Why do scientists create academic spin-offs? The influence of the context.

Ugo Rizzo
ugo.rizzo@unife.it
Department of Economics and Management, University of Ferrara, Ferrara, Italy

Abstract:
The aim of this work is to examine the nature of academic spin-offs in a specific context: the Emilia-Romagna region (Italy). More specifically we investigate the individual reasons as to explain why scientists create academic spin-offs and how the creation process unfolds. Most economics and management literature on the topic considers the technological characteristics of such a choice, although recently the individual motivations behind the creation of such ventures have been investigated. However, less attention has been paid to the social and contextual dimensions of the matter. This study relates contextual characteristics to individual motivation. In particular it is argued that the funding constraints of the Italian academic environment, the low level of demand for doctorate holders within the Italian public and private sectors and the presence of favourable supporting policy tools in the region analysed, play a fundamental role in shaping the individual motivation of scientists in choosing this option. By way of a multiple case study research this work provides evidence that the academic spin-off in Emilia-Romagna is, for young scientists, a way to escape the bottlenecks of the Italian academic system allowing them to work in their field of expertise. This paper builds on the research regarding individual reasoning underlying personal decisions to create an academic spin-off and the need to analyse the phenomenon in relation to its context. Finally some policy implications are put forth.

Keywords: Academic spin-off; individual motivations; context of reference; opportunity entrepreneurship; necessity entrepreneurship.

1. Introduction

In recent years scholars of innovation have focussed great attention on technology transfer from university to industry. Among the wide variety of direct and indirect mechanisms by which academic knowledge is transferred into the market place (D'Este and Neely 2008, D'Este and Patel 2007), considerable attention has been directed towards the creation of academic spin-offs (ASOs); those firms whose business is the exploitation of research results developed within the academic environment. Such firms are considered important in fostering technological change and economic development (Shane 2004, Vincett 2010) and are seen as a bridge between university and industry allowing newly developed tacit knowledge to reach the market as a product (Shane 2002, Fontes 2005, Chiesa and Piccaluga 2000). As a consequence most academic and management literature investigated the determinants to the creation and performance of such types of ventures. It has only been recently that the investigation of the individual incentives underlying the creation of such types of ventures has been explored.

The literature on individual motivations has mainly addressed the issue looking at the characteristics of the technology to be exploited (Chiesa and Piccaluga 2000, Shane 2004), and argues that different mechanisms of knowledge transfer are mainly engaged as an answer to the specificities of the technology to be commercialised (e.g. Shane 2002, Minshall and Wicksteed 2007). Some studies have also been directed toward the investigation of the individual reasons leading scientists to undertake such practice (e.g. Fini et al 2009, Hayter 2010). This work contributes to this matter and investigates the individual motivations for which scientists choose to create an ASO in relation to the specific characteristics of the context in which such firms have been generated.

The paper claims that several factors have a role in shaping the individual motivations of scientists to create ASOs. More specifically these include the funding constraints of the Italian academic environment, the low level of demand for doctorate holders within the Italian public and private sectors and the presence of favourable supporting policy tools in the region analysed.

We also refer to the literature on the "push" and "pull" factors moving individuals to create a firm (e.g. Storey 1991). An individual is pulled toward the creation of a firm when they pursue the exploitation of an opportunity: Reynolds et al (2002) labelled this situation as "opportunity entrepreneurship", in which the main incentive to the creation of a firm is the increase in the founder's wealth (Baumol 1990, Douglas and Shepherd 1999). On the contrary, push factors are associated with "necessity entrepreneurship" (Reynolds et al 2002), in which individuals are moved to create a firm in order to escape some situations of dissatisfaction (Uhlaner and Thurik 2007), among which unemployment represents the most important factor (Storey 1991, Ritsilä and Tervo 2002).

However, it has been shown that the boundary of these two types of motivation is not clear cut and that undertaking a firm's formation may be a complex matter involving several factors (e.g. Giacomin et al 2011). In this paper we deal with these issues by considering the contextual characteristics in which scientists are embedded and how such features shape their decision process.

The empirical analysis is based on a multiple case study research in which a total of 14 regional ASO firms were interviewed face to face using a semi structured questionnaire. Results show that different types of ASOs were created under different types of incentives. More specifically this paper provides evidence that the ASOs in which the team of founders is mostly made up of non-tenured researchers at university create ASOs in order to escape the bottlenecks of the Italian academic system and to allow the researchers to work in their field

of expertise. In other words, for the region in discussion, the specific characteristics of the context exert an important effect on the nature of the academic spin-off phenomenon.
The second paragraph will briefly explain the literature review on the topic. The third section describes the context of reference with the aim of framing the context in which to investigate our research questions. Such analysis will first outline a picture of the R&D job market situation both in Italy and in Emilia-Romagna, and then it will describe the regional institutional background. This scenarios leads to the formulation of our conjectures that will be put forth together with the research design description in the fourth section. A qualitative analysis will then seek to give evidence of our conjectures and finally some concluding thoughts will be presented.

2. Literature review

Academic literature concerning the motivations for the decision of an individual or a team of individuals to start up a firm from research results developed within the academic environment, has significantly increased in the last two decades. Works have mostly been concerned with the analysis of the characteristics of the technology to be transferred. However, more recently some studies have also investigated non-technological motivations leading scientists to undertake such a path of research results exploitation.
One of the main reasons regarding the decision to start up an ASO firm concerns the very early stage of development of the technology to be exploited. The need for further development required by such technologies in order for them to be ready for the market place, may create many obstacles to a direct transfer from the academic to the industrial environment (Thursby et al 2001, Chiesa and Piccaluga 2000). Regarding this issue, Shane (2002), adopting a transaction cost economics approach, finds that the higher the transaction costs involved in licensing a technology directly from university to industry are, the higher the probability is that the technology will be licensed back to its inventor and he will develop it further for the market by creating a firm with that proper aim. Similar conclusions are reached by Fontes (2005), who addresses the scientist to the important function of reducing agency costs, by directly going into the market place to transfer some tacit knowledge from academia to industry.
A sort of taxonomy of motivations in starting up ASOs was put forth by Minshall and Wicksteed (2007). By asking technology transfer offices (TTOs) the reasons why ASO is chosen as the way of exploitation instead of other mechanisms of technology transfer, answers have been the following: for platform technologies, for technologies with several and different applications, when the technology is not ready for the market and finally when the scientist is willing to bring its results to market. It is possible to note that four of such motivations regard the sphere of the technological element, while the last one refers to personal reasoning not directly related to technological issues.
Although less explored compared to its technological counterpart, non-technological motivations explaining the choice of undertaking an ASO route of exploitation can be divided in two main groups. The first represents the pecuniary reasons. Such logic refers to the pull factors reasoning in traditional entrepreneurship literature. Individuals become entrepreneurs when they see an opportunity to increase their income (Amit et al 1995, Baumol 1990). According to such reasoning, the higher the financial rewards individuals are expected to gain are, the higher the possibility they will leave their occupation and become entrepreneurs will be (Campbell 1992).
Such reasoning has also been applied to the ASO phenomenon: the basic assumption is that scientists create ASOs to pursue higher profits (Shane 2004). Although some scholars provide

evidence that the monetary incentives may play a role in the overall technology transfer activities (Friedman and Silvermann 2003, Link and Siegel 2005), more recent studies identify this power of monetary payoff as particularly relevant only for patents and spin-offs (D'Este and Perkmann 2009). In other words scientists that create an ASO, compared to other routes of technology transfer activities such as R&D collaborations, are largely driven by the possibility of generating personal payoffs.

In the second group we find a variety of reasons, that we could sum up as the non-monetary motivations. Here we find explanations to start up ASO such as the need for independence and tax avoidance (Birley and Westhead 1994, Shane 2004), the demand for recognition by peers (Stuart and Ding 2006), the search for research funding (Hayter 2010, Fini et al 2009), individual willingness to bring some research onto the market (Minshall and Wicksteed 2007, Shane 2004, Fini et al 2009) and the university and peer style of thinking that pushes academics on such a path (Stuart and Ding 2006).

