according to a recent study by Yang *et al.* (2009), despite the growing interest in the science-park phenomenon, empirical attempts at indentifying whether new technology-based firms located within these structures are more innovative are limited and the results are ambiguous. Schwartz (2009) argued that direct comparisons between survival rates of tenant companies and control-groups of off-park firms may not be meaningful. In fact, the incubator-specific selection process induces relatively low failure rates during incubation and thereby selection bias tends to result in an overestimation of the effectiveness of science parks and incubators to this aim. Similarly, Lindelof and Lofsten (2004) asserted that one logical way to assess the technological innovation of science parks is to compare the performance of their tenants to off-park firms. But this approach has its limitations because of the difficulties of identifying a reliable comparison sample.

4 Literature review and research hypotheses

Space matters for firms (see among the others Walter Isard, 1956, the "father" of Regional Economics), and location is important for research spin-offs, too. Gilbert *et al*. (2006) identified geographic location as a compelling factor influencing new venture growth. Geographic location has become a commonly recognized factor for differences in new and young venture survival (Gilbert *et al.*, 2006). Competition for resources that firms have to face in high-clustering locations has an influence on their ability to acquire key resources. In particular, an inability to acquire resources at local level will have consequences on the level of growth of new ventures, because these firms are highly dependent on the local environment for resources. Therefore, "*as there is an inequality of resources available in differing locations, a venture's geographic location has strong implications for the growth it may be able to realize*" (Gilbert *et al*., 2006, p. 933). For instance, greater access to

[9] See Rowe (2002), ANGLE Technology (2003), Parry, Russell (2000); Siegel *et al.* (2003) for the UK; Mian (1996) and Rothaermel, Thursby (2005) for the US; Colombo, Delmastro (2002), Salvador (2011), Salvador, Rolfo (2011) for Italy; Schwartz, Hornych (2010) for Germany.

financial capital is an advantage for a firm with growth ambition located in cluster regions like Silicon Valley, while an inner city or a rural firm are at a disadvantage in financial capital availability. Furthermore, given the fact that regions and universities are heterogeneous, according to Mustar *et al.* (2008) the nature of university-industry links may depend on the nature of the region in which a university is embedded, meaning core and peripheral. And according to Lejpras and Stephan (2008, p. 5), "*the potential and quality of the firm's location*" of spin-offs "*can be viewed as the sum of potential inherent in a variety of locational conditions. Moreover, the impact of the location on firm economic activities can be resolved into the separate effects of various locational conditions, such as regional availability of skilled labor or support from local government*". Besides, "*the potential and quality of the firm's location can be viewed as the sum of potential inherent in a variety of locational conditions. Moreover, the impact of the location on firm economic activities can be resolved into the separate effects of various locational conditions, such as regional availability of skilled labor or support from local government*" (Lejpras and Stephan, 2008, p. 5).

Considering more specifically the research spin-off phenomenon, Shane (2004) argued that differences in access to capital, locus of property rights and licensing policy, rigidity of the academic labor market and the industrial composition of the area, are the main factors explaining variation in research spin-off activity at national level. Therefore, we expect differences in location and most of all we expect to find these differences in a country like Italy. According to Iammarino *et al.* (2009, p. 78), Italy shows strong territorial imbalances "*that are among the sharpest in the European Union*": the territorial distribution of innovation in Italy is concentrated in a very few northern regions, "*a phenomenon known as the Italian innovative divide*". Therefore, given the regional divide in Italy, the spatial location of firms seems particularly important. The empirical investigation undertaken by Iammarino *et al.* (2009) confirmed the historically North-South distinction in the Italian innovation system. A visible innovation divide pattern in terms of perception of obstacles emerged. Firms located in the North and the Centre of Italy perceived the obstacles to innovation on average as less significant than those located in the South. Furthermore, firms in the North and the Centre perceived lack of financial resources as an impediment to innovative activity significantly less than firms located in the South. Another investigation undertaken by Nosella and Grimaldi (2009, p. 692 and 694) has recently argued that "*localisation of university is statistically significant, thus affecting the generation of academic spin-offs*" and "*universities located in the north and more industrialised part of Italy are more likely to generate spin-offs, confirming the importance of a fertile local context to enhance the creation of new companies*". Besides, according to the Netval annual survey (2007, 2009, 2010, 2011): over 50% of the spin-offs in the sample of analysis is located in the North of Italy, evidence which is confirmed by the recent descriptive analysis developed by Salvador and Rolfo (2011). With these considerations in mind, we expect that:

H1. Research spin offs hosted by science parks-incubators tend to be located in the North of Italy.

