

Organizational and individual factors of the spin-off process from academic laboratories: an exploratory case study in life sciences

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ABSTRACT

Purpose: Combining economic and psychological perspectives, identify some of the main factors that influence academic scientists' decisions whether to start or not a spin-off process.

Aims: The study considers both economic and psychological outlooks by employing, on a business perspective, some already validated psychological frameworks.

Methodology/approach: To explore the motivation and critical questions that may lead scientists to start, or not, an academic spin-off company, a two-level perspective is applied: an organizational level and an individual level. The survey was answered by 59 volunteer faculty or non-clinical researchers with research focused on life science fields. The total number of members of the survey universe was 148, so the response rate was 40%.

Findings: Since the aim was to explore trends and motivations, not to test hypotheses, inferential statistical tests were not used but just descriptive statistics tools. The study allowed to identify the aspects to be considered in academic policies to promote research valorisation processes through starting spin-off companies.

Limitations of the study: The study is subject to several limitations, some of which are common to qualitative research in general and some of which are unique to the study design; namely (i) it is based on a purposefully selected sample; (ii) qualitative studies are subject to researcher bias; (iii) the findings may not be generalizable to other contexts.

The results achieved may be validated through further research in other contexts, since entrepreneurial activities may vary according to different cultures.

Practical implications: The study conducted leads us to argue that it is necessary - albeit not sufficient - to equip academic researchers with "right" knowledge and adequate relational capital to make the entrepreneurial challenge as desirable as a prosperous academic career.

Value: The exploratory case study aims to analyse the "unconditional" entrepreneurial intentions of scientists regarding the commercialization of knowledge, through the founding of companies.

KEY WORDS

academic spin-off, academic entrepreneurship, entrepreneurial self-efficacy, university-industry interaction, innovation, knowledge transfer, technology transfer.

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1. INTRODUCTION

The paper's purpose is to investigate some factors influencing the academic scientists' behavior in pursuing the idea of starting - or not - a spin-off firm to commercialize the results of their research. The basic theoretical framework falls within the broad area of academic literature on entrepreneurship, particularly by overlapping business management and psychology studies.

The disciplinary origin and characteristics of the so-called “underlying knowledge” are important variables for the study of academic entrepreneurship (Bekkers and Freitas, 2008). Since contextual factors influence an individual’s propensity to do business, to circumscribe this effect, the survey was focused on the phenomenon in the field of life sciences. This is one of the most dynamic areas of university knowledge transfer and it represents the largest proportion of funds invested in academic research worldwide coveting the interest of industry, governments, and non-for-profit institutions. Nevertheless, it has not been sufficiently investigated from an entrepreneurial perspective.

Two sections form this paper. The first introduces the theoretical background and presents the literature review, while the second is dedicated to the presentation of some results of the analysis conducted on the case study, at organizational and individual levels. Both sections present the analysis and discussion of the data along with practical and theoretical implications.

The article is therefore structured as follows: (i) theoretical background, (ii) explorative case study, (iii) management implications and discussion and (iv) conclusions and limitations.

2. THEORETICAL BACKGROUND

Academic entrepreneurship occupies an area of study that partially overlaps with those of innovation and entrepreneurship. Literature discussing this topic is focused on universities’ spin-offs or on nascent entrepreneurship, but it is difficult to recognize a dominant and converging theoretical paradigm.

In the reference literature, there are two important and mutually compatible points of observation: (i) the theory of the “entrepreneurial events” and (ii) the theory of “planned behavior”. The theory of entrepreneurial events considers business creation as the result of the contextual analysis by the individual that leads to actions related to firm creation. The theory of planned behavior, which is much more detailed, instead examines the individual's efforts to carry out entrepreneurial behavior.

A renewed point of interest is the academic commitment (Perkmann et al., 2013; Salter and Sobrero, 2013) in which the commercialization of research results represents the discriminating factor. Most academic engagement activities aimed at obtaining resources to support projects strictly adhere to a traditional research approach. Academic entrepreneurship marks a profoundly different behavior with respect to making businesses from academia or measuring market acceptance of research outputs. It is also true that commercialization (exploitation) often follows or overlaps typical academic engagement activities.

The theoretical background can be traced back to two broad fields of study: (i) *University-Industry interactions and University Entrepreneurship* and (ii) *Academics’ Entrepreneurial Intentions and Entrepreneurial Self-efficacy*. These two fields will be explored below.

2.1 UNIVERSITY-INDUSTRY INTERACTIONS AND UNIVERSITY ENTREPRENEURSHIP

Universities have different attitudes and behaviors toward the enhancement of innovation resulting from internal research and or carried out in collaboration with businesses. Likewise, different attitudes are adopted by national governments regarding measures taken to stimulate the country's economic and social growth, based on the creation of innovative opportunities arising from university-industry interactions.

EU governments, like many others all around the world, promote policies related to science and technology to afford universities a central role in supporting economic growth through knowledge transfer to industry. Concurrently, universities themselves play an active role in the exploitation of research results, extending beyond the phase of scientific exploration. This “new” approach to academic governance has strengthened collaboration between academia and industry, placing much emphasis on commercializing research results as a source of funding as well as of economic returns.

The widely held belief in literature is that university and industry belong to culturally different worlds: (i) science and (ii) commercialization of science. Traditional researchers consider money a means of promoting scientific progress, while for the businessperson, the end is money, and the means is science. Sharing research itineraries facilitates interaction between these two worlds that have - or should have -

common interests, even if complex, such that they lead them to collaborate to improve the application of scientific results to the business world.

It is true, however, that every university in the world, both public and private, interacts with industry in different ways. However, it is possible to identify elements and characteristics that determine the efficiency of the innovation's system. In fact, a simple interaction does not necessarily translate into a flow of knowledge and technology between actors. The actors must develop organizational skills, individual and/or group, based on an integrated social system that can facilitate communication and therefore the sharing of activities. Hence, the abilities to absorb and release knowledge represent fundamental elements for both actors – university and industry – until the process can take place.

The research stream on university entrepreneurship is rich in numerous theoretical and empirical contributions (Landry et al., 2006). Recently the debate has focused on the topic of entrepreneurial universities and on the triple connection between institutions, academic innovation and industry but also on the evolution of the roles assumed by the actors in this field (Rothaermel et al., 2007; Perkmann et al., 2013; Hmieleski and Powell, 2018).

The changing relationship between academic scientists and the marketplace has resulted in a heated debate on the consequences of blurring the boundaries between science and business. Scholars who fear the convergence of academic interests with those of industrial capitalism oppose those who view this profound institutional transformation positively. This is because from such a condition an identity crisis could arise with respect to the academic scientists' role and the erosion of their freedom and autonomy.

After all, institutional change occurs as a natural process that inevitably leads to entrepreneurial university, a management model suited to the current context.

Framing the issues more broadly, academic researchers' involvement in commercialization of research results, identified as academics' states of the mind regarding a business concept, can range between two relatively opposite points:

- i) to be totally opposed to transitioning to the business world and then focusing on exploration, or
- ii) to be oriented to founding and/or managing a spin-off to pursue exploitation.