The literature investigating such non-monetary motivations not only points to the role of peers and recognition, but also stresses the role of the environment in shaping particular patterns of behaviour enabling scientists to commercially exploit their research results (Mayer 2003, Bercovitz and Feldman 2008, Stuart and Ding 2006). Regarding this matter, Chiesa and Piccaluga (2000) highlight the high level of risk aversion of Italian scientists to starting up ASOs, and the consequent low numbers of ASOs created compared to other scenarios such as the Anglo-Saxon one. In other words, the influence of the context in which the phenomenon is analysed may reveal specific causal effects moving scientists to create ASOs.

This latter element is in line with entrepreneurship literature on necessity entrepreneurship. Several studies have investigated the relationship between unemployment status and the propensity of becoming self-employed (Storey 1991). They found that that being unemployed (Evans and Leighton 1990, Ritsilä and Tervo 2002), the lack of prospects in the current job and a general dissatisfactory situation (Burke 1997) are positively related with the foundation of a business.

This work seeks to move a step in this direction and aims at linking such insights on opportunity and necessity entrepreneurship to the ASO firm formation. More specifically we aim to analyse the characteristics of a specific context, that of the Emilia-Romagna region, and explore the presence of different motivations to the formation of ASO firms. In order to accomplish such a task, a brief picture of the Italian scenario will be put forth, then the analysis will investigate the regional situation in depth and map the regional evolution of the ASO phenomenon.

3. The context

3.1 The labour market for doctorate holders

3.1.1 The Italian scenario

One of the objectives of this paper is to show that ASOs in Emilia-Romagna are created also to allow young researchers to secure a job related to their field of expertise. In order to prove such a statement a picture of the Italian job market situation for doctorate holders is required. In this section we will do so by analysing existing data when available and referring to some reports on the topic.

The Italian statistical office, Istat, started to collect data about the educational level of R&D personnel only in 2005. From such data, as reported in the tables below, we can note that in 2008 6636 doctorates were employed in the R&D function, half of whom were working in public organisations and the other half working in the private sector. The share of people with

a PhD employed in a firms' R&D function, seems to be particularly low being 1.8 in 2005 and 2.6 in 2008.[1]

Table 1: Number of PhD and graduates employed in R&D function, by type of organisation

		PhD	Graduates	Total	Total R&D working force
2005	Public organisation	4475	15147	19622	32684
	Firms	1306	32393	33699	70725
	University	….	….	….	66976
	Non-profit private organisations	499	3129	3628	4863
	Total	6280	50669	56949	175248
2008	Public organisation	3029	18743	21771	37472
	Firms	2817	47372	50189	106643
	University	….	….	….	86979
	Non-profit private organisations	790	4006	4797	7922
	Total	6636	70121	76757	239016

Source: Istat

However it is possible to observe from table 2, that the share of doctorate holders working in firms, and in the private sector more in general, increased while there was a decrease in the employment of PhD graduates in public organisation. The overall number of doctorate holders working outside university decreased from 3.6 to 2.8 percent from 2005 to 2008.

Table 2: Share of PhD graduates employed in the private, public and non-university environment

Year	Share of PhD holders working in firms' R&D function	Share of PhD holders working in private sector's R&D function	Share of PhD holders working in public sector's R&D function	Share of PhD holders on whole R&D function	Share of PhD holders on non-university R&D function
2005	1.8%	2.4%	13.7%	3.6%	5.8%
2008	2.6%	3.1%	8.1%	2.8%	4.4%

Source: author's elaboration of Istat data

The rise in the share of doctorate holders employed in firms and even more in the private sector could be seen mostly as the consequence of the decrease in public funding to research organisations, rather than to an increase of the valorisation of such profiles in the private sector. In fact we can observe from the tables above, that doctorate holders working in public organisations decreased from almost 4500 to just over 3000 from 2005 to 2008, in contrast to an overall small increase in PhD holders employed in R&D function from 6280 to 6636.
However if we weigh up the number of doctorate holders working outside university against the whole working force in the R&D function we can see a decrease in its share, from 3.6% to 2.8%. The same thing happens if we weigh up the number of doctorate holders working outside university against the number of people working in the R&D function outside

[1] The Eurostat database does not yet contain any relevant information enabling us to compare Italy and other countries in terms of employment characteristics of doctorate holders. However, it emerges that in Italy the share of human resources employed in 'Science and Technology' reveals itself to be significantly lower than its major European counterparts.

university, going from 5.8% to 4.4%. We can therefore state a decline in the job market share for PhD holders.
Such a scenario is supported by the results of some surveys conducted in Italy in recent times, where some associations are building up a type of monitoring system for PhD careers. According to the Istat (2010) investigation regarding the rate of employment of PhD holders showed: in 2009 almost 6% of those who obtained their PhD in 2004 and 7.2% of those who received their doctorate in 2006, still do not work. This report also shows that 52% of the 2004 PhDs and 38% of the 2006 PhDs had at the end of 2009, a permanent position. For the others, the type of employment is the following: 12.6% of the 2004 PhDs work in post-doctoral positions, 8.7% are employed with some form of collaboration, 12.8% are autonomous workers and 13.8% are employed under fixed term contracts. For the 2006 PhDs the picture resembles the former: 22.2% are employed in post-doctoral positions, 10.3% with some form of collaboration, 14% are autonomous workers and 15% are employed with fixed term contracts.
In contrast a study relating to doctorate careers in Netherlands (Sonneveld et al 2010) reports that in 2008-09, at the time of the thesis defence, 86% of PhD candidate/holders were working and more than half of them in a permanent position. Moreover, the report highlights that 88% declared they "perform work that is in someway related to their PhD degree" (Sonneveld et al 2010, p. 22).
On the contrary the Istat (2010) report stresses that among people with an occupation, around 25% in each group is employed in a job not at all consisting of R&D, and less than half of them work in a prevalently R&D type of position. It is also observed that in 2009, 6% of 2004 PhDs are employed abroad and that this share rises to almost 8% for the 2006 PhDs. Finally, around 11% of those that obtained the PhD in 2004 and 14 % that obtained it in 2006, in year 2009 are thinking of searching for jobs outside Italy.
From such data three main points can be raised: (i) a significant share of Italian doctorate holders are employed in non-R&D function, (ii) a high share already works or is thinking of moving abroad in order to be employed in a function related to their academic career, and (iii) the route to securing a permanent position in the Italian academia is long and uncertain.
Such considerations are further corroborated by other studies. MIUR (2006) (Ministry of Education, University and Research) conducted a survey on people that obtained a PhD between 1998 and 2003 in four Italian universities. A total of 464 doctorate holders answered the survey. The main findings of such a survey, in our perspective, regard the aspirations of PhD students. In particular 82% of the respondents would have liked to remain within the university environment when still studying for the PhD, but only 45% forecast they would be able to do so when answering the questionnaire, that is between 2004 and 2005, that is when they were already PhD holders.
Similar evidence may be reached analysing the evolution of the academic recruitment processes that have been taking place in Italy at least since the late nineties: in fact from 1999 to 2007 more than twelve thousand permanent positions were created. More than half of them were directed toward Full professor positions, and just a small share were directed toward the opening of positions of *Ricercatore*[2] (MIUR 2006, CONVUI 2008). The Italian regulation system has de facto favoured the career moves of already permanent staff, that is from Ricercatore to Associate professor or from Associate to Full professor, compared to the creation of new Ricercatore positions (MIUR 2006, CONVUI 2008). The MIUR (2008) report also highlights the bottlenecks the university recruitment system has faced in the last decade or so. In fact it states that the age at which individuals become Ricercatore is shifting ahead: after obtaining a PhD, individuals tend to remain employed with temporary positions within the university for longer periods compared to the recent past. Among the factors

[2] First level of permanent position in the Italian academic recruitment system in the time interval analysed here

leading to such a shift, an important role is played by the low number of Ricercatore positions opened in proportion to Full and Associate professors positions. Consequently also the age range of people working under post-doctoral positions is rapidly widening.
Finally some other considerations emerged from these reports. In particular it has been highlighted that doctorate holders do not consider the PhD experience as particularly useful in order to find a first occupation. In fact more than ninety percent of the respondents of the MIUR (2006) survey said that the doctorate title does not offer appropriate perspectives in terms of professional entry. In particular it emerges that the doctorate reveals to be a very weak title for the private sector, and better valorisation processes regarding this situation seems to be an urgent requirement indicated by doctorate holders (MIUR 2006). On the contrary, in Netherlands, only 4% of PhD holders claims to be dissatisfied with their job after graduation, and less than 1% claims to be very dissatisfied (Sonneveld et al 2010).