Another interesting aspect of research spin-offs is the sector. The industry sector distribution of research spin-offs reveals in general a prevalence of companies in the ICT and in the biopharmaceutical sectors (Netval 2007, 2009, 2010, 2011; Shane, 2004; Lindelof, Lofsten, 2004; Gupte, 2007; Mustar, 1997). While the Internet revolution (Benghozi *et al.*, 2009) had certainly a deep influence in the high number of companies in the ICT industry, according to Shane (2004) and Zhang (2009) possible explanations for biopharmaceutical being fertile grounds for the creation of spin-offs are linked to the long product development horizons and to the expertise of universities in the creation of biomedical inventions. Young firms in the biopharmaceutical industry usually spend many years on R&D activities before putting the first product on the market. Therefore, the condition of tenant companies of a science park-incubator may be important given the possibility to use resources and laboratories. Therefore, we hypothesize that:

H2. Research spin offs settled in science-parks/incubators are more willing to operate in the biopharmaceutical sector.

According to Autio and Yli-Renko (1998), small firms have strengths that can not easily be replicated by a large firm, including entrepreneurial dynamism, internal flexibility and specialised expertise. Chiesa and Piccaluga (2000) emphasised the international pattern of the Italian research spin-offs of their sample, which can be explained by the technology intensity of their businesses. Such contexts are, indeed, often international by definition and there is nearly no room for purely local markets. Besides, McDougall and Oviatt (1996) stated that spin-offs tend to be international since their founding date. Last but not least, Harrison and Leitch (2007) highlighted that for the most part UK spin-offs appear to start and remain small, even when they are dealing on international rather than local and national markets. These firms are not a success in terms of employment: Mustar (1997) underlined that major successes of French research spin-offs in terms of job creation are rare, and Pérez Pérez and Sànchez (2003) underlined in the empirical investigation from university of Aragòn's case studies that this kind of firm is not a significant source of employment. Also Zhang (2009) in an exploratory analysis on US venture backed companies found that research spin-offs are significantly smaller than other venture-backed start-ups in terms of employment. Clarysse *et al*. (2007) in an empirical investigation on European research spin-offs, which included Italy, found that the firms were overwhelmingly very small at start-up in terms of employees, with mean employment of 1.6 people.

Nonetheless, even if research spin-offs are small in size, we expect they have an international propensity thanks to the aid from the incubator-science park. And in particular we expect that Italian

research spin-offs hosted in an incubator-science park are international oriented also because Italy has historically been characterized by a predominance of small and very small firms with a high level of flexible specialisation (Bianchi *et al*., 2010). Hence, the third hypothesis is the following:

H3. Research spin offs located in science-parks/incubators mainly tend to operate in the international market.

Given these assumptions, in the next sections we test the validity of the hypotheses by means of an empirical analysis on a sample of 155 Italian spin-offs.

5 Data and methodology

The empirical analysis is based on a comprehensive survey of Italian research spin-off firms through face-to-face interviews and a questionnaire (for a detailed overview, see a previous work by Salvador and Rolfo, 2011), which are also the most used tools of investigation for this kind of firm[10]. The main problem was to identify the actual number of research spin-off firms founded in Italy, because an official, complete and updated list of spin-offs at the regional or national level does not exist. In Italy, indeed, each university adopts an autonomous policy. Thus, the first step was to look at the Industrial Liaison Office (ILO), the Technology Transfer Office (TTO) and the university websites to find a list of spin-offs and the second step was to verify the completeness and updating of this list. Another problem was due to the fact that the university takes care only of spin-offs participated by the university itself. Since we decided to adopt a large definition of spin-off including also companies not participated by the university, the university list had to be completed with the Italian science park and incubator tenants list. A final problem was due to the fact that science parks and incubators do not make any difference between spin-offs and start-ups, which means firms not created by university staff and therefore not linked to the academic world. Telephone and e-mail contact with university staff as well as science park and incubator personnel were pivotal in filling this gap and in excluding start-ups from the final list.

