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Title: *Research spin-off firms: does the university involvement really matter?*

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Abstract: The research spin-off phenomenon has attracted a significant amount of interest in recent years. Spin-off firms are recognised as a potential key opportunity for universities in terms of knowledge valorisation and exploitation. This paper aims to contribute to the debate on research spin-offs (RSO) through an examination of the relationship between these particular kind of firms and their parent institute. Original empirical evidence on the Italian research spin-off context is provided by means of a questionnaire investigation. The results of the survey answers given by 155 research spin-offs are presented with a focus on companies that aroused more interest from their parent institute and the ones that did not so. More specifically, descriptive statistics of the answers provided to the main sections is followed by a cluster and a factor analysis approach. The groups and the factors as identified by the cluster and the factor analysis are carefully examined and policy suggestions follow. Two main groups of research spin-offs are clearly identified with some specificities: *more open-oriented* and *less open-oriented* research spin-offs. The initiatives carried out in Italy in recent years, the interest towards the research spin-off phenomenon and the number of research spin-offs established in the last ten years makes this country a suitable case-study for such an analysis. Nonetheless, the results are generalizable beyond the Italian case.

Keywords: research spin-offs; technology transfer; cluster analysis; factor analysis; questionnaire

JEL Classifications: O3, L2

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Introduction

In recent years, there has been an increased attention on the research spin-offs (RSO) phenomenon (Mustar *et al.*, 2006, 2008; Clarysse *et al.*, 2011). RSO can be considered as one of the main tools for the external transmission of knowledge realized in the university, usually referred to as the parent institute. The growing importance of the role of universities in the local development - the so-called *third mission* (Chapman *et al.*, 2011) - is linked to a large number of initiatives enhancing the academic entrepreneurship both through the creation of internal structures devoted to technology transfer and the creation of RSO.

The persistence of close links with the parent institute and the importance of the degree of support that a research spin-off receives from its university for company success has been underlined in the literature (Westhead, Storey, 1995; Mustar, 1997; Steffensen *et al.*, 1999; Chiesa, Piccaluga, 2000; Shane, 2004; Rothaermel, Thursby, 2005). But, what about the *effective* link between RSO and their parent institute? Are there any differences between companies that aroused more interest from their university and the other ones? The international literature on RSO has focused on several perspectives and has proposed many taxonomies in recent years. The institutional model, meaning a more formal or informal relation with the university, has been analysed (Wright *et al.*, 2007; Mustar *et al.*, 2006; Rasmussen, 2006). This paper aims at contributing to this debate through the analysis of the results of a questionnaire survey undertaken in Italian research spin-off founders¹. Primary data sources that captured data directly from the spin-off firm have been used and subjective data based

¹ In this paper we define research spin-offs all the firms 1) coming from the research world, 2) with or without a university share and a patent, 3) established by current or former university/research centre members - professors, researchers, technical and administrative staff, PhD candidates -, 4) with the aim to take advantage of research results.

on perceptions and judgements of a questionnaire respondents are then analysed. Particular attention is paid to a comparison between RSO that fostered more interest from their parent institute and the ones that did not so.

The Italian case-study is remarkable because this country faced a booming of the RSO phenomenon in the recent years (Iacobucci *et al.*, 2011). Several initiatives have then been carried out in order to improve the conditions for the establishment of this kind of firms: many Italian universities, since 2002, issued spin-off regulations following the Legislative Decree n. 297/1999 (Salvador, 2009); specific attention has been devoted to science park and incubator structures; Technology Transfer Offices (TTOs), and Industrial Liaison Offices (ILOs) have been created following the law 262/2004 (Nosella, Grimaldi, 2009). The industrial context evolved with more and more structures created in all the Italian regions and a growing importance of the RSO phenomenon. Nonetheless, the results are generalizable beyond the Italian case.

An extended analysis of the phenomenon has been undertaken thanks to a questionnaire investigation, between January and June 2008. It starts from general descriptive statistics of the answers provided to the several sections of the questionnaire with particular attention to the relationship between RSO and their parent institute; then, a cluster analysis and a factor analysis approaches contribute at building some groups and factors. The cluster analysis revealed the existence of two main kinds of RSO: “*more open-oriented research spin-offs*” and “*less open-oriented research spin-offs*”. The factor analysis confirmed and improved these results by underlining the importance of three factors: “*competencies*”, “*company attitude*” and “*spin-off founders and university choices*”. These findings as well as the questionnaire analysis confirmed the importance of the role played by the research spin-off’s parent institute, as perceived

directly by company's founders. Notwithstanding, the analysis of the relationship between RSO and their parent institute underlined also several specificities: this call for some insights for future university strategy towards a particular kind of firm like a research spin-off.

The paper is structured as follows. Section 1 focuses on the main research spin-off perspectives and taxonomies suggested in recent literature. Data and methodology are presented in section 2. The main results of the empirical investigation are described in section 3: descriptive statistics of the 155 questionnaires received as well as the results of the cluster analysis method and technique applied are provided. These results are confirmed and deepened through a factor analysis approach. Discussion of the results and suggestions for improvement follow.

1. Theoretical framework: main research spin-off perspectives and taxonomies in recent literature

In recent years, different definitions and several theoretical perspectives (Wright *et al.*, 2007) have been used to analyse RSO. They highlight the complexity of the research spin-off and, consequently, many taxonomies have been derived. The type of resources, the business model and the institutional link are used to differentiate between RSO in order to clarify on the heterogeneity and diversity of these firms. Recently, Rasmussen (2011) argued that *life-cycle*, *teleological*, *dialectic* and *evolutionary* theories (see Table 1 for details) explain different aspects of the research spin-off venturing formation process. In particular, the dialectic perspective underlines also the influence of the university culture on spin-off firm behavior.

Wright *et al.* (2007) recently attempt to build spin-off taxonomies to fill the gaps with previous investigations. They classify the scientific production on spin-offs (Table

2), distinguishing three main types of spin-offs: the *venture capital backed* spin-off, the *prospector* spin-off and the *lifestyle* spin-off. This distinction is based on a set of variables identified by the authors and fit into three theoretical perspectives (Table 1): the *institutional*, based on formal or informal relation with the parent institute and its strategic choices, the *business model*, that look at the activities developed by the firm, the sector and the key indicators, and the *resource-based* with a key role played by scientific resources.

Shane (2004) focused on spin-off *needs and sources of finance*, featuring the assorted funding sources for RSO. A first category includes spin-off firms needing a minimum amount of finance, because they are financed through personal and family capital. A second category includes those RSO that need a high level of finance.

If Shane (2004) identified two categories, other authors like Clarysse *et al.* (2002, 2005), Degroof and Roberts (2003; 2004), O'Shea *et al.* (2005) identified three or four types of RSO. Clarysse *et al.* (2002, 2005) and Degroof and Roberts (2003; 2004) classified companies according to the *low selective*, *supportive* and *incubator* models. According to these different models, the creation of spin-offs may vary from several companies of low-medium quality to only a few but with high level potentialities. The parent institute strategy adopted for the creation of these companies and the availability of adequate infrastructures like science parks and incubators are the main determinants of these results. O'Shea *et al.* (2005) analysed not only the impact of university policies and the impact of factors such as the availability of adequate infrastructures and venture capital financing, but they focused also on *personal characteristics* of academics that become managers, with special attention to the desire for independence (Shane, 2004).

Recent focus has been made on *network activities, internal communication and adhocracy* (Gupte, 2007) and the diffusion of *innovation* perspective. Thanks to their research activities, RSO can be a typical example of the “innovative firm” described by Schumpeter (1934). Their potential pivotal tool of technology transfer fostering the creation of wealth and employment call to take into consideration the relation between “tacit and codified knowledge” (Cowan et al., 2000; Powell, Grodal, 2005; Witt, Zellner, 2007). On the one hand RSO develop on the market the potential of the tacit knowledge residing in the heads of scientists, on the other hand, the knowledge potential of a the firm needs to be sustained by an efficient and effective use of internal resources organised in a business model and linked to university rules. All these perspectives and taxonomies support diverse structural explanations of how a research spin-off firm works “well” in different ways. The following consequences can be assumed. A first distinction is between service and product spin-offs: the former are not considered, in general, as research innovative firms (Schumpeter, 1934) but they are important in the university strategy of having a high number of spin-offs, while the latter can be defined as innovative firms and they give more prestige to the university mission in terms of commercialisation of scientific results. A second distinction is between spin-offs that need a high level of financial support and the ones that need a minimum amount of financing. The former are most of all product firms with a patent, they are a typical example of the venture capital-backed spin-offs and they can be included in the incubator model. The latter are most of all service firms, they are a typical example of the lifestyle companies and they can be associated with the low selective model. Prospector spin-offs are in the middle and they can be included in the

supportive model. Tables 1 and 2 provide a summary of the characteristics of these main perspectives and taxonomies on RSO.