Between these two extremes, researchers operate in a grey area characterized by consulting and seeking partnerships and/or various commercial opportunities. Beyond the operational behaviors, there are the intentions, latent, to be entrepreneurs that, unconsciously or not, exist among many academic researchers.

A specific topic in the debate on university-industry relationships concern difficulties and problems inherent in the relations of cooperation and growth between a spin-off and the "parent" university. This aspect takes on relevance in the academic case under study, which is likely to be placed between a traditional management approach and the current more diffused and therefore "innovative" one.

A further topic that, however, has received little attention in the literature concerns relationships between the institution and the spin-off company. Specifically, if the researchers believe that involvement in the spin-off could slow down or accelerate career advancement, with all the consequent effects on the behavior of both the researcher and the institution. This, like the issues listed above, is discussed in the analyzed case study.

2.2 ACADEMICS' ENTREPRENEURIAL INTENTIONS AND ENTREPRENEURIAL SELF-EFFICACY

In the context of studies related to the analysis of individual personality, some "milestones" of the literature can be placed, including:

- *academic knowledge exploitation and national growth*: Etzkovitz and Leydesdorff (2000); Link et al. (2011).
- *knowledge and technology transfer from university to industry*: Roberts and Malone (1996); Lockett et al. (2003); Landry et al. (2006, 2007, 2010); Scuotto et al. (2020).
- *involvement of organizational, individual, and institutional factors*: Louis et al. (1989); Cohen and Levinthal (1990); Davenport and Prusak (2000); Di Gregorio and Shane (2003); Siegel and Wright (2015); Ahmad et al. (2018).
- *academics' external engagement*: Klofsten and Jones-Evans (2000); Bozeman and Gaughan (2007); D'Este and Perkmann (2011); Haeussler and Colyvas (2011).

To these are added *self-efficacy and entrepreneurial intention*, then applied in the case study.

2.2.1 ENTREPRENEURIAL SELF-EFFICACY AND INTENTION

Entrepreneurial self-efficacy (ESE), grounded in social cognitive theory, is the individual's perception about their capabilities of being an entrepreneur and having the necessary skills and the belief in performing entrepreneurship roles and tasks successfully (Boyd and Vozikis, 1994; Bandura, 1977; Bandura and Adams, 1977; Senelwa et al., 2016). The ESE construct measures a person's belief in their ability to carry on an entrepreneurial project venture and incorporates both personality and environmental factors; these factors shape one's beliefs in having the ability to successfully perform a specific behavior. Individuals with high levels of self-efficacy set challenging goals, have a tolerance for failure, and persist in achieving goals even under difficult and stressful circumstances. This approach can be seen congruent with Maslow's (1954) self-actualization concept about of *what a man can be, he must be*.

ESE perception is higher among individuals who believe they have the capability to be entrepreneurs and therefore have entrepreneurship intentions and who ultimately act. A given environment can be perceived as full of opportunities or full of obstacles, and this depends on the individual's level of self-efficacy. Therefore, it is the result of the (conscious or unconscious) analysis carried out by the individual or a group about the desirability and feasibility of a specific situation. Liñán et al. (2005: 4), utilizing the entrepreneurial intention model, distinguished: (i) the perceived desirability, referring to the degree to which an individual feels attraction for a given behavior (to become an entrepreneur), from (ii) the perceived feasibility, which is defined as the degree to which people consider themselves personally able to carry out certain behavior.

Consequently, according to Bandura's (1986) assertions, self-efficacy affects individuals' choices, the strength and degree of perseverance directed towards an activity when obstacles are encountered, as well as an individual's capacity to be resilient. To be more predictive, self-efficacy should be focused on specific tasks and domains, such as on core entrepreneurial activities that require certain roles and skills. General self-efficacy instead reflects an individual's perception of a variety of tasks across a variety of situations.

Entrepreneurial intentions, rather, are self-recognized beliefs of individuals who intend to form new entrepreneurial initiatives and consciously plan to do so at an imminent or indeterminate point in the future (Thompson, 2009). This construct is fundamental for entrepreneurship studies even though there are many defining approaches and consequently many disparate metrics (McGee et al., 2009). Entrepreneurial intent, which incorporates different concepts such as individual aspirations and career orientations, nascent entrepreneurship and/or self-employment, can be considered as an "umbrella notion". Personal situations and contexts create mental states and intentions that influence an individual's behavior. However, it is fundamental to distinguish entrepreneurial intent from entrepreneurial disposition. Someone, after having thought about starting a new activity (intention) in the future, may (i) not have done so yet but, at the same time, not have yet set aside this possibility or (ii) may have already abandoned or realized his project (disposition).

Hence, intention-based models can predict entrepreneurial behaviors better than other variables like individual (personality) or situational ones (employment status). It is generally assumed, for corporate as well as for academic contexts, that at the heart of entrepreneurship, one can find the individual's passion embedded in their entrepreneurial (self-) identity, and so in their entrepreneurial intentions, attitudes, and behaviors as well as in their critical developmental experiences. Intention is the immediate antecedent of behavior (Ajzen, 2012) although it is true that scholars discuss the hypothesis that outcome expectations directly influence feasibility perceptions (Williams, 2010). For example, it is a fact that financial opportunities and reputational gains could increase the perception of being able to take on such a challenge. It is equally true that intentions imply the will to engage in behavior, while self-efficacy implies the belief that one can engage in that behavior. Previous successful behavioral performances and their observation, verbal persuasion, physiological and affective states are some of the main factors influencing self-efficacy judgments.

Moreover, Fitzsimmons and Douglas (2011), according to expectancy theory, consider interacting perceptions of feasibility and perceptions of desirability in the formation of the individual's entrepreneurial intentions; they discuss four possible typologies based on the interaction between perception of feasibility and desirability of being entrepreneurs and hypothesize a negative interaction effect. They "find evidence that individuals with lower levels of perceived desirability (or 'motivation' in

the authors' terminology) may form the intention to act entrepreneurially if they perceive themselves as having sufficient perceived feasibility (or 'knowledge' in authors' terminology) to do so. But we also find empirical evidence that individuals with strong perceptions of desirability may form the intention to act entrepreneurially even when they perceive themselves as not having the perceived feasibility (self-efficacy) to do so" (2011: 437). High perceived feasibility combined with low perceived desirability – the most frequent instance in our survey (see further) – determines an "accidental entrepreneur": the high feasibility of entrepreneurial action induces the intentional entrepreneurship although without any strong desire to become an entrepreneur. In the presence of an attractive opportunity and a low perceived feasibility but high desirability to become entrepreneur, the exploration of opportunities forms an "inevitable entrepreneur". "This person typically may not have the self-efficacy (nor the underlying skills, education and experience) that will ensure successful entrepreneurial action but is very highly motivated to be one's own boss and subsequently forms the (potentially ill-fated) intention to become an entrepreneur" (2011: 438).

