New venture creation in academia: preconditions and drivers for the emergence of academic spin-offs

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Abstract

***Purpose of the paper**: This study aims to explore determinants for the emergence of academic spin-offs (ASOs). We analyzed individual, institutional and infrastructural factors that lead to the emergence of ASOs and their influence on the business model choice of firms in their start-up phase.*

***Methodology**: The analysis is based on quantitative and qualitative methods; the field of research is the life sciences faculty of the University of Siena.*

***Findings**: Consultancy by researchers is a positive predictor of the propensity to create a business. Quality and quantity of scientific production are associated positively but only up to a certain threshold, beyond which academics have less inclination for entrepreneurship. University department size plays a decisive role: scarcity of resources may limit the emergence and growth of ASOs. Science parks and university-industry liaison structures play a crucial role in the emergence and survival of new businesses. The resources, competence and motivation of the founders are the main determinants of the choice of business model of ASOs during the start-up phase.*

***Research limitations**: The analysis regarded one medium-sized university and a single (albeit large) scientific field, i.e. life sciences.*

Managerial implications: The results can help managers assess ex ante which university careers potentially lead to the emergence of ASOs.

***Originality of the paper**: Few prior studies have considered qualitative and quantitative empirical evidence on factors influencing the emergence of ASOs and the choice of business model during the start-up phase.*

Key words: spin-off; academic entrepreneurship; entrepreneurial orientation; technology transfer; university-industry links; business model

1. Introduction

Scientific knowledge is a key factor for industrial development and technological innovation. The application of theoretical knowledge to technical solutions through technology transfer is a major source of competitive advantage for many companies. In this context, universities and research centers play a vital role through traditional research and training and the exploitation of research results that can lead to economic development (Vincett, 2010) in a regional context (Zanni, 1995). In recent years, the range of activities and channels available to universities to implement technology transfer has gradually expanded: *producing highly qualified graduates,*

publishing academic results, grantsmanship, consulting, industry training courses, contract research, patenting and licensing, technology parks (Philpott *et al.*, 2011, p. 162). This has prompted many scholars to study the new *entrepreneurial mission* of universities (Lazzeroni and Piccaluga, 2003) and to define an *entrepreneurial paradigm* according to which universities work "*with the objective of improving regional or national economic performance as well as the university's financial advantage and that of its faculty*" (Etzkowitz *et al.*, 2000, p. 313). The creation of academic spin-offs (ASOs) is an outstanding way to activate technology transfer (Lazzeri and Piccaluga, 2014).

Many scholars investigating the phenomenon of academic entrepreneurship have preferred the institutional point of view, focusing in particular on university characteristics (cf Rasmussen *et al.*, 2014) and the organizational models implemented by structures devoted to technology transfer. In this case the aim is to understand which contextual factors facilitate the emergence and growth of ASOs (e.g. Di Gregorio and Shane, 2003; Rasmussen and Borch, 2010; Algieri *et al.*, 2013). Other studies that rely on a *resource-based* approach (Barney, 1991) have explored the resources and competence of founders that give emerging ASOs a competitive advantage (e.g. O'Shea *et al.*, 2005). In new businesses, particularly in the scientific sector, competitive advantage is based on the skills and knowledge of the founders (Cooper and Bruno, 1977). Resources allowing certain researchers to develop new business activities include cognitive capacity, organizational and relational resources (Landry *et al.*, 2006), risk propensity, potential loss of prestige in academic circles and research team cohesion (Compagno *et al.*, 2005).

There does not seem to be any generally accepted definition of ASO in the literature (Pirnay *et al.*, 2003) or taxonomy of the types with which this form of entrepreneurial activity may arise (Fryges and Wright, 2014). Some authors focus on the source of innovation, others on the relationship between researchers and their working structure, others on the role of lenders promoting entrepreneurial start-up. A definition that attempts to grant the various contributions used in this paper is that of Pirnay *et al.* (2003) who defined university spin-offs as "*new firms created to exploit commercially some knowledge, technology or research results developed within a university*" (p. 356). In their view, an ASO must essentially be a profitable new business that is independent from the university that generated it.