The contributions of the literature support, therefore, our assumption that the parent institute plays a key role in the differences among all these perspectives and taxonomies. The university approach towards these particular kinds of firms determines the prevalence of a low, supportive or incubator model of selection; and the company orientation towards a more or less narrow approach with the parent institute may determine the prevalence of a venture capital-backed, a prospector or a lifestyle classification. Our empirical analysis aims at providing a contribution to the literature on RSO' perspectives and taxonomies through a focus on the relationship between these companies and their parent institute. Actually, the results carried out from 155 RSO founders exhibit that the presence or absence of university interest towards a spin-off firm initiative has consequences on the company orientation.

Table 1: Summary of the main perspectives on RSO suggested in recent literature

<i>Perspectives</i>	
Resource-based	The resources (technological, human, social and financial resources), and in particular the scientific and social ones, of the firm may be a differentiator and a predictor of competitive advantage (Wright <i>et al.</i> , 2007; Mustar <i>et al.</i> , 2006)
Business model	Three groups: the “first” one analyzes the business model focusing on the activities undertaken by spin-offs (service or product); a “second” group of studies focuses upon the growth orientation of companies by analysing not only how much these firms grow, but also if and when spin-off founders decide to implement a growth strategy. Finally, a “third” group of studies examine how technologies or knowledge can be transformed in commercial value (Wright <i>et al.</i> , 2007; Mustar <i>et al.</i> , 2006)
Institutional	The link with the university, usually referred to as “the parent institute” and the institutional environment are pivotal. Factors like environment support, local group norms and university culture and university institutional framework influence spin-offs’ behaviour (Wright <i>et al.</i> , 2007; Mustar <i>et al.</i> , 2006; Rasmussen, 2006)
Network activities, internal communication and adhocracy	Factors that enable a research spin-off to grow faster and thus to become more successful: network activities and internal communication. The relationship between network activities and company success is also influenced by the disposition of an organisational culture characterized by flexibility, openness, creativity and dynamism, called “adhocracy” (Gupte, 2007)
Innovation	Spin-offs are a typical example of tools for the diffusion of innovation: they help to understand the organisation of the link between knowledge and business activity (Schumpeter, 1934)
Life-cycle	A process or set of events that occur through a necessary sequence of defined steps or stages of phases (Rasmussen, 2006, 2011).
Teleological	The purpose or final goal guides the development process. The process develops from constructive action: a repetitive sequence of goal formulation, implementation, evaluation, and modification (Rasmussen, 2006, 2011).

Dialectic	Embeddedness in a context where environment support, local group norms and university culture affect the company behaviour. Development processes refer to the balance of power between opposing entities (Rasmussen, 2006, 2011).
Evolutionary	The external environment affects the company process by influencing the opportunity, the individuals involved, and the university context. Change processes go through a continuous cycle of competitive selection (Rasmussen, 2006, 2011).

Source: Author's elaboration

Table 2: Summary of the main taxonomies on RSO suggested in recent literature

<i>Taxonomies</i>	
Venture capital-backed	Attractive for venture capitalists; scientific credibility, visibility, growth process, international market. Number of these RSO: very limited (Wright <i>et al.</i> , 2007)
Prospector	Attractive for capital from public or private equity funds (Wright <i>et al.</i> , 2007)
Lifestyle	Low-growth oriented at start-up; sometimes high-growth oriented after the start-up phase. Less demanding in terms of human, financial and technological resources (Wright <i>et al.</i> , 2007)
Low selective model	Aim: maximize the number of spin-offs: not very competitive, focused on local and national markets, with a low level of capitalisation, and with a weak managerial structure (Clarysse <i>et al.</i> , 2002, 2005; Degroof, Roberts, 2003, 2004).
Supportive model	Focus on spin-offs willing to grow and with average resource intensity. Technology licensing and business plan have a key role. Compared with the previous model, the number of spin-offs is very limited (Clarysse <i>et al.</i> , 2002, 2005; Degroof, Roberts, 2003, 2004).
Incubator model	Clear plan of development, based on a license and a deep knowledge of a specific technology. Venture capitalists are interested in this type of spin-off companies since the beginning (Clarysse <i>et al.</i> , 2002, 2005; Degroof, Roberts, 2003, 2004).
Finance needs	Research spin-off firms need a minimum amount or a high level of finance (Shane, 2004).
Characteristics of spin-off founders	Desire for autonomy and independence (Shane, 2004; O'Shea <i>et al.</i> , 2005).

2. Methodology

The empirical analysis was based on a comprehensive survey of Italian RSO through face-to-face interviews and a questionnaire. The main problem was to identify the actual number of RSO founded in Italy. Thus, the first step was to look at ILO, TTO and university websites for a list of spin-offs and the second step was to verify the completeness and updating of this list. Since a large definition of RSO may be considered, 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 personnel and therefore not linked to the academic world. Telephone and e-mail

contacts 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 RSO identified in Italy was 419. Nonetheless, 394 firms were contacted, because 25 RSO had the positive approval of the university at the time of the survey, but they had not yet been established. A questionnaire was sent to these companies. The response rate was 39.5%: 155 companies accepted to answer to the questionnaire. The location of the questionnaires received was 58% from the North of Italy, 23% from the Centre and 19% from the South and Islands. This distribution is almost the same for the location of the universe of 419 RSO at country level. Therefore, given the response rate and the geographical distribution, this sample can reasonably be considered as representative.

The questionnaire was sent by e-mail to research spin-off founders between January and June 2008 with information about the purpose and details of the survey. Some interviews were undertaken between September and October 2007 before drawing up the questionnaire as a crucial tool in order to understand the general context and check the main aspects of deep examination. This approach enabled to understand the most important features of this kind of firm and thus to draw up a questionnaire as much as possible linked to the particularities of spin-offs. The questionnaire was divided in the following sections: a) general characteristics of the spin-off firm; b) funding sources; c) university and spin-off firm relationship; d) incubator/science park and spin-off firm relationship²; e) patents; f) industrial partnership; g) geographical location of the spin-off firm. The respondents were invited to complete the questionnaire by filling

² This section has been carefully analysed in Salvador and Rolfo (2011).

in the space provided for open questions or by submitting answers to the multiple choice questions.

A cluster analysis was then applied. The various questionnaire questions were clustered into homogeneous groups and it was ascertained whether these groups were different from or similar to one another. First of all, a table with qualitative variables transformed into quantitative ones was built, following the order of questions of the questionnaire. The second step was to choose the analytical tool to be applied: these variables were organized into groups by means of the cluster analysis methods (Everitt *et al.*, 2001). Cluster analysis approach allows for the identification of groups of objects with small within-cluster variation for discriminating variables and high variation between clusters. The list of variables used for the cluster analysis is provided in Annex B. The third step was to choose the clustering method and technique. After multiple runs on several hierarchical and partitional methods and different measures, K-means, one of the most widely used partitional clustering techniques for cluster analysis, was applied.

Finally, a factor analysis was performed on the main variables that influenced the differences between the two Clusters identified by the cluster analysis. Principal component extraction factors was the method chosen and the Kaiser-Meyer-Olkin was the measure of sampling adequacy. This last one was quite low, but acceptable (see Annex C). To determine the number of components the latent root criterion (Eigenvalue > 1.0) was applied: a three-dimensional solution explaining 47% of the variance was obtained.

3. Survey results

This section analyses first of all the contents of the 155 questionnaires fulfilled by Italian RSO founders. Descriptive statistics with tables and figures providing frequencies of the answers are provided. The specific focus is on RSO that fostered more interest from their parent institute (100 questionnaires) - hereafter usually defined as *RSO with interest* - and the ones without their parent institute interest (42 questionnaires)³ - hereafter usually defined as *RSO without interest*.

Secondly, the cluster analysis results are presented and the two Clusters identified are labelled and discussed. Finally, a factor analysis was run on the main significant variables identified by the cluster analysis and the three factors identified are labelled and described.

3.1 *The parent institute “interest” towards a spin-off firm initiative: a preliminary outlook over RSO*

Section C of the questionnaire was focused on the link between a research spin-off firm and its parent institute. More specifically, this section investigated whether or not the university showed any “interest” towards the spin-off initiative. A positive interest led to the parent institute support for the creation of the research spin-off, in terms of participation in the capital of the company and/or of other forms of support and promotion, like aid from TTOs and ILOs, the possibility to use resources and laboratories, the use of the university logo, the possibility to be hosted in the university structures and the employment of the university’s PhD students in the company. In general, the various forms of support and promotion provided by a parent institute are

³ The sample is reduced to 142 because of missing answers.