2.2.2 GENDER DIMENSIONS IN THE COMMERCIALIZATION OF ACADEMIC RESEARCH OUTPUTS

In the mainstream and widely shared literature, a ubiquitous topic is the exploration of gender differences in academics' perceptions regarding the commercialization of research results. In general, the percentage of female participation in the process of commercialization of university research results, especially as founders of spin-offs, is very low compared to their male counterparts. This condition depends on many barriers identified as significant for women compared to men in the entrepreneurial challenge, which may also include national cultural influences (Ding et al., 2006; Rosa and Dawson, 2006; Bonte and Piegeler, 2012; Shinnar et. al., 2012; Stephan and Drews, 2015; Alonso-Galicia et al., 2015; Goel et al., 2015; European Commission, 2023). Among these, we like to list:

- females' tendency to be part of an entrepreneurial team together with senior male colleagues.
- underrepresentation of female academic staff in science research.
- females' aversion to a high level of risk and fear of failure (low risk tolerance).
- widespread lack of support from institutions, family, lenders, customers and suppliers.
- less confidence on the part of females in their abilities.
- external interest in senior researchers who are predominantly male; and
- last, and equally important, females' interest in home and social life that more often prevails over job satisfaction.

These aspects of different nature, social, cultural, infrastructural, educational and work-related, are obstacles rather than facilitators to female entrepreneurship, they are expressed differently in unrelated local contexts but still characterize them today.

3. AN EXPLORATORY CASE STUDY OF ENTREPRENEURSHIP FROM ACADEMIC LAB

This study has its origins in a broader research project on academic entrepreneurship from laboratories by three departments of the University of Campania L. Vanvitelli, a public university in southern Italy, leading entity in the foundation, in 2007, of the Regional Center of Competence in Industrial Biotechnology of Campania. The Center aimed to foster the encounter between the wealth of biotechnology skills and the business world.

3.1 THE EXPLORATIVE RESEARCH PLAN

The aim of the research conduct was to explore motivation and critical matters that led scientists to found, or not, an academic spin-off firm. We applied a two-layered perspective: an organizational perspective and an individual one.

To achieve this goal, a study was conducted involving 59 voluntary non-clinical faculty members or researchers, with research activities focused on life sciences sectors. It is essential to point out that in the context investigated the approach to Technology Transfer (TT) matters is predominantly "traditional", i.e.

poorly oriented towards direct commercial exploitation by researchers; therefore, the sample is necessarily "skewed".

The Departments that presented those skills were as follows: (i) Biochemistry, Biophysics and General Pathology (based in Naples), (ii) Environmental, Biological and Pharmaceutical Sciences and Technologies (based in Caserta), and (iii) Experimental Medicine (based in Naples too). The total number of scientists operating in these three departments was 148, and the response rate was 40%. The sample was therefore composed of researchers of which approximately 49% were from the Department of Experimental Medicine, 45% from Biochemistry, Biophysics and General Pathology and 25% from Biological and Pharmaceutical Sciences and Technologies (Table 1); 3 interviewees did not indicate in which of the three Departments they worked.

Table 1. Sample characteristics

Position of the respondent within sample			
Position	%	n =	Ph.D.s
Full Professor	20%	12	3
Associate Professor	22%	13	10
Other researcher positions ¹	31%	18	14
Undisclosed	27%	16	10
Total	100%	59	37
Department of the Respondent and Response Rate ²			
Department	n =	RR%	
BioCFGP ³	14	45.16%	
EBPST ⁴	16	25.00%	
ExpMed ⁵	26	49.06%	
Undisclosed	3		
Total staff of the departments = 148			
Respondent's average age and average length of service in Dept			
Position	Age	Length of service	
Full Professor	61	34	
Associate Professor	53	22	
Other researcher positions ¹	42	14	
<i>min</i>	27	2	
<i>max</i>	70	50	
<i>Average (total)</i>	50	21	
Respondent's Gender			
Gender	n =	%	Average age
Female	27	51%	54.11
Male	27	51%	46.04
Undisclosed	5	9%	

¹Including PhDs, PhD students, temporary research fellows, technical staff. ²RR calculated by dividing the self-reported research disciplines of the respondents by the number of staff in the corresponding departments surveyed. ³Biochemistry, Biophysics and General Pathology. ⁴Environmental, Biological and Pharmaceutical Sciences and Technologies. ⁵Experimental Medicine. *PhD rate approximated – only individuals younger than 57 years considered (based on Italian PhD program history). *Mailing lists may have included non-target individuals.

As mentioned above, the choice to focus the study within the academic domain of life sciences was made because it is one of the “most active areas of university knowledge transfer (Salter and Sobrero, 2013)” and represents the largest share of funds invested in academic research worldwide, which conveys the interests of industry, governments and non-profit institutions. However, it is an area of research that is studied little from an entrepreneurial perspective.

The research plan focused on entrepreneurial factors in an academic context in order to depict the specific local system.

To formulate the survey, some models previously validated in the literature by scholars including Izquierdo and Buelens (2008), Lam (2009, 2011), Schofield (2013), and Malebana and Swanepoel (2014) were used. The analysis of the results considered specific context facts given the awareness that a simple

application of models tested in other systems to support a benchmark analysis can lead to a distorted vision of reality.

To ensure accuracy, the questionnaire was prepared in English, then translated into Italian and then back into English. To administer the survey and collect data and opinions, we invited all identified members to fill out the online questionnaire anonymously. After the first invitation to connect to a URL, we sent a reminder to the entire target population to ensure valid, standardized and anonymous data collection that took place between January and December 2017.

The questionnaire contemplated two sections to detect items and data about (i) the research organization (Departments) and (ii) each individual researcher.

The first section was aimed at the organization to which the interviewees belonged to detect elements relating to:

- general information about the structure.
- research focus of the groups in terms of Basic Research (BR, research that is not motivated by an immediate application), Applied Research (AR, research geared towards a specific application), and Experimental Development (ED, prototyping and other systematic work using practical experience).
- characterization of the departments' technological fields of operation.
- spin-off firms founded.
- partnerships with firms and/or other research institutions.

The second section noticed questions on the respondent's background:

- demographic information, such as age, academic status, and previous work experience.
- number of patent ownership, production of scientific papers.
- orientation toward business creation, problems faced about the relationship between the institution and the spin-off firm, gender differences in the commercialization of academic research, entrepreneurial intentions, and scientists' beliefs, motivations, and attitudes toward university-industry links.

This contribution considers only some of the research questions of the full survey, namely:

- What is the awareness of the spin-off phenomenon for the commercialization of research results?
- Do the partnerships activated with companies and/or other public/private research institutions influence the entrepreneurial orientation of researchers?
- Which problems can arise and affect the relationship between the academy and the spin-off company?
- Is the gender of researchers a factor that can influence their entrepreneurship orientation?
- What are the entrepreneurial intentions of researchers?

3.2 THE DEPARTMENTS: DATA AND RESULTS

Below we begin by exploring the data collected on the Departments to conduct the analysis at the organizational layer.

