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A spill over effect of entrepreneurial orientation on technological innovativeness: an outlook of universities and research based spin offs

Veronica Scuotto[1,2] · Manlio Del Giudice[3,4,5] · Alexeis Garcia-Perez[6] · Beatrice Orlando[7] · Francesco Ciampi[8]

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Abstract
By shifting towards Romer's (Am Econ Rev 94:1002–1037, 1986) economy and so the spread of knowledge economy, universities started to adopt a collaborative approach with their entrepreneurial ecosystem. They turn out to be risk taker, autonomous, proactive, competitive, and innovative. In a nutshell, they are entrepreneurial oriented with the aim to generate new innovative ventures, known as research-based spin offs. Doubly, this has induced an improvement of technology transfer and the degree of entrepreneurship in the current knowledge economy. However there still is a paucity of studies on the spill over effect of entrepreneurial orientated universities and research-based spin off on technology transfer need to be more explored. Therefore, the article investigates the link between entrepreneurial orientation and such spill overs by offering an outlook of two universities and two research-based spin offs in the United Kingdom. The scope is to provide a deep view of technological innovativeness in a research context, entrepreneurial oriented. Our research suggests that entrepreneurial attitude has become an imperative to succeed in the context where British institutions currently operate. Entrepreneurship brings the necessary technological innovation to the university and its students, which results in better positioning of the university at national and international levels, with the subsequent impact on their ability to attract not only new students and academics but also funding to conduct their research.

Keywords Entrepreneurial orientation · Technological innovativeness · Research based spin off · Technology transfer theories

1 Introduction

Starting from an interesting article by Audretsch (2014), the research attention toward technological innovativeness in an academic context has forged the present study. Audretsch clearly describes the shift to Romer's (1986) economy from Solow's (1956)

✉ Veronica Scuotto
Veronica.scuotto@unito.it

Extended author information available on the last page of the article

economy, pointing out the relevance of knowledge and then entrepreneurship in the current economic realm.

In this line, a spill over effect is generated, moving from a mere knowledge producer to a commercialised knowledge (Audretsch 2014; Montoro-Sánchez et al. 2011; Villasalero 2013). The commercialization out of the universities has introduced new ways to transfer knowledge (Martin-Perez and Martin-Cruz 2015, Matsuo 2015, Krylova, Vera and Crossan 2016, Stadler and Fullagar 2016).—Not only research and development (R&D) within an enterprise but there is also the involvement of research institution in joint initiatives with enterprises (Carayannis and Alexander 1999). For instance, in USA was legislated the Boyh-Dole act to encourage the involvement of universities in the commercialisation knowledge process (Link and Siegel 2005; Link et al. 2017; Kenney and Patton 2009). Universities, thus, introduced the technology transfer office (TTO) to support enterprises in patent and intellectual property generation (Siegel et al. 2007; O'Shea et al. 2008; Phan and Siegel 2006). Doubly, this has enhanced the level of technology transfer and entrepreneurship in the current knowledge economy (Audretsch and Keilbach 2006; Audretsch 2014; Foos et al. 2006; Carayannis et al. 2014; Secundo et al. 2017) and inducing the development of new ventures in a research context—called research-based spin offs (Rogers et al. 2001; Mustar et al. 2006). A RBSO is a new venture born in an academic environment and it can fall into one of the three following sectors: "1. Consultancy and R&D contracting; 2. Product oriented mode; and 3. Technological asset mode" (Stankiewicz 1994 in Rasmussen and Clausen 2012, 838). An ulterior reason of interest for this research is the abundance of evidences on the existence of a close connection between the firm's business model and technological innovativeness.