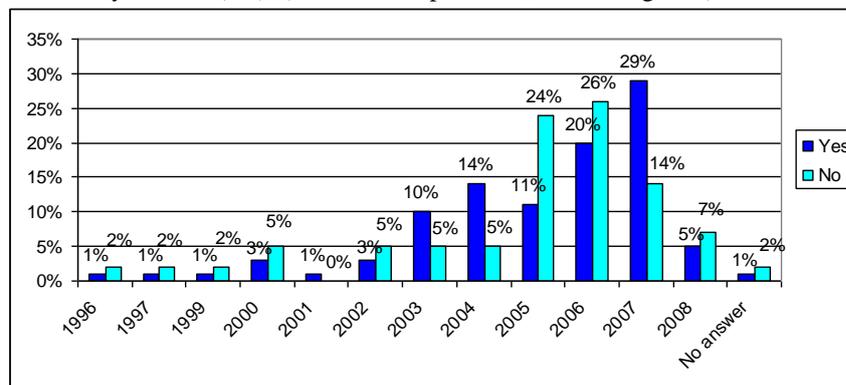
set in the specific rules for spin-off creation issued by the university itself (Salvador, 2009). As a consequence, a lasting relationship is created between the research spin-off firm and its parent institute. In the case of lack of interest on the part of the parent institute, the research spin-off project is created with the autonomy and independence of the founders. In order to investigate the presence and the consequences for RSO of their parent institute interest, section C of the questionnaire included specific questions aiming at highlighting how many companies benefited from a positive attention from their university and at understanding the main RSO' reasons for looking or not for their parent institute involvement. The results highlighted the emerging attention of Italian universities towards the RSO phenomenon with a high percentage of interest (65% of the questionnaires) and a low level of absence of university interest towards a spin-off initiative (27%). The main reasons for searching for a lasting relationship with the parent institute were linked to the benefits deriving from university contacts and the use of university resources in terms of infrastructures and personnel. Otherwise, the companies without any relationship with their parent institute, underlined the absence of real benefits, meaning a sort of prejudice linked to a lack of business culture on the part of the university. Furthermore, the main characteristics of the two kinds of companies, RSO with and without their parent institute interest, are illustrated, as well as the reasons for company creation, the solutions to the lack of managerial competences and the relationship with banks. The results highlighted that most of the companies with patents and of companies that benefited from regional, national and European grants are RSO with university interest. Nonetheless, a strongly higher level of turnover of RSO with interest compared to RSO without their parent institute interest was not registered. Interestingly, companies without university interest have a deeper independence attitude

and they are more international oriented compared to the ones with interest. Notwithstanding, they suffer more from a management knowledge gap and from difficulties with banks.

3.1.1 General characteristics of RSO: year of creation, form of society, capital, turnover, market

Looking at the year of creation, these RSO are relatively young firms: most of the companies analysed was established between 2003 and 2007. A comparison between RSO with and without interest from their parent institute revealed that the number of companies with university interest increased sharply between 2003 and 2007 (see Figure 1). Nonetheless, also the number of RSO without interest from the parent institute increased between 2005 and 2007. This result is in line with the growing number of RSO in Italy and the increasing issuing of university rules for spin-offs (Salvador, 2009).

Figure 1: Year of creation of RSO with university interest (Yes) and RSO without university interest (No), (142 answers provided, 13 missing data)



These companies are most of all limited liability companies: some of the few companies in the form of joint-stock companies benefited from the interest of the university. Two thirds of companies are service oriented while only one third is product oriented: looking at companies with parent institute interest, it emerged that 38% are product companies while 62% are service companies. On the other hand, RSO without

university interest are 24% product companies and 76% service companies. According to the literature (Mustar, 1997; Pérez Pérez, Sánchez, 2003; Lockett *et al.*, 2003; Wright *et al.*, 2004; Shane, 2004; Clarysse *et al.*, 2007; Zhang, 2009) this kind of firm is not a significant source of employment and less than 20% of the founders left the university position to work full time in the spin-off firm. Furthermore, few are the companies with patents: 63% are RSO with university interest, while 37% are RSO without university interest.

Initial and present capital is low (between 10,000 and 20,000 euro) and few are the increases in capital registered. A comparison between RSO with (RSO interest) and without university interest (RSO no interest), revealed the absence of strong differences both in the initial as well as in the present capital of the company (Table 3).

Table 3: Initial and present capital of the company

<i>Capital (euro)</i>	Initial capital				Present capital (year 2008)			
	RSO interest	%	RSO no interest	%	RSO interest	%	RSO no interest	%
Very low (<10,000)	2	2%	2	5%	1	1%	1	2
Low (from 10,000 to 20,000)	69	69%	29	69%	62	62%	25	60
Medium (from 20,001 to 50,000)	13	13%	5	12%	16	16%	7	17
Medium-high (from 50,001 to 90,000)	9	9%	1	2%	7	7%	2	5
High (> 90,000)	6	6%	3	7%	11	11%	5	12
No answer	1	1%	2	5%	3	3%	2	5
Total	100	100.00	42	100.00	100	100.00	42	100.00

The questionnaire results confirmed the importance of personal and family capital as a source of financing (Roberts, 1991) as well as the availability of public funds. Companies that benefited from regional, national and European grants and won Start-Cup⁴ and MIP⁵ competitions are most of all RSO with university interest.

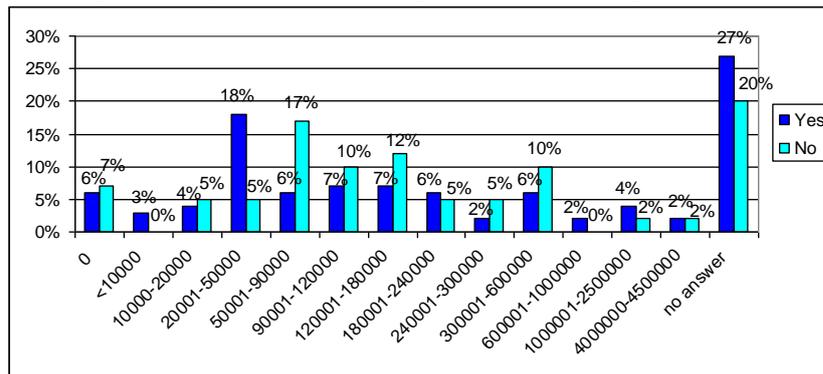
⁴ Start-Cup competition has the goal to foster and support the creation of high knowledge companies, to promote regional economic development and to stimulate the entrepreneurial orientation of researchers. The best business plans are awarded with cash prizes.

⁵ *Mettersi in Proprio* (Start up your own business) is a support service to enterprise creation. It is made up of several integrated actions to stimulate new business ideas and to foster the start-up and development of successful companies. It is a free service of the Province of Turin, funded by the European Union (European Social Fund), the Italian State (Ministry for Labour and Social Policy) and Piedmont Region.

The industry sectors showed a strong prevalence of the ICT sector (33%) followed by the biopharmaceutical one (25%). This result is coherent according to the influence exerted by the new and emerging technologies revolution (Benghozi *et al.*, 2009) and it is in line with literature evidence (Mustar, 1997; Shane, 2004; Gupte, 2007; Clarysse *et al.*, 2007).

A comparison of the company turnover in the year 2007 revealed a subtle difference between the two samples of RSO: in general, RSO with their university interest did not register a strongly higher level of turnover compared to RSO without their parent institute interest (Figure 2).

Figure 2: Turnover (2007) of RSO with university interest (Yes) and RSO without university interest (No), (142 answers provided, 13 missing data)



An interesting finding was the one about the marked prevalence of the national-international attitude (46% and 43% respectively of the 155 respondents). Therefore, these companies are small and young, but they have a high international attitude. This is in line with the literature evidence: in general, small firms have strengths like entrepreneurial dynamism, internal flexibility and specialised expertise (Autio, Yli-Renko, 1998).

The most important reasons for looking for the creation of a relationship between the company and its parent institute were linked to the opportunity to maintain contacts with the parent institute and the possibility to use university resources like students and

laboratories (see Table 4). The most cited disadvantage was bureaucracy. In case the university interest led to university participation in the capital of the company (84%), administrative procedures required in general from three to six months. In case of lack of any relationship with the university, the main reasons were linked to lack of real advantages and lack of dynamism by the university.