3.2.1 RESEARCH FOCUS OF THE GROUPS

To characterize the research activities carried out, the study considered the research groups made up of people who collaborated daily on the same projects and/or for the same scientific area, such as a research school or a sub-department or, in general, people who have worked in the same place. We asked respondents to indicate how much time (as a percentage of total working time) their research group was spending on BR, AR, and ED.

By analyzing the results and grouping them into three-time classes dedicated to research activities (up to 30% for BR, from 31% to 70% for AR and >70% for ED), it emerged that, although the attention to BR prevails among the interviewed groups, none of the three types of research was definitively excluded (Table 2a). Out of 54 interviewees, those who did not dedicate any time to one or two of the other indicated searches were only 1 for BR, 9 for AR and 34 for ED. The results support the idea that groups also devoted part of their time to AR and ED.

Subsequently, the cases were counted in which – again in relation to the time dedicated by the group – each type of activity had been considered as a main or minor activity (Table 2b). The analysis verified that

BR was the main activity, ED the minor, and AR received fair attention. We can therefore assert that from a systematic view, the groups dealt with the whole path involving scientific research, from BR to AR and, interestingly, also carrying out ED.

Table 2a. Interviewees per percentage of total time spent by research's group for

Research Type	0-30%	31-70%	>70%	N.R.	0%	100%
Basic Research (BR) *	11	21	22	5	1	9
	20%	39%	41%		2%	17%
Applied Research (AR) **	32	22	0	5	9	0
	59%	41%	0%		17%	0%
Experimental Development (ED) ***	51	3	0	5	34	0
	94%	6%	0%		63%	0%

Table 2b. Interviewees for total time spent by research's group in

Research Type	Main	%	Minor	%
Basic Research (BR) *	36	75%	3	13%
Applied Research (AR) **	11	23%	5	21%
Experimental Development (ED) ***	1	2%	16	67%

*Basic Research: research that is not motivated by an immediate application

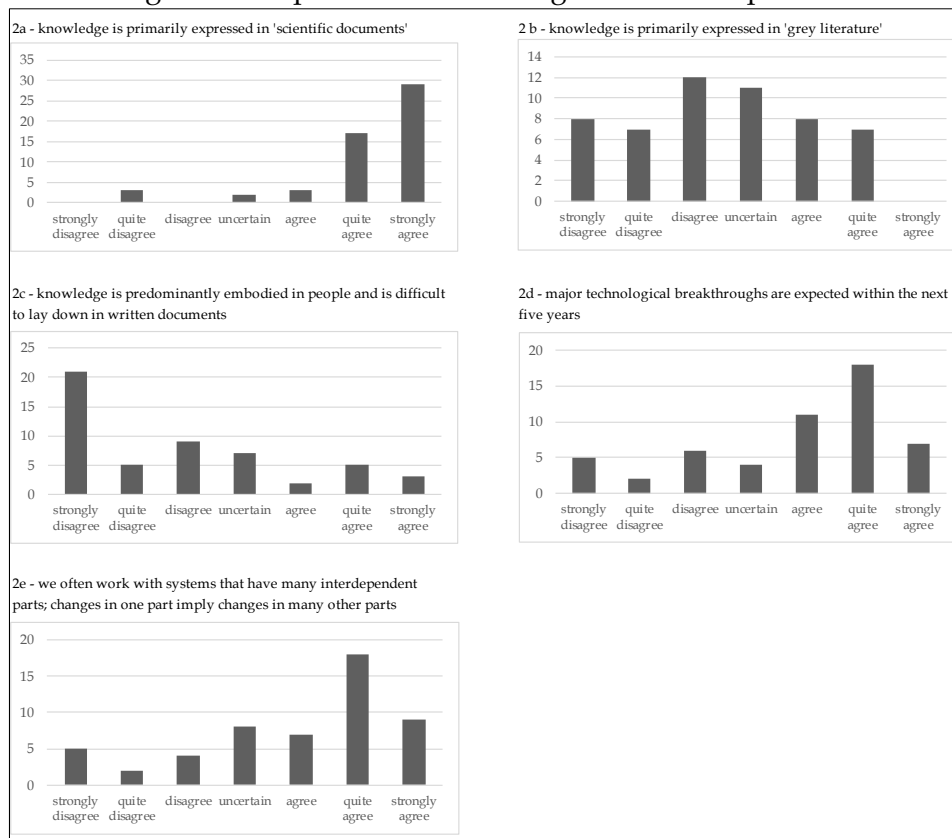
** Applied Research: geared towards a specific application

*** Experimental Development: prototyping and other systematic work using practical experience

3.2.2 TECHNOLOGICAL FIELDS OF OPERATION

To collect data characterizing the departments' technological fields of operation, we proposed five items plotted using a 7-point Likert scale (1 = strongly disagree, and 7 = strongly agree) (Figure 1: a, b, c, d, e).

Figure 1 - Departments' technological fields of operation



It can be noted that none of the five proposed items met the conditions of perfect discrimination or nondiscrimination. It was possible to observe a prevalent consensus on considering knowledge to be

primarily being expressed in “scientific documents” (e.g., journal articles, conference papers, and proceedings). On the other hand, opinions on considering knowledge to be expressed primarily by the so-called “grey literature” (e.g., patents, industrial reports, confidential memorandums, discussion lists) appeared conflictual. There was also no consensus that knowledge is primarily embodied in people and therefore difficult to transcribe into written documents; therefore, we can argue that interviewees believed that knowledge could be codified and transferable. Furthermore, there was strong agreement on two other positions: (i) major technological innovations are expected within the next five years, and (ii) researchers often work with architectural systems that have many interdependent parts, so changes by one bring about changes in many others.

3.2.3 AWARENESS OF THE SPIN-OFF PHENOMENON FOR THE COMMERCIALIZATION OF RESEARCH RESULTS

This topic has been examined from several angles.

A first question was designed to reveal whether in the last ten years academic spin-offs had been born from the respective departments (therefore linked to the research focus or Intellectual Property of professors/researchers). Thirty-six researchers showed awareness that some spin-offs had been founded; thirteen replied “no”, whereas only six were unable to provide information on the matter.

An interesting result obtained is the refutation of the simplistic hypothesis according to which the level of spin-off awareness was higher in groups that devoted more time to application-oriented and/or development-oriented research activities. In fact, this level of awareness mirrored that found in relation to the time spent by the research groups on the three types of activities (Table 3).

Table 3 – Interviewees aware that their organizations have founded spin-off firms in the last decade per percentage of total time spent by research group in

Research Group	0–30%		31–70%		>70%		N.R.
Basic Research (BR)	6	17%	14	40%	15	43%	1
Applied Research (AR)	13	48%	14	52%	0	0%	9
Experimental Development (ED)	13	87%	2	13%	0	0%	21

On the other hand, it was found that in this context, the attention of individuals and their involvement in entrepreneurial activities were low, and there was a lack of attention from institutional communication on the issues of academic entrepreneurship. All this, despite the significant presence of research groups active in AR and ED.

It can therefore be assumed that two clearly distinct realities coexist: (i) one formed by those who were actively involved in the processes of valorizing research results and the other (ii) by those who were not. For that reason, it can be asserted that attention to BR represents a permeable barrier to the diffusion of entrepreneurial culture.

