

Academic spin-offs incubation strategies: the case of the Andalusian region

Estrategias de promoción de las spin-offs académicas: el caso de Andalucía

F. RAFAEL CÁCERES CARRASCO¹
MARÍA-TERESA ACEYTUNO²
Universidad de Sevilla (Spain)
Universidad de Huelva (Spain)

Recibido el 7 de julio de 2014, aceptado el 11 de diciembre de 2014

Nº de clasificación JEL: O33, O38

DOI: 10.5295/cdg.140479ma

Abstract:

The objective of this paper is to analyze the incubation strategies developed in the universities of Andalusia, a relatively low-income region of Spain, to promote the creation of university spin-offs. These strategies are also compared to the incubation models noted in the literature. The performance of the university spin-offs created and its relation to the incubation strategies developed by the university are also analysed. The analysis is based on data from a survey of nine public universities that carry out strategies for the promotion of university spin-offs. The result of the analysis shows that university spin-off incubation strategies in Andalusia present specific characteristics not covered by certain models that are well-known in the literature on innovation. Then, a new stage in the process of the university spin-off incubation is proposed. We consider it to be a pre-strategic stage to the academic spin-off incubation strategies. The analysis also finds certain environmental factors associated to those spin-offs promoted by Andalusian universities that achieve the highest level of performance. This result suggests that previous to making any decision involving investment into developing incubation strategies, universities should gauge whether they have sufficient resources and the possibilities of connecting with a Technology Park.

Keywords:

University spin-off, incubation strategy, university, firm, technology transfer, university-industry relations.

Resumen:

El objetivo de este artículo es analizar las estrategias de promoción de la creación de spin-offs universitarias que han desarrollado las universidades andaluzas, para lo cual se comparan con las descritas en la bibliografía existente. Además, se analiza la evolución posterior de las empresas creadas a partir de las estrategias de incubación implantadas por las universidades, así como su relación con dichas estrategias. Para llevar a cabo este objetivo, se utiliza una base de datos procedente de un cuestionario realizado en las nueve universidades

¹ Departamento de Economía Aplicada I, Facultad de Ciencias Económicas, Avda. Ramón y Cajal nº 1, 41071 Sevilla (España). rcaceres@us.es

² Departamento de Economía, Facultad de Ciencias Empresariales, Plaza de la Merced nº 11, 21071 Huelva (España). maria.aceytuno@dege.uhu.es

públicas que llevan a cabo estrategias de promoción de la creación de spin-offs universitarias. Como resultado, se obtiene que las estrategias desarrolladas por las universidades andaluzas difieren de los modelos analizados en la literatura. Principalmente se observa la existencia de una nueva etapa en las estrategias de promoción de la creación de spin-offs, que se considera que constituye una fase pre-estratégica de las mismas. Del igual modo, se observan ciertos factores del entorno que se pueden asociar con los casos de spin-offs más exitosos. Así, se considera que las universidades deben valorar la disponibilidad de recursos de la que disponen antes de desarrollar una estrategia de incubación de empresas, especialmente la disponibilidad de un parque científico y tecnológico.

Palabras clave:

Spin-off universitaria, estrategia de promoción, universidad, empresa, transferencia de tecnología, relaciones universidad-empresa.

1. INTRODUCTION

University spin-offs have been widely acknowledged as a crucial way to transfer technology from universities into industry, while simultaneously changes in their institutional environment have boosted those ventures. These shifts have contributed towards the reinforcement of the concept of the entrepreneurial university. This underlines the major role played by universities in economic growth and employment creation. In this context, many universities have boosted spin-off companies not only as a way of taking advantage of technological knowledge created within the universities themselves, but also in order to contribute towards economic growth within their territory.

Researchers have addressed various aspects of university spin-off incubation. Pirnay et al. (2003) and Steffensen et al. (2000) differentiate between the typologies of spin-offs created in universities. Nicolau and Birley (2003a), O'Shea et al. (2008), and Pirnay et al. (2003) have focused on university spin-offs and defined them. Shane (2004), Rothaermel and Thursby (2005), O'Shea et al. (2007), among many other authors, have underlined these firms' contributions to territorial economic growth and employment and their relevance for policy makers today. The majority of studies on university spin-offs have addressed the factors boosting this type of firm (Nlemvo Ndonzuau et al. 2002, Vohora et al. 2004, Lockett et al. 2005, O'Shea et al. 2007, Rothaermel et al. 2007), and a large number of macroeconomic and microeconomic factors influencing university spin-offs have been identified.

Furthermore, several incubation models for the promotion of the creation of spin-offs by universities have been analysed (Clarysse et al. 2005, Mustar et al. 2006, Bergek and Norman 2008, Beraza and Rodríguez 2012). Nevertheless, not much is yet known about the effectiveness, suitability and success rate of these incubation strategies. As a consequence, in spite of the growth in the literature on university spin-offs, certain aspects remain controversial or unknown. Then, we consider that empirical analyses on a number of universities and contexts are necessary in order to accumulating insights into this phenomenon.

This paper explores the spin-off incubation strategies developed by the public universities in Andalusia, a region characterized by a relatively low-income level in southern Spain. The analysis of the case of Andalusia may provide results that could be useful to other relatively backward regions with similar characteristics since research on this topic has seldom focused on backward regions, but instead on developed economies.

The objective of this paper is to identify the characteristics of the university spin-off incubation strategies in Andalusia, and compare them to the models of incubation existing in the economic literature in order to determine their similarities and differences. Furthermore the work also evaluates the performance achieved by these firms. The main contribution of this paper is to show that academic spin-off incubation strategies in Andalusia present specific characteristics which are not covered by certain models of spin-off incubation that are well-known in the literature on innovation, and a new stage in the process of the academic spin-off incubation is proposed.

The paper is structured as follows. Following this introduction, the literature about the factors that influence incubation strategies of universities is reviewed in Section 2. Section 3 shows the design and results of empirical analysis. These results are discussed in Section 4. Finally, conclusions and implications are presented in Section 5.

2. UNIVERSITY SPIN-OFF INCUBATION STRATEGIES. THEORETICAL FRAMEWORK

In the literature on university spin-off incubation strategies there is a wide range of factors that could have influence on the creation and characteristics of those firms. According to these contributions, one of the most important factors is the incubation strategy developed by the university in order to promote the creation of university spin-offs. Following the literature, we assume that an incubation strategy is determined, at the university level, by three groups of elements (Figure 1):

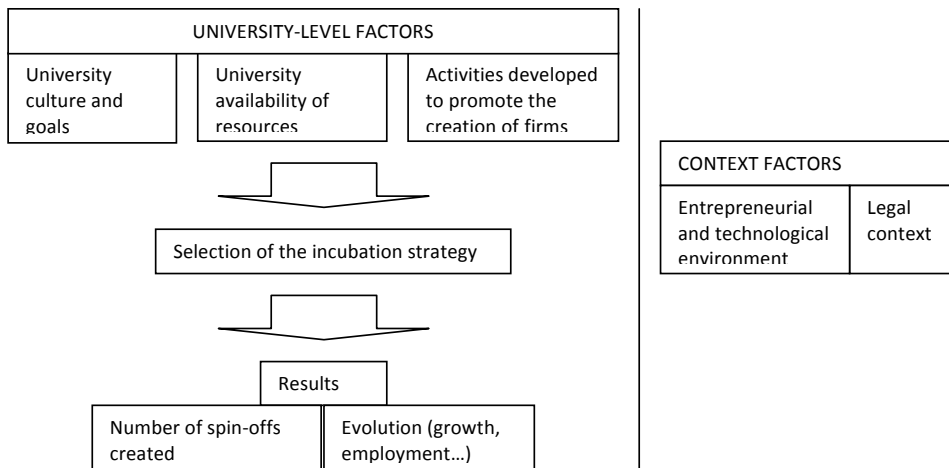
1. University culture and goals.
2. Availability of resources at the university
3. Activities developed by the university to promote the creation of spin-offs.

Furthermore, there are two factors of the context that have influenced the selection of the incubation strategy, but also over its results. These factors are:

1. Legal context.
2. Entrepreneurial and technological environment.

Figure 1

Factors influencing the incubation strategies of universities



Source: Author's own.

Table 1 summarises the single factors in every group that we have found after an extensive review of literature on spin-off incubation strategies developed by universities. These factors influence the design and development of the incubation strategy and, as a consequence, influence the spin-off generation and performance.