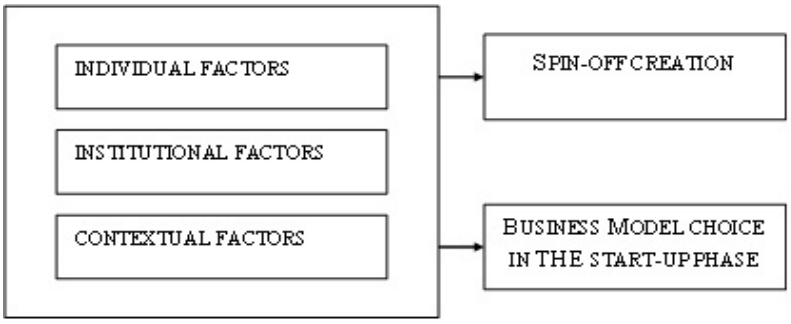
As already pointed out, a number of studies have investigated the determinants of ASO emergence, although little is available in the literature on these different determinants jointly. Research has generally only focused on individual (e.g. Landry *et al.*, 2006; Abramo *et al.*, 2012), institutional (e.g. Algieri *et al.*, 2013; Ramacciotti and Rizzo, 2014), contextual or infrastructural determinants (e.g. Fini *et al.*, 2011; Link and Scott, 2005; Corsi and Prencipe, 2015; Rizzo, 2015). Studies that analyze how these determinants may influence the ASO business model structure during the start-up phase are also rare (Lehoux *et al.*, 2014; Stanckiewicz's, 1994).

The aim of the paper is to provide insights that help bridge this gap, investigating into the factors that promote/hinder the emergence of ASOs. In particular, we aim to answer the following research questions:

1) Which factors influence the propensity to create ASOs and how?
2) Which factors influence the choice of ASO business models in the start-up phase and in what way?

Figure 1 illustrates the used research framework.

Fig.1: Research framework: factors influencing ASO emergence and business model choice in the start-up phase



Source: our elaboration

The framework refers to three groups of factors:

- *individual factors*: the scientific and technological competences of the team founder, managerial and marketing skills complementary to these competences and propensity of researchers for academic technology transfer (e.g. research, patenting, counseling);
- *institutional factors*: support structures (e.g. liaison offices), university size and policy, department size;
- *contextual and infrastructural factors*: incubators and science parks favoring development or reducing operating costs during the start-up (Piccaluga, 2000), industrial characteristics of the ASO sector (e.g. technological clusters or industrial districts).

Section 2 of this paper reviews the literature on the emergence of ASOs, showing the relationship of the present study with existing research. Section 3 outlines the research method. The results of the study are presented and discussed in Section 4, concluding with suggestions for future research in Section 5.

2. Theoretical background

The study of ASOs is part of the broader stream of literature on technology transfer. Until the first half of the 2000s, such studies focused mainly on the role of institutions, especially universities and technology transfer offices (TTOs) (e.g. Lamboy, 2004; Clarysse *et al.*, 2011; Feldman *et al.*, 2002; Siegel *et al.*, 2003). In this case the formation of relationships

with industry was linked to the context in which they were established: type of organization, culture, research environment, etc. Subsequent research has however shown that engagement with industry also depends heavily on the capacity and skill of the actors, whether they are individual researchers or entire organizations (Giuliani *et al.*, 2010; Rasmussen *et al.*, 2011). Therefore, the latest studies seek to integrate the two approaches, using individual and institutional factors to explain the propensity and intensity of links between universities and industry.

For example, Landry *et al.* (2007) focus on patenting and spin-off emergence in the field of life sciences and engineering, suggesting that such activities are influenced by five groups of factors: "*financial and partnership assets*" (internal financing from the university, funding from the private sector and partnerships); "*attributes of knowledge assets*" (related to scientific production and its innovativeness); "*network assets*" (the strength of links between the researcher and managers or professionals of other organizations); "*organizational assets*" (university size, research unit size, training time); "*personal assets*" (experience and academic status of the researcher). The results of Landry *et al.* (2007) show that the novelty of the conducted research and the size of the laboratories are the only variables that significantly explain patenting and ASO emergence in the two disciplines considered. D'Este and Patel (2007) propose a model to verify the influence of: characteristics of individual researchers (certain individual determinants are predictors of subsequent commercial activities conducted by a researcher, in particular the size of the business set up, as well as the researcher's age and academic status); department characteristics (university departments and especially resources available for research and the quality of research) may influence the propensity of its researchers to transfer technology; university characteristics; the variety of interactions between university and industry (universities have different commercial orientations that can be measured in terms of existence, age and resources of TTOs, resources from the industry). The results of the study by D'Este and Patel (2007) show that university researchers are more often involved in certain channels of interaction with industry (consultancy, research contracts, training, joint research) than in others (patenting and ASO emergence). In particular, the authors show that individual characteristics are more decisive than the characteristics of university departments in explaining the propensity to entertain relations with industry. D'Este and Perkmann (2011) also show that academics driven by learning-related motivation are more often involved in joint research and research contracts, whereas motives related to the possibility of commercialization of research results lead to the exploitation of channels such as patenting, consulting and ASO.