Table 4: Reasons for looking for the university participation-support

<i>Possible answers</i>	<i>First choice</i>		<i>Second choice</i>	
	Spin-off	%	Spin-off	%
Greater visibility	26	16.77	16	10.32
More prestige	6	3.87	12	7.74
Keep links with the university	37	23.87	17	10.97
Use university resources	17	10.97	29	18.71
Guarantee of reliability	9	5.81	13	8.39
More easiness in finding potential financiers	3	1.94	5	3.23
Others	0	0.00	1	0.65
No answer	57	36.77	62	40.00
Total	155	100.00	155	100.00

The verdict on the support provided by the parent institute was positive (Table 5).

Table 5: Verdict on the university participation in terms of collaboration/aid

<i>Possible answers</i>	Spin-off	%
Excellent	22	14.19
Good	34	21.94
Sufficient	24	15.48
Poor	9	5.81
Insufficient	6	3.87
No answer	60	38.71
Total	155	100.00

A comparison between the sample of companies with university interest and the one without it, revealed the following difference in national and international attitude (Table 6): RSO with university interest are more national oriented (50%) compared to companies without university interest (43%). The contrary was observed in the international propensity (39% and 45% respectively).

Table 6: Market orientation

	Spin-off - interest	%	Spin-off – no interest	%
Local/regional	11	11%	4	10%
National	50	50%	18	43%
International	39	39%	19	45%

No answer	0	0%	1	2%
Total	100	100.00	42	100.00

3.1.2 *The managerial knowledge gap, its roots and consequences*

Main motivations for company creation have been the willingness to use research results and to work with independence (Annex A, Table 7). Looking specifically at RSO with and without their parent institute interest, questionnaire results highlighted that companies with university interest have chosen as main reasons for company creation “use research results” (43%) and “move from idea to market” (27%). On the other hand, RSO without university interest have mainly chosen “desire for independence” (31%), “lack of job in university” (20%), “use research results” (21%).

The literature on this particular kind of firms has highlighted a lack of managerial and business competencies (Shane, Stuart, 2002; Lockett *et al.*, 2003; Heirman, Clarysse, 2004; Wright *et al.*, 2004; Shane, 2004; Iacobucci *et al.*, 2011). And the solutions adopted for the knowledge gap revealed by the present survey were mostly “self-training” and “aid by the incubator” (Annex A, Table 8). Self-training appeared to be far more chosen than aid by the incubator, even if the latter has been chosen only by on-park spin-offs (65 out of 155). The existence of a lack of business competence is underlined by the fact that only 21.29% of the sample chose “no lacks” as first answer. A comparison between RSO with and without university interest highlighted that all but few of the respondents that chose “no lacks” are companies with university interest as well as most of the companies that chose “aid from industrial partner” as main solution. Aid from an “external manager” and “self-training” have been chosen more by RSO without university interest (17% and 38% respectively) than by companies with their parent institute interest (14% and 35% respectively).

The knowledge gap has one of its main consequences in the relationship with venture capitalists and banks. Only 11% of the sample is participated by a venture capital. While more than 50% of the sample affirm to have no difficulties with banks (Annex A, Table 9), main difficulties are given by lack of competence by spin-offs (15%) or by banks (15%). Comparing RSO with and without university interest, it emerged that two thirds of respondents that chose “no difficulties” are companies with university interest, while only one third are companies without university interest.

3.2 Two clusters structuring the various RSO

These results from the descriptive statistics underline the different perspectives of RSO regarding management concerns and governance relations with their university. Consequently, one should ask whether some specific organisations emerge or not in such structure variety.

The comparison between RSO with interest from their parent institute and the ones without it highlighted interesting but somehow contradictory findings. More specifically, even if most of the companies with patents and of companies that benefited from various forms of grants are RSO with university interest, they did not exhibit a strongly higher level of turnover compared to RSO without their parent institute interest. Interestingly, these last ones were more international oriented even if they suffered more from a management knowledge gap and from difficulties with banks.

These results fostered a deeper analysis in order to characterise these distinctive features. Consequently, we chose to apply a cluster analysis in order to test the existence of similar groups amongst the sample of 155 RSO firms. Actually, confirming our assumptions the analysis made clear the emergence of two main clusters of RSO, exhibiting specific characteristics. Interestingly, the main specificities of the two

clusters for the most part reflect the similarities and the differences emerged in the comparison between RSO with and without university interest.

3.2.1 The cluster analysis results

In the cluster analysis, questionnaire respondents were divided into several groups of RSO. In order to choose the more efficient of the grouping divisions, the Calinski/Harabasz pseudo-F index was used (Calinski, Harabasz, 1974; Milligan, Cooper, 1985). Accordingly, the results demonstrate that the best partition is the one into two groups (Table 10). No correlation problems emerged (see Annex D).

Table 10: Results for Calinski/Harabasz pseudo-F index

Number of clusters	Calinski/Harabasz pseudo-F
2	25.45
3	24.28
4	20.63
5	20.08
6	18.75

Table 11 describes the analysis of variance (ANOVA) results for the grouping into two clusters. The ANOVA table highlights the variables that most contributed towards the identification of the two clusters. As can be seen, the reasons for company creation (var06 & var07) and relationships with banks (var19) were the most influential.

Table 11: ANOVA results for the grouping into two clusters⁶

Source	Partial SS	df	MS	F	Prob > F
Model	27.1990905	47	.578704052	7.25	0.0000
Year of foundation in the last five years	var1 .014664458	1	.014664458	0.18	0.6692
Form of society	var2 .302747817	2	.151373909	1.90	0.1561
Number of shareholders between 1 and 5	var3 .367314335	1	.367314335	4.60	0.0346
Some shareholders left the university	var4 .033986453	1	.033986453	0.43	0.5158
Company	var5 .00104984	1	.00104984	0.01	0.9090
Reasons for company creation (first choice)	var6 3.81487294	5	.762974587	9.56	0.0000
Reasons for company creation (second choice)	var7 5.94640363	6	.991067272	12.41	0.0000
Increase in capital	var8 .079836973	1	.079836973	1.00	0.3200
Actual capital under 50,000 euro	var9 .011443786	1	.011443786	0.14	0.7059
Solutions to lack of managerial competence	var10 .577994787	4	.144498697	1.81	0.1338
Market	var11 .126608333	2	.063304166	0.79	0.4556
Use of self-financing	var12 .379004731	1	.379004731	4.75	0.0320
Use of loans from banks	var13 .05869901	1	.05869901	0.74	0.3935
Regional, national and European grants	var14 .067697941	1	.067697941	0.85	0.3596
Start-cup	var15 .468145808	1	.468145808	5.86	0.0175
MIP	var16 .140423298	1	.140423298	1.76	0.1881
Support of credit	var17 .007126594	1	.007126594	0.09	0.7658
Venture capital financing	var18 .008902636	1	.008902636	0.11	0.7392
Relationship with banks	var19 2.02160588	4	.50540147	6.33	0.0002
Agreement benefiting on-park spin-offs	var20 .000365802	1	.000365802	0.00	0.9462
University interest	var21 .093415771	1	.093415771	1.17	0.2823
Hosted by a science park-incubator	var22 .006590482	1	.006590482	0.08	0.7745
Patent	var23 .000116406	1	.000116406	0.00	0.9696
Industrial partnership	var24 .045771821	1	.045771821	0.57	0.4509
Verdict on company location	var25 .430280932	3	.143426977	1.80	0.1535
Aid from the Region	var26 .178077228	1	.178077228	2.23	0.1388
Company location	var27 .155244703	2	.077622352	0.97	0.3821
Residual	7.18496752	90	.079832972		
Total	34.384058	137	.250978525		

More precisely, Table 12 provides a description of the mean values of all the variables in the two groups.

Table 12: Summary statistics: mean values of variables by cluster

Definitions of variables	Var	Cluster 1	Cluster 2	Total
Year of foundation in the last five years	Var01	1.692308	1.69863	1.695652
Form of society	Var02	1.061538	1.150685	1.108696
Number of shareholders between 1 and 5	Var03	1.292308	1.493151	1.398551
Some shareholders left the university	Var04	1.923077	1.69863	1.804348
Company	Var05	1.615385	1.712329	1.666667
Reasons for company creation (1° choice)	Var06	4.569231	2.90411	3.688406
Reasons for company creation (2° choice)	Var07	4.538462	2.671233	3.550725
Increase in capital	Var08	1.8	1.835616	1.818841
Actual capital under 50,000 euro	Var09	1.184615	1.191781	1.188406
Solutions to lack of managerial competence	Var10	3.415385	2.69863	3.036232
Market	Var11	2.353846	2.342466	2.347826
Use of self-financing	Var12	1.184615	1.123288	1.152174
Use of loans from banks	Var13	1.938462	1.863014	1.898551
Regional, national and European grants	Var14	1.723077	1.657534	1.688406
Start-cup	Var15	1.769231	1.90411	1.84058

⁶ The number of observations was reduced to 138 because of missing values in answers.