3.1. 2 The Emilia-Romagna region

The PhD job market situation in Emilia-Romagna seems to resemble the Italian one. Although the region does not represent a closed economy, the difference in the number of PhD graduates and of new positions of Ricercatore created within the academic environment in the last decade, we think, can offer a reliable picture of the situation.
In fact, if from 1999 to 2009, 1863 new positions of Ricercatore were created in the region, from 2001 to 2008 more than six thousand students obtained a PhD (MIUR data). In other words, each year, on average, the region produced almost 900 doctors and opened less than 200 Ricercatore positions. If we moreover consider that in 2009 there were more than 700 active post-doctoral positions and more than 2000 active PhD students, given the Italian PhD students' aspiration as described above, we can appreciate that the share of academics willing to obtain a tenured position at university may be significantly larger than university possibilities.
Nevertheless the Emilia-Romagna region represents one of the richest regions in Europe in terms of GDP (Hollanders et al. 2009), and sits above the average levels in terms of innovative indicators. In the Regional Innovation Scoreboard for the year 2009 (Hollanders et al. 2009) Emilia-Romagna is classified as a medium-high innovator; only Lombardy shares the same position in Italy, while all other regions remain behind. In the national context the region comes in top positions both in terms of GDP and in terms of personnel involved in R&D functions (MSE 2009, Unioncamere[3] data). In terms of technology transfer from university to industry indicators, such as the number of university patents, of spin-off firms creation and of research income, Emilia-Romagna comes in again in the top Italian regions (Netval 2009).
Italian regulation recognised technology transfer activities as important in the economic growth of the country in the late 90s, by the enactment of law number 297 in 1999. This law gave life, via the operative D.Lgs. 593/2000, firstly to the generation of university internal regulations in order to manage issues related to patents, licensing and academic spin-off, and secondly to the generation of several local actions in different Italian regions with the aim of incentivising or at least disciplining such practices.
From that time Emilia-Romagna has been one of the most active regions in Italy in promoting technology transfer activities (Bianchi and Ramaciotti 2005). The region, in the sphere of the POR (Regional Operative Programme) under the third objective of the ESF (European Social Fund), first activated in 2000 the "Spinner Programme" in order to promote employment in research and technological positions. The consortium Spinner was formed by the regional higher education institutions of public research, represented by five universities and three public research institutions. The objective of Spinner is the realisation of projects aimed at the

[3] Chambers of Commerce organisation

valorisation of human capital, promotion of research, technology transfer and innovation activities, also and above all at the creation of new ventures, not necessarily spin-off. Among various measures within the Spinner Programme, the most important regarded the provision of resources and complementary services to conduct a feasibility study for the duration of one or two years. The first Spinner Programme took place in the time period 2000-2006, while the second started in 2007 and will last until 2013.

3.2 The ASO in Emilia-Romagna

The aim of this section is to describe the history of the ASO firms in Emilia-Romagna in order to highlight that the regional institutional framework seems to have played a central role in shaping the incentive mechanisms toward the creation of high-tech firms. Let us first define what we mean by academic spin-off.

Considering the intention of this paper is to study the decisions moving scientists to transfer some academic knowledge onto the market place using the creation of a new firm, we can rely on a broad definition of ASO. We therefore consider ASOs all those firms in which the university detains some shares of the firm, or those firms created by at least one academic tenured researcher, on an idea of business generated within the academic environment. Such a broad definition is similar to the definition used by Netval (Network for the valorisation of public research) and by Osiride (Observatory of Emilia-Romagna Spin-offs, Aster 2008), and this allows us to refer to their available data in order to map the regional ASOs.

Matching the information from those two sources with university and research centres websites, we mapped 92 ASOs in Emilia-Romagna created from 1996, year of the first recognised ASO in the region, to the 31st of 2007. The table below shows the number of firms created per year from 1996 to 2007.

Table 3: ASOs created in Emilia-Romagna per year of constitution (1996-2007).

Year of constitution	Number of ASO created
1996	1
1997	1
1998	0
1999	5
2000	4
2001	5
2002	5
2003	16
2004	16
2005	22
2006	8
2007	9
Total	92

We can clearly see that from 2003 there was an important increase in the number of ASOs created compared to before. The effects of law 297, an indirect stimulation to create ASOs, that came into force in 2000 via the D.Lgs 593, can be seen some years later. Moreover the implementation of the Spinner Programme seems to have played an even more important role. As said, the first Spinner programme took place from 2000 to 2006. Four calls for proposals were activated in this interval: the first one at the end of 2000.
Considering that ideas have to be first selected and awarded, that the projects need to be tested for one or two years, effects on the number of firms created can generally be seen only from 2003. From 2006 we note a significant decline in ASO firms constitution that could be due to the diminishing number of latent business opportunities that were on the shelf within the academic environment and to the decreased resources the Spinner Programme devolved for the creation of new ventures in the last calls for proposals (Ramaciotti et al 2011). It therefore emerges that the Spinner Programme is an important supporting tool toward the generation of ASO firms.

4. Research design

This work conjectures and seeks to give evidence that in Emilia-Romagna the ASO phenomenon has emerged also as a way for young scientists to be involved in a job somehow related to their background field of expertise. We therefore identify two hypothetical opposite types of ASOs: firstly, one that we label "young researchers-based spin-off", in which founders are mostly researchers working in university under non-permanent positions; and a second one in which the team of founders is composed by mostly tenured researchers, which we label "senior researchers-based spin-off".[4] The aim of this paper is to study if such a classification of ASOs may be reasonable, and if there are, as expected, significant differences in the motivations lying under the decision to create an ASO by two such types of firms.
In searching for the reasons that motivate scientists to start up ASOs, the study looks at the dynamics of a particular setting that deals with decision processes (Eisenhardt 1989). Moreover our research questions are in the *why* and *how* forms and the case study research is particularly suitable in order to answer such type of questions (Yin 1994).
The unit of analysis of our research is the team of founders of ASO firms constituted between 1996 to 2007. In order to test our conjectures, we needed to select, on the one hand, teams of founders mainly composed of young scientists and, on the other hand, teams mostly composed of tenured researchers. Giving the difficulties of collecting such information across the whole region, we decided to start from one of the four universities: the University of Ferrara. Such an institute represents a leading Italian university in terms of both exploitation performances (CIVR –Italian committee for research evaluation– 2007) and scientific production (TIS 2011).
The University of Ferrara produced its first spin-off in 2000, and up to 2007 21 firms were spun-off from this institute. With the help of the TTO (Technology Transfer Office) staff of the university we selected a sample of the firms to be interviewed in order to provide both literal and theoretical replication (Yin 1994). Eight ASO firms were selected, four of which included mostly young scientists in the team of founders, and four of which were mostly made up of tenured researchers in the constituting team. Moreover, in order to reduce bias, we

[4] In this and following sections we refer to young or temporary scientists or researchers to indicate non-tenured academics, while we refer to senior or tenured scientists or researchers to indicate academics with permanent positions within the university.

selected, for each group, both firms that had participated in Spinner and firms that had been constituted without such a supporting policy tool.

Data was collected via in-depth face-to-face interviews conducted between 2009 and 2010. First of all background material from the Chambers of Commerce, from firms' websites and from the university's TTO was collected. Then we contacted the firms and we asked for the possibility to speak with more than one founder. In one firm we were only able to interview the external CEO; in six firms we spoke to at least two founders, and in the remaining one we spoke separately with a founder and with the external CEO. The central open-ended questions along which the interview was developed were the following:

(i) Why did you decide to create a spin-off?