A problematic aspect of ASOs is the relationship between entrepreneurship and research (Abramo *et al.*, 2012). Studies that have examined this relationship at an institutional level have shown a positive link between quality of scientific production of a faculty and the number of created ASOs (O'Shea *et al.*, 2008). At an individual level, however, the relationship remains controversial (Giuliani *et al.*, 2010) and there have

been conflicting results in relation to both the quantity and the quality of research carried out by individual academics. The question in this case is whether the effect of the reputation of academic research is positive, i.e. is an indicator of the skills and expertise of individual researchers (inviting the industry to establish relations with them), or negative, in the sense that high quality academic research means less time dedicated to commercial activities (Landry *et al.*, 2007; Haeussler and Colyvas, 2011; Lowe and Gonzales-Brambila, 2007; Buenstorf, 2009).

Among the contextual and infrastructural factors influencing the emergence of ASOs, many studies have focused on science parks and incubators. A "*science park" can be defined as "a property-based initiative which i) has formal operational links with centers of knowledge creation, such as universities and (public and/or private) research centers, ii) is designed to encourage the formation and growth of innovative (generally science-based) businesses, and iii) has a management function which is actively engaged in the transfer of technology and business skills to customer organizations*" (Colombo and Delmastro, 2002, p. 1107). Science parks generally feature research laboratories and an incubator. The latter is defined as "*a property-based venture which provides entrepreneurs and start-ups with physical facilities and technical and business services*" (OECD, 1997; Colombo and Delmastro, 2002, p. 1105). Especially in technology-intensive sectors, science parks and incubators not only promote the development and reduce the cost of managing the start-up phase, but may also play a role in the mentoring and integration of innovative processes generated by the new business, thus ensuring continuous transfer of knowledge and technology between academia and industry.

3. Methodology

The empirical analysis that follows is based on the use of quantitative and qualitative methodologies. We chose to use the case method in addition to an analysis of secondary sources (Stokes, 2000), because we believe that it can promote understanding of complex subjects (Gilmore and Carson, 1996) such as emergence of ASOs, while further validating the results of quantitative analysis. Quantitative analysis will focus on the relationship between individual and institutional factors and the propensity of individual researchers to set up businesses. Qualitative analysis will be used to investigate individual, institutional and contextual factors that influence the emergence of ASOs and the choice of business model in the start-up phase of new businesses.

In the field of life sciences (Pavitt, 1984), the scientific and technological expertise of the founding members is crucial for ASO emergence (Visintin and Pittino, 2014). The University of Siena has a good number of ASOs in the national context (Bax *et al.*, 2014, p. 98) and, above all, it is a center of excellence in Italy for biotechnology and pharmaceutical research and the respective technology transfer (Ramella and Trigilia, 2010, p. 56). It is also part of one of the first Italian life science technology clusters (Pucci and Zanni, 2012). The cluster includes a rich population of firms (including

multinational pharmaceutical companies) that drives technology transfer between academia and industry (consultancy, research contracts, joint PhDs with industry, etc.).

3.1 Quantitative methodology

The study was based on a dataset, collected by the authors between 2011 and 2012, containing the career information, scientific productivity, number of patents filed and consulting activities of all academics at the University of Siena in the field of life sciences. The data sources for each section of the dataset were: *scientific productivity*: ISI-"Web of Science" bibliographic database; *career-related variables*: researchers' curricula vitae, available on their Departmental web pages; patents: University of Siena's Liaison Office patent database; *consultancy work and research agreements with industry*: data provided by the university's Liaison Office.

The measures used in this study were those generally used in the literature with reference to individual and institutional determinants of researcher engagement with industry.

The dependent variable was the Spin-off, recorded as a dichotomous variable with a value of "1" for founders of new academic ventures in the 1991-2010 period; "0" otherwise.

The independent variables were:

"Demographic" and "Sectorial" effects

- *Gender*: as a dichotomous variable, with a value of "1" for males and "0" for females
- *Age*: (in years) of each academic researcher in 2010
- *MED*: as a dichotomous variable, with a value of "1" for researchers in the medical sector and "0" otherwise.