MIP	Var16	1.953846	1.958904	1.956522
Support of credit	Var17	1.984615	1.986301	1.985507
Venture capital financing	Var18	1.846154	1.945205	1.898551
Relationship with banks	Var19	4.523077	2.917808	3.673913
Agreement benefiting on-park spin-offs	Var20	1.876923	1.849315	1.862319
University interest	Var21	1.276923	1.452055	1.369565
Hosted by a science park-incubator	Var22	1.569231	1.561644	1.565217
Patent	Var23	1.661538	1.808219	1.73913
Industrial partnership	Var24	1.523077	1.712329	1.623188
Verdict on company location	Var25	2.184615	2.109589	2.144928
Aid from the Region	Var26	1.569231	1.520548	1.543478
Company location	Var27	1.446154	1.616438	1.536232

3.2.2 Clusters description

One could underline that the size of these two clusters is quite similar. According to the K-means partitioning clustering method applied, Cluster 1 comprises 65 questionnaire respondents and Cluster 2 comprises 73 questionnaire elements. Then, what characterizes these two clusters and which are their main specificities? According to the cluster analysis meaning, the objects belonging to cluster one, presumably, share certain similarities that are not shared by the ones belonging to cluster two. The main results of the cluster analysis were the following. Looking at Tables 11 and 12, the key features of the two groups can be identified. Some specific variables do characterize each group more than others. Both in Cluster 1 and in Cluster 2 the main reasons for the company creation, the solution adopted for lack of managerial competencies and the relationship with banks are the key characteristics (variables 06, 07, 10 and 19). Starting from these general considerations, each cluster has to be examined for other characteristics, both included and excluded from the dataset.

Both the two Clusters are characterized by a similar distribution of RSO created in the last five years or before; while limited liability companies (*srl*) and joint-stock companies (*SpA*) are equally distributed in the two clusters, most of the limited partnerships (*sas*) are included in Cluster 2. In Cluster 1 it can be observed a prevalence of product companies, while service companies are included for the most part in Cluster

2. Cluster 1 comprises companies with a number of shareholders not exceeding five persons, while Cluster 2 includes most of the companies with a number of shareholders over five. Nearly all the few founders that left – or did not have – the university position are included in Cluster 2 that is also characterized by less interest from the parent institute (var21). Looking at the main motivations for company creation, Cluster 2 includes all the choices concerning lack of job in the university and desire for independence, while Cluster 1 comprises all the choices about going from an idea to the market and personal prestige. The remaining motivations are equally distributed in Cluster 1 and Cluster 2.

In both the two Clusters there is a prevalence of low capital companies as well as few increases in capital. The solutions to lack of managerial competencies (var10) highlighted a prevalence of no lacks or aid from the industrial partner in Cluster 1, and self-training, aid from the incubator and an external manager in Cluster 2. Linked to these characteristics, the relationship with banks (var19) underlined a lack of difficulties in Cluster 1 and the presence of difficulties due to lack of competencies by spin-offs and by banks in Cluster 2.

Concerning the market (var11), a prevalence of importance of the international market is observable in Cluster 1, while the national market is predominant in Cluster 2. The distribution of the sources of financing highlighted a prevalence of personal and family capital, bank loans, regional, national and European grants in Cluster 2, and a predominance of Start-up and venture capital financing in Cluster 1. Slight differences have been observed in the influence of var22 (hospitality in a science park-incubator), while Cluster 1 highlighted a higher presence of patents and industrial partnerships compared to Cluster 2.

Lastly, the variables linked to the location (var25-27) have underlined a general prevalence of indifference as a verdict on company location in both the two clusters as well as an overall predominance of no aid from the Region, with a subtle prevalence of aid in Cluster 2. Cluster 1 shows a prevalence of companies located in the North and in the Centre of Italy, while Cluster 2 includes RSO located in the North and in the South of the country.

To sum up, the cluster analysis identified two groups. These two clusters share many characteristics quite similar to the ones emerged in the comparison between RSO with and without university interest. Therefore, according to the above description, we suggest to refer to them as “*More open-oriented research spin-offs*” (Cluster 1) and “*Less open-oriented research spin-offs*” (Cluster 2). Figure 3 provides a summary of the main specificities of these two clusters.

Figure 3: **Cluster 1: More open-oriented research spin-offs**



Factor8		0.68143	0.03920	0.0681	0.8923
Factor9		0.64224	0.20723	0.0642	0.9565
Factor10		0.43500	.	0.0435	1.0000

LR test: independent vs. saturated: $\chi^2(45) = 123.53$ Prob> $\chi^2 = 0.0000$

Factor analysis/correlation	Number of obs	=	140
Method: principal-component factors	Retained factors	=	3
Rotation: orthogonal varimax (Horst off)	Number of params	=	27

Factor		Variance	Difference	Proportion	Cumulative
Factor1		1.65374	0.03558	0.1654	0.1654
Factor2		1.61816	0.19760	0.1618	0.3272
Factor3		1.42056	.	0.1421	0.4692

LR test: independent vs. saturated: $\chi^2(45) = 123.53$ Prob> $\chi^2 = 0.0000$

Rotated factor loadings (pattern matrix) and unique variances

Variable		Factor1	Factor2	Factor3	Uniqueness
Form of society	Var02	-0.4830	-0.0529	-0.1361	0.7454
Some shareholders left the university	Var04	0.3448	-0.1643	0.5367	0.5661
Company	Var05	0.0382	0.8143	-0.0220	0.3350
Reasons for company creation	Var06	0.4820	-0.3479	0.1473	0.6250
Solutions to lack of managerial competence	Var10	0.6469	0.2751	0.1142	0.4928
Market	Var11	-0.1838	-0.3654	-0.4419	0.6375
Relationship with banks	Var19	0.6899	-0.0875	-0.1547	0.4924
University interest	Var21	-0.3299	0.1975	-0.5191	0.5827
Patent	Var23	-0.0442	0.7260	0.1156	0.4576
Company location	Var27	-0.1696	0.1459	0.7594	0.3732

Factor 1 groups the items relating to the solutions adopted for lack of managerial competencies and relationships with banks (var10 and var19). It seems that financial and managerial competencies are linked to the relationship with banks, therefore Factor 1 can be labelled “*Competencies*”. Factor 2 includes the items pertaining to the kind of company, meaning product or service company, and the presence of patents (var5 and var23). Questionnaire results highlighted that product companies have patents more than service companies. Therefore, Factor 2 can be labelled “*Company attitude*”. Finally, Factor 3 includes items that show a link between company location and the choice of some shareholders of leaving the parent institute as well as a negative link with the university interest towards the research spin-off initiative. And in fact questionnaire results showed that most of the RSO are located in the North of the country as well as the few founders that left the university position and if company

founders maintain the university position, there is more probability to attract interest from their parent institute. As a consequence, Factor 3 can be labelled “*Founders and university choice*”.

To sum up, these results complement the characteristics of the two groups as identified by the cluster analysis as well as of the description of the questionnaire answers with a focus on RSO with and without their parent institute interest. The importance of “competencies” highlighted by Factor 1 confirms the peculiarities of the two clusters: absence of lack of managerial competencies and absence of difficulties with banks were prevalent in Cluster 1, while lack of business knowledge and problems with banks because of lack of competencies characterized Cluster 2. Similarly, the “attitudes” underlined by Factor 2 are confirmed by the finding that Cluster 1 includes product companies with patents, while Cluster 2 comprises service companies without patents. Finally, the founders’ “choice” of leaving the university position and the parent institute interest towards the spin-off initiative is also confirmed by the clusters’ grouping: if research spin-off founders do not leave the university position there is a greater interest by the parent institute (Cluster 1), otherwise, if they leave – or do not have – the university position there is less interest by the parent institute (Cluster 2).

4. Discussion and concluding remarks

A great attention has been recently devoted to the *third mission* of universities (Chapman *et al.*, 2011). Hottenrott and Thorwarth (2011) argued that economic and social value could be created by industry funded research resulting in technologies patentable as well as industrially relevant.

Looking specifically at the RSO phenomenon, two main dimensions have been underlined in the literature: the persistence of close links with the parent institute and

the importance of the degree of support that a research spin-off receives from its university for company success (Mustar, 1997; Chiesa, Piccaluga, 2000; Westhead, Storey, 1995; Steffensen *et al.*, 1999; Shane, 2004; Rothaermel, Thursby, 2005). Our survey confirmed the importance of this support, but it also highlighted some specificities of RSO with and without their parent institute interest. According to our results, RSO that aroused interest from their university are more product oriented and they have more patents compared to RSO without their parent institute interest. Furthermore, RSO with interest from their university have less difficulty with banks and less knowledge gaps compared to RSO without interest from their university. Notwithstanding, no significant differences were observed in the capital as well as in the turnover. Last but not least, the independence attitude and the international propensity is more evident in companies without university interest.