(ii) How did the process unfold?

The conjecture put forth is the following: teams largely composed of young researchers build up an ASO firm in order to escape university and at the same time provide themselves with a job related to their academic background. In other words they may be considered necessity-type entrepreneurs. Conversely, in firms where the proportion of young scientists is small compared to tenured researchers, the firm was created for the benefits of the senior researchers involved, that is on the motivations identified by ASO literature, among which the need of personal rewards should emerge. Such firms may be regarded as opportunity type of entrepreneurship.

The people interviewed were not aware of the research intentions, that is the presence of different patterns of opportunity versus necessity motivations. In some cases the interviewees answered the main questions by mainly pointing to the technicalities of the business: in these cases we sought to drive the conversation toward reasons that were distinct from the technological features of the product to be exploited. In some cases, although rarely, in order to reach our objective, we needed to ask if the career prospects or the potential financial reward had played a role. We also sought to understand if different founders would have undertaken the firm creation process under different motivations.

We are aware that technological reasons are important motivating factors moving scientists to create ASOs. Such reasons are however misleading in respect to our research intentions and we decided not to account for them in our analysis.

While testing the delineated conjecture by means of the questions highlighted above, in order to strengthen the validity of the results we sought to expose some corroborating propositions (Yin 1994) and we derived two main statements to be tested. The first regards the evolution of the composition of the team of founders. In particular we assumed that if the young researchers are the proponent of the firm's initiative, they will also be the major, if not the only, forces involved in conducting the business. As a consequence the senior researchers in the team will probably have a minor role, that will tend to decrease moving along the time horizon: it seems in fact plausible to assume that when the firm becomes established on the market and the university influence decreases, as usually happens in academic spin-offs (e.g. Clarysse and Moray 2004), the senior academics will leave the company or at least their active involvement in the business will decrease. We therefore put forth the following proposition: if the firm is a young researchers-based spin-off, the share, or at least the involvement, of tenured academics among the members will tend to decrease as time goes by.

The second proposition we present regards the future plans for the firm. The academic literature on academic spin-off has largely based its insights on firms that have been generated in order to exploit powerful patents and are consistently supported by venture capitalists funds (e.g. Shane 2004). The mission of this type of firm is to generate enough revenue in the short run in order to return the private investors rewards. Such a task may be accomplished either by creating a very high growth firm, or by developing a technology to be exclusively sold to a large incumbent. Given the usual later career stage of academics involved in creating ASOs

(Klofsten and Jones-Evans 2000, Shane 2004)[5] and the typical risk aversion of Italian scientists to leaving the academic system to start a business (Chiesa and Piccaluga 2000), it emerges that the aspiration of a senior researcher based spin off should be to create a business in order to develop a technology just enough to sell it exclusively to a large incumbent firm, as often happens with biotechnology start-ups (Chesbrough 2003). Or, alternatively, to create a tool to increase their personal benefits, above all given by financial rewards (D'Este and Perkmann 2011). On these grounds, we put forth the following proposition: if the firm is a senior researchers-based spin-off, future plans regard the possibility of selling either the technology developed or the new firm to a large incumbent, or at least the senior researchers involved seeks his payoff in the short run; on the contrary young researchers-based spin-offs, having created the firm to escape the university recruitment system, will pursue the idea of keeping the firm operating in the market place in the long run.

Two such propositions have been tested by asking to the founders the following open questions:

(iii) How did the team evolve and why?

(iv) What are the future plans for the firm and for the founders?

Finally, in order to provide triangulation (Yin 1994), we conducted an in-depth interview with the TTO director of the University of Ferrara, allowing us to compare our interpretation of the data with an external expert figure. The TTO director directly followed the generation process of each of the Ferrara's ASOs in the time interval analysed, and provided us with several inputs with which to interpret our data. Moreover, in order to ensure a correct interpretation of the data, an independent reviewer visualised and coded the transcribed material.

Once the case study about the University of Ferrara had been conducted, in order to see if our conjectures could apply to the regional context, we undertook 6 more interviews, selecting two firms for each of the remaining universities of the region. In order to select the firms to be interviewed, given the difficulties of finding detailed information about the composition of each team of founders, we decided to select firms according to their performance. So, first of all, we took into account only the most populated sectors in each university: such selection was done in order to investigate our research conjectures in those fields in which the ASO process is more consolidated. That is, we chose to concentrate on those sectors in which creating an ASO represents a shared practice in that academic context. At this point we gathered data mainly from local Chambers of Commerce and university TTOs: this consisted of indicators of performance, including turnover volume and turnover growth rate, number of employees (where available), number of patents, and presence and amount of Venture Capitalist or other private investors funding. The findings were then analysed in order to create a sort of hierarchy of ASOs (Eisenhardt 1989). We directly interviewed two firms per university; we spoke to two founders or one founder and one manager per firm and asked the same questions and tested the same propositions.

5. Data analysis

5.1 University of Ferrara

In this section the aim is to link conjectures to data. First of all we can note that the number of ASOs in which the team of founders is composed of mostly young researchers tends to increase in our time frame: from 2000 to 2003, 5 out of 7 total ASOs created may be

[5] Other studies find that often ASOs are formed by scientists in the early part of their career (e.g. Bercovitz and Feldmann 2003). However the profile of our 'senior researchers-based spin-off" is to be considered as a firm in which academics create a venture in their later stages of career

classified as senior researchers-based spin-off; conversely from 2004 to 2007, in 9 out of 11 ASOs the team of founders is mostly composed by young researchers. [6] This is in line with our expectations, in which as time goes by the possibilities of obtaining a tenured position at university decrease, and we therefore expect an increase in the share of young researchers-based ASO compared to senior researchers-based ASOs.

We now seek to determine, according to the data collected from the interviews summarised in tables 4 and 5, if the group of young researcher-based ASO behaves like the insights we gathered from the contextual analysis. It has to be specified that the University of Ferrara regulation, signed in 2002, in order to give a firm the status of spin-off requires the presence of a tenured researcher in the team of founders. However, one firm in our sample (firm c, as displayed in tables 4 and 5) was created in 2001 by a team of only young researchers because at that time there was no such restriction.

From the interviews with the four teams of founders of this group it is possible to appreciate that the difficulties of remaining in the academic environment played a central role, sometimes directly sometimes more indirectly. For example a team of founders (firm c) said:[7]

> "All of us were working or used to work for the university. None of us was tenured though. [...] Two of us had already been self-employed [...] The idea of business, together with the possibility to keep working in a research related environment, consolidated the team: not one of us would have done this on our own.

Another team, more directly oriented towards finding an opportunity of escaping the university system stated (firm a):

> "In contrast to other ASOs, it was us who had to look for a senior researcher that wanted to participate in our idea. We needed a tenured researcher in order to create a spin-off […] and benefit from the advantages of being a spin-off, such as the university logo, accreditation and so on."

We can see that in this case the initiative to start up an ASO came directly from the young researchers. It emerges clearly that a young team is looking for career possibilities, and outside the university environment.

In the remaining two ASOs of this group, the decision to start up an ASO came from a joint decision between young and tenured researchers. However the critical university recruitment system remains fundamental, as stated by the founders of firm d:

> "We knew there clearly were no possibilities [to remain within the department] for all of us. An idea of business was in the air for a little while; it sounded good, so we all decided to go into it with our professor."

Similarly, founders of firm b said:

> "We [research group of the university] were frequently working on private orders. We therefore decided to create a firm through which our professor would have brought many of these private requests. […] Instead of being temporarily hired by the department on private research contracts, we had the possibility of being directly paid by the same companies, with many advantages, and doing the same things."

[6] We have been able to obtain such information only for 18 of the 21 total ASOs from the University of Ferrara: some of the population firms are ASOs as defined in the broad sense, therefore the University does not detain any share and the TTO staff was not able to provide us with such information; some of these ASOs did not answer our information requests.