"Education" effects

- *Visiting*: dummy variable, with a value of "1" for academics who were visiting lecturers at universities or research centers abroad during their postgraduate training or are currently visiting professors.
- *Spec./PhD*: as a dichotomous variable measuring academic qualifications, with a value of "1" for doctorate or specialist qualification (the latter in medicine) and "0" otherwise.

"Status" effects

- *Role*: dummy variable, with a value of "1" for full professor or associate professor and "0" otherwise.
- *Instit. Position*: dummy variable, with a value of "1" for institutional positions in the department or university between 1991 and 2010; "0" otherwise.

"Complementarity" effects

- *Patenting*: dummy variable, with a value of "1" for those who filed a patent in the years between 1991 and 2010; "0" otherwise.
- *Consultancies (no.)*: number of research agreements or consultancies in which researcher was involved in the 1991-2010 period.
- *Consultancies (amount)*: average value of consultancies (divided by 1000);

"Reputation" effects

- *No. publications*: total number of researcher's publications in the 1991-2010 period.
- *Average IF*: average impact factor of researcher's publications.

"Institutional" effects

- *Dept. size*: number of researchers affiliated with the researcher's department.

3.2 Qualitative methodology

To answer the questions we posed, we analyzed the case (Eisenhardt, 1989; Yin, 2003) of an academic start-up of the University of Siena. We used the theoretical framework for the analysis of business models developed by Pucci *et al.* (2013) and Casprini *et al.* (2014). The conceptual model proposed by these authors envisages a business model composed of three major systemic components: New Product Development System, Market Management System and Organizational Process System, derived from the intersection of three different blocks of activities: strategy, organization and business skills (Casprini *et al.*, 2014, p. 4). This framework allows us to analyse the characteristics of the business model at its start-up and highlight the preconditions and drivers that led to the setting up of the business. For a discussion on the concept of business model, see the literature review of Zott *et al.* (2011).

We conducted interviews with figures in several key business roles to cross-check the data collected (Stake, 1995), but above all to understand the interactions among the systemic components of the firm's business model. In particular, we interviewed the Director General and the heads of the administrative offices. After a first round of interviews in 2013, the research process was divided into two updated interviews that took place in 2014. The collected information, supplemented with data from the administrative offices of the company and its financial statements, was then overlaid and analyzed to answer our research questions.

4. Results

4.1 Results of the quantitative analysis

Table 1 shows the descriptive statistics of all variables and their correlation coefficients.

Tab. 1: Descriptive statistics and correlations

	Variables	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]
[1]	Spin-off	1,000													
[2]	Gender	0,007	1,000												
[3]	Age	0,027	0,249	1,000											
[4]	MED	-0,158	0,206	0,125	1,000										
[5]	Visiting	-0,042	-0,029	-0,003	-0,163	1,000									
[6]	Spec./PhD	-0,034	0,059	-0,019	0,219	0,350	1,000								
[7]	Role	0,068	0,300	0,599	0,026	0,110	0,061	1,000							
[8]	Instit. Position	0,272	0,188	0,259	0,047	0,114	0,067	0,293	1,000						
[9]	Patenting	0,210	0,039	0,003	-0,259	0,147	-0,084	0,186	0,114	1,000					
[10]	Consultancies (No.)	0,441	0,204	0,186	0,053	0,106	0,035	0,288	0,340	0,182	1,000				
[11]	Consult. (amount)	0,060	-0,064	-0,041	-0,103	0,176	0,025	0,137	-0,008	0,198	0,061	1,000			
[12]	N° Publications*	0,089	0,151	0,140	0,178	0,213	0,109	0,329	0,326	0,206	0,283	0,174	1,000		
[13]	Average IF	0,122	-0,139	-0,191	-0,263	0,104	-0,094	-0,043	-0,013	0,211	0,070	0,197	0,087	1,000	
[14]	Dept. Size	0,175	-0,047	0,147	0,001	-0,053	-0,073	-0,006	0,020	0,243	0,050	0,101	0,010	0,084	1,000
	Mean	0,037	0,618	53,977	0,581	0,279	0,542	0,555	0,110	0,203	2,841	4,394	41,043	3,108	25,233
	Std. Dev.	0,188	0,487	8,840	0,494	0,449	0,499	0,498	0,313	0,403	7,114	18,866	45,825	1,418	6,535
	Min	0	0	33	0	0	0	0	0	0	0	0	5	0,51	11
	Max	1	1	70	1	1	1	1	1	1	53	180	546	9,97	33

N = 301. Correlation coefficients with an absolute value greater than 0.114 are statistically significant at 95%. * Total number of ISI Publications: 12354.