Table 1

Literature review of the factors influencing the incubation strategies of universities

			AUTHORS
University-level factors	University culture and goals	University goals and objectives	Roberts (1991); Kenney and Goe (2004); O'Shea et al. (2007 and 2008).
		University history and tradition	Kenney and Goe (2004); O'Shea et al. (2008).
		Culture	Nlemvo Ndonzuau et al. (2002); Kirby (2006); Stuart and Ding (2006); O'Gorman et al. (2008)
University resources available	Resources for research	Amount and nature of the research funds	Blumenthal et al. (1996); Lockett and Wright (2005); Powers and McDougall (2005).
		Nature of the research and technological resources	Shane (2004); O'Shea et al. (2005); Siegel and Phan (2006); Gilsing et al. (2010).
		Researcher quality and university prestige	Zucker et al. (1998); Di Gregorio and Shane (2003); Powers and McDougall (2005); Colombo et al. (2010); Gilsing et al. (2010).
	Instruments to support technology transfer	Technology Transfer Offices (TTO)	Parker and Zilberman (1993); Roberts and Malonet (1996); Debackere (2000); Colyvas et al. (2002); Siegel et al. (2003); Lockett and Wright (2005); O'Shea et al. (2005); Powers and McDougall (2005); Markman et al. (2006 and 2008); Jain and George (2007); Jain and George (2007); O'Shea et al. (2008); O'Gorman et al. (2008).
		Incubators	Steffensen et al. (2000); Rogers et al. (2001); Di Gregorio and Shane (2003); Clarysse et al. (2005); Rothaermel and Thursby (2005), Bergek and Norrman (2008).
		Venture capital	Florida and Kenney (1988); Sorenson and Stuart (2003); Di Gregorio and Shane (2003); Wright et al. (2004 and 2006); Powers and McDougall (2005).
	Activities to promote the creation of firms	Identification	Smilor et al. (1990); O'Shea et al., (2007).

		Project development	Nlemvo Ndonzuau et al., (2002); Lockett and Wright (2005); O'Shea et al. (2005); O'Gorman et al. (2008).
		Performance	Nlemvo Ndonzuau et al. (2002),
Context factors		Technological and entrepreneurial environment	Roberts (1991); Saxenian (1994); Feldman and Francis (2003); Gofard and Henrekson (2003); Jong (2006); O'Shea et al. (2007); Autio et al. (2009); Fini et al. (2009); Gilsing et al. (2010); Mustar and Wright (2010); Van Looy et al. (2011).
	Legislation	Policy orientation	Bozeman (2000); Etzkowitz (1998); Etzkowitz et al. (2000).
		Bayh-Dole Act	Dasgupta and David (1994); Henderson et al. (1998); Nelson (2001); Siegel et al. (2003); Shane (2004); Mowery and Sampat (2005); Sampat (2006); Fabrizio (2007); Thursby and Thursby (2011).

Source: Authors' own.

2.1. Factors influencing the incubation strategy of universities

A. University-level factors

University culture and goals

O'Shea et al. (2007) and Roberts (1991) analyze the explanatory factors of the success of the Massachusetts Institute of Technology (MIT) in spin-off generation. In O'Shea et al. (2008), three institutional factors are singled out as decisive for spin-off creation: the university mission, its tradition, and its culture. The goals pursued by the parent university must be consistent with the resources available. For example, O'Shea et al. find that there is agreement between the final goal of MIT, its objectives, and its activities. MIT's mission is to promote the advance of science and research. The commercialization of results is a key element to achieving this. Therefore, its policies and practices are clearly oriented towards technology commercialization and, more specifically, towards the creation of firms. Several authors also consider that this success is the result of the history and tradition of the university (O'Shea et al. 2007, Kenney and Goe 2004).

The influence of culture has especially attracted researchers (Kenney and Goe 2004, Kirby 2006, Stuart and Ding 2006, O'Gorman et al. 2008). For example, Nlemvo

Ndonzuau et al. (2002) emphasize the importance of the culture for the implementation of an “entrepreneurial paradigm” instead of the “scientific paradigm”, that is, to orientate the university towards the creation of university spin-offs.

Availability of resources for university incubation strategy

Resource availability is a key factor in the characterization of the spin-off incubation strategy since if resources are not consistent with incubation goals, then achieving these goals becomes difficult. Two separate groups of resources can be identified: 1) Research-related resources; 2) Instruments to support technology transfer. In regard to the former three groups of research-related resources can be identified:

1. Amount and nature of the research funds. Most empirical research shows that the availability of research funds in the university is crucial to generate spin-offs. Nevertheless, there is no agreement on the influence of the nature of the funds. Blumenthal et al. (1996) show that research financed by private funds is more easily commercialized, both by patent licences and the generation of spin-offs, than research that is publicly funded. Furthermore, Powers and McDougall (2005) find similar results when the influence of the nature of funding sources is analyzed. However, other studies emphasize the importance of public funds. Thus, Lockett and Wright (2005) find a positive relation between university R+D expenditure and the creation of spin-off firms which are also influenced by the expenditure on external intellectual protection.
2. Nature of research and technological resources. The nature of the research carried out at the university and the availability of technological resources influence the incubation strategy developed by a university. On one hand, the amount of funds designated each year for technological resources at the university determines its research orientation. In this sense, O’Shea et al. (2005) found that the availability of funds for research in life science and engineering has a positive influence on the number of spin-offs created by a university. On the other hand, the propensity to commercialize technologies varies considerably between the various scientific fields (Shane 2004, Siegel and Phan 2006, Gilsing et al. 2010).
3. Quality of research and university prestige. Zucker et al. (1998) analyze the creation of firms in the biotechnology sector in the United States and point out the important role played by “star scientists”, those most famous within a given research field, and the organization’s prestige. Some research also finds a positive relation between research quality and the creation of spin-offs (Colombo et al. 2010, Gilsing et al. 2010). Di Gregorio and Shane (2003) find that successful researchers are more likely to start firms to exploit their inventions with the objective of capturing the profits of their intellectual capital. These authors also find a positive relation between the university’s prestige and spin-off generation, and state that prestige strengthens the credibility of the entrepreneur when the commercial result of the spin-off is uncertain. Similar results are provided by research carried out by Powers and McDougall (2005). They and suggest that building and maintaining a base of faculty leaders in a specific research field is crucial for creating university spin-offs.

On the other hand, the spin-off incubation strategy developed by a university involves a set of supportive instruments whose availability determines the strategy performance. These instruments include laboratories, incubation facilities, assessment offices, technology transfer offices, venture capital, and any other infrastructure which promotes the creation of firms (Meyer 2003, Link and Scott 2005, Lockett and Wright 2005, Fini et al. 2009).

Among these, technology transfer offices (TTO) and incubators are considered to represent the most important supportive instruments. Roberts and Malonet (1996) point out several supportive functions developed by technology transfer offices and their importance for spin-offs' creation. Various studies analyze the typology of technology transfer offices and their effectiveness as transfer mechanisms (Parker and Zilberman 1993, Colyvas et al. 2002, Jain and George 2007, Markman et al. 2005). Although TTOs used to be considered crucial to create university spin-offs (Lockett and Wright 2005, O'Shea et al. 2005, O'Gorman et al. 2008, Markman et al. 2008), there is no agreement among authors about their effectiveness. Thus, several authors find out that researchers are often dissatisfied with the services received (Siegel et al. 2003) while others point out that their effectiveness depends on their experience, since TTOs with greater experience present better performance (Powers and McDougall 2005). Nevertheless, the role played by a TTO in the incubation strategy depends greatly on the social and institutional context of the university (Jain and George 2007). Debackere, for example, finds that the TTO of the University of Louvain, whose performance in spin-off creation is very positive, is surrounded by an entrepreneurial environment where both structures and processes facilitate the creation of firms (Debackere 2000).

On the other hand, company incubators have also been emphasized as relevant instruments for the spin-off incubation strategy (Rogers et al. 2001, Clarysse et al. 2005, Rothaermel and Thursby 2005), mostly during the launch of the firm (Steffensen et al. 2000). Bergek and Norrman (2008) underline the role played by incubators in cost reduction, management advice, and access to networks for the new firms. Other studies find that the involvement of the faculty should be strengthened to maximize the incubator performance since it could facilitate the transfer of tacit knowledge, which reduces the likelihood of failure (Rothaermel and Thursby 2005).

Finally, with respect to venture capital, Di Gregorio and Shane (2003) point out that this is more effective if it comes from outside the university, since university venture capital is merely a substitute when private venture capital fails to materialize. However, the availability of venture capital, regardless of whether it is provided by the university, seems to increase the number of new spin-offs created (Powers and McDougall 2005, Wright et al. 2004, Sorenson and Stuart 2003, Di Gregorio and Shane 2003). In addition, the importance of this instrument is increasing for complex and high-risk entrepreneurial projects, since these firms usually encounter difficulties in accessing traditional methods of financing (Florida and Kenney 1988). The barriers to spin-offs accessing venture capital (Wright et al. 2006) and the effect of geographic distance between venture capital and firms (Sorenson and Stuart 2003) both represent key aspects of venture capital that have also been analyzed in the literature.