[7] Interviews were conducted in Italian, and the extracted selections have been translated by the author

It is evident that this group of ASOs, although pushed toward a business in slightly different ways, it is the faults in the university recruitment system and the possibility of securing a job position within the field of expertise, which represent an important and common determinant to the ASO creation. It seems therefore plausible to state that these motivations represent a visible pattern among young researchers-based spin-offs.
If we now turn to the other group of ASOs, in which senior researchers count for the majority of the team of founders, the answers reveal themselves to be consistently different. The story of one of these ASOs has been largely documented also by national newspapers and by scientific manuscripts: it resembles the typical ASO used for case study research, because of its high investments by venture capital funding and because its economic activity is based on the development of a very promising set of patented technologies.[8] This ASO still does not displace any operational activity after 6 years of existence, and the objective of the imported from industry CEO is clearly to develop the technology until it will be exclusively licensable to a big multinational company. The firm (firm h) is at the time of the interview (six years after constitution) constituted only by senior academics and a CEO coming from a venture capitalist company, who stated:

> "Our patents are now valued at millions of Euros. But we won't sell them. Our goal is to develop the product to the end."

In this case the firm's objective is to get the maximum from a very promising well protected technology. Another ASO of this group displays a similar, although settled on a lower value level, situation, and a founder affirmed:

> "We had a very interesting patent. We thought: why don't we start up a spin-off to develop it and sell it? It seemed quite easy and straight forward at the time."

Another ASO was created by two tenured scientists and a young one, where the latter was the CEO and was supposed to carry out most of the firm's activities. However, the low industrial experience of both the senior and the young researchers led the founders to decide to hire an expert profile from the industrial world. This figure become the new CEO and reorganised significantly the firm. The young scientist remained for a short period of time in the firm conducting mainly administrative activities and then left the company. The ASO has since then been growing on the networking assets and management capabilities of the imported CEO, who stated:

> "The idea of business was nothing really new. The value added was the connection with the university: we would have offered better services compared to our competitors. We thought that being directly connected with the university, and to its expertise and training services would have made us particularly attractive. So it has been, and the firm has grown a lot since my arrival."

We can see by the above interview extract that the senior researchers involved in the business aim at constituting a profitable business. In fact the young researcher not only detained a minor role, but he soon left the company and a new CEO was hired in his place. In contrast, the fourth ASO of this group was created by only a tenured researcher. It was generated as a compromise solution between different parties: the founder, the university and a company interested in the technology that was under development in the university. This company understood the potential of the technology that a professor of the physics department was

[8] It has to be acknowledged that these kind of ASO firms, although largely used in literature, do not represent the average Italian ASO firm, nor the average regional ASO firm (Fini et al 2009): in Emilia-Romagna, there were around 86 active ASO in the region, less than ten received private investment funding, and less than 20 of them were developing some patents (Aster 2008).

developing. This interest raised the awareness of the product potentialities by the professor, who, in accordance with the university and the company, decided to create the firm. He said:

> "I knew the sensor was worthy. We were already in touch with O. [company name]. However the technology needed to be developed much more, because at that time it was just a prototype. […] The spin-off created by myself, the university and the company represented the best solution: for me to keep the technology property, for the company in order to see the sensor developed according their requirements and for the university in order to gain visibility and possibly to generate some returns."

In this case we can note how the spin-off is the solution to a difficult contracting situation among the company, the university, and the professor who developed the patented technology. The spin-off become the tool to secure the property of the technology and was therefore created in order to generate personal returns for the professor.

These extracts of interviews seem to confirm our conjectures: it emerges that scientists create ASOs in several different processes, however it seems plausible to read from the interviews that young researchers-based spin-offs keep an eye on the mission of finding a job and, as a consequence, on creating a business that survives in the long term, while tenured researchers-based spin-offs direct such attention on other reasons, among which the generation of returns seems to represent an important point.

In order to provide further power to our conjectures, we shall now test the propositions we delineated above (Table 5): (i) if the firm is constituted by young researchers, the share of tenured academics in the team of founders will reduce while the firm establishes in the market place; (ii) senior researchers-based ASOs will be sold or dismantled sooner compared to their young counterparts, or at least the senior researchers look for their payoff in a considerable short period of time.

Table 4: University of Ferrara's ASO firms: characteristics and motivations for the firms creation

	Date of constitution	Spinner Programme	Founding team composition	Current activity description	The generation of the idea of the business
Firm a	2004	Yes	3 young researchers; 2 senior researchers	Environmental services: territorial planning when there are sustainable environmental requirements.	Three post-doc students of the geology department want to create a business through which to exploit their scientific competences. They look for a tenured researcher in order to create a spin-off
Firm b	2007	Yes	2 young researchers 1 senior researcher	Synthesis, chemical modification and advanced characterization of industrial polymers and composites for structural applications and for biomedical use.	The already developed contacts with the industrial world by a research group lead to the creation of a firm whose operations would have been mainly carried out by the two young researchers, supervised by their professor, who was in charge of bringing contracts to the firm in the initial phase of development of the firm
Firm c	2001	No	5 young researchers	Wide and integrated set of services related to the territorial specificities: environmental management, mollusc culture, aquaculture, flora-fauna monitoring and census, and restoration.	A team of post-doc students of the biology department, some of them with previous industrial experience, decide to create a business in order to offer the local territory services related to their academic background. Many years of temporary contracts at university and the complementary background specialisation of a consolidated group of colleagues lead to the decision to create a spin-off
Firm d	2004	No	2 young researchers; 1 senior researcher	Research and prototypation in the field of vibration and acoustics. Consultancy services on acoustic and vibration matters, related to environmental, mechanic and architectural sectors.	Two post doc students with their professor, given the difficulties of permanently entering academia, see a possibility of business and decided to set up a firm on their qualifications.
Firm e	2003	Yes	1 young researcher; 2 senior researchers	Contract research organization: assistance in clinical investigations to institutional, non-profit and private sponsors	A professor of pharmacology sees a lack of clinical research organisations in Italy and builds one with the value added of being connected to the university, therefore able to provide further services compared to competitors, such as training and specific consultancy
Firm f	2003	Yes	1 young researcher; 4 senior researchers	The firm provides products/services to the biotechnology and pharmaceutical industry which consist of custom synthesised bioactive peptides and contract research service	The research group developed an interesting set of patents and created the ASO firm to develop them further
Firm g	2000	No	1 senior researcher	Production of products for continuous monitoring of air and water quality	A firm interest in the works of a senior researcher makes him aware of the potentiality of his work and in particular of a specific product emerging from his research. The spin-off is the contract solution among the university, the professor, and the company
Firm h	2003	No	3 senior researchers	Biopharmaceutical company active in the discovery and development of fully proprietary therapeutics for the treatment of neuropathic pain	Generation of a set of very powerful patents within the academic environment. A CEO coming from a Venture Capitalist is recruited to manage the firms development

Table 5: University of Ferrara's ASO firms: member teams evolution and future plans