The analysis of the correlation matrix did not reveal any collinearity issues among variables, as confirmed by calculating the VIF (variance inflation factor) scores and tolerance (Table 2).

Tab. 2: VIF scores and Tolerance

Variables VIF	Sqrt	VIF	Tolerance
Gender	1,20	1,10	0,832
Age	1,78	1,34	0,561
MED	1,44	1,20	0,696
Visiting	1,33	1,15	0,752
Spec./PhD	1,29	1,13	0,777
Role	1,94	1,39	0,515
Instit. Position	1,32	1,32	0,759
Patenting	1,31	1,14	0,764
Consultancies (No.)	1,25	1,12	0,799
Consult. (amount)	1,14	1,07	0,876
N° Publications*	1,43	1,20	0,698
Average IF	1,19	1,09	0,838
Dept. Size	1,13	1,06	0,887

N = 301; Mean VIF = 1,37; Condition number = 35,060

Source: our elaboration

A logistic regression was used to predict the probability of ASOs being created. Table 3 shows the results.

Tab. 3: Results of logistic regression for spin-off emergence

	Model A	Model B	Model C	Model D	Model E	Model F
"Demographic" and "Sectoral" effects						
Gender	0,350 (0,633)	0,355 (0,626)	-0,350 (0,744)	-1,322 (1,250)	-1,360 (1,191)	-1,518 (1,201)
Age	0,026 (0,048)	0,032 (0,051)	-0,028 (0,066)	0,001 (0,054)	0,019 (0,059)	0,038 (0,074)
MED	-2,026* (0,816)	-2,333* (0,824)	-1,867* (0,842)	-3,895* (1,573)	-4,495* (1,910)	-4,105* (1,664)
"Education" effects						
Visiting		-1,093 (0,879)	-1,313 (0,925)	-1,910 (1,267)	-2,336^ (1,245)	-1,891 (1,161)
Spec./PhD		0,512 (0,673)	-0,079 (0,654)	0,217 (0,888)	0,364 (1,000)	0,445 (1,004)
"Status" effects						
Role			0,204 (0,990)	-1,054 (1,100)	-1,381 (1,085)	-1,624 (1,273)
Instit. Position			2,903** (0,821)	2,440* (1,056)	2,259^ (1,196)	2,560^ (1,350)
"Complementarity" effects						
Patenting				1,030 (1,115)	0,886 (1,142)	-0,909 (1,745)
Consultancies (No.)				0,180** (0,052)	0,181** (0,055)	0,204** (0,072)
Consult. (amount)				0,005 (0,015)	0,004 (0,015)	0,005 (0,019)
"Reputation" effects						
N° Publications					0,007^ (0,004)	0,010* (0,005)
Average IF					0,280^ (0,153)	0,398* (0,160)
"Institutional" effects						
Dept. Size						0,280** (0,101)
Constant	-4,141 (2,568)	-4,392 (2,799)	-1,454 (3,073)	-3,165 (2,870)	-5,062 (3,312)	-14,160* (6,024)
Pseudo R^2 *Wald χ^2*	*0,091* *8,05**	*0,112* *12,45**	*0,250* *29,95***	*0,544* *39,36***	*0,556* *44,36***	*0,619* *45,58***

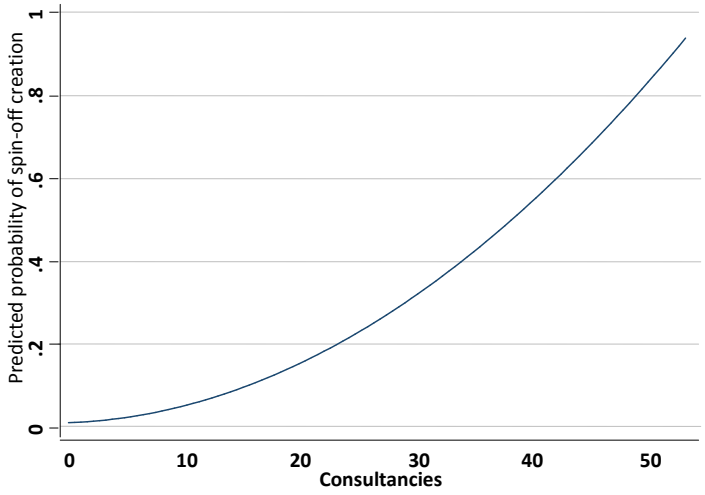
^ p < 0,10; * p < 0,05; ** p < 0,01; N = 301; Robust standard error in parenthesis

Source: our elaboration

The different groups of effects were gradually added to the six models. The regression results of model F (the model that best fits our data) indicate that the probability of an ASO emergence is a positive function of the number of consultancies (b = 0.204), the number of publications (b = 0.010), the average impact factor (b = 0.398) and department size (b = 0.280). The coefficient of institutional position is positive (b = 2.560), albeit borderline significant. Among demographic and sectorial effects, medical discipline has a negative effect on the probability of creating a spin-off (b = -4.105).