Activities to promote university spin-offs

Despite the growth in research in recent years, very few studies on the way universities organize spin-off incubation exist, although certain researchers have pointed out several activities that the university or parent organization develop during the various stages of the spin-off process (Nlemvo Ndonzuau et al. 2002, Vohora et al. 2004). On the basis of these studies, four stages can be identified. The most important activity during the first stage is the assistance given to the entrepreneur in the identification of a technological opportunity and in its evaluation. During this stage, the entrepreneurial culture of the university plays a crucial role since it determines the support received for the new firm and the predisposition of the researchers to become involved in the new project (Smilor et al. 1990, O'Shea et al. 2008). During the second stage, that of project development, a business plan is designed. To this end, it is especially important to the intellectual protection of the technology to be transferred and the development of the business idea (Nlemvo Ndonzuau et al. 2002). In this stage, both the commercial development of the project and the formation of the founding team can require assistance from the parent organization, that is, from the university (Lockett and Wright 2005, O'Shea et al. 2005, O'Gorman et al. 2008). The third stage involves the launch of the academic spin-off. At this point the university can provide access to financial resources, intangible resources (expert advice, hiring of staff, access to company networks and venture capital, among others), and/or material resources (Leitch and Harrison 2005, Kinsella and McBrierty 1997). University support is especially relevant during this stage if the newly entrepreneurial researchers lack the competencies required when managing the firm (Roberts and Malonet 1996, Steffensen et al. 2000, O'Gorman et al. 2008). Finally, the performance of the fourth stage, which can be named "creation of economic value", depends on how relationships between spin-offs and the university have evolved during the previous stages. According to Nlemvo Ndonzuau et al. (2002), although spin-offs finally separate from the academic world, most of them maintain a relationship with their parent university, which could well help towards the better performance of the firm.

B. Context-level factors

Entrepreneurial and technological environment

A number of studies analyze the influence of environmental factors on academic spin-off creation and evolution (Louis et al. 1989, Henrekson and Rosenberg 2001, Feldman et al. 2002, Mlemvo Ndonzuau 2002, Di Gregorio and Shane 2003, Link and Scott 2005, Lockett and Wright 2005, O'Shea et al. 2005, Djokovic and Souitaris 2008, Martinelli et al. 2007, Markman et al. 2008). Several of these emphasize the economic, technological, and/or cultural environment in order to conclude that one or a number of these three factors, which are frequently closely related to each other, influence incubation strategy developed by universities, (Autio et al. 1996, Fini et al. 2009, Gilsing et al. 2010, Van Looy et al. 2011). For example, the high rate of company creation in MIT and Stanford University is related to their good economic and highly technological and entrepreneurial context. In this environment, a great number of entrepreneurs become examples for other entrepreneurs,

and also offer the possibility of creating networks, collaborating, and/or creating sectorial clusters (Roberts 1991, Saxenian 1994, Feldman and Francis 2003, Golfard and Henrekson 2003, Jong 2006, O'Shea et al. 2007).

Legal context

Other work emphasizes the legislative environment, and highlights the significance of legislative changes in fostering an innovative and entrepreneurial culture. Some of these legislative changes have brought about the establishment of the Triple Helix model in university-industry-government relations (Etzkowitz 1998, Etzkowitz et al. 2000, Bozeman 2000). From this point of view, the Bayh-Dole Act, in the United States, was of great interest and gave rise to numerous controversial studies (Nelson 2001, Henderson et al. 1998, Dasgupta and David 1994, Siegel et al. 2003, Mowery and Sampat 2005, Fabrizio 2007, Shane 2004, Sampat 2006, Thursby and Thursby 2011). Here, innovation policy plays a major role. Mustar and Wright (2010) compare the policies developed for the promotion of the creation of university spin-offs in France and the United Kingdom, finding an absence of any convergence of the two national policies. They suggest that these differences can be the result of the dependence of the spin-offs upon the policies paths.

2.2. Incubation strategies to promote the creation of university spin-offs

The aforementioned factors constitute a general framework for the analysis of spin-off incubation strategies developed by universities. The majority of these strategies have been taken into account by authors who have striven to classify incubation strategies (Clarysse et al. 2005, Davenport et al. 2002, Degroof and Roberts 2004, Beraza and Rodríguez 2012). From among these typologies, that developed by Clarysse et al. constitutes a reference for our empirical analysis.

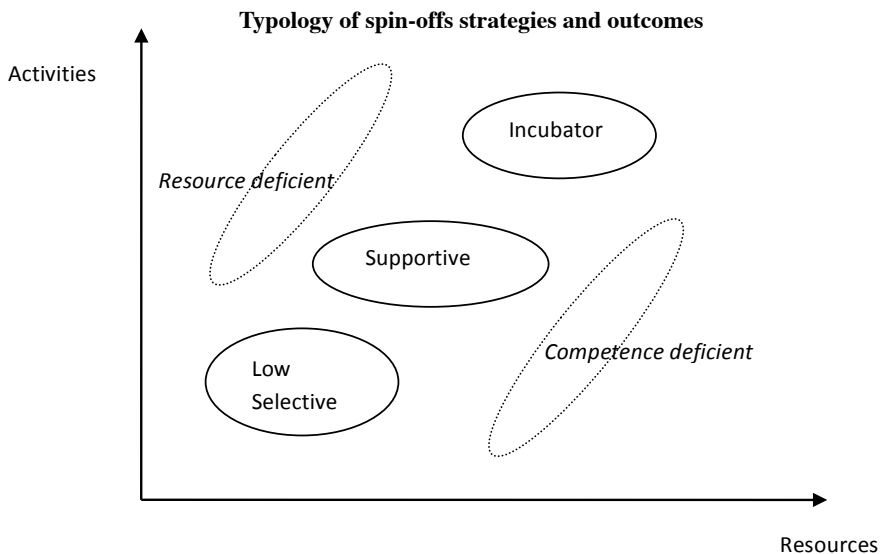
Clarysse et al. (2005) identify three different models within the incubation strategies for the promotion of the creation of university spin-offs (Figure 2). First is the Low Selective model. The University of Twente (The Netherlands) and Crealys (France) provide good examples of this model. The most important goals in this strategy are to maximize the number of university spin-offs created, their profitability being a secondary objective. According to Clarysse et al. (2005), although this model generates a great number of firms and jobs, in most cases these firms are not growth-oriented but survival-oriented. The Supportive Model is the second model identified and a good example of this is the Catholic University of Louvain. Within this model, spin-off creation is considered to be an alternative to patent licensing in the commercialization of research results. Thus, the technology transfer office (TTO) analyzes the opportunity's characteristics and decides if its commercialization fits better with the creation of a patent licence or a firm. If they decide to promote the creation of an academic spin-off, this has to meet some requirements, such as a minimum expected benefit. As a consequence, the number of firms created in this model is lower than in the Low Selective model. On the other hand, resource availability is higher in this model and the TTO is not only involved in the company's creation, but also in the following stages of company development (Clarysse et al. 2005). The Incubator is

the third model. The IMEC (InterUniversity Institute for Microelectronics, in Lovain), TTP (The Technology Partnership, in Cambridge, United Kingdom) and Scientific Generis (also in Cambridge) provide good examples of this model. The principal goal of this model is to identify entrepreneurial opportunities to be exploited by the creation of spin-offs, which are expected to have explosive growth in the future and to become leaders in their field. Selection criteria are significantly more demanding in this model and, as a consequence, the number of spin-offs created is considerably lower than in previous models; however these firms are both market- and growth-oriented (Clarysse et al. 2005).

Along with these three models, Clarysse et al. identify two suboptimal situations, where the strategies fail to perform as expected: 1) resource deficiency, when strategy goals do not match the availability of resources since goals become too ambitious when faced with scarce resources; 2) Competence deficiency, when resources match goals but the parent organization has not developed the capabilities needed to perform the incubation activities due to a lack of knowledge or experience on the part of the staff.

The three incubation models are graphically represented in Figure 2. The level and complexity of activities are presented along the vertical axis, while the level and heterogeneity of resources are shown along the horizontal axis. The figure shows the combination of resources and activities in each incubation model. The two sub-optimal situations are also represented in the figure, showing how an unmatched combination of activities and resources may give place to a non-successful strategy.