3.2.4 PARTNERSHIPS POWERED UP WITH FIRMS AND/OR OTHER PUBLIC/PRIVATE RESEARCH ORGANIZATIONS

Another critical factor capable of influencing the propensity toward academic entrepreneurship is the diffusion of partnerships powered up by academic/research organizations with firms and/or other public/private research institutions.

The survey revealed a widespread presence of partnerships between the three departments and industries or other external institutions: 49 respondents, or 89% of the total, reported that their membership organizations had initiated partnerships. Only six respondents did not believe that their organizations had powered up partnerships with firms and/or other public/private research organizations: three belonged to a research group more focused on BR, and the others to a group not very committed to AR.

The types of partnerships indicated as the most widespread were *research and development contracts*, regardless of the research focus of the groups, followed by *product co-development* (Table 4). For groups focused on BR, all typologies of partnership were nurtured by their organizations; in contrast, *product co-*

development was particularly significant when the focus was on AR or ED. We can note that *license contracts* rarely appeared to be activated (only three respondents pointed it out), and it was never reported for research groups focused on ED; *joint ventures* appeared to be marginal and *logistical services* and *informal contacts* were even more so.

Table 4 – Typologies of partnerships entered by organizations with firms and/or other public/private research institutions, per time spent by research's group

Typology	a.v.	t.s. BR ≥ 50%*	t.s. AR ≥ 50%*	t.s. ED ≥ 40%**
Research & Development Contracts	43	31	11	3
Logistical services	2	2	1	1
Licences	3	1	2	0
Products Co-Development	10	6	3	1
Joint ventures	3	3	0	0
Only informal contacts	1	1	0	0

*Two respondents stated that the research group equally shares time between Basic Research (BR) and Applied Research (AR).

** For this typology, the threshold taken into consideration was 40%.

The propensity of organizations to form partnerships did not appear to be directly related to the research groups' focus (Table 5). In the three departments examined was evident a latent possibility of enhancing the outputs stemming from the interaction between science and industry which, probably due to the diversity of interests and cultures, is not configured as a characteristic activity of the "usual" academic path.

Table 5 – Interviewees whose organizations have powered up partnership with companies and/or other public/private research institutes, per range time spent by the research group in

Research Group	0%	1-30%	31-70%	>70%	N.R.	TOT
BR	1	8	21	18	1	49
	2%	17%	44%	38%		
AR	9	19	20	0	1	49
	19%	40%	42%	0%		
ED	30	15	3	0	1	49
	63%	31%	6%	0%		

The analysis of the relationships between the types of partnerships formed by the organizations and the number of spin-off companies already founded or projects in progress (Table 6), led to some additional considerations. Thirty-four respondents whose organizations had started both partnerships and spin-offs, all reported that their organizations had founded spin-off firms, and twenty said that they were also aware of spin-off projects being underway. From the opinions expressed, research and development contracts appeared to be the type of partnership that more than others, could lead to the foundation or advanced design of spin-off companies, followed by product co-development. Indeed, logistics services, licenses, joint ventures, and informal contacts were secondary findings.

Table 6 – Respondents whose organizations have entered in partnerships and have already founded or have spin-offs' projects in progress

Partnership Type	Spin-off founded*	Spin-off in progress**
Research & Development Contract	29	18
Logistical services	2	0
Licences	3	1
Product's Co-Development	10	4
Joint ventures	2	3
Only informal contacts	1	1

*Interviewees whose organizations powered up partnerships are 34; all report that their organizations have founded spin-off firms.

**Interviewees whose organizations powered up partnerships are 34; 20 report that their organizations have spin-off projects in progress.

3.3 THE RESEARCHERS: DATA AND RESULTS

After having explored the data on the Departments, we moved on to the individual level of analysis through the data collected by the researchers who represent themselves.

3.3.1 ACADEMIC ENTREPRENEURSHIP AND RESEARCHERS' INDIVIDUAL FACTORS

In the survey, respondents' gender was equally distributed between males and females (five did not indicate their gender) (Table 1 above). The youngest was twenty-seven years old, and the oldest was seventy; the average age for males was >54, while it was 46 for females. We counted a lower number of women who were full professors but respectively a greater number who were associate professors and academic researchers (PhDs, PhD students, temporary research fellows, and technical staff); about 26% did not indicate their academic status. The average length of service was 21 years, with a variation between 2 and 50 years, and is distributed naturally in relation to the progression of academic status (Table 1 above).

Given the opinion that the typology of research conducted in the laboratories influences researchers' orientation toward the commercialization of research outputs, we determined the main nature of research conducted by respondents asking them to express the type of prevailing research on a scale from 1 (BR) to 6 (AR) (Table 7).

Table 7 – Interviewees per nature of research conducted

Main nature of research	1	2	3	4	5	6	N.R
No.	15	9	14	10	3	3	5
%	28%	17%	26%	19%	6%	6%	

Scale from 1 (basic research) → 6 (applied research)

BR (classes 1 and 2) prevailed over AR (5 and 6), which was slightly marginal with respect to the total; a concentration in the middle classes (3 and 4) of the scale was evident.

The modal value collected 28% of the respondents in the specific extreme class of BR. Note that, by aggregating the six classes in a pairwise sequence of two, we would have a bimodal distribution. This would express an equivalent maximum frequency for BR (classes 1 and 2) and for the pair in the center (3 and 4) of the proposed interval. Therefore, it was evident that there were research activities whose nature was perceived as equidistant between BR and AR. Furthermore, we can state that AR received marginal attention from researchers. This situation mirrors the one drawn by noting the time spent by their research group on the three types of research activities (see below). It is important to emphasize, however, that the roles of BR and AR must be consistent with the mission of a public university in Italy. From the picture drawn for the analyzed academic structures, we can assume that researchers' attention is probably shifting towards a mix of BR and AR.

We then considered individual's academic research and innovation activities by analyzing some factors, in detail:

i. *Number of patent holders and number of patents held:* only twenty of the interviewees held patents, on average 3.45 each. The distribution of the interviewees was homogeneous with respect to (i) the type of research mainly carried out and (ii) the ownership of patents, thus highlighting a widespread capacity to generate innovation. It is important to note that (i) for the number of patents held, the productivity of application-oriented researchers was prevalent (five patents each on average), and (ii) only one patent, held by a senior researcher not focused on AR, generated economic returns. Full professor was the prevalent academic status among patent holders, while female researchers held only 17% of the total patents. It should be added that in the specific context of the academic areas of life sciences, patenting has only recently assumed an express value in career paths, and this may now represent a stimulus to patent in general and for female researchers in particular.

ii. *Orientation toward business creation:* the respondents had rarely participated in business plan competitions (only seven in total—five males and two females). It should be noted that Academic Researchers have never had this experience which, on the contrary, is considered particularly significant from a training point of view and to gain awareness of their entrepreneurial self-efficacy. Only nineteen

respondents (35%) had ever thought founding a firm to commercialize their research, and in almost all cases, the organization to which they belonged had initiated the partnerships; barely four “mezzanines” (38 to 49 years old) had already done so (one was an associate professor and three were academic researchers, of which only one was a female). It is a fact that respondents who had never thought about starting a company to commercialize the results of their research lived in a more entrepreneurial social dimension (with respect to the research group too), unlike the few who had already started a business. We know that the extensive presence of “pro-entrepreneurs” encourages a business approach to the exploitation of research outputs. It is evident that its marginal presence in this academic community greatly reduced its entrepreneurial potential.

iii. *Previous work experience*: half of the respondents (26) had previous work experience and, among them, only three were focused on AR; universities/education and public or semi-public research organizations had been the previous employers for 85% of the respondents (Table 8). It is interesting to highlight three circumstances. Among the respondents, the propensity to start a company to commercialize research results was high (i) if they had previously been employed in a company; (ii) if, in the last decade, a spin-off company had been created by the organization to which they belonged or if (iii) a project with this aim was underway. The other half of the respondents had never been previously employed; only one had already founded a company and six had thought about it (Table 8).