Our research highlighted further interesting findings. Two groups of RSO exhibit some clear similarities but also several specificities. A first Cluster, named *more open-oriented research spin-offs*, includes more product companies with patents, internationally oriented, located in the North and the Centre of Italy, with few shareholders with university position and linked to their parent institute interest. These RSO have been founded for moving from idea to market and – in some few cases - for founders' personal. They have more probabilities to be financed from venture capitalists and they have few difficulties with banks as well as no lack of managerial competencies that are sometimes provided by an industrial partner. A second Cluster, named *less open-oriented research spin-offs*, consist of more service companies without patents, nationally oriented, located in the North and South of Italy, with many shareholders without a university position and with less interest from the parent institute. These

companies have been founded because of lack of job in university and for independence desire. They are financed more by personal and family capital, bank loans and regional, national or European grants. These RSO face difficulties with banks because of lack of competencies as well as lack of managerial competencies filled by self-training, aid from incubator or from an external manager.

Therefore, it seems that the findings emerged from the comparison between questionnaire respondents with university interest and the ones without it, have been reflected by the cluster grouping with few exceptions, like the market orientation and some forms of financing.

Finally, three main significant factors confirm the importance of managerial competencies, the product or service attitude and the link between research spin-off founder's position in university, the parent institute interest and the company location.

A first key role is played by *choices* and a second role is given by *competencies*. Choices and competencies influence the company's *attitude*. These three components taken together are the pillars of the cluster analysis grouping and should be taken into account for research spin-off policy strategy. Going into details, choices mean reasons for company creation and founder personal choices: the cluster analysis highlighted a positive link between moving from idea to market -and research spin-off founder with a university position on the one hand, and the parent institute interest on the other hand (Cluster 1). Otherwise, the cluster analysis highlighted a link between lack of job in university and desire for independence with less interest from the parent institute (Cluster 2). Therefore, it seems that RSO founded by university staff have more probability to be judged as interesting initiatives by their university and consequently receive support from their parent institute. It would be useful to understand *why*: further

research could highlight whether this interest is linked to university prestige or to a desire for more revenues. This has consequences on company competencies. In fact, a knowledge gap is observable more in RSO not founded by university personnel (Cluster 2). Again, possible reasons of this finding can be identified in the more easiness for spin-off firms supported by their parent institute in filling the knowledge gap through aid from university structures as well as meetings, tutorship, consultancy services, networking with colleagues and not only through self-training. And the lack of managerial and business competencies has consequences on the company's attitude - product or service orientation with or without patents - meaning that entrepreneurial competencies have a pivotal importance. The effective role played by venture capital financing and industrial partnerships is not investigated further in this study. Notwithstanding, the overall performance of Italian RSO seems to be lower compared to other start-ups (Salvador, 2011a). Furthermore, it is also true that spin-off founders with a university position have to balance a trade-off between the time devoted to teaching and research and the daily management of the firm. This could be one of the possible reasons for the absence of marked differences in turnover between RSO more or less open-oriented.

Therefore, from these considerations it can be assumed that spin-off founders without a university position should be more encouraged and helped in fostering the potentialities of their codified and tacit knowledge. This means first of all that they need to be helped in filling the knowledge gap of managerial and business competencies, that is one of the main weaknesses of RSO underlined in the literature (Clarysse *et al.*, 2011; Iacobucci *et al.*, 2011; Mustar *et al.*, 2008; Wright *et al.*, 2007, 2004; Shane, 2004). In order to fill this knowledge gap, entrepreneurship education could be a crucial factor in

fostering not only entrepreneurial attitude but also entrepreneurial competence and growth of this particular kind of firms (Gorman *et al.*, 1997; Pittaway, Cope, 2007; Fayolle, 2008; Bureau *et al.*, 2012). RSO have some peculiarities that need to be valorized in order to become successful. To this aim, key actors that could help RSO are not only universities but also business schools (Wright *et al.*, 2007) in partnership with science park and incubator structures, TTOs and ILOs. The “brand name” of science parks and incubators could be an important signal of credibility (Salvador, 2011) and the proactive role of TTOs and ILOs should not be underestimated (Clarysse *et al.*, 2007; Jain, George, 2007). Therefore, if the cluster grouping and the factor analysis results are reasonable, and if the overall performance of these companies is not brilliant (Bathelt *et al.*, 2010; van Geenhuizen, Soetanto, 2009; Mustar *et al.*, 2008), as a consequence it is important to focus more on *less open-oriented research spin-offs*. This focus could help in understanding why in general RSO do not show a rapid growth with consequent suggestions for improvement. This means first of all that *less open-oriented research spin-offs* should have more attention from their parent institute – and encouraged to this aim even if they have an independence attitude – and the possibility to fill the knowledge gap. Secondly, the time devoted to the spin-off initiative by founders with a university position should be strictly balanced: neither the research and teaching duties nor the company management have to be neglected to the detriment one of the other. In other words, personal prestige and self-celebration should not overcome the enlargement of the scientific perspective and wealth creation. Last but not least, business schools in partnership with science parks, incubators, TTOs and ILOs should have the chance and should be encouraged to play a more active role not only in filling the entrepreneurship education gap but also in fostering the potentialities of the codified

and tacit knowledge held by this particular kind of firms for company creation and employment opportunities.

Nevertheless, this empirical investigation is not without limitations. First of all, the population of RSO did not cover the universe. Secondly, the study is limited to the Italian context and does not attempt at providing a cross analysis with other European countries. Thirdly, the analysis relies on data covered on a given time period. Nonetheless, despite these limitations and potential biases, the originality of this empirical investigation is given by the provision of data taken directly from “effective” RSO through a questionnaire investigation. Given the lack of reliable official data, this analysis provided primary data and highlighted interesting findings and it was useful for better understanding the perceptions of Italian RSO as well as for stimulating further research. Future research along this line and with a focus on other countries could highlight further consequences of the presence or absence of interest of the parent institute for a research spin-off. The focus on the presence or absence of the parent institute interest and its main reasons and consequences may be a key step in order to shed more light and to improve future policy strategies for a particular kind of firm like a research spin-off.

References

- Autio E., Yli-Renko H. (1998), “New, technology-based firms in small open economies – An analysis based on the Finnish experience”, *Research Policy*, vol. 26, n. 9, pp. 973-987.
- Bathelt H., Kogler D. F., Munro A. K. (2010), “A knowledge-based typology of university spin-offs in the context of regional economic development”, *Technovation*, vol. 30, n. 9-10, pp. 519-532.
- Benghozi, P.-J., Bureau, S., Massit-Folléa, F. (2009), “*The Internet of Things, What Challenges for Europe?*” Editions de la Maison des Sciences de l’Homme, Paris.
- Bureau S., Salvador E., Fendt J. (2012), “Small firms and the growth stage: can entrepreneurship education programs be supportive?”, *Industry and Higher Education*, vol. 26 n. 2, April, ISSN 0950-4222, pp. 1-22.
- Calinski T., Harabasz J. (1974), “A dendrite method for cluster analysis”, *Communications in Statistics-Simulation and Computation*, vol.3, n. 1, pp. 1–27.
- Chapman D., Lawton Smith H., Wood P., Barnes T., Romeo S. (2011), “University enterprise: the growth and impact of university-related companies in London”, *Industry&Higher Education*, vol. 25, n. 6, pp. 1-10.