Figure 2



Source: Clarysse et al. (2005).

3. EMPIRICAL ANALYSIS

3. 1. Objective

This empirical analysis focuses on the analysis of spin-off incubation strategies carried out by public universities in Andalusia, a relatively backward economic region in southern Spain. Our objective is analysing the incubation strategies carried out by Andalusian universities in the light of the incubation models developed in the literature, identifying its similarities and differences.

The case of Andalusia constitutes an interesting example for analysis since, in recent years, the regional government has promoted the creation of university spin-offs as a way of boosting innovation and economic development in the territory. The first university spin-off in Andalusia was created by the University of Córdoba in 1995 and until 2004 the number of firms created remained low. But since then that number has increased rapidly; from 2006 more than 160 spin-offs have been promoted by universities. In that period, Andalusia was the most prolific region in Spain with respect to the number of spin-offs created (RedOtri 2007).

One reason that explains this growth is the promotion policy implemented by the regional government, the Junta de Andalucía, in 2003, the Campus Program being a key instrument³. Therefore, over recent years an increasing amount of funds has been invested in the creation of university spin-offs. Nevertheless, very little is known about the effectiveness, suitability and rate of success of these activities.

Data in Table 2 show some economic characteristics of Andalusia, which is the most populated and extensive region of the country. It is characterized as a less-developed region in Europe since its per capita income is around 80% of the European standard (Table 1). The productive structure of Andalusia is characterized by a low proportion of manufacturers (10.5%) in the Gross Domestic Product and by an agricultural share (4.7%) nearly twice that of the mean in the whole Spanish economy (2.7%). In contrast, the importance of R&D expenditure (1.1% of GDP, 199€ per inhabitant) is lower than in the rest of Spain and very far from Europe. Moreover, it can be seen that the unemployment rate in Andalusia is one of the highest in Spain and Europe, while the activity rate is low when compared to the rest of Europe. Finally, a high presence of small and micro enterprises in the entrepreneurial structure can also be observed.

³ This program is financed by European funds (FEDER funds) and developed by universities together with IDEA, a public regional agency which depends on the regional government (Junta de Andalucía). The Campus Program includes both professional advice and financial assistance for entrepreneurs.

Table 2

Main indicators of the Andalusian economy

INDICATORS	Andalusia	Spain	EU-27
GDP per inhabitant at current prices	18,300	24,400	25,600
GDP per inhabitant as a percentage of EU-27 mean (PPS)	80	96	100
Participation of sectors in formation of GDP (percentage)			
Agriculture-Fishing	4.7	2.7	1.7
Industry (except. Construction)	10.5	15.9	18.7
Construction	11.2	10.2	6.0
Services	73.6	71.2	73.6
R&D			
R&D expenditure (as percentage of GDP)	1.1	1.3	2.08
R&D expenditure (euro per inhabitant)	199.7	303.9	516.2
Labour market indicators			
Activity rate	69.92	73.36	71.01
Unemployment rate	34.6	26.7	11.9
Firm structure			
Percentage of firms with fewer than 10 workers	95.62	95.04	91.8

Source: Author's own.

Note: All data refers to 2012, except GDP and percentage of GDP by sectors, which refer to 2010 and R&D expenditure (euro per inhabitant) which refers to 2011. Sources: INE (Spanish National Statistics Bureau) Eurostat.

3.2. Data and methodology

To analyze the incubation strategies developed by the nine public universities in Andalusia⁴ we use both primary and secondary sources of information. Our primary source was a questionnaire, which was directed to the person in charge of each TTO (Technology Transfer Office), that is, the personnel who manage the spin-off incubation strategies in each university. The questionnaire was filled out by means of two personal interviews pre-scheduled by phone. The objective of survey was to determine the characteristics of the spin-off incubation strategies developed by the Andalusian universities and obtaining information about the performance of the spin-offs created. The survey was carried out in 2011. A pilot questionnaire was first repeatedly tested in order to identify possible mistakes

⁴ In Andalusia there are ten public universities and a few private universities but the presence of university spin-offs in private universities and in the public Universidad Internacional de Andalucía is very limited and no strategy is implemented to promote spin-offs. Therefore, none of these universities are included in this analysis.

or misunderstandings. The secondary sources of information were databases from universities, statistics offices (Eurostat and INE) and studies published by Andalusian institutions.

All the factors analysed and their ranges are shown in Table 3. We also indicate its relations with the elements of the theoretical framework (Figure 1) in brackets. For qualitative factors, a Likert scale between 0 and 4 has been applied, except for the dichotomous factors. In certain complex factors the range depends on the number of factors involved and their components and ranges are explained in the table.

Table 3

Factors

<i>Factor</i>	<i>Brief explanation</i>	<i>Range</i>
<i>Number of university spin-offs 1994-2010*</i> (RESULTS)	Number of university spin-offs created during 1994-2010 in each university	1-60
<i>Ratio spin-offs/researchers*</i> (RESULTS)	Number of spin-offs created by the university divided by the number of researchers in 2009.	0.21-5.21
<i>Entrepreneurial culture (UNIVERSITY CULTURE AND GOALS)</i>	Sum of the values given by the respondent (from 0 to 4) to the following questions relating to researchers Need to validate research results in the market. Attractiveness of business. Legitimacy of business earnings. Business orientation. Profit-seeking orientation. Entrepreneurial capacity. Degree of recognition received from the university if involved in technology transfer. Degree of recognition received from the university if involved in university spin-off creation.	0-32
<i>Use of instruments to promote the entrepreneurial culture (UNIVERSITY CULTURE AND GOALS)</i>	Sum of the values given by the respondent (from 0 to 4) to the following questions relating to the university: Information campaigns to promote company creation. Competition or awards for the entrepreneurial ideas. Seminars and courses on the formation of firms. Distribution of information on entrepreneurial opportunities.	0-16

<i>Participation TTO/researcher in opportunity management (ACTIVITIES)</i>	Ratio: involvement of the TTO / the researcher in identifying and managing the entrepreneurial opportunity.	0-100
<i>Number of criteria used in the selection of a project (ACTIVITIES)</i>	Number of criteria used in deciding which projects are going to be promoted by the university.	0-8
<i>Percentage of projects selected (ACTIVITIES)</i>	% of projects selected with respect to those presented.	0-100
<i>Degree of development of projects selected* (ACTIVITIES)</i>	It is labelled as 4 (high), 3 (medium), 2 (low) or 1 (very low)	1-4
<i>Percentage of projects with technological base (ACTIVITIES)</i>	From all the projects promoted.	0-100
<i>Does the TTO buy licences to complete the technological base of the spin-off?* (ACTIVITIES)</i>	yes or no (1-0).	0-1
<i>Is the TTO involved in the different stages of development of the spin-off? (ACTIVITIES)</i>	yes or no (1-0).	0-1
<i>Private/public funds in spin-off* (ACTIVITIES)</i>	Financing could be mostly public, totally private or mixed.	
<i>Availability of human resources* (RESOURCES)</i>	Number of full-time personnel of the TTO in relation to the university size, measured by the number of researchers in each university in 2009.	0.04-0.69
<i>Availability of organizational resources* (RESOURCES)</i>	Sum of the values given by the respondent (from 0 to 4) to the questions about the degree of involvement of the university in Financing/Objectives/Strategy design.	0-12
<i>Availability of technological resources (RESOURCES)</i>	Sum of the values given by the respondent (from 0 to 4) to the questions about the availability of resources regarding Computers/Laboratories/Specialized machines/Equipment to develop technology.	0-12
<i>Availability of physical resources (RESOURCES)</i>	The availability of incubators or any other place to locate firms on campus. yes or no (1-0).	0-1
<i>Private/public funding in strategy financing (RESOURCES)</i>	Financing could be mostly public, totally private or mixed.	Public Private Mixed
<i>Access to networks (CONTEXT)</i>	The existence of links between the incubation strategy and the entrepreneurial environment. yes or no (1-0).	0-1

<i>Existence of a definition of the strategy goal (ACTIVITIES)</i>	yes or no (1-0).	0-1
<i>Motivation behind the selection of the strategy (ACTIVITIES)</i>	<p>The survey covers four possible motivations:</p> <p>The university has analyzed its environment and has designed a fitting strategy (Environment).</p> <p>Availability of resources (Resources).</p> <p>Decision made by university and/or government (Decisions).</p> <p>Another motivation (Other).</p>	<p>Environment</p> <p>Resources</p> <p>Decisions</p> <p>Other</p>
<i>USO Exploiting new knowledge (RESULTS)</i>	Percentage of university spin-offs that are exploiting genuinely new knowledge which is not available on the market.	0-100
<i>Collaboration with University (RESULTS)</i>	Percentage of firms that are developing any kind of collaboration with a university, such as joint research, knowledge transfer, and commercial relations.	0-100
<i>Returns (RESULTS)</i>	Percentage of firms that are generating or are going to generate returns for the university, whether in terms of dividends, royalties or patent licensees.	0-100
<i>%USO with high growth (RESULTS)</i>	Percentage of firms that have grown notably and are generating jobs	0-100
<i>%USO without growth</i>	Percentage of firms that are not growing	0-100
<i>%USO disappeared</i>	Percentage of firms that have disappeared or remain inactive	0-100

(*) Variables that present a statistical significance.