Figure 2 shows the predicted probability of an ASO emergence as a function of the number of consultancies.

Fig. 2: Predicted probability of spin-off emergence as a function of number of consultancies

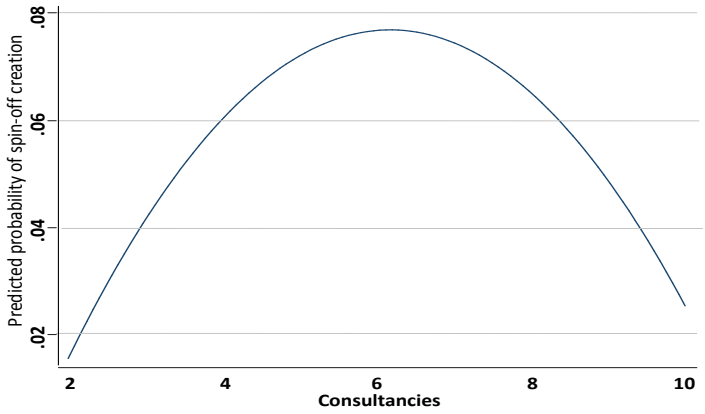


Source: our elaboration

Figure 2 shows that the number of consultants is a key determinant for the emergence of ASOs. The results did not, however, show a positive association between the average value of consultancies and the probability of creating an entrepreneurial venture. So it seems that the frequency of interaction with industry is a precondition for emergence of ASOs, rather than the extent of this interaction. A greater number of consultations may therefore signal greater understanding of the market on the part of the involved researchers, and it may therefore be a major driver of new academic venture creation.

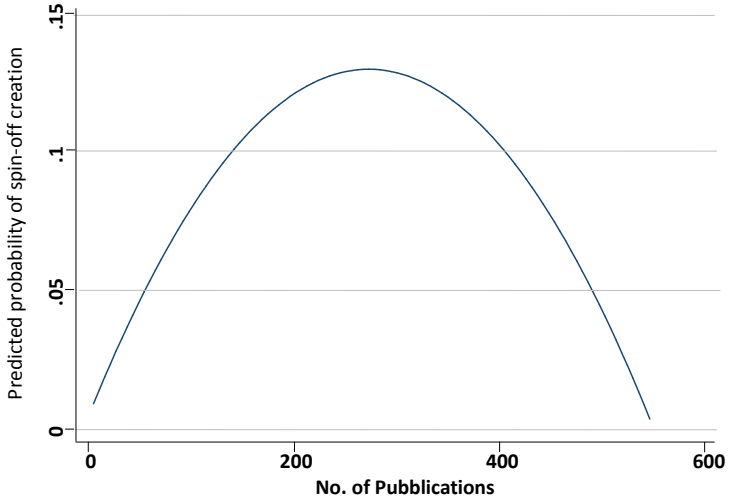
Figures 3 and 4 show the predicted probabilities of an ASO emergence as a function of the researcher's average impact factor and the total number of the researcher's publications, respectively.

Fig. 3: Predicted probability of spin-off emergence as a function of scientific quality



Source: our elaboration

Fig. 4: Predicted probability of spin-off emergence as a function of scientific production