- Chiesa, V., Piccaluga, A. (2000), "Exploitation and diffusion of public research: the case of academic spin-off companies in Italy", *R&D Management*, vol. 30, n. 4, pp. 329-340.
- Clarysse B., Lockett A., Quince T., Van de Velde E. (2002), "*Spinning off new ventures: a typology of facilitating services*", Institute for the Promotion of Innovation by Science and Technology in Flanders, *IWT-Observatory, Innovation, Science, Technology*, n. 41.
- Clarysse B., Wright M., Lockett A., Mustar P., Knockaert M. (2007), "Academic spin-offs, formal technology transfer and capital raising", *Industrial and Corporate Change*, vol. 16, n. 4, pp. 609-640.
- Clarysse B., Wright M., Lockett A., van de Velde E., Vohora A. (2005), "Spinning out new ventures: a typology of incubation strategies from European research institutions", *Journal of Business Venturing*, vol. 20, n. 2, pp. 183-216.
- Clarysse B., Wright M., Van de Velde E. (2011), "Entrepreneurial origin, technological knowledge and the growth of spin-off companies", *Journal of Management Studies*, doi: 10.1111/j.1467-6486.2010.00991.x, vol. 48, n. 6, pp. 1420-1442.
- Cowan R., David P. A., Foray D. (2000), "The Explicit Economics of Knowledge Codification and Tacitness", *Industrial and Corporate Change*, vol. 9, n. 2, pp. 211-253. Degroof J.-J., Roberts E. (2003), "*Spinning-off new ventures from academic institutions in areas with weak entrepreneurial infrastructure: insights on the impact of spin-off processes on the growth-orientation of ventures*", MIT Sloan School of Management, Working Paper 4311-03.
- Degroof J.-J., Roberts E. (2004), "*Overcoming weak entrepreneurial infrastructures for academic spin-off ventures*", MIT, Industrial Performance Center, Working Paper Series, MIT-IPC-04-005.
- Everitt B., Landau S., Leese M. (2001), *Cluster Analysis*, Edward Arnold, London.
- Fayolle A. (2008), "Entrepreneurship education at a crossroads: towards a more mature teaching field", *Journal of Enterprising Culture*, vol. 16, n. 4, pp. 325-337.
- Gorman G., Hanlon D., King W. (1997) "Some research perspectives on entrepreneurship education and education for small business management: a ten-year literature review", *International Small Business Journal*, vol. 15, n. 3, pp. 56-77.
- Gupte, M. (2007), "*Success of University Spin-offs. Network Activities and Moderating Effects of Internal Communication and Adhocracy*", Kiel, Deutscher Universitäts-Verlag.
- Heirman A., Clarysse B. (2004), "How and why do research-based start-ups differ at founding? A resource-based configurational perspective", *Journal of Technology Transfer*, vol. 29, n. 3-4, pp. 247-268.
- Hottenrott, H. and Thorwarth, S. (2011), Industry Funding of University Research and Scientific Productivity. *Kyklos*, 64: 534–555. doi: 10.1111/j.1467-6435.2011.00519.x
- Iacobucci D., Iacopini A., Micozzi A., Orsini S. (2011), "Fostering entrepreneurship in academic spin-offs", *International Journal of Entrepreneurship and Small Business*, vol. 12, n. 4, pp. 513-533.
- Jain S., George G. (2007), "Technology transfer offices and institutional entrepreneurs: the case of Wisconsin Alumni Research Foundation and human embryonic stem cells", *Industrial and Corporate Change*, vol. 16, n. 4, pp. 535-568.
- Lockett, A., Wright, M., Franklin, S. (2003), "Technology Transfer and Universities' Spin-Out Strategies", *Small Business Economics*, vol. 20, n. 2, pp. 185–200.
- Milligan G. W., Cooper M. C. (1985), "An examination of procedures for determining the number of clusters in a data set", *Psychometrika*, vol. 50, n. 2, pp. 159–179.
- Mustar P. (1997), "Spin-off enterprises. How French academics create hi-tech companies: the conditions for success or failure", *Science and Public Policy*, vol. 24, n. 1, pp. 37-43.
- Mustar P. Wright M., Clarysse B. (2008), "University spin-off firms: lessons from ten years of experience in Europe", *Science and Public Policy*, vol. 35, n. 2, pp. 67-80.
- Mustar P., Renault M., Colombo M., Piva E., Fontes M., Lockett A., Wright M., Clarysse B., Moray N. (2006), "Conceptualising the heterogeneity of research-based spin-offs: a multi-dimensional taxonomy", *Research Policy*, vol. 35, n. 2, pp. 289-308.
- Nosella A., Grimaldi R. (2009), "University-level mechanisms supporting the creation of new companies: an analysis of Italian academic spin-offs", *Technology Analysis & Strategic Management*, vol. 21, n. 6, pp. 679-698.
- O'Shea, R. P., Allen, T. J., Chevalier, A., Roche, F. (2005), "Entrepreneurial orientation, technology transfer and spinoff performance of U.S. universities", *Research Policy*, n. 34, n. 7, pp. 994 – 1009.

- Pérez Pérez M., Sánchez A. M. (2003), "The development of university spin-offs: early dynamics of technology transfer and networking", *Technovation*, vol. 23, n. 10, pp. 823-831.
- Pittaway L., Cope J. (2007), "Entrepreneurship education: a systematic review of the evidence", *International Small Business Journal*, vol. 25, n. 5, pp. 479-510.
- Powell W., Grodal S. (2005), "Networks of Innovators", in Fagerberg J., Mowery D. C., Nelson R.R., eds. (2005), *The Oxford Handbook of Innovation*, Oxford, Oxford University Press.
- Rasmussen E. (2006), "Spin-off venture creation in a university context. An entrepreneurial process view", paper presented at the 14th Nordic Conference on Small Business Research in Stockholm, Sweden.
- Rasmussen E. (2011), "Understanding academic entrepreneurship: exploring the emergence of university spin-off ventures using process theories", *International Small Business Journal*, vol. 29, n. 5, pp. 448-471.
- Roberts, E. (1991), "High Stakes for High-Tech Entrepreneurs: Understanding Venture Capital Decision Making", *Sloan Management Review*, vol. 32, n. 2, pp. 9-20.
- Rothaermel, F. T., Thursby, M. (2005), "Incubator firm failure or graduation? The role of university linkages", *Research Policy*, vol. 34, n. 7, pp. 1076-1090.
- Salvador E. (2009), "Evolution of Italian universities' rules for spin-offs: the usefulness of formal regulations", *Industry & Higher Education*, vol. 23, n. 6, pp. 445-462.
- Salvador E. (2011), "Are science parks and incubators good "brand names" for spin-offs? The case-study of Turin", in *Journal of Technology Transfer*, ISSN 0892-9912 (Print) 1573-7047 (Online), DOI 10.1007/s10961-010-9152-0, vol. 36, n. 2, pp. 203-232.
- Salvador E. (2011a), "How effective are research spin-off firms in Italy?", *Revue d'Économie Industrielle*, n. 133, 1er trimestre, ISSN 0154-3229, pp. 99-122.
- Salvador E., Rolfo S. (2011), "Are incubators and science parks effective for research spin-offs? Evidence from Italy", *Science and Public Policy*, DOI: 10.3152/016502611X12849792159191, vol. 38, n. 3, pp. 170-184.
- Schumpeter J. (1934), *The Theory of Economic Development*, Cambridge Mass., Harvard University Press.
- Shane S., Stuart T. (2002), "Organizational endowments and the performance of university start-ups", *Management Science*, vol. 48, n. 1, pp. 154-170.
- Shane, S. (2004), *Academic Entrepreneurship. University Spinoffs and Wealth Creation*, Cheltenham, UK, Edward Elgar.
- Steffensen M., Rogers E. M., Speakman K. (1999), "Spin-offs from research centers at a research university", *Journal of Business Venturing*, vol. 15, n. 1, pp. 93-111.
- Van Geenhuizen M., Soetanto D. P. (2009), "Academic spin-offs at different ages: a case study in search of key obstacles to growth", *Technovation*, vol. 29, n. 10, pp. 671-681.
- Westhead P., Storey D. J. (1995), "Links between higher education institutions and high technology firms", *Omega*, vol. 23, n. 4, pp. 345-360.
- Witt U., Zellner C. (2007), "Knowledge-based entrepreneurship: the organizational side of technology commercialization", Malerba F., Brusoni S., eds., (2007), *Perspectives on Innovation*, Cambridge, Cambridge University Press.
- Wright, M., Clarysse, B., Mustar, P., Lockett, A. (2007), *Academic Entrepreneurship in Europe*, Cheltenham UK, Edward Elgar.
- Wright, M., Vohora, A., Lockett, A. (2004), "The Formation of High-Tech University Spinouts: The Role of Joint Ventures and Venture Capital Investors", *Journal of Technology Transfer*, vol. 29, n. 3-4, pp. 287-310.
- Zhang J. (2009), "The performance of university spin-offs: an exploratory analysis using venture capital data", *Journal of Technology Transfer*, vol. 34, n. 3, pp. 255-285.