Autio and Kauranen (1994) first and Meyer (2003) then, both pointed out that technology is actively disseminated in a technology based entrepreneurial environment. Indeed, RBSOs are typical of biotech and high-tech industry (Bonardo et al. 2010; 2011). By definition, universities are deemed the locus where knowledge is originated and, then, transferred from one generation to another (Kao and Hung 2008; Hormiga et al. 2017; Fullwood et al. 2013; Ramirez and Gordillo 2014; Kong and Bezhani 2010). They also play an active role in society by enhancing employability and education levels. Anyway, the role of universities has not remained steady over-time. As instance, before the economic crisis started in 2008, universities where mainly knowledge producers. However, the crisis had heavily impacted the labour market, with an employment rate sharply dropped down. This situation brought a change in society and market's mindset, and people started claiming new ways for generating income. The crisis turned out to be an opportunity for those universities which sensed the new trend and started offering programmes to nurture new young entrepreneurs (Clark 1998, 2004; Murray and Scuotto 2016). This has resulted in a widespread of entrepreneurial oriented enterprises, even in research contexts. Afterwards, universities started to be acknowledged not only for their role of new knowledge creation, but also as a place for seeding and accelerating novel ventures.

Apparently, university-generated spin offs are extremely entrepreneurial oriented (Perez and Sánchez 2003; Bray and Lee 2000; Walter et al. 2006; Steffensen et al. 2000). They are proactive, risk takers, competitive aggressive, innovative and autonomous—the five catalysts of the entrepreneurial orientation (EO) framework (Zahra 1993; Lumpkin and Dess 1996). EO is considered relevant for the performance of an enterprise (Lumpkin and Dess 1996; Covin et al. 2006; Rauch et al. 2009). Sarkar et al. (2001) retain the EO is also crucial for new entrepreneurs. This concept is enforced by Nerkar and Shane (2003) who extended this relevance to RBSOs.

On this regard, the EO framework was used to implement the present research which seeks to offer an empirical study by examining two different universities and likewise new research ventures, which are UK research-based spin offs (RBSO) operating in a high-technology environment. In line with similar prior studies on EO in research contexts, (Smilor et al. 2007; Wong et al. 2007; O'Shea et al. 2008), we adopt an exploratory approach to the theme as a means to expand the current scarce knowledge on spill-over of EO in technology transfers. Precisely, this study aims to novel the literature on technology transfer and entrepreneurship by applying a qualitative approach for theory building. As stated by Mathisen and Rasmussen (2019), studies in this field are still "phenomenon–driven" and therefore conceptual contributions are still scarce (see also Rothaermel et al. 2007).

In addition, whilst antecedent publications mostly examined technology transfers strategies at a firm level (Rasmussen and Wright 2015; Moray and Clarysse 2005; Audretsch 2014; Niosi 2006; Link and Scott 2005; see also Davenport and Völpel 2001), we differentiate our contribution by focusing on the micro-level and on the motivations of individual choices related to technology transfer.

The remainder of the paper is structured as follows: first, we review the literature on universities' technology transfer and entrepreneurial oriented research-based spin off. Then, we test our propositions by examining the case studies of two universities and two research-based spin off in UK and we discuss our findings. Finally, we suggest practical and academic implications, we underscore the research's limits, and we draw the pathway for future studies.

2 Theoretical background

2.1 Entrepreneurial orientation in a research context

The concept of entrepreneurial orientation was introduced in strategic management literature during the eighties "to model firm level entrepreneurship" (Lumpkin and Dess 1996, p. 136). Entrepreneurial orientation can be defined in relationship to the concept of entrepreneurship: whilst the latter consists in entering a new business, entrepreneurial orientation explain "how" to enter a new business (Covin and Slevin 1989, 1991; Miller 1983; Lumpkin and Dess 1996) and it is commonly studied in relationship to firm performance (Wiklund 1999, Wiklund and Shepherd 2005). Accordingly, EO literature mostly entails the study of how the entrepreneurial intention is formed, and how the action is purposively put in place (Van de Ven and Poole 1995). All the factors that affect this strategic choice can widely vary basing on contingency aspects. As instance, innovativeness, risk taking, aggressiveness, autonomy, and proactiveness are deemed the essential dimensions affecting entrepreneurial behaviour and co-variant factors (Miller 1983, Ginsberg 1985; Burgelman 1983; Naldi et al. 2007; Anderson et al. 2015; Covin and Wales 2019). In the purview of current research, the innovativeness and proactiveness dimensions emerge as more salient than others. As matter of fact, to have a forward-looking perspective, an experimental or pioneering attitude, a strategic posture and capability of anticipating future needs shape the way the venture pursues and capitalizes on opportunities (Wiklund and Shepherd 2005). In other words, EO is an overarching construct that explains how new opportunities are searched and pursued in an entrepreneurial manner. However, it is the degree of innovativeness and proactiveness of the firm that more specifically contribute to determine the response to competitive pressure and the shrinking of products life cycle. In fact, these two