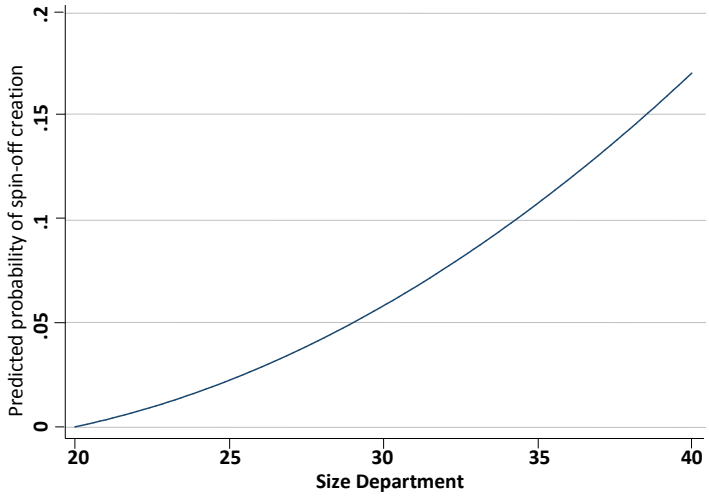


Source: our elaboration

Both figures show an inverted U-shaped relationship between the quality/quantity of publications and the probability of an ASO emergence. Below a certain threshold, the quantity and quality of scientific productivity are a positive factor for the propensity to set up a business, since scientific reputation is based on the production of knowledge and skills that can easily be transferred to commercial ventures. Above this threshold, there is a substitution effect between the two channels of technology transfer, where academics prefer to do research rather than engage in entrepreneurial activity.

Finally, Figure 5 shows the predicted probabilities of an ASO emergence as a function of department size.

Fig. 5: Predicted probability of spin-off emergence as a function of department size



Source: our elaboration

Among institutional factors, department size seems to be a positive driver of the emergence of new ASOs. It can in fact be considered a proxy of the resources that are available to the department: it is possible that the greater the number of components of the organizational unit, the higher the probability that a research group within it can specialize in activities that are closer to the industry world.

4.2 Results of the qualitative analysis

In discussing the case study, we refer to the firm as "Alpha". Alpha Company is a example of success in the world of academic start-ups. Founded in 2009 and incubated at the bio-incubator TLS[1], Alpha is a service company that has achieved a turnover of almost three million Euros with 11 employees in just over five years. Although it did not follow the protocol and procedures for the establishment of ASOs, Alpha was founded by three academics: a professor and two researchers. It can therefore be considered an ASO. It focuses on the organization and management of basic, clinical and applied research protocols, including clinical trials, evaluation of therapies and preventive measures such as vaccines. The main reason the business was started was the founders' need to overcome some of the constraints on counseling that they had previously conducted at the university. Specifically, the growing demand

[1] The Tuscan Life Sciences (TLS) Foundation is a non-profit organization that has been supporting research in the life sciences and technology transfer processes from basic research to industrial application (www.toscanalifesciences.org) since 2005.

of the market for clinical tests on class 3 pathogens could not be met by the research team due to the lack of appropriately equipped laboratories at the university. The recognized skills and scientific expertise of the team, gained over years of basic and applied research, could not be exploited due to lack of resources and the necessary assets to tackle all phases of clinical trials in increasing demand. The company was founded as a single-product business specializing in clinical tests for the licensing of vaccines, but grew through diversification. In 2013, Alpha obtained the ISO-17025 certification and entered the field of agro-food certification. Diversification arose from the possibility of replicating the screening of drugs used in the main business on other products, such as cosmetics and food. In 2013, Alpha also strengthened its core business by buying into a new service company dealing with calibration, maintenance and regulation of laboratory equipment. The following year it floated a new research company, entirely owned by Alpha, which provides new technological solutions for the parent company.

In the theoretical framework proposed by Casprini *et al.* (2014), the business model of Alpha in its start-up phase was "*Organizational Process-Oriented*". This model was created by the intersection of "*organization*" and "*business skills*" components. Indeed, Alpha combines the efficiency maximization of the processes behind its services (reduction of transaction costs, complementarity of resources, standardization) with skill development, especially relational skills. The latter is one of its fundamental drivers of success. The entrepreneurial team does indeed count on a wide network of relationships, both operational and learning-oriented, gained from conducting research and consultancy at the university. This has also enabled the company to go into business with some of the big players of the pharmaceutical industry that provided access to international markets of strategic importance.

The "*strategic*" component of the business model was initially less developed. This is probably due to its lack of specific skills in the management context during the start-up phase. The multiple-product model implemented by the company in recent years and the entry of professionals with a background in business have progressively transformed the business model into one of "*Market-Oriented Management*" (Casprini *et al.*, 2014). The business model of Alpha is now more focused on the management of various areas of activity, improving distribution channel efficiency and the management of served markets (Pucci *et al.*, 2013).

5. Discussion and implications

The aim of this paper was to analyze the three main factors that promote/hinder the emergence of ASOs and to understand how these factors may influence the choice of business model of companies in their start-up phase. Empirical studies enabled us to highlight some typical aspects of the emergence of ASOs.