Annex A: Tables 7, 8, 9

Table 7: Reasons for creation of the firm

<i>Possible answers</i>	<i>First choice</i>		<i>Second choice</i>	
	Spin-off	%	Spin-off	%
1-Lack of job in University	20	12.90	22	14.19
2-Desire for independence	23	14.84	25	16.13
3-Desire to work in "a business way"	11	7.10	23	14.84
4-Use research results	55	35.48	35	22.58
5-Move from idea to market	35	22.58	31	20.00
6-Personal prestige	0	0.00	4	2.58
7-Other (a mix of answers 1, 2, 4, 5)	10	6.45	8	5.16
No answers	1	0.65	7	4.52
Total	155	100.00	155	100.00

Table 8: Solutions to lack of managerial competence

<i>Possible answers</i>	<i>First choice</i>		<i>Second choice</i>	
	Spin-off	%	Spin-off	%
1-External manager	21	13.55	0	0.00
2-Aid from incubator	29	18.71	2	1.29
3-Self-training	54	34.84	18	11.61
4-Aid from industrial partner	10	6.45	8	5.16
5-No lacks	33	21.29	8	5.16
No answer	8	5.16	119	76.77
Total	155	100.00	155	100.00

Table 9: Relationship with banks

<i>Possible answers</i>	Spin-off	%
1-Difficult due to lack of competence by spin-off firm	23	14.84
2-Difficult due to lack of competence by banks	24	15.48
3-Pivotal aid from incubator	6	3.87
4-Pivotal aid from university	7	4.52
5-No difficulties	83	53.55
No answer	12	7.74
Total	155	100.00

Annex B: Definitions of variables used for cluster analysis

Var01	Year of foundation in the last five years (1=yes; 2=no)
Var02	Form of society (1=srl; 2=spa; 3=sas)
Var03	Number of shareholders between 1 and 5 (1=yes; 2=no)
Var04	Some shareholders left the university (1=yes; 2=no)
Var05	Company (1=product; 2=service)
Var06	Reasons for company creation (first choice)
Var07	Reasons for company creation (second choice)
Var08	Increase in capital (1=yes; 2=no)
Var09	Actual capital under 50,000 euro (1=yes; 2=no)
Var10	Solutions to lack of managerial competence
Var11	Market (1=local-regional; 2=national; 3=international)
Var12	Use of self-financing (1=yes; 2=no)
Var13	Use of loans from banks (1=yes; 2=no)
Var14	Regional, national and European grants (1=yes; 2=no)
Var15	Start-cup (1=yes; 2=no)
Var16	MIP (1=yes; 2=no)
Var17	Support of credit (1=yes; 2=no)
Var18	Venture capital financing (1=yes; 2=no)
Var19	Relationship with banks
Var20	Agreement benefiting on-park spin-offs (1=yes; 2=no)
Var21	University interest (1=yes; 2=no)

Var22	Hosted by a science park-incubator (1=yes; 2=no)
Var23	Patent (1=yes; 2=no)
Var24	Industrial partnership (1=yes; 2=no)
Var25	Verdict on company location (1=advantage; 2=indifference; 3=disadvantage)
Var26	Aid from the Region (1=yes; 2=no)
Var27	Company location (1=North; 2=Centre; 3=South and Islands)

Annex C: Kaiser-Meyer-Olkin measure of sampling adequacy

Variable	Kmo
Var02	0.7278
Var04	0.6589
Var05	0.4685
Var06	0.7013
Var10	0.6214
Var11	0.6651
Var19	0.6612
Var21	0.5202
Var23	0.4803
Var27	0.6197
Overall	0.5807

Annex D: Correlation matrix

	var1	var2	var3	var4	var5	var6	var7	var8	var9	var10	var11	var12	var13	var14
var1	1.0000													
var2	0.0216	1.0000												
var3	-0.2014	-0.1431	1.0000											
var4	-0.1674	-0.1804	0.1403	1.0000										
var5	-0.0668	-0.0374	0.1361	-0.0000	1.0000									
var6	0.0283	-0.1341	0.0104	0.2662	-0.0981	1.0000								
var7	-0.0812	0.1202	-0.1144	0.1048	0.0030	0.0356	1.0000							
var8	-0.2702	-0.1958	0.0755	0.1949	0.1863	0.0489	-0.1448	1.0000						
var9	0.0770	0.0979	-0.0137	-0.1828	-0.2097	0.0355	-0.0142	-0.3989	1.0000					
var10	0.0667	-0.1693	0.0228	0.1257	0.1257	0.1289	0.0396	0.0852	0.1003	1.0000				
var11	0.0882	0.1034	-0.1408	-0.1023	-0.1193	-0.0072	-0.0682	-0.0381	0.0563	-0.2650	1.0000			
var12	-0.0705	0.0842	-0.0976	0.0055	-0.1284	-0.0431	0.0051	0.0421	0.1570	-0.0891	0.0218	1.0000		
var13	-0.1179	-0.0862	-0.0206	0.0763	-0.0339	0.2319	-0.0599	0.0289	0.0391	0.0461	-0.0049	-0.0581	1.0000	
var14	-0.0030	-0.1645	0.1322	0.0231	0.0221	0.1121	-0.0029	-0.0321	0.0441	0.0667	-0.0253	-0.2377	0.3440	1.0000
var15	0.0991	0.0669	-0.1711	-0.0152	0.1120	-0.0594	-0.1138	-0.0507	0.0580	-0.0790	-0.1028	-0.0911	0.1815	-0.0793
var16	-0.0638	0.0563	0.1010	-0.0156	0.0754	0.0248	-0.0144	-0.1003	0.1027	0.0332	-0.1606	-0.1075	0.1637	-0.0667
var17	-0.0802	0.0320	-0.0251	-0.0598	0.1715	-0.0233	-0.1022	-0.0570	0.0584	0.0963	0.0655	-0.1174	0.1601	-0.0816
var18	-0.0136	-0.0862	0.1755	0.1368	0.2715	-0.0202	-0.1715	0.2158	-0.4519	0.0093	-0.1166	-0.3254	-0.1129	-0.0188
var19	-0.0067	-0.0869	-0.2619	0.2023	-0.0562	0.1771	0.0738	0.0441	0.0167	0.2321	-0.0024	0.0350	0.1525	0.0665
var20	0.0099	0.1055	-0.0184	0.1210	0.0744	0.0010	0.0057	0.0305	-0.1839	0.0756	-0.0780	-0.0649	0.0050	-0.1326
var21	0.0823	0.1626	-0.1327	-0.2657	0.1911	-0.1494	-0.0269	-0.1466	0.0150	-0.1824	0.1226	-0.0318	0.0086	0.0613
var22	-0.0718	-0.1236	0.3258	0.1202	0.0000	-0.0063	0.1109	0.0809	0.0114	0.2037	-0.1844	-0.1168	-0.0042	0.1043
var23	-0.1060	-0.0035	0.0791	-0.0434	0.4201	-0.1551	-0.0880	0.3204	-0.3468	0.0292	-0.1147	-0.0699	-0.0903	-0.1503
var24	-0.0593	-0.0126	0.0221	0.0311	0.0846	-0.0943	-0.1075	0.1778	-0.0460	-0.1160	-0.0908	-0.0869	0.0359	0.0903
var25	0.0348	0.0713	-0.0152	0.0563	0.0109	0.0343	0.0713	-0.0673	0.1223	0.0722	-0.1662	0.0845	0.0007	0.0370
var26	-0.1320	-0.0054	0.1221	-0.0120	0.1234	0.0483	0.2343	0.2110	-0.0421	0.1258	-0.1600	-0.0167	0.1739	0.0744
var27	-0.0291	-0.0230	0.0834	0.1708	0.1281	0.0115	-0.1251	0.0801	0.0013	0.0925	-0.2072	-0.0066	0.1652	0.0402
	var15	var16	var17	var18	var19	var20	var21	var22	var23	var24	var25	var26	var27	
var15	1.0000													
var16	0.3925	1.0000												
var17	0.1128	0.2715	1.0000											
var18	0.0504	-0.0716	-0.0407	1.0000										
var19	0.0220	0.0442	0.1236	-0.0229	1.0000									
var20	-0.0017	0.2242	0.1275	0.0747	0.0487	1.0000								
var21	0.0464	0.0160	-0.0328	0.0584	-0.1405	-0.0426	1.0000							
var22	-0.0625	0.2431	0.1383	-0.1010	-0.0228	0.2011	-0.2370	1.0000						
var23	0.0568	-0.0457	-0.0720	0.2376	-0.0577	0.0021	-0.0922	-0.0550	1.0000					
var24	0.1107	-0.0191	0.0308	0.2340	-0.0451	-0.0503	0.0377	0.0118	0.0148	1.0000				
var25	-0.0170	0.0327	0.1470	-0.0247	-0.0022	0.1504	-0.0062	0.1655	-0.0661	0.0560	1.0000			
var26	0.0778	0.1613	0.0106	-0.0670	-0.0402	0.0138	-0.0518	0.2820	0.1181	-0.0522	0.1098	1.0000		
var27	-0.0050	0.1429	0.0813	0.0452	-0.0324	0.0312	-0.1191	0.2224	0.0888	0.1287	0.1177	0.1961	1.0000	