Source: Author's own.

The analysis first addressed the identification of homogenous groups covering the various universities according to the characteristics of incubation models stated in the literature on innovation. The results of this classification were then confirmed by means of a K-means cluster analysis. Given the limited number of cases, just nine universities, the application of the cluster analysis *a posteriori* proves highly effective since if the previously obtained results are confirmed, then they are reinforced. Once different groups of universities have been identified and confirmed by the cluster analysis, a measure of the association between each respective cluster and its specific characteristic has been calculated. The Chi-Square Test of Independence has been applied to nominal variables (Appendix, Table 1) and an ANOVA is used to ascertain whether there are statistical significance differences between the clusters when quantitative variables are analyzed (Appendix, Tables 2 and 3).

Secondly, the analysis focuses on the variables about the performance of spin-offs created by Andalusian universities. The study use the Anova analysis in order to test if there statistically significant association between the performance variables and the previously identified clusters (Appendix, Table 4).

3.3. Analysis

A. Characteristics of the incubation strategies developed in Andalusia

Four groups of universities have been identified in accordance with value that show the characteristics of the incubation strategy (Table 3) developed by each university as is confirmed by means of a cluster analysis. The variables that present a statistical significance in the ANOVA analysis are indicated in Table 3. These variables are used in the characterization of the clusters, and those variables that no present a statistical significance are useful to identify the common characteristics of the incubation strategies developed by Andalusian universities.

- Group 1. Solely features the University of Malaga, since this institution develops a clearly different incubation strategy compared to the rest of the universities: a) The ratio of the number of spin-offs to the number of researchers is the highest; b) The availability of resources is significantly higher than the others, especially in human and physical resources; c) It is the only university which has clearly defined the goals to be attained by promoting the creation of university spin-offs; d) It shows the lowest rate of projects selected and the highest rate of technological projects; e) Its TTO occasionally bought patent licenses to complete the technological base of the projects selected; f) It is one of the universities involved in all the stages of the spin-off development; g) The availability of technological resources is the second in importance; h) The participation of private funding is the lowest ; i) The number of university spin-offs created is the highest in Andalusia, 60 firms.
- Group 2. This includes the universities of Almería, Cádiz, Córdoba, and Sevilla. These universities share the following characteristics, which all differ from the remaining cases: a) Both the ratio of spin-offs to researchers and the availability of resources show intermediate values; b) The development of projects selected is high with respect to other groups; c) The number of spin-offs created (between 15 and 19) can also be considered intermediate when compared to the remaining cases.
- Group 3. The universities of Jaén, Huelva, and Pablo de Olavide feature in this group since they share the following characteristics: a) The ratio of spinoffs to researchers has the lowest values; b) The availability of resources is low especially for human, technological, and physical resources; c) The rate of projects selected is high and most have no technological base; d) A very low number of spin-offs created, between 1 and 5.
- Group 4. This features only the University of Granada, which ratio of spin-offs to researchers has an intermediate value, similar to the cases included in Group 2 and creates a high number of spin-offs, 31. Also the participation rate of the TTO in the management of opportunity is one of the highest and buys licences. It is different to other strategies since its TTO is involved in the whole spin-off development process,

both private and public funding are equally important in spin-off financing and the availability of technological resources is the highest.

In spite of these differences, it is also possible to find some common characteristics between the incubation strategies developed by the public universities in Andalusia:

- Except for the case of Malaga, universities do not clearly define the objectives to be attained by means of the creation of university spin-offs.
- Resources tend to be scarce, although there are major variations between universities. Moreover, in most cases, the results show deficiencies in human resources, training, and/or capacity.
- The management of the opportunity is largely the responsibility of the researcher-entrepreneur. Therefore, the involvement of the TTO is reduced except for the case of the University Pablo de Olavide which obtains 66.6%.
- The percentage of projects selected is high in all these cases. The lowest percentage corresponds to Málaga (50%).
- The development of technology in selected projects is medium or low.

B. Performance of spin-offs created by Andalusian universities

Table 4 shows data on the performance of firms created by Andalusian universities according to the classification in Table 3. Although this data is too sparse to carry out an in-depth analysis on how the spin-off incubation strategies developed by universities contribute to Andalusia development, it could still be used to approximate the impact of these firms on the economy.

Results show that, according to the Anova analysis, there is no statistically significant association between the performance variables and the previously identified clusters. The majority of spin-offs seem to be innovative, since they are exploiting new knowledge in markets although certain universities, such as Córdoba and Sevilla, show a low level of innovative activity. Furthermore, except in Almeria and Pablo de Olavide, a high percentage of spin-offs created offer services that were previously offered by the university, via a contract with firms in the market. That is, the spin-offs have been started up by researchers to exploit opportunities which had previously been identified and exploited within the university.

About the results of the spin-offs created, results show that the percentage of spin-offs which create returns for the university is low or even zero in three universities. Nevertheless, the percentage of spin-offs created with high growth, which is measured through employment, varies greatly between universities, from 6.89% in Almeria to 100% in Pablo de Olavide. The percentage of spin-offs with no growth is high in most universities. Furthermore, it may be interesting to bear in mind that universities which created the highest number of firms, such as those of Málaga and Granada, also present a considerable rate firm growth.

Table 4

Post-entry performance of the university spin-offs created in Andalusian universities

PERFORMANCE INDEX	Cluster 1	Cluster 2				Cluster 3			Cluster 4
	MALAGA	ALMERIA	CADIZ	CORDOBA	SEVILLA	JAEN	HUELVA	PABLO DE OLAVIDE	GRANADA
%Firm exploiting new knowledge	70	80	70	20	33	50	80	100	80
% Firms collaborating with University	60	0	80	80	80	50	100	33	100
% Firms with positive returns	0	0	-	25	75	-	80	66	-
%Firms with high growth	31.03	6.89	10	22.22	20	16.67	42.85	100	23.46
%Firms with no growth	60.34	75.87	90	66.67	50	83.33	57.15	0	76.54
%Firms disappeared	8.63	17.24	0	11.11	30	0	0	0	0

Note: (-) no data available.

Source: Author's own.

4. DISCUSSION

Three interesting issues arise from this empirical analysis:

- 1) What are the similarities between the Andalusian incubation strategies and other strategies characterized in the literature on innovation?
- 2) Are there specific features in the the strategies of incubation of spin offs carried out by the Andalusian universities? And if so, how might the experience of Andalusia contribute towards enlarging knowledge concerning the role of universities in the promotion of university spin-offs?
- 3) What is the performance of the spin-offs created by Andalusian universities and what impact do they have on the economy?

In order to answer the first question, the Andalusian typology is compared to a typology which is well-known in the literature on spin-off strategies of incubation; that of Clarysse et al. (2005) typology.

Results are summarized in Table 5. Each characteristic is labelled if it matches any of the models identified by Clarysse – that is, the Low Selective Model (LS), the Supportive

Model (SM), the Incubator Model (IM) or a sub-optimal situation (SO). When the characteristic fails to fit all the models, then the cell remains blank.