Firm	Team members composition – at constitution	Team members composition – time of the interview	(i) Changes in the share of tenured and young researchers in the member team	(ii) Plans for the future
Firm a	3 young researchers; 2 senior researchers	4 young researchers 1 senior researcher	A young researcher left the company but two new ones entered it: new competences within the team in order to enlarge the business activities	The ASO is taking the first steps outside Emilia-Romagna. In particularit is increasingly working in the Veneto region. The objective is to continue growing and expanding the customer base
Firm b	2 young researchers 1 senior researcher	Same composition	No changes. In recent times the firm has attracted its own customers and the influence of the senior professor, whose role was mainly to bring customers to the firm, is decreasing	The firm is gaining independence in respect to the senior professor involved who still provides the firm with a considerable number of contracts. The plans point to growth and possibility of expansion in terms of customers and employees
Firm c	5 young researchers	6 young researchers	A new young researcher brought new competences and consequently the firm offered a new service	A new product with associated patents is in development together with an Italian firm. The ASO aims at expanding the business toward the whole of Italy
Firm d	2 young researchers; 1 senior researcher	3 young researchers; 2 senior researchers (one of which was young at constitution)	A young researcher became tenured in the university, but still remains in the team, like the other senior. Two new young PhD graduates coming from the same department of the founders have entered the team	The firm is expanding both in terms of customers and products, some of which are in development with an external partner. The objective is to continue to grow
Firm e	1 young researcher; 2 senior researchers	1 senior researcher; 1 external CEO	The young researcher left the company pretty soon. One senior researcher also left the company obtaining a conspicuous payoff	The plan is to give the remaining senior researcher his payoff in order for him to leave the company. The CEO sees important potentialities for the firm and intends to run it for some more years
Firm f	1 young researcher; 4 senior researchers	4 senior researchers	The young researcher left the company	The firm is developing a new set of patents with the aim of returning on the market with a higher quality product
Firm g	1 senior researcher; private company	The firm has been took over by the company	No changes up to the sale of the ASO to the company	Once the product was properly developed toward the company requirements, the ASO was acquired by the member company
Firm h	3 senior researchers	Same composition	No changes	The plan is to develop the technologies until they can be exclusively licensed to a big pharmaceutical company

Table 6: Emilia-Romagna ASO firms: characteristics and motivations for the firm's creation

	Date of constitution	Spinner Programme	Founding team composition	Current activity description	The generation of the idea of business
Firm i	2004	No	3 young researchers; 2 senior researchers	Prototypes and services related to the human-machine interaction.	Business generated on a big research contract coming from a company to a new born interdisciplinary research centre. The head of the centre decides to create a spin-off to be run by the best young researchers of the centre. The ASO will also employ many researchers of the research centre
Firm j	2006	Yes	2 young researchers 1 senior researcher	Development of ad hoc informatics tools for disabled people	One of the founders is disabled and saw a market opportunity while postgraduate. With a colleague he creates an ASO with the help of their supervisor
Firm k	1999	No	3 young researchers 4 senior researchers	Physical diagnostic technologies applied to electrical equipment	The research group has 20 years experience and leadership in physical diagnosis of electrical equipment. The university pushes the professor head of this research group to create an ASO. He decides to create a venture through which to employ, also in the executive functions, the best young researchers of the research group. The other three senior researchers were mostly out of the decision and operational activities of the ASO.
Firm l	2005	Yes	2 young researchers; 3 senior researchers	Carrying out R&D related to the chemistry of the solid state drugs	A private research contract would have altered the basic research focus of the department. The professor head of the group, in agreement with two young researchers, decides to go ASO to secure this contract and at the same time does not alter the research within the department. The two young researchers clearly see an occupation opportunity. The senior professor seeks prestige. The other two senior researchers were not really involved in decision and operations.
Firm m	2003	Yes	3 young researchers; 2 senior researchers	Environmental consultancy services related to the territorial specificities	The difficulties of obtaining t a permanent position within university makes three young researchers look for an alternative solution, which was the creation of an ASO firm.
Firm n	2003	Yes	3 young researchers; 2 senior researchers	Acoustic measurement instruments	A research group developed an interesting product with high potentialities. Some young but expert researchers decide to leave university to undertake such experience. Two senior professors of the research group join the initiative.

Table 7: Emilia-Romagna ASO firms: member teams evolution and future plans

	Founding team composition – at constitution	Team members composition – time of the interview	(i) Change in the share of tenured and young researchers in the member team	(ii) Plans for the future
Firm i	3 young researchers; 2 senior researchers	4 young researchers 2 senior researchers	A senior left because he was not participating at all in the firm's activities	The firm grew at a rate of between 30 and 40% per year both in terms of turnover and employees. A radical new set of products is in development next to the already consolidated main products.
Firm j	2 young researchers 1 senior researcher	2 young researchers	The senior left as not involved in the business	Business growths and expansion for the product portfolio
Firm k	3 young researchers 3 senior researchers	2 young researchers 1 senior researcher	The firm grew and expanded consistently and few of the founders are still part of the company: only the professor head of the research group and a couple of young engineers	The firm is now a multinational, with many subsidiaries all around the world. The idea is to keep the head quarter in the region and possibly take over another company.
Firm l	2 young researchers; 3 senior researchers	2 young researchers; 2 senior researchers	Only one senior researcher has an active, although secondary, role: the professor head of the department. The other two do not have any role: one left and the team is working to make the other leave	The firm grew consistently from its inception and expanded considerably also in terms of employees. Products portfolio also expanded greatly, and customers are each year more international. Plans are to keep growing.
Firm m	3 young researchers; 2 senior researchers	3 young researchers; 1 senior researcher	One senior researcher left the company because the core business changed and he decided to create another business	The business needed to change consistently since the constitution as various problems were encountered with the initial idea of business. The new direction seems to be more fruitful and the business is now starting a phase of growth.
Firm n	3 young researchers; 2 senior researchers	3 young researchers (one new); 2 senior researchers (1 of which was non-tenured at constitution)	1 young and 1 senior left; another young entered the team, and 1 of the young got tenured in the meantime	The first ASO product was licensed out because of the possibility of producing some cash flow. However the firm kept working and started the development of a new product based on similar ideas. Up to the time of interview the need to remain deeply in contact with university research was high, and this explains the presence of tenured researchers in the team. The first prototype of the new product is now reaching the market and the plans for the firm are to keep expanding the business in the long run.

In respect to the first proposition we analysed the changes in the share of tenured and temporary researchers within the member team. As expected, two opposite patterns seem to unfold: if the firm is a young researchers-based ASO, the seniors tend to move out of the company, while if the firm is a senior researchers-based ASO, the academics firmly remain within the firms' members up to the point at which they can derive the maximum or at least a satisfactory payoff. For example, firm a, commenting on the role of a senior researcher, revealed:

> "There also was [in the team of founders] a professor apparently known in the Udine province, whose role should have been to find us customers in that area. […] We got nothing from him, and he luckily left the company quite soon."

Some teams of young founders seem to be keen to include within the team new young researchers with needed capabilities in order to develop the firm towards market needs. Firm c represents a good example of this trend:

> "We used to refer to the market when agronomics issues were requested. […] Some years ago our professor suggested getting in contact with F., who was collaborating with the department. We liked her, and we asked her to collaborate with us. She accepted, and now she is part of the company."

On the contrary the interviewed senior researchers-based ASOs did not experience any increase in the number of young researchers. In only one case did we register a decrease in the number of senior researchers: in firm e one of the senior researchers left the company with a conspicuous payoff, according to the CEO. Moreover in the same ASO we also register the exit of the only one young researcher involved in the firm, because his role was downgraded with the new entry.

In respect to the second proposition we sought to understand the future projects concerning firm development. The evidence in our case studies seems to indicate that ideas on how to manage the business in the long run are sharply different among young and senior researchers-based teams. In particular we can reveal that young-based researchers ASO aim at keeping the firm running and possibly growing, while senior researchers involved in the senior researchers-based ASOs aim, mostly, at generating personal reward.

For example the external CEO of firm h said:

> "Once the patents and the technology have been developed, we will exclusively sell it to a big pharmaceutical company. There is only a 15-20% possibility that we will get to the end of the route successfully, but that's our mission"

Another example of this matter is given by firm f: the senior academics involved in such businesses do not want to keep the business operating if profits are not worthy compared to the efforts. The CEO stated in this regard:

> "The crisis had some impact on the business, and consequently profits decreased. However I think some good business can still be done. […] One of the academics already left the company with his very good payoff. The other is still in, but he wants to get out as well: at the moment we are negotiating his payoff amount."

We can see how the rewards rest at the heart of the motivation pushing senior researchers to create a spin-off. On the contrary a team of young researchers said, in order to describe the central role of the regular earning side of the business:

> "One of us left quite unexpectedly. He got a research grant at CNR [National Research Council]. He wanted to do research. He was brilliant, he was continuously coming up with new product ideas. But

> our job is not to develop new stuff all the time; we need to be focused on the business: at the end of the month we have to have produced the necessary money to live and carry on with the business."