Table 8 – Interviewees having had a previous work experience

No one previous work experience:			
	n	Have ever thought founding a firm	Have already founded a firm
Academic researcher	8		
Full Professor	8		
Associate Professor	3		
N.R. (no response)	7		
Total	26	6	1
One previous work experience at least			
Type of Organisation	n	of which	Have ever thought founding a firm to commercialize their research
university/education; public/semi-public research organization	22	8	yes
large company	3	2	yes
small business	1	1	yes
N.R. (no response)	33		

After all, as is well known, the “master experience” is a factor capable of strongly determining the level of self-efficacy based on the search for solutions adopted in the past and this favors academic entrepreneurship.

3.3.2 RELATIONSHIP PROBLEMS BETWEEN THE SPIN-OFF FIRM AND THE ACADEMIC INSTITUTION

The initial screening question was as follows: *In your opinion, could there be problems in collaboration and growth in the relationship between the spin-off and your academic institution?*

No perception of risks emerged from the survey conducted. Forty-three respondents believed there could not be problems regarding cooperation and growth between the spin-off and their organization, whereas eleven thought otherwise.

Two sets of questions were used to collect opinions on the probable problems or advantages/disadvantages that could arise between the founders of the spin-off company on the one hand and their “parent” organization on the other.

The first set, in order to bring out the problems that could arise during the relations between the spin-off and the academic institution, included four items (Table 9), namely, the formal involvement of

researchers, agreements between the NewCo and the academic organization, the use of infrastructures, and availability of spaces to rent.

Table 9 – Items able to reveal which problems could arise in the relationships of collaboration and growth between the spin-off and the academic institution

Item	In total	Agrees	%	Disagrees	%	Neutral	%
Formal involvement of researchers from the tenured organization	11	6	55%	1	9%	4	36%
Formal agreement of NewCo with the tenured organization	11	6	55%	2	18%	3	27%
Using the infrastructure of the tenured organization	11	8	73%	3	27%	0	0%
Space available for rent in the tenured organization	11	8	73%	2	18%	1	9%

43 interviewees believe that there could not be problems in the relations of cooperation and growth between spin-off and their organization.

To investigate this issue, we cross-referenced the data with those in which the respondents indicated whether they thought of founding a spin-off company, or not, to market the research outputs, or if they had already done so. Among the eleven respondents who believed that there could be problems regarding cooperation and growth between the spin-off and their organization, in the past most (64%) had frequently thought of setting up a company to commercialize their research; however, only two had already done it. On the other hand, among the forty-three respondents who did not believe there could be problems, those who had never thought of starting a company prevailed (31 or 72%), whereas among those who had thought about it (12 or 28%), only two had already founded a firm to commercialize the research outputs.

We can therefore argue that the prevailing perception among researchers that problems cannot arise with their own organization in founding a spin-off firm to enhance the results of their research work is determined by being little or not really involved in the processes of academic entrepreneurship. However, usually scientists fear that problems will arise in relations with their organizations, strongly discouraging the founding of a spin-off company. The risk of probable conflict with the parent organization acts as a "hygienic factor": if the risk is high, researchers are discouraged from commercializing their results but if the risk is low, they are not necessarily encouraged to do it.

Through applying a set of three items, we have also analyzed the perception that researchers had about the advantages/disadvantages related to being involved in a spin-off process in terms of their careers. On this point, the convictions expressed differed, specifically with respect to whether involvement in the spin-off would slow down or accelerate career advancement. The perception prevailed that involvement in spin-off companies would not slow career advancement (38 units) while there was greater uncertainty about the possibility of making it faster (25 units), even if 38% (or 20 units) of respondents believed that this was also possible (table 10). Instead, there was broad agreement that incentives serve to stimulate the involvement of researchers in TT's academic activities.

Table 10 – Respondents' believing that ...

Statement	Yes	Don't know	No	N.R.
... involvement in the spin-off can slow career advancement in their organization and:	4	14	34	7
- have thought founding a firm in the past to commercialize their research ...	1	4	14	
- have founded a firm in the past to commercialize their research *	0	2	2	
... involvement in the spin-off can speed up career advancement in their organization and:	20	25	7	7
- have thought founding a firm in the past to commercialize their research ...	6	9	4	
- have founded a firm in the past to commercialize their research *	0	4	0	
... incentives are used to stimulate the involvement of their researchers in TT activities and:	27	15	10	7
- have thought founding a firm in the past to commercialize their research ...	11	3	5	
- have founded a firm in the past to commercialize their research *	1	1	2	

** Subset of those who have thought founding a company in the past to commercialize their research*

The deepening of the topic with respect to the entrepreneurship orientation of researchers, had confirmed that those who believed they could not slow down their professional advancement had also thought about founding a company. There was great uncertainty, however, about the possibility that this could accelerate one's career. Indeed, we can say that scientists did not think that starting a company to commercialize the results of their research was a beneficial or detrimental action, which could therefore speed up or slow down their careers.

It is also interesting to note that most respondents ($n=27$) had considered their organization's incentives to be useful in stimulating involvement in TT activities. Therefore, it could be argued that the possible risks (failure, greater difficulty in internal career advancement, etc.) and the commitment connected to involvement in TT activities can be rebalanced by incentives, defined in a broad sense. This condition suggests that a low degree of propensity for entrepreneurship was widespread among respondents.

3.3.3 GENDER DIMENSIONS IN THE COMMERCIALIZATION OF ACADEMIC RESEARCH RESULTS

The issue of gender and entrepreneurial propensity is still hotly debated in academic and corporate entrepreneurship literature.

Especially for academic entrepreneurship, gender differences fuel the search for personal, social, and environmental factors to explain the motivation to become an entrepreneur (Rosa and Dawson, 2006; Fitzsimmons and Douglas, 2011; Shinnar et al., 2012; Alonso-Galicia et al. 2015; Teixeira and Nogueira, 2016).