Table 5

Comparison to the Clarysse et al. typology

	Cluster 1	Cluster 2				Cluster 3			Cluster 4
	MALAGA	ALMERIA	CADIZ	CORDOBA	SEVILLA	HUELVA	JAEN	OLAVIDE	GRANADA
Ratio of spin-offs to 100 researchers	LS	LS	SO	SO	SO	SO	SO	SO	SO
Entrepreneurial culture		LS			LS	LS			
Instruments to promote entrepreneurial culture	LS	LS	LS	LS			LS	LS	
Opportunity managed by TTO/researcher	LS	LS	LS	LS	LS	LS	LS	SM	LS
Selection criteria	LS	LS	LS	LS	LS	LS	LS	LS	LS
% selected projects	SM	LS	LS	LS	LS	LS	LS	LS	LS
Development of projects selected							LS		
%projects with technological base	SM	LS	SM	LS	LS	LS	LS	LS	LS
Licences to complete technological base	SM	LS	LS	LS	LS	LS	LS	LS	SM
Involvement of TTO in different stages	SM	LS	LS	SM	LS	LS	LS	LS	SM
Private/public funds in spin-off financing	LS	LS	LS	LS	LS	LS	LS	LS	LS
Human resources	SO-LS	SO	SO	SO	SO	SO	SO	SO	SO-LS
Organizational resources	LS	LS	LS	LS	SM	SO	LS	LS	LS
Technological resources	SO-LS	SO	SO	LS	SO	SO	SO	SO	LS
Physical resources	LS	LS	SO	SO	LS	SO	SO	SO	SO
Private/public funds in TTO	SM	LS	LS	LS	SM	LS	LS	LS	LS

Access to networks					LS				LS
Definition of strategy goals	LS	SO	SO	SO	SO	SO	SO	SO	SO

Note: SO: Sub-optimal situation; LS: Low Selective model; SM: Supportive model; When the cell is blank, it is not possible to match the data with any of the incubation strategies.

Source: Author's own.

The University of Malaga (Group 1) develops the strategy which has more features of the strategy that Clarysse named “supportive model”. Perhaps it is interesting to underline that this university collaborates with a Science and Technology Park located very close to the Faculties (Parque Tecnológico de Andalusia) and specialized in information and communication technologies. The existence of many spin-offs created in the University of Malaga in the ICT sector suggests that those infrastructures can be positively influencing the creation of technological firms.

On the other hand, the cluster composed of the universities of Almeria, Cádiz, Córdoba, and Sevilla (Group 2) seems to develop a “low selective model” due to the ratio of the number of spin-offs to the number of researchers, and the availability of resources. Nevertheless, the strategy of the University of Sevilla could also be considered as “competent-deficient” since the ratio spin-offs/researchers is lower than would be expected, given its availability of resources. Group 3, composed of the universities of Jaén, Huelva, and Pablo de Olavide seems to develop a “resource-deficient” strategy with characteristics from the “low selective model” while, due to the low value of the ratio of spin-offs to the number of researchers, it is also “competence-deficient” according to Clarysse et al. (2005) terminology. Finally, the University of Granada (Group 4) shows some characteristics from the “supportive model”, but, according to the typology provided by Clarysse et al. (2005), the availability of physical resources, (the availability of firm incubators, for example), is insufficient to classify the University of Granada as pertaining to that model. The characteristics appear to show that Granada is developing that which Clarysse et al. (2005) named a “model in transition”.

Therefore, the analysis suggests that the “low selective model” dominates in the universities of Andalusia although it simultaneously shows major deficiencies in their incubation strategies. In the majority of cases, there is no definition of the objectives, and a scarcity of resources, which are considered to be a symptom of deficiency in the strategy – either in resources or in competences. These deficiencies are characteristics of sub-optimal situations. The results also show that the features of incubation strategies in several universities are characteristic of more than one model.

With respect to the second question, an interesting observed fact is that in certain universities the strategy is, according to the terminology by Clarysse *et al.* (2005), both resource-deficient and competence-deficient. This is difficult to place in the Cartesian axes where Clarysse et al. (2005) illustrate and explain their typology (Figure 2). In their model, an unsuccessful strategy is “resource-deficient” or “competence-deficient”, but cannot be both at the same time. We have therefore found an incubation model which could perhaps be considered as a pre-strategic stage to the academic spin-off incubation strategies.

With respect to the third question, unfortunately, our data just allows us to develop a first approximation to the performance of spin-offs and their impact on the economy. A first observation is that the ANOVA shows no statistically significant association between the performance of spin-offs and the strategy developed by universities. One possible explanation is that performance of firms depends on entrepreneurship, which is not included in the analysis. For example, most of the analysed spin-offs exploit an opportunity which was being previously exploited via research contracts. In these cases, the motivation for starting a new firm remains unclear. Then, entrepreneurial motivation could be crucial in this study (Hebert and Link 1989, Wennekers and Thurik 1999).

With respect to the impact of spin-offs created on the economy, our results show that the percentage of high-growing spin-offs is notable in Málaga and Granada. Therefore, they make the greatest contribution to economic development, at least in terms of firms and employment. These two universities have the highest level of resources, especially in human and technological resources.

5. CONCLUSIONS, IMPLICATIONS AND LIMITATIONS

Several conclusions can be drawn from this analysis. Firstly, the results show that the features of incubation strategies in several Andalusian universities are characteristic of more than one model although they are mostly characterized by a lack of resources and competences. This may be due to the relative novelty of these strategies. Nevertheless the “low selective model” is predominant among the incubation strategies developed in Andalusia. This can be also explained by the recent and rapid diffusion of the strategies, since “low selective” is the strategy with lowest resource requirements.

Results also indicate that in certain Andalusian universities the strategy is both resource-deficient and competence-deficient at the same time. This situation is not possible to place within the typology provided by Clarysse et al. (2005). This new typology could be known as the pre-strategic stage of academic spin-off incubation strategies. In our opinion this incubation model could be related to the lower level of income in Andalusia, since most of the empirical studies in the literature focus on universities located in regions of Europe that are more developed than Andalusia. As a consequence, this case could provide interesting findings for other backward European regions.

Secondly, our data shows a relation between the number of spin-offs created and both the presence of a Science and Technology Park and the availability of resources. These are the cases of the Universities of Málaga and Granada. These universities also seem to make the greatest contribution to the economy in terms of firms created and employment. One implication of these results could be that, previous to making any decision involving investment into developing incubation strategies, universities should gauge whether they have sufficient resources and the possibilities of connecting with a Technology Park. Otherwise, patent licences and research contracts could be a good alternative for knowledge transfer.

Thirdly, performance variables, except the number of spin-offs created, present no significant statistical association to the clusters indentified in the empirical analysis. In our opinion this could be due to the omission of the entrepreneurship factor in the analysis.

Finally, this work has certain limitations. The questionnaires were each answered by only one person, which inadvertently incorporates certain subjectivity. We have tried to correct this by introducing objective data from secondary sources of information. Nevertheless, further data should be gathered in order to develop an in-depth analysis of the performance of academic spin-offs and their impact in economic development of the region.

6. REFERENCES

- Autio E., Hameri A.P. and Nordberg, M., 1996. A Framework of Motivations for Industry-Big Science Collaboration: A Case Study. *Journal of Engineering and Technology Management*, 13, 301-314.
- Beraza J.A. and Rodríguez A., 2012. Tipologías de programas de apoyo a la creación de *spin-offs* en las universidades: Reino Unido y España. *TELOS Revista de Estudios Interdisciplinarios en Ciencias Sociales*, 14(1), 31-55.
- Bergek A. and Norrman C., 2008. Incubator Best Practice: A Framework. *Technovation*, 28, 20-28.
- Blumenthal D., Campbell E.G., Causino N. and Louis K., 1996. Participation of Life Science Faculty in Research Relationships with Industry. *The New England Journal of Medicine*, 335(23), 1734-1740.
- Bozeman, B., 2000. Technology Transfer and Public Policy: A Review of Research and Theory. *Research Policy*, 29, 627-655.
- Carayannis E.G., Rogers E.M., Kurihara K. and Allbritton M.M., 1998. High Technology Spin-offs from Government R&D Laboratories and Research Universities. *Technovation*, 18 (1), 1-11.
- Clarysse B., Wright M., Lockett A., Van de Velde E. and Vohora A., 2005. Spinning-out New Ventures: A Typology of Incubation Strategies from European Research Institutions. *Journal of Business Venturing*, 20, 183-216.
- Colombo M.G., D'Adda D. and Piva E., 2010. The Contribution of University Research to the Growth of Academic Start-ups: An Empirical Analysis. *Journal of Technology Transfer*, 35, 113-140.
- Colyvas J., Crow M., Gelijns A., Mazzoleni R., Nelson R.R., Rosenberg N. and Sampat B.N., 2002. How Do University Inventions Get into Practice? *Management Science*, 48 (1), 61-72.
- Dasgupta P. and David P.A., 1994. Toward a New Economic of Science. *Research Policy*, 23, 487-521.
- Davenport S., Carr A. and Bibby D., 2002. Leveraging Talent: Spin-off Strategy at Industrial Research. *R&D Management*, 32(3), 241-254.
- Debackere, K., 2000. Managing Academic R&D Business at K.U. Leuven: Context, Structure and Process. *R&D Management*, 30(4), 323-328.
- Deegroof J.-J. and Roberts E.B., 2004. Overcoming Weak Entrepreneurial Infrastructure for Academic Spin-off Ventures. *Journal of Technology Transfer*, 29, 327-352.
- Di Gregorio D. and Shane S., 2003. Why do Some Universities Generate More Start-ups than Others? *Research Policy*, 32, 209-227.