Another example is represented by firm c:

> "We have been working all around Italy for three or four years now. We also just applied for a couple of patents of a new product we developed with a southern Italian firm. [...] We've been growing quite a bit lately, and we'd like to reach, in the next couple of years, double the turnover we're doing now."

We can see how surviving and/or growing represents the main mission of these young researchers-based spin-offs. The analysis referred to the university of Ferrara seems to indicate that creating an ASO firm can be strictly related to the characteristics of the context and consequently to the composition of the proponents. It has, in fact been shown that two opposite patterns of behaviour leading researchers to create ASOs are present in the studied context: one in which young researchers-based spin-offs get created in order to deal with the difficulties for young scientists to secure a job within the university or related to their qualification background, and the other in which senior researchers-based ASOs are created by senior scholars mainly looking for the classic reward motives. Let us now explore the regional scenario.

5.2 The Emilia-Romagna region

In order to extend our research questions to the regional context, we interviewed 6 more ASOs, two from each university. We selected the best performing firms according to indicators such as turnover, financial investments, patented technologies and number of employees within those sectors in which the single university was producing more ASOs. A couple of firms did not accept an interview, and we therefore moved on to the next firm in our hierarchy.

We interviewed the selected firms in order to understand if they could be classified into one of the two groups we identified above or not. Table 6 describes the firms interviewed. From this table it is possible to note that 4 of them, according to the composition of the team of founders, resemble the young researchers-based spin-off model. The interviews moreover confirmed that the reasons why such scientists, mainly non-tenured, decided to create an ASO firm is mainly an answer to the difficulties in obtaining permanent positions within academia. Firm m clearly put this point straight forward:

> "The idea does not emerge from a specific research project, but mostly as a solution for finding a job for the two of us [post-doctoral fellows]"

While in the above quoted extract the initiative of creating a job position came directly from the young researchers, in firm i the decision is matured by the senior researchers who decide, together with some young scholars, to create an ASO firm through which to direct most of the doctorate holders working in their research centre. A young founder said:

> "The research centre was living mostly on private research funding. A big contract came to the door, and the head of the centre, together with some of us [former post-docs of the centre], decided to create a spin-off on which to start the business with such a contract. […] Now the centre lives on the spin-off funds and we represent the main employment opportunity for young scientists taking the PhD at the centre"

These examples testify the ASO firms have been generated with an occupational purpose for young researchers, even though the idea for the business came from different sources. The

other two firms, conversely, show at constitution the prevalence in the team of founders of more senior researchers rather than young ones. However, in contrast to the ASO firms of the University of Ferrara, in these cases the young researchers represent an important share of the firm composition.
The interviews with these two ASO firms, reveal that different objectives underlie the decision of senior and of young researchers involved in the creation of the business. For example, the two young founders of firm l, explain the start up process their team encountered:

> "In 2004 a large corporation contacted our professor's research group in order to finance the study of 20-60 molecules: an important volume of work. The professor has a precise idea of academic research: it has to be half pure and half applied. This research contract would have shifted the research group's attention to the applied research (more or less 80% applied versus 20% pure) going against the philosophy of the professor. However there was an opportunity, and it would have been a shame to lose it. The difficulties for us to remaining within the university, and the possibility for our professor to do something for the society, something to talk about, to increase his prestige, lead the two of us, the professor and two [senior] colleagues of his, to become the founders of this firm."

It clearly emerges from this extract of interview that two different types of motivations for creating the ASO are present: the young researchers aim at finding a research-linked career outside academia, while the professor head of the research group, the one securing the initial research contract, engaged in this activity for different and already known purposes such as peer recognition and prestige (e.g. Hyter 2010).
A similar pattern is recognised in firm k, where in the late nineties the university executives urged its best research groups to create an ASO as it was a sign of prestige for the whole university. The professor head of the research group, with some colleagues, decided to create a firm on their group capabilities, but also decided that the firm would be run by its best young fellows. In particular the "most brilliant PhD student" of the research group was appointed CEO by the professor from the very beginning. Moreover this firm which now is a multinational company, is composed of more than 40 employees in the head-quarters, many of whom were PhD students within the university parent department. Again the motivations for the creation of this firm were both of prestige and recognition for the university and for the senior researchers involved, but there was also a clear mission of employment opportunities for young scientists.
For what concerns the strengthening propositions, we can state that all 6 regional ASOs behave as in the model of the young researchers-based spin-off, as described in table 7. An example of this trend is given by firm j:

> "My supervisor remained in the firm just for a couple of years. We became independent from university facilities and research quite soon, and he left the company roughly at the same time"

Regarding the second propositions, the interviews revealed that there is no clear cut idea of developing a technology or a product and then selling the technology or the firm. Basically all firms behave as if they should operate in the market for a long term. Firm i for example, since its inceptions, has considerably grown in terms of turnover, employees and of products put on the market. The intention of keeping the business expanding and surviving in the long run can be seen in the following passage:

> "We also developed a series of products, such as particular libraries, rapid prototyping software, a small ad hoc hardware and so on, in order to better understand and answer customer requirements. […]

> Such products are only for technicians and developers. But now we are also developing a specific series of similar products fittingly for the final customers."

Only the manager of firm k affirmed that they are thinking about expansion, but there is no intention of losing control of the business. He stated::

> "It is some time now that we have been thinking of taking part in something like a merge or an acquisition. But we don't think we will ever merge, we want to keep our headquarters here and be independent. An acquisition may be more likely to take place. However not in the very near future."

From the interviews we can understand that different reasons lie behind the decision of creating an ASO, and accordingly reflect different team members' evolution and aspirations. However, it emerges clearly that the difficulties for young scientists in finding a permanent position within the academic environment played a central role in each of the teams' decision of this group to start up the firm. In firms l and k we noted the prevalence of senior researchers in the team of founders at constitution. However, in contrast to the senior researcher based spin-off of the University of Ferrara, the share of young researchers in these two teams had been significant since constitution. This indicates that not only firms in which young researchers are the majority can be classified as young researchers-based spin-off. However, we also noted that they represented the majority of the founders playing an active role in conducting the business, and that the senior researchers tend to move out of the team as time goes by.

This work gives evidence that senior and young researchers, in the analysed context, create ASOs for different reasons. Senior researchers are driven mainly by the possibility of financial returns, especially when the ASO does not involve, or only marginally, young researchers. In contrast, when young scientists play an important role in constituting the business, the seniors involved tend to be moved by different reasons, such as peer recognition, social approval and environmental push. Table 8 summarises the main incentives of both senior and young researchers in the different teams we interviewed. This table highlights how scientists belonging to the same team of founders are motivated to create the ASO firm for rather different reasons.

Table 8: Senior and young researchers motivations[9]

Firm	Team of founders	Type of ASO	Motivation to the ASO creation by young researchers	Motivation to the ASO creation by senior researchers
Firm a	3 young researchers; 2 senior researchers	Young researchers-based	Job creation	Not clear
Firm b	2 young researchers 1 senior researcher	Young researchers-based	Job creation	Job creation for young researchers
Firm c	5 young researchers	Young researchers-based	Job creation	-
Firm d	2 young researchers; 1 senior researcher	Young researchers-based	Job creation	Job creation for young researchers; financial rewards
Firm e	1 young researcher; 2 senior researchers	Senior researchers-based	Not clear	Financial rewards

[9] Some of the ASO we interviewed did not provide a clear cut motivational reasons for all the founders, therefore in some cases we stated that some motivational factors were "not clear"

Firm f	1 young researcher; 4 senior researchers	Senior researchers-based	Not clear	Financial rewards
Firm g	1 senior researcher	Senior researchers-based	-	Financial rewards
Firm h	3 senior researchers	Senior researchers-based	-	Financial rewards
Firm i	3 young researchers; 2 senior researchers	Young researchers-based	Job creation	Financial rewards; Prestige
Firm j	2 young researchers 1 senior researcher	Young researchers-based	Job creation	Not clear
Firm k	3 young researchers 4 senior researchers	Senior researchers-based	Not clear	University push; Financial rewards; Prestige
Firm l	2 young researchers; 3 senior researchers	In between	Job creation	Financial rewards; Prestige
Firm m	3 young researchers; 2 senior researchers	Young researchers-based	Job creation	Not clear
Firm n	3 young researchers; 2 senior researchers	Young researchers-based	Job creation	Financial rewards

The most relevant finding of this work is that young researchers involved in the creation of an ASO in Emilia-Romagna, a region that offers young researchers strong incentives to create high-tech firms, are mainly driven by occupational solutions that allow them to work in their field of expertise, as an alternative to the difficult private and public sectors market for R&D. In other words we may conclude that young researchers seem to be mostly driven by necessity: they aim at escaping unemployment, long term precarious positions and dissatisfaction. In contrast, senior researchers are driven by a variety of factors, in which the rewards, financial or not, seem to play a major role, resembling the opportunity entrepreneurship style of motivations. However it also emerges that in some cases (firms b and d) also the senior researchers involved are moved to create an ASO in order to find a career solution for the young researchers in their research.