We have already highlighted that our survey showed a substantially equivalent distribution between males and females; this composition was not fully representative of the reference universe of academic researchers, where even today women are less numerous than men. Therefore, it is not possible to attribute to the gender variable a discriminating value in the dataset considered, or at least it is not to the advantage of the male component. In fact, as we have already pointed out, a convergence of opinions that the female gender is almost rare in academic spin-off processes, especially in the life sciences, was evident. Therefore, given the equal gender composition of our survey, it was interesting to analyze some behavioral aspects.

Female researchers held only 17% of the total number of patents held by all respondents. In fact, this confirms the claim in the principal literature that females get fewer patents because they are influenced by administrative, financial, and technical considerations beyond the control of inventors (Colyvas et al., 2012).

There were thirty-five researchers who had never thought of founding a company, of which twenty-one ($\approx 60\%$) were female, with an average age of ≈ 47 . Furthermore, six respondents out of nineteen in total were female researchers who had thought of founding a company, from which only one, an academic researcher, had done so.

The literature also asserts that participation in business plan competitions could be considered an expression of an individual's orientation toward business creation. In our survey, respondents who had participated were few (only seven professors), and only two were women ($\approx 29\%$).

To the question "Does the gender of the researcher play a role in a spin-off process?" our survey (Table 11) expressed strong (54%) and in general widespread (74%) disagreement, which was indifferent to researchers' gender; neutral expressions (12%) were slightly less than those in accord with the formulated proposition (16%).

Table 11 – Does the researcher's gender play a role in a spin-off process?

		n		male		female	
-3	Strongly disagree	54%	28	12	43%	16	57%
-2	Quite disagree	10%	5	3	60%	2	40%
-1	A little disagree	10%	5	2	40%	3	60%
0	Nor disagree, nor agree	12%	6	5	83%	1	17%
1	A little agree	6%	3	2	67%	1	33%
2	Quite agree	8%	4	1	25%	3	75%
3	Strongly agree	2%	1	1	100%	0	0%

After cross-examining the data, we concluded that in the departments examined, the opinion prevailed that the researcher's gender does not play a key role in a spin-off process. Note that among respondents to this statement

- i) different academic statuses were equally present,
- ii) the age group with the highest concentration was 30–59,
- iii) no research group focused on AR or ED, though
- iv) AR was present among the main typologies of personal research, and
- v) reflecting the general condition found in our survey (16/20), among the patent holders there was only one female with a clear prevalence of males ($n = 7$).

The widespread belief that gender is an influential variable in initiating spin-off processes corroborates the thoughts of those who attribute a primary role to other factors, first personal and contextual ones.

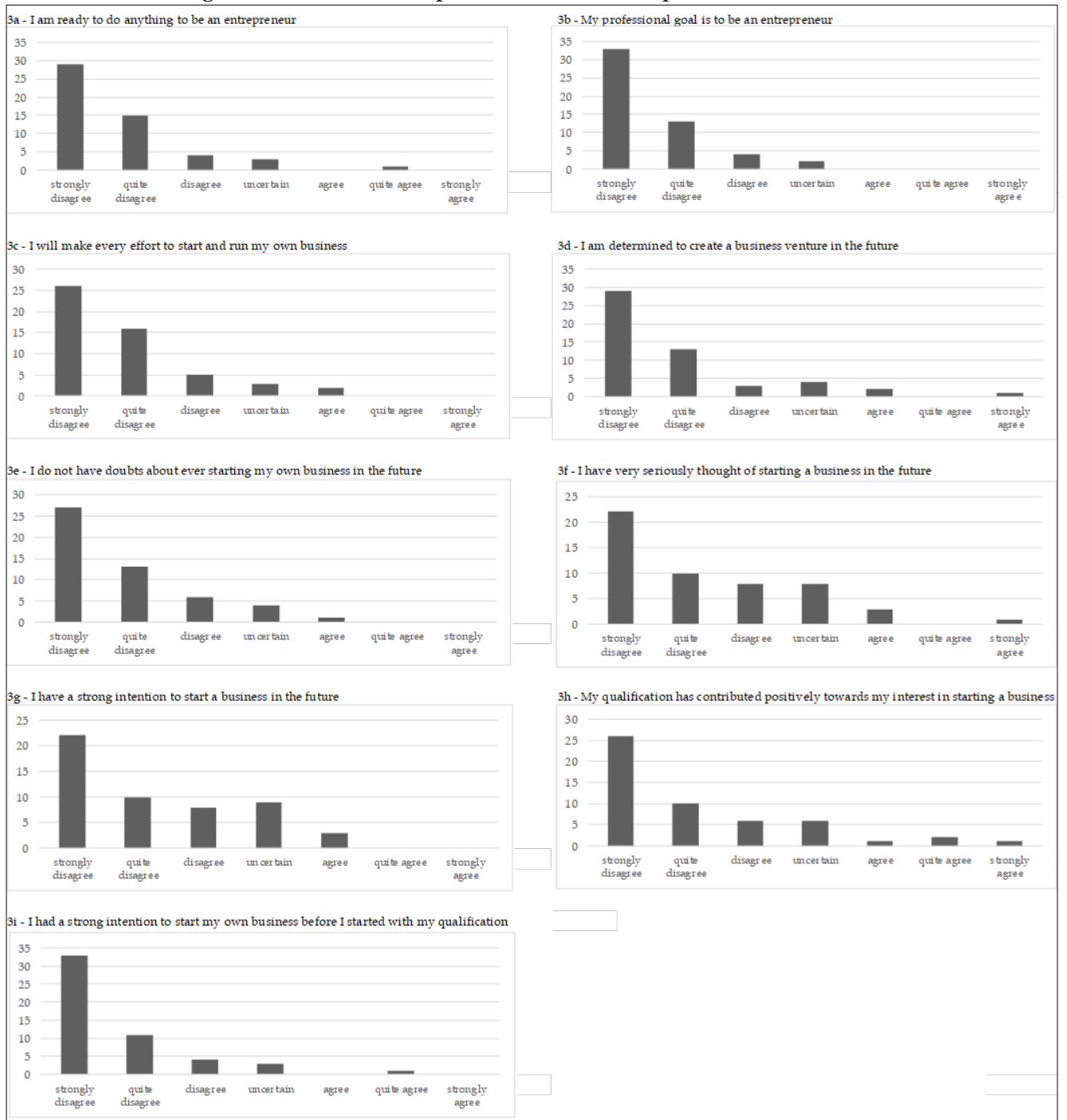
3.3.4 ENTREPRENEURIAL INTENTIONS

To study entrepreneurial intentions, a section of the questionnaire was designed based on surveys validated in previous studies (Liñán, 2008; Guerrero et al., 2008; Malebana and Swanepoel, 2014), opting, once again, for a 7-point Likert scale (1 = strongly disagree, and 7 = strongly agree). Nine items were adopted to measure entrepreneurial intentions (Figure 2):

- Q1. I am ready to do anything to be an entrepreneur.
- Q2. My professional goal is to be an entrepreneur.
- Q3. I will make every effort to start and run my own business.
- Q4. I am determined to create a business venture in the future.
- Q5. I do not have doubts about ever starting my own business in the future.
- Q6. I have very seriously thought of starting a business in the future.
- Q7. I have a strong intention to start a business in the future.
- Q8. My qualification has contributed positively towards my interest in starting a business.
- Q9. I had a strong intention to start my own business before I started with my qualification.