The universe of research spin-off firms we identified in Italy was 419. We were able to contact 394 firms: 25 research spin-offs had the positive approval of the university at the time of the survey, but they had not yet been established. Face-to-face interviews were carried out between September

[10] See, for example, Westhead, Storey, 1995; McDougall, Oviatt, 1996; Autio, 1997; Mustar, 1997; Autio, Lumme, 1998; Steffensen *et al.,* 1999; Klofsten, Jones-Evans, 2000; Chiesa, Piccaluga, 2000; Franklin *et al.,* 2001; Shane, Stuart, 2002; Colombo, Delmastro, 2002; Pérez Pérez, Sànchez, 2003; Heirman, Clarysse, 2004; Lindelof, Lofsten, 2004; Wright *et al.,* 2004; Fontes, 2005; Link, Scott, 2005; Clarysse *et al.,* 2007; Gupte, 2007; Zahra *et al.,* 2007; Squicciarini, 2008; Schwartz, 2009; Fini *et al.,* 2009.

and October 2007 in some Italian university spin-off firms selected as case-studies and a questionnaire was sent between January and June 2008 to the universe of Italian research spin-off firms. The response rate was 39.5%: 155 spin-offs accepted to answer to the questionnaire. Lack of time and privacy were the most predominant reasons for not participating in the questionnaire investigation: these motivations seem sound considering the inflationary rate of questionnaires received by research spin-offs in recent years (Gupte, 2007). Nevertheless, given the response rate and the geographical distribution of the universe and of the sample, we can reasonably consider this sample as representative.

As previously underlined, similarities and differences between on-park and off-park spin-offs have been investigated in a previous work by Salvador and Rolfo (2011), by means of descriptive statistics, while differences in the performance between these firms and a sample of start-ups have been analysed in Salvador (2011a). The present paper starting from the descriptive evidence developed by Salvador and Rolfo (2011) aims to investigate the characteristics of Italian research spin-offs by means of a probit estimation relating the probability to be either on-park or off-park.

The probability is expressed as follows:

$$F(x'i\ \beta) \text{ where } F(.) = \exp(.)/[1+\exp(.)], \qquad (1)$$

where β is the vector of coefficients; for the discrete choice we measure 0 if the firm is off-park, and 1 if it is on-park.

The explanatory variables are the following:

- *Capital_Start* – capital of the firm at the time of foundation.
- Y_p^t – value added of manufacturing production and services (total), computed in the NUTS3 provinces, where the firms are located, one year before the foundation.
- $Univ\,\mathrm{Re}\,gulat_p$ - number of universities, which developed specific spin-off regulations, located in the NUTS3 province, one year before the foundation.
- *Patent* – patents developed by the firm (dummy), at the time the questionnaire has been filled[11]
- $Incentives_p$ - regional incentives and other facilitations (i.e. tutoring phase, incentives assistance, etc.) obtained by the firm (dummy), at the time the questionnaire has been filled.
- *Macroarea* – geographical macro-area where the firm is located (dummy).
- *Market* – firm market orientation (dummy).
- *Sector* – firm sector (dummy).

The equation suggests that the variables that may influence the probability for a research spin-off of being located in an incubator-science park are: (i) initial capital of the firm, when it was

[11] This variable takes the 0 value if the off-site spin-offs did not develop a patent (or even more than one), and if the in-site firms have developed a patent once they left the science-park/incubator. *Viceversa*, the variable takes

founded; (ii) valued added of manufacturing and services in the NUTS3 provinces[12], where the firm is located; (iii) number of universities, which developed spin-off regulations, located in the NUTS3 provinces; (iv) willingness to develop patents; (v) regional incentives and other facilitations obtained by the firms. Finally, macro-area, market and sector dummies have been included in order to control for fixed effects.

6 Descriptive statistics

The present section focuses on the results of the descriptive statistics carried out on the sample of firms, consisting of 65 on-park spin-offs and 90 off-park spin-offs. More than half of the sample (50%) are settled in the North of the country, about 15% in the Centre and the remaining 17% in the South and Islands. The supremacy of the North is confirmed in the two groups of firms, but the North-west macro-area accommodates a more significant number of on-park firms (31) compared to off-park firms (14) (Table 1).

Table 1: The macroarea of location of spin-offs (absolute number and percentage)

	Centre	North east	North west	South&Islands	Tot.
Off-park	29 (32%)	29 (32%)	14 (16%)	18 (20%)	90 (100%)
On-park	10 (15%)	16 (25%)	31 (48%)	8 (12%)	65 (100%)
Tot.	39 (25%)	45 (29%)	45 (29%)	26 (17%)	155 (100%)

Table 2: Research spin-offs: sector, market and patent

	Off-park	On-park	Tot.
Sector			
Automobile industry	5	6	11
Biopharmaceutical	15	20	35
Engineering	25	11	36
ICT	29	15	44
Other	8	9	17
Missing	8	4	12
Tot.	90	65	155
Market			
International market	31	36	67
National market	50	22	72
Regional market	9	6	15
Missing		1	1
Tot.	90	65	155
Patent			

the 1 value if the off-site firms developed a patent, and the in-site firms developed a patent in the incubating period.