- Djokovic D. and Souitaris V., 2008. Spinouts from Academic Institutions: A Literature Review with Suggestions for Further Research. *Journal of Technology Transfer*, 33(3), 225-247.
- Etzkowitz, H., 1998. The Norms of Entrepreneurial Science: Cognitive Effects of the New University-Industry Linkages. *Research Policy*, 27, 823-833.
- Etzkowitz H., Webster A., Gebhardt C., Cantisano T. and Branca R., 2000. The Future of the University and the University of the Future: Evolution of the Ivory Tower to Entrepreneurial Paradigm. *Research Policy*, 29, 313-330.
- Fabrizio, K.R., 2007. University Patenting and the Pace of Industrial Innovation. *Industrial and Corporate Change*, 16(4), 505-534.
- Feldman M.P. and Francis J.L., 2003. Fortune Favours the Prepared region: The Case of Entrepreneurship and the Capitol Region Biotechnology Cluster. *European Planning Studies*, 11(7), 765-788.
- Feldman M.P., Feller I., Bercowitz J. and Burton R., 2002. Equity and the Technology Transfer Strategies of American Research Universities. *Management Science*, 48(1), 90-104.
- Fini R., Grimaldi R. and Sobrero M., 2009. Factors Fostering Academics to Start up New Ventures: An Assessment of Italian Founders' incentives. *Journal of Technology Transfer*, 34(4), 380-402.
- Florida R.R. and Kenney M., 1988. Venture Capital-Financed Innovation and Technological Change in the USA. *Research Policy*, 17, 119-137.
- Gilsing V.A., Burg E. and van Romme A.G.L., 2010. Policy Principles for the Creation and Success of Corporate and University spin-offs. *Technovation*, 30(1), 12-23.
- Goldfarb B. and Henrekson M., 2003. Bottom-up versus Top-down Policies towards the Commercialization of University Intellectual Property. *Research Policy*, 32, 639-658.
- Hébert R.F. and Link A.N., 1989. In search of the meaning of entrepreneurship, *Small Business Economics*, 1, 39-49.
- Henderson R., Jaffe A.B. and Trajtenberg M., 1998. Universities as a Source of Commercial Technology: A Detailed Analysis of University Patenting, 1965-1988. *The Review of Economics and Statistics*, 80(1), 119-127.
- Henrekson B. and Rosenberg N., 2000. Incentives for Academic Entrepreneurship and Economic Performance: Sweden and the United States. *The Journal of Technology Transfer*, 26(3), 207-231.
- Jain S. and George G., 2007. Technology Transfer Offices as Institutional Entrepreneurs: The Case of Wisconsin Alumni Research Foundation and Human Embryonic Stem Cells. *Industrial and Corporate Change*, 16(4), 535-567.
- Jong, S., 2006. How Organizational Structures in Science Shape Spin-off Firms: The Biochemistry Departments of Berkeley, Stanford, and UCSF and the Birth of the Biotech Industry. *Industrial and Corporate Change*, 15(2), 251-283.
- Kenney M. and Goe W. R., 2004. The Role of Social Embeddedness in Professorial Entrepreneurship: A Comparison of Electrical Engineering and Computer Science at UC Berkeley and Stanford. *Research Policy*, 33(5), 691-707.
- Kinsella R. and McBrierty V., 1997. Campus Companies and the Emerging Techno-Academic Paradigm: The Irish Experience. *Technovation*, 17(5), 245-251.

- Kirby, D.A., 2006. Creating Entrepreneurial Universities in the UK: Applying Entrepreneurship Theory to Practice. *Journal of Technology Transfer*, 31, 599-603.
- Leitch C.M. and Harrison R.T., 2005. Maximising the Potential of University Spin-outs: The Development of Second-order Commercialisation Activities. *R&D Management*, 35(3), 257-272.
- Link A.N. and Scott J.T., 2005. Opening the Ivory's Tower Door: An Analysis of the Determinants of the Formation of US University Spin-off Companies. *Research Policy*, 34, 1106-1112.
- Lockett A. and Wright M., 2005. Resources, Capabilities, Risk Capital and the Creation of University Spin-out Companies. *Research Policy*, 34, 1043-1057.
- Lockett A., Siegel D., Wright M. and Ensley M.D., 2005. The Creation of Spin-off Firms at Public Research Institutions: Managerial and Policy Implications. *Research Policy*, 34, 981-993.
- Markman G.D., Phan P.H., Balkin D.D. and Gianiodis P.T., 2005. Entrepreneurship and University-Based Technology Transfer. *Journal of Business Venturing*, 20, 241-263.
- Markman G.D., Gianiodis P.T. and Phan P.H., 2008. Full-Time Faculty or Part-Time Entrepreneurs. *IEEE Transactions on Engineering Management*, 55(1), 29-36.
- Martinelli A., Meyer M. and Von Tunzelman N., 2008. Becoming an Entrepreneurial University? A Case Study of Knowledge Exchange Relationships and Faculty Attitudes in a Medium-sized, Research-oriented University. *Journal of Technology Transfer*, 33(3), 259-283.
- Meyer, M., 2003. Academic Entrepreneurs or Entrepreneurial Academics? Research-based Ventures and Public Support Mechanisms. *R&D Management*, 33(2), 107-115.
- Mowery D.C. and Sampat B.N., 2005. The Bayh-Dole Act of 1980 and University-Industry Technology Transfer: A Model for other OECD Governments? *Journal of Technology Transfer*, 30 (1/2), 115-127.
- Mustar P. and Wright M., 2010. Convergence or Path Dependency in Policies to Foster the Creation of University Spin-offs Firms? A Comparison of France and the United Kingdom. *Journal of Technology Transfer*, 35(3), 42-65.
- Mustar P., Renault M., Colombo M.G., Piva E., Fontes M., Lockett A., Wright M., Clarysse, B. and Moray N., 2006. Conceptualising the Heterogeneity of Research-based Spin-offs: A Multi-dimensional Taxonomy. *Research Policy*, 35, 289-308.
- Nelson, R.R., 2001. Observations on the Post-Bayh-Dole Rise of Patenting at American Universities. *Journal of Technology Transfer*, 26, 13-19.
- Nicolau N. and Birley S., 2003. Academia Networks in a Trichotomous Categorisation of University Spinouts. *Journal of Business Venturing*, 18, 333-359.
- Nlemvo Ndonzuau F., Pirnay F. and Surlemont B., 2002. A Stage Model of Academic Spin-off Creation. *Technovation*, 22, 281-289.
- O'Gorman C., Byrne O. and Pandya D., 2008. How Scientists Commercialise New Knowledge via Entrepreneurship? *Journal of Technology Transfer*, 33(1) 22-34.
- O'Shea R.P., Allen T.J., Morse K.P., O'Gorman C. and Roche F., 2007. Delineating the Anatomy of an Entrepreneurial University: The Massachusetts Institute of Technology Experience. *R&D Management*, 37(1), 1-16.
- O'Shea R.P., Chugh H. and Allen T.J., 2008. Determinants and Consequences of University Spinoff Activity: A Conceptual Framework. *Journal of Technology Transfer*, 33, 653-666.