Conclusions

This work gives evidence that in Emilia-Romagna there is a pattern of behaviours that pushes young researchers to create an ASO firm in order to find a job position related to their background field of expertise, and an opposite pattern that sees senior researchers founding an ASO firm mainly due to the motivation of monetary payoffs. The present work therefore contributes to an understanding of the ASO phenomenon in multiple ways. First of all our study enriches literature on the non-technological motivations pushing scientists to start up ASOs, and secondly it shows how the context in which the process takes place plays a fundamental role in the development of the academic entrepreneurship phenomenon. In fact it has been shown that in Italy, in the last decade, the number of doctorate holders aiming to undertake an academic career, or at least a career related to R&D, significantly exceeds the demand for them. Data reveals that in Emilia-Romagna universities the number of PhD students graduating is four to five times greater than opening *Ricercatore* positions. Moreover the private sector in Italy does not place much value on the doctorate title, and offers a poor

alternative to university. In other words, young researchers wanting to do research whether it be inside or outside the academic world in Italy, have to face a long and uncertain career path.
This study has been conducted in a rich and significantly innovative region. Emilia-Romagna represents a dynamic context which is well-endowed with policy instruments toward the creation of high technology based firms: this is an important reason that may lay behind the generation of young researcher-based ASO firms. To put it differently, the analysed context registers low prospect careers for doctorate holders, but at the same time provides supporting tools to people that want to pursue a high tech entrepreneurial career. Further research could be useful to comprehend the level of policy influence on the trends which have emerged from this work: more specifically it would be interesting to investigate these conjectures in other Italian regions with the same career prospects for doctorate holders, but less endowed with policy measures.
On these premises, some policy implications can be derived. While the Spinner Programme provides important incentives for young researchers to create high-tech firms, policies directed toward the creation of an environment favourable to the creation of ASO firms and high tech start-up would also benefit the whole context. For example, policies directed toward creating an entrepreneurial culture, toward simplifying the entrepreneurial process (Fini et al 2009), and toward improving the weak Italian high-tech entrepreneurial awareness (Chiesa and Piccaluga 2000) could benefit the entire economic system. It has been shown that, particularly among young people, becoming an entrepreneur is also related to knowing other people that made the same choices (Williams and Williams 2012). Enhancing the entrepreneurial awareness, we believe, would possibly increase the number of ASO firm creation. These considerations are important because, although literature on necessity and opportunity entrepreneurship tends to find higher growth and survival rate for opportunity rather than for necessity entrepreneurship firms, in the case of ASO firms the young researcher-based ASOs aim to stay in the market for longer compared to senior researcher-based ASO firms. This element may be of particular relevance for economies such that of Emilia-Romagna. In fact Emilia-Romagna is mostly specialised in low and medium-tech industries, and its growth prospects are mostly represented by the integration of new and old technologies rather than by the creation of new sectors (Freddi 2009). Regional ASOs are often service based companies operating in sectors related to regional industrial specialisation (Aster 2008). As a consequence young researcher ASO firms operating in the local context with long term prospects may represent an important mechanism in the technological upgrade of the regional economic system. Further research is required to investigate the relationships between the ASO nature – ie necessity versus opportunity entrepreneurship – and the complementarity between the ASOs economic activity and the industrial specialisation of the local production system. If future investigation were to reveal that necessity entrepreneurship ASOs operates in the local market to a higher extent than opportunity entrepreneurship ASOs, it may be argued that the Spinner Programme has also contributed to the technological upgrade of local industries.
The recognition of the importance of context features leads to the formulation of general policy implications. In particular this argument requires policies to be deeply related to the specificities of the context instead of being a replication of successful policies adopted in very different contexts (Rose 1991, Hospers and Beugelsdijk 2002). Recognising that an important share of ASO firms are necessity-driven rather than opportunity-driven as may be the case in other contexts such as Anglo-Saxon countries, would call for reflection on policy design and implementation, especially regarding the potential targets of such policies.
Many scholars have in fact pointed to the specificities of a context, its history and its formal and informal institution as main drivers of the economic development of that context (e.g. Hospers and Beugelsdijk 2002). As a consequence a main role is played by the idiosyncratic

processes by which such conditions come into place (Feldman 2001). Therefore, understanding such features remains a priority in order to design appropriated policies. This proves to be true also in the realm of technology transfer policies (Mowery and Sampat 2005, 2006). In line with this reasoning, policies incentivising ASO creation would benefit from an understanding of the characteristics, motivations and objectives of the potential entrepreneurs. As a consequence, given that opportunity and necessity entrepreneurship should be targeted by different policies (Bohla et al 2006), it may be desirable to differentiate policies in favour of ASOs in respect to their opportunity versus necessity nature. This would be particularly useful if further research into ASO phenomenon were to reveal diffused presence of the patterns highlighted in this work.

An important contribution of this article has therefore regarded the linking of literature on incentives for ASO creation to research on opportunity and necessity entrepreneurship. It has been shown that in Emilia-Romagna ASOs may either represent an answer to unsatisfactory career prospects, or their creation may be driven by the willingness to exploit higher income opportunities. Another issue deserving further investigation regards the comprehension of if and how these motivational categories influence the firm success, survival, and strategies. Such investigations would link the phenomenon of ASO firms to the wide body of research investigating the relationship between motivation behind firms' constitution and firms' growth and survival.

The proposed categorisation of ASO firms was derived from the literature on push and pull factors. Although we believe it represented a valuable exercise in order to enrich the understanding of the ASO phenomenon, we also show how such dichotomy may be blurry when referred to new ventures. In fact by highlighting that in a team of founders there may be present both people mostly incentivised by necessity-type of motivations and people influenced by opportunity-type of motivations, we contribute to the literature questioning the unambiguousness of such a dichotomy (e.g. Hughes 2003, Williams 2009, Giacomin et al 2011).

This work is however, not without limitations, especially regarding the generalizability of our findings. The investigation is mostly exploratory and further research is required in order to understand if such a classification may be extended. We did not survey the entire region, and therefore we are not able to indicate how many regional ASOs may be classified according to our interpretation, and above all, how many regional ASO firms can be considered young researcher-based spin-off as we delineated them. We do know however, that from 2001 to 2007 around 65% of ASO firms created in the region were granted by Spinner, therefore indicating a considerable presence of young researchers in the team of founders.

Moreover, further research questioning the validity of our conjectures in different contexts would strength the value of our results. For example, we would expect that in the Netherlands, where doctorate holders are generally satisfied with their post-PhD working conditions (Sonneveld et al 2010), ASO firms created by young scientists would mostly be of an opportunity entrepreneurship nature, rather than of a necessity entrepreneurship one. Another interesting contribution to this topic would regard an understanding of the dimensions of the phenomenon, both in Emilia-Romagna and Italy, and in other contexts. To this end more quantitative studies could lead, on the one hand to an understanding the relationships between contextual research career prospects and motivational choice in becoming scientists entrepreneurs, and on the other hand would give a clearer picture of the dimension of the phenomenon across different contexts.

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