[12] These data are provided by the Italian Statistical Institute (ISTAT).

Without patent	65	49	114
With patent	24	16	40
Missing	1		1
Tot.	90	65	155

In line with the literature (see section 4), most of on-park firms operate in the biopharmaceutical (40%) and the ICT sectors (31%), while off-park companies are most of all in the ICT (36%) and in the engineering sectors (29%), (Table 2). As far as the market is concerned, 65% of on-park spin-offs operate in the international market while only 34% works or the national one (Table 2). It can, therefore, be argued that notwithstanding their small size, Italian research spin-offs have a high international attitude and they are strongly not limited to the local-regional level. This result is coherent with the literature (McDougall, Oviatt, 1996; Autio, Yli-Renko, 1998; Chiesa, Piccaluga, 2000; Harrison, Leitch, 2007). Besides, it seems that, on average, off-park firms are more prone to develop patents than on-park firms (Table 2).

Table 3: Capital of the research spin-offs

Variable	*Obs*	*Mean*	*Std. Dev.*	*Min*	*Max*
On park					
Capital	64	22148.95	25413.67	516	100000
Off park					
Capital	88	30811.65	41898.19	2000	300000

Table 4: Value added and university regulations – NUTS3 provinces

Variable	*Obs*	*Mean*	*Std. Dev.*	*Min*	*Max*
Province On park					
VA tot	65	49641.08	4303.6	39606	60450
$Univ\,\mathrm{Re}\,gulat_p$	65	1.769231	1.057255	0	5
Province Off park					
VA tot	90	47876.56	5950.196	35069	60450
$Univ\,\mathrm{Re}\,gulat_p$	90	1.488889	1.282943	0	5

This result can be partially explained by the size of the two groups of firms: on-park firms are smaller, on average, than off-park ones, in terms of capital at the time of their foundation. Specifically, on-park firms are from 1/4 to 1/3 smaller than off-park (Table 3). The last consideration concerns the characteristics of the provinces where the two groups of firms are located. As expected, the provinces hosting the sample of on-park firms show a higher value added, that is they are more competitive, and a larger number of universities developing regulations to support spin-offs.

7 Econometric findings

This section aims at corroborating the results of the descriptive statistics by means of an econometric analysis, which investigates the characteristics of on-park and off-park spin-offs. In doing so, the framed hypotheses are tested.

We computed a probit analysis as described in formula (1), to see whether the difference between on-park and off-park spin-offs are significantly different from zero. The results can be found in Table 5. We ran three models in sequence, including market and sector dummy variables in the second and the third, respectively.

Table 5: Results of the probit-analyses

	Model 1a	Model 1b	Model 1c
Capital_Start	-3.59E-06	-3.49E-06	-4.01E-06
Y_p^t	-3.6E-05	-3.2E-05	-3.69E-06
$Univ\,\mathrm{Re}\,gulat_p$	0.10	0.06	-0.11
Patent	-0.65***	-0.67***	-1.12***
$Incentives_p$	0.75***	0.72***	0.67***
MA_Northwest	1.27***	1.29***	1.37***
MA_Northeast	0.35	0.39	0.22
MA_S&I	-0.07	-0.04	0.08
Market_regional		-0.19	0.53
Market_national		-0.56***	-0.44
Sector_ICT			-0.94***
Sector_Automobile			0.05
Sector_Engineering			-0.76**
Sector_Other			0.05
Cons.	0.79	0.93	0.32
Log likelihood	-78.784385	-75.46067	-63.993482
Pseudo R^2	0.20	0.23	0.30
N.	144	143	133

Notes:
***, ** and * mean results are significant at the 1%, 5% and 10% level respectively
The reference group for MA (macroarea) is the Centre, for Market is the international market, for the sector id the biopharmaceutical one.

In model 1a) we specifically regressed *Capital_Start,* Y_p^t, $Univ\,\mathrm{Re}\,gulat_p$, *Patent, Incentives*$_p$, and *Macroarea.* In models 1b) and 1c) we added *Market* and *Sector* dummies.

The comparison of on-park and off-park spin-offs shows that these two sets of firms differ significantly on the following accounts. In all the models, we see that on-park spin-offs show a higher probability to be positively affected by incentives/facilitations provided by the region of location. Besides, on-park have a significant higher probability to be located in the North west, to supply the international market, and to operate in the biotech sector than off-park firms. On the other hand, on-park firms are less willing to develop patents, as showed in the last regression 1c). *Viceversa*, the explanatory variables: capital, value added and $Univ\,\mathrm{Re}\,gulat_p$ are not significant in the three regressions.