There was no prevailing convergence for any of the nine items proposed. The surveyed researchers showed agreement on their reluctance to be entrepreneurs. Respondents' agreement on the intention to not start a business in the future appeared to a lesser extent. In fact, just 35% of respondents had thought about founding a firm. It is also possible, after reading the data, to perceive the attribution of importance, albeit minimal, to professional qualifications, which could be a factor nurturing the intention to start a business.

Figure 2. Nine items adopted to measure entrepreneurial intentions



Introducing an intermediate mode between a high or low expression of feasibility and desirability, we can hypothesize three median positions, where the individual will assume a cautiousness to avoid mistakes and, in such situations, will tend to adopt neutral behavior, neither active nor passive. In this context, planned interventions that can increase the perceived levels of desirability or feasibility could support the possible fitting paths.

4. DISCUSSION AND MANAGERIAL IMPLICATIONS

In Italy the level of opportunity's TEA (Total early-stage Entrepreneurship Activity) is notorious to be very low between the fifty main economies all around the world (3,8, in the 2016, the lowest in Europe and North America areas (GEM, 2020); in medium/high-tech TEA rate was 0,4%, close to UE's average.

The above can contribute to increasing the rate of entrepreneurship from university research laboratories. In fact, one of the objectives of academic management is to reduce the "missing entrepreneur rate" from laboratories by fueling economic and social development and, at the same time, generating financial flows to the academic system.

In this sense, academic policy must consider some aspects.

Main type of research and valorization of results. The simplistic hypothesis that the level of awareness of spin-offs was higher in groups that devoted more time to application-oriented and/or development-oriented research activities was disproved. Therefore, encouraging the participation in research projects of different nature (AR, BR or ED) improves the propensity to valorize their results.

The risk of a possible conflict with the parent organization in cases of valorization of the results achieved. If the risk of conflict is high, researchers are discouraged from commercializing their results, but it is also true that if the risk is low, they are not necessarily encouraged to do so. Therefore, it could be argued that the possible risks (failure, greater difficulty in internal advancement, etc.) and the commitment associated with involvement in TT activities can be rebalanced by incentives, defined in a broad sense, made available by academies.

Factors that influence the propensity to found a company to commercialize research results. The propensity can be high (i) if researchers had previously been employed in a company; (ii) if, in the last decade, a spin-off company had been created from the organization to which they belong or if (iii) a project with this aim was underway. The "master experience" is a factor capable of strongly determining the level of self-efficacy based on the search for solutions adopted in the past.

From 2007 to 2019, entrepreneurial activation rates were significantly higher for men than for women; women's rates were about half of those observed for men in Italy as in nine other countries in Europe (Slovenia, Greece, Sweden, Switzerland, Great Britain, Norway, Germany, Ireland and Cyprus). This testifies to the existence of cultural factors that influence individual perceptions based on gender. The widespread belief that gender is an influential variable in the initiation of spin-off processes corroborates the thinking of those who attribute a primary role to other factors, first of all personal and contextual ones. Taking care of these factors in the managerial choices of academies could increase an active role of all genders in the process of valorizing research results.

Many ever-changing factors influence entrepreneurial academic propensity. Within this complex system, experiences and personal characteristics are those factors that dominate the choices of individuals more than others do.

To foster a favorable environment for academic researchers who want to consciously satisfy their needs to do business, it is necessary to provide them with the right knowledge to make the entrepreneurial challenge as desirable as a career in academic research.

Moreover, extrinsic motivations can affect the intrinsic ones. The relationship between entrepreneurial self-efficacy and entrepreneurial intention is partially influenced by researchers' subjective norms. In fact, the belief that an important person or group of people will approve and support a particular behavior determines a perceived social pressure from the researcher influencing his conduct. Therefore, also unconsciously, individual searches the approval by his closest social context – including family and friends – determining the orientation on to be or not academic entrepreneur. Tsai et al. (2014: 6) validate this hypothesis: "Subjective norms negatively moderate the relationship between entrepreneurial self-efficacy and entrepreneurial intention".

Finally, it is known that resources and support, from family members or other people with whom one has a strong bond, are essential at the beginning of the entrepreneurial process and can increase the strength and will to undertake entrepreneurial activities. Therefore, facilitating the acceptance of academic entrepreneurship in the social context would facilitate the rapprochement between the actors, academia and industry.

To promote the creation of research spin-offs, it is therefore important to outline a system of synergic interventions ideally divided into three moments: (i) before genesis; (ii) during start-up; (iii) to support development. The ten main actions are the following:

1. Literacy on the topics of culture and business creation.
2. Stimulation of entrepreneurship.

3. Animation and awareness of the scientific community and technological scouting in research centers.
4. Technological and market evaluation of entrepreneurial ideas.
5. Support for the protection of intellectual property.
6. Support and accompaniment in the drafting of the business plan.
7. Tutoring and technical-scientific and market supervision of the projects.
8. Economic, managerial and financial tutoring for the start-up of the spin-offs.
9. Ongoing monitoring programs.
10. Ex-post monitoring programs.

These actions project their effects into different temporal references, from the short (operational nature) to the medium and long (strategic nature).

5. CONCLUSIONS AND LIMITATIONS

From the analysis of the case that is the subject of this contribution, some hypotheses can be put forward that should be verified in the future with appropriate in-depth research.

The reason why researchers show a low propensity to create spin-offs could be determined by the fact that there is a discrepancy between their orientation towards innovation/entrepreneurship and the presence of some facilitating/hindering factors that characterize the organizations they work for.

Researchers working in the same organizational context may not develop similar levels of job satisfaction. In fact, it derives from the congruence between organizational characteristics and individual needs. Researchers with high self-efficacy who therefore have confidence in their work abilities may have a greater chance of successfully starting an activity to valorize the research results achieved, especially if they perceive low job satisfaction.

This would not reduce the gender effect which, instead, would be strongly influenced by the work and social context as well as by the presence, or absence, of adequate resources, internal and external to university research laboratories.

Since 2014, that University has launched many initiatives to promote the transfer of technologies to industry - regardless of the research area - including entrepreneurship training programs dedicated to PhD students, the creation of a TTO to support projects for the valorization of research results. The positive effects of these interventions are already perceptible but will be even more so with the passing of time and in a synergic manner with local and national policy choices.

The generalizability of the results is limited because the study considered researchers with highly contextualized study, research and work experiences. This study is subject to several limitations, some of which are common to qualitative research in general and some of which are unique to the study design; namely (i) it is based on a purposefully selected sample; (ii) qualitative studies are subject to researcher bias; (iii) the findings may not be generalizable to other contexts.

The initial project envisaged a second round of investigation 3/5 years after the first, but it did not materialize. The results achieved may be validated through further research in other contexts, since entrepreneurial activities may vary according to different cultures. The problem always comes down to the availability of the "right resources".

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