- O'Shea R., Allen T.J., Chevalier A. and Roche F., 2005. Entrepreneurial Orientation, Technology Transfer and Spinoff Performance of US Universities. *Research Policy*, 34, 994-1009.
- Parker D.D. and Zilberman D., 1993. University Technology Transfer: Impacts on Local and US Economies. *Contemporary Policy Issues*, 11(2), 87-100.
- Phan P.H. and Siegel D.S., 2006. *The Effectiveness of University Technology Transfer*. Series on Foundations and Trends in Entrepreneurship. Boston: Now Publishers.
- Pirnay F., Surlemont B. and Nlemvo F., 2003. Toward a Typology of University Spin-offs. *Small Business Economics*, 21, 355-369.
- Powers D.B. and McDougall P.P., 2005. University Start-up Formation and Technology Licensing with Firms that Go Public: A Resource-based view of Academic Entrepreneurship. *Journal of Business Venturing*, 20, 291-311.
- RedOTRI, 2007. *Informe RedOTRI 2007*. Madrid: RedOTRI-CRUE.
- Roberts, E.B., 1991. *Entrepreneurs in High Technology. Lessons from MIT and Beyond*. New York and Oxford: Oxford University Press.
- Roberts E.B. and Malonet D.E., 1996. Policies and structures for spinning off new companies from research and development organizations. *R&D Management*, 26(1), 17-48.
- Rogers E.M., Takegami S. and Yin J., 2001. Lessons Learned About Technology Transfer. *Technovation*, 21(4), 253-261.
- Rothaermel F.T. and Thursby M., 2005. Incubator Firm Failure or Graduation? The Role of University Linkages. *Research Policy*, 34, 1076-1090.
- Rothaermel F.T., Agung S.D. and Jiang L., 2007. University Entrepreneurship: A Taxonomy of the Literature. *Industrial and Corporate Change*, 16(4), 691-791.
- Sampat, B.N., 2006. Patenting and US Academic Research in the 20th Century: The World before and after Bayh-Dole. *Research Policy*, 35, 772-789.
- Saxenian, A., 1994. *Regional Advantage: Culture and Competition in Silicon Valley and Route 128*. Cambridge (Mass.) and London: Harvard University Press.
- Shane, S., 2004. Encouraging University Entrepreneurship? The Effect of the Bayh-Dole Act on University Patenting in the United States. *Journal of Business Venturing*, 19, 127-151.
- Phan P. and Siegel D.S., 2006. *The Effectiveness of University Technology Transfer*. Foundations and Trends in Entrepreneurship, 2(2). Boston and Delft: Now Publishers.
- Siegel D.S., Waldman D.A., Atwater L.E. and Link A.N., 2003. Commercial Knowledge Transfers from Universities to Firms: Improving the Effectiveness of University-Industry Collaboration. *Journal of Technology Management Research*, 14, 111-133.
- Smilor R.W., Gibson D.V. and Dietrich G.B., 1990. University Spin-out Companies: Technology Start-ups from UT-Austin. *Journal of Business Venturing*, 5, 63-76.
- Sorenson O. and Stuart T.E., 2001. Syndication Network and the Spatial Distribution of Venture Capital Investments. *American Journal of Sociology*, 106(6), 1546-1588.
- Steffensen M., Rogers E.M. and Speakman K., 2000. Executive Forum: Spin-offs from Research Centers at a Research University. *Journal of Business Venturing*, 15, 93-111.
- Stuart T.E. and Ding W.W., 2006. When Do Scientists Become Entrepreneurs? The Social Structural Antecedents of Commercial Activity in the Academic Life Sciences. *American Journal of Sociology*, 112(1), 97-144.

- Thursby J.G. and Thursby M.C., 2011. Has the Bayh-Dole Act Compromised Basic Research? *Research Policy* 40, 1077-1083.
- Van Looy B., Landoni P., Callaert J., Van Pottelsberghe B., Sapsalis E. and Debackere K., 2011. Entrepreneurial Effectiveness of European Universities: An Empirical Assessment of Antecedents and Trade-offs. Forthcoming: *Research Policy*.
- Vohora A., Wright M. and Lockett A., 2004. Critical Junctures in the Development of University High-tech Spinout Companies. *Research Policy*, 33, 147-175.
- Wennekers S. and Thurik R., 1999. Linking entrepreneurship and economic growth. *Working Paper*, Erasmus University, Rotterdam, The Netherlands.
- Wright M., Lockett A., Clarysse B. and Binks M., 2006. University Spin-out Companies and Venture Capital. *Research Policy*, 35, 481-501.
- Zucker L.G., Darby M.R. and Brewer M.B., 1998. Intellectual Human Capital and the Birth of US Biotechnology Enterprises. *The American Economic Review*, 88, 290-306.

APPENDIX

Table A.1
Results of Chi-cuadrado Test

Degree of Development of projects selected *Conglomerate						
	Valor	gl	Sig. asintótica (2 caras)			
Chi-cuadrado de Pearson	13,00	6	,043			
Purchasing of licenceses to complete technological base * Conglomerate						
	Valor	gl	Sig. asintótica (2 caras)			
Chi-cuadrado de Pearson	9,000	3	,029			
% universities by conglomerate		Conglomerate				Total
		1	2	3	4	
Development of projects selected	1,00			66,7%		22,2%
	2,00	100,0%		33,3%	100,0%	33,3%
	3,00		100,0%			44,4%
Total		100,0%	100,0%	100,0%	100,0%	100,0%
% universities by conglomerate		Conglomerate				Total
		1	2	3	4	
Licences to complete technological base	,00		100,0%	100,0%		77,8%
	1,00	100,0%			100,0%	22,2%
Total		100,0%	100,0%	100,0%	100,0%	100,0%

Source: Author's own.

Table A.2
Results of ANOVA (Quantitative variables)

		Sum of squares	gl	Quadratic mean	F	Sig.
Spin-offs created 1994-2010	Between groups	2671,556	3	890,519	215,448	,000
	Within groups	20,667	5	4,133		
	Total	2692,222	8			
Ratio of number of USO/number of researchers	Between groups	18,224	3	6,075	4,825	,061
	Within groups	6,295	5	1,259		
	Total	24,519	8			
Private/public funds in spin-off financing	Between groups	14057,954	3	4685,985	5,905	,042
	Within groups	3967,785	5	793,557		
	Total	18025,739	8			
Human resources	Between groups	63,000	3	21,000	4,200	,078
	Within groups	25,000	5	5,000		
	Total	88,000	8			
Organizational	Between groups	50,806	3	16,935	7,877	,024
	Within groups	10,750	5	2,150		
	Total	61,556	8			
Technological resources	Between groups	59,222	3	19,741	32,901	,001
	Within groups	3,000	5	,600		
	Total	62,222	8			

Source: Author's own.

Table A.3
Means of quantitative variables by conglomerates

CONGLOM.	Spin-offs created 1994-2010	Ratio of num. of USO/num of researchers	Entrep. culture	Instrum. to promote entrepren. culture	Ratio of opport. managed by TTO/resser	Number of selection criteria	% selected projects	% projects with techno-log. base	Involv. of TTO in all stages	Priv./pub. funds in spin-off financing	Human RR	Organiz. RR	Tech. RR
1	Mean	5,21	12,00	12,00	37,50	6,00	50,00	98,00	1,00	45,45	16,00	7,00	4,00
	N	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
2	Mean	2,10	18,25	12,00	30,76	5,75	81,25	78,75	0,25	91,79	8,50	9,25	0,50
	N	4,00	4,00	4,00	4,00	4,00	4,00	4,00	4,00	4,00	4,00	4,00	4,00
	D.S.	1,44	4,99	2,16	7,31	1,71	13,15	11,81	0,50	26,94	2,52	1,26	1,00
3	Mean	0,37	20,00	12,00	34,09	6,33	96,67	70,00	0,00	81,62	7,00	4,00	0,00
	N	3,00	3,00	3,00	3,00	3,00	3,00	3,00	3,00	3,00	3,00	3,00	3,00
	D.S.	0,21	2,65	1,00	29,76	1,53	5,77	8,66	0,00	29,92	1,73	1,73	0,00
4	Mean	1,52	10,00	8,00	55,56	8,00	100,00	80,00	1,00	200,00	10,00	9,00	8,00
	N	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
	D.S.												
Total	Mean	1,80	17,22	11,56	35,37	6,22	85,00	78,11	0,33	95,27	9,00	7,22	1,56
	N	9,00	9,00	9,00	9,00	9,00	9,00	9,00	9,00	9,00	9,00	9,00	9,00
	D.S.	1,75	4,94	1,94	17,44	1,48	17,68	12,08	0,50	47,47	3,32	2,77	2,79

Source: Author's own.

Table A.4

Results of ANOVA. (performance variables)

		Sum of squares	gl	Quadratic mean	F	Sig.
% Firm exploiting new knowledge	Between groups	2697,556	3	899,185	1,780	,267
	Within groups	2526,000	5	505,200		
	Total	5223,556	8			
% Firms collaborating with University	Between groups	1890,889	3	630,296	,468	,717
	Within groups	6732,667	5	1346,533		
	Total	8623,556	8			
% Firms with positive returns	Between groups	6928,000	3	2309,333	3,443	,108
	Within groups	3354,000	5	670,800		
	Total	10282,000	8			
%Firms with high growth	Between groups	10637845,333	3	3545948,444	2,249	,200
	Within groups	7882502,667	5	1576500,533		
	Total	18520348,000	8			
%Firms with no growth	Between groups	17435605,472	3	5811868,491	,344	,796
	Within groups	84464227,417	5	16892845,483		
	Total	101899832,889	8			
%Firms disappeared	Between groups	1363542,806	3	454514,269	1,112	,427
	Within groups	2044402,750	5	408880,550		
	Total	3407945,556	8			

Source: Author's own.