The importance played by regional grants as well as other support initiatives at the regional level are a key evidence of the existence of funding possibilities at public level. And according to Clarysse *et al.* (2007, p. 610) the availability of public funds aimed at addressing the so-called "*financing and knowledge gap*" is one of the factors that accelerated the rise in number of research spin-offs in the last years.

The key role played by the North of the country, and specifically, by the Nort west, in hosting spin-offs is stressed by the literature, as stated in section 4. Being located in the core area means to have better access to key resources: skilled labour force, agglomeration economies, knowledge spillovers, infrastructures networks (including universities and science parks-incubators), and so on. The North west of Italy, indeed, shows the highest GDP per-capita, it accommodates about 57% of the total inward FDI (Mariotti, Mutinelli, 2008). Besides, it hosts the most technologically oriented sectors.

The predominance of the biopharmaceutical sector is explained by the literature, indeed, biopharmaceutical has long product development horizons and needs university expertise for the development of biomedical inventions. Besides, young firms in the biopharmaceutical industry usually spend many years on R&D activities before putting the first product on the market. Therefore, being settled in a science park-incubator where resources and laboratories are available, might play a key role.

The international orientation is a specific pattern of spin-offs, as stated in the literature (section 4); specifically, the international orientation might be linked to the sector specialisation, which mainly concerns technological intensive industries.

It can be, therefore, stated that the following three hypotheses are accepted:

H1. Research spin offs hosted by science parks-incubators tend to be located in the North of Italy.

H2. Research spin offs settled in science-parks/incubators are more willing to operate in the biopharmaceutical sector.

H3. Research spin offs located in science-parks/incubators mainly tend to operate in the international market.

8 Concluding remarks

The aim of the present paper is to investigate the probability of an Italian research spin-off of being located in a science park and incubator. Three main hypotheses have, therefore, been framed and tested by means of an econometric analysis. More specifically, the results of the probit model confirmed that Italian research spin-offs hosted by an incubator-science park are more willing to be located in the North west of Italy, they are operating in the biopharmaceutical sector, and are more international oriented, supplying international markets. Besides, the results of the empirical analysis revealed that research on park spin-offs benefit from financing and other kind of facilitations provided

by the Italian regions. Surprisingly, the analysis also underlined that on-park spin offs are less willing to develop patents.

What can we assume from these results? They seem to confirm the literature evidence and highlight interesting links not previously underlined. More specifically, the econometric model does not show any influence of spin offs' capital on the probability of being in an incubator-science park; similarly, the value added and the presence within the province of the universities promoting spin-off regulations did not show a significant sign, therefore, they had no impact on the probability of being in an incubator-science park. In other words, our hypotheses have been confirmed, but with few other significant variables adding more significance to our empirical analysis results. We underline the positive link between regional aid and the science parks and incubators, but we also argue that these structures could improve their aid towards research spin-offs.

However, this study is not without its limitations and potential biases. Nonetheless, many of these shortcomings are common to most recent empirical investigations in this field[13]. First of all, we had a population of Italian research spin-offs that did not cover the universe. Second, our study is limited to the Italian context and does not attempt at providing a cross analysis with other European countries. Furthermore, this analysis relies on data covered on a given time period.

Given the lack of reliable official data, this analysis highlighted interesting findings and it was useful for better understanding the characteristics of Italian research spin-offs located in a science park-incubator as well as for stimulating further research along this line.

Viceversa, the explanatory variables: capital, value added and regulations are not significant in the three regressions. The negative and significant sign of the patent explanatory variable can be due to the fact that research spin-offs are more willing to develop a patent after the incubation period, therefore at a later stage after the start-up process. This statement is supported by the fact that the greatest number of research spin-offs with a patent are companies outside the science park-incubator and/or they have finished their incubation period. We therefore stimulate future research on the link between research spin-offs' capital, patent, province's value added and the science park-incubator hospitality.

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[13]On this topic see: McDougall and Oviatt, 1996; Colombo and Delmastro, 2002; Lindelof and Lofsten, 2004; Heirman and Clarysse, 2004; Rothaermel and Thursby, 2005; Zahra *et al.*, 2007; Clarysse *et al.*, 2007; Squicciarini, 2008; Schwartz, 2009; Fini *et al.*, 2009; Clarysse *et al*., 2011; Messeni Petruzzelli, 2011.

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