With regard to individual factors, the results show that the skills and competence of the founders are a determining factor not only of the propensity to create ASOs, but also of the choice of business model in the

start-up phase. Firstly, we found that the scientific and technological expertise of the proponents is important. The quantity and quality of research are an expression of their technical skills. However, the attainment of certain thresholds of scientific excellence can divert academics from commercial activities. Secondly, the limited business skills of teams of distinctive scientific origin may make them unaware of target markets (particularly in terms of commercial potential), while inadequate marketing and management skills may explain the discontinuous economic performance and limited turnover that are typical of many ASOs. Scientific and technological skills alone are not enough to ensure a sustainable competitive advantage in the long run. Entrepreneurs must also have the business and management skills necessary to effectively perform the three main entrepreneurial functions (strategic, political and organizational) (Fazzi, 1982). The development of relational skills can also significantly improve the performance of ASOs (cf Walter *et al.*, 2006; Soetanto and Van Geenhuizen, 2015). In technology-intensive sectors in particular, a lack of strategic and managerial skills in the start-up phase can favor a choice of business models that is more oriented towards the innovation and development of new products, or focused on organizational efficiency (Pucci *et al.*, 2013; Casprini *et al.*, 2014). Among individual factors, the quantitative analysis also showed that previous working experience as consultants in universities trained the founders in interacting with industry and acquainted them with the market for future ASOs. Finally, from a teleological viewpoint (Vallini, 1990), the ultimate objective of creating an ASO cannot simply be to enhance the results of scientific research from a commercial point of view. In countries facing an economic crisis (like Italy), public universities have fewer and fewer resources. Academic start-ups may therefore offer an alternative to researchers who are not contemplating an academic career or unfunded university research.

With regard to institutional factors, department size emerged as a positive predictor of ASO emergence. This is linked with our previous observations on the lack of resources: larger departments and research groups can presumably count on a greater allocation of resources that can be invested in the development of commercial activities. The existence of support structures (e.g. university liaison offices) may promote the start-up of ASOs (provided it has the necessary resources), but it is not sufficient to ensure company growth, which must rely on its own entrepreneurial resources or external support (e.g. business angels, venture capitalists). Incubation incentives (university supplied tools and machinery) can promote early development, thus reducing operating costs, but they cannot be considered permanent resources for the subsequent growth of the business. In terms of public policy, creating ASOs can also be a way to overcome the problem of shortage of institutional resources. This is true of problems related to the ownership of the results of innovation (patents): innovations produced in universities are licensed to third parties because universities do not have the resources for their commercial exploitation.

Finally, with reference to contextual factors, the literature often observes that insufficient own or third-party capital (in Italy the figure

of the venture capitalist is relatively uncommon) makes it impossible to support company growth. However, the case study showed that this can be overcome through other contextual factors. An ASO emerging in a vital technological cluster can count on social and relational capital that in certain circumstances may limit the need for financial capital. This may be true of joint ventures between researchers and industry, which facilitate practical training and new business skills; or of clusters including medium and large enterprises with a high degree of internationalization (e.g. multinationals) that can act as a bridge for access to new markets; or of cluster support structures that not only provide specialized services but also mentor new a business in its early stages.

6. Conclusions, limitations and further research

The analysis that we have conducted shows that the propensity to create an ASO can be influenced not only by individual factors, but also by institutional and contextual factors. These same factors can also determine the choice of the business model of the new firm in its start-up phase. The way in which these factors act is complex. On the one hand, a quantitative analysis of some individual variables (for example the quantity and quality of scientific publications) can be carried out and it may be a useful tool to evaluate the entrepreneurial propensity of the faculty of a University's researchers. On the other hand, the analysis of contextual and institutional factors is highly dependent on the understanding of the meso- and macro-economic dynamics that characterize the environment in which the University is located. Henceforth, in this case a qualitative analysis seems to be most effective to understand the influence of the context and institutions on new ASOs' emergence.

The results of the study show that these analyses can help the public decision-maker and, above all, the same TTOs to understand where to channel resources in order to maximize the number of new businesses created.

The study highlights some limitations. The analysis focused on a single university. An analysis of other universities (also of different sizes) may reveal links between different variables. Especially at an institutional level, department or research group size, the resources available to them and specific academic policies could provide further insights into the research questions. An international comparative analysis may reveal differences in drivers and prerequisites for the emergence of ASOs in different countries. Finally, extending the study to a wider domain (e.g. engineering, social sciences, etc.) could further validate the results.

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