dimensions ex-ante influence the way the firm seeks or recognize opportunities. At large, there are three main streams describing the way firms may seek opportunities: opportunity discovery studies (Shane and Venkataraman 2000), opportunity creation studies (Schumpeter 1934; Auvinet and Lloret 2015), and opportunity imagination studies (Hamel and Prahalad 1991). Thereby, a firm can be an opportunity seeker, it can create opportunities, or it can imagine them. The EO bears on the way an opportunity is recognized. An innovative and proactive firm creates and imagines opportunities rather than simply discovering them in an adaptive and routinely manner.

In this vein, Wiklund and Shepherd (2003) propose that knowledge-based resources define the opportunity pathway of a firm. Yet, knowledge-based resources markedly impact the firm's ability to be enterprising (Galunic and Eisenhardt 1994). Similarly, Lee and Peterson (2000) and Rauch et al. (2009) suggest the societal culture engender the EO. More in general, EO dimensions and opportunity recognition behaviour are both influenced by the learning ability of the firm (Wang 2008). In its turn, the way a firm creates and uses the knowledge depends on its learning orientation (Sinkula et al. 1997). Thereon, innovativeness and proactiveness are also mediated by the adaptive or generative learning behaviour of a firm (Wang 2008; see also Ferraresi et al. 2012).

In the copious literature of the EO research domain, there is still an underexplored stream: EO in research contexts. Over time, universities have changed their role from mere disseminators of knowledge, through teaching and research activities, to business opportunity creators, thanks to their newly acquired EO (Heinonen and Hytti 2010; Perkmann and Walsh 2008; Martinelli et al. 2008; Zhao 2004; Murray and Scuotto 2016).

Nowadays, entrepreneurial universities are forging new entrepreneurial agents who often originate research-based spin off. This form of business is generated from a research developed in an academic context where innovation, competition, risk taking, autonomous and proactiveness are the catalysts for society growth (Clarysse and Moray 2004; Martens et al. 2016; Secundo et al. 2017). These catalysts are the underpins of the EO framework (Lumpkin and Dess 1996; Zahra 1991, 1993). An academic entrepreneur and an entrepreneurial university face up market challenges finding new, innovative solutions which are anticipative of customers' needs. They operate freely in highly competitive environment and in uncertain situations. They are innovative and proactive by nature, they adopt a generative learning approach, and their EO is strongly shaped by the knowledge resources they own. In this innovation capacity, research-based spin-offs act as opportunity creators.

In this way, new ventures based on a research exploitation generate intellectual property (IP) and two breeds of agents: 'entrepreneurial academic' and the 'academic entrepreneur' (Jain et al. 2009). As defined by Meyer (2003), the entrepreneurial academic transfers his knowledge expertise to who, like academic entrepreneurs, decide to run their own business. To make this happens, universities provides technology transfer offices, funds, a close collaboration with entrepreneurial ecosystem, and spread a vivid enterprising culture within its academic context (Audretsch and Keilbach 2006; Clark 1998, 2004). This change has evoked a new form of EO, the science-based entrepreneurial orientation (SEO) (Tijssen 2006). The SEO concept entails an opportunity creation/imagination approach through the exploitation of scientific and innovative knowledge. Hence, researchers become entrepreneurs through converting their knowledge into a product and\or a service. In a broad sense, SEO is based on the logic of economies of scope (Panzar and Willig 1981; Teece 1980): "with economies of scope, joint production of two goods by one enterprise is less costly than the combined costs of production of two specialty firms" (Willig 1979, p. 346). In fact, SEO and research-based spin off base their competitive advantage on costs saving due to the joint production of product of research/innovation and product of the firm.

2.2 Entrepreneurial universities

Land, labor and capital were considered the key determinants of an economic society (Smith 1973). Solow (1956) gives a more emphasis to capital; whereas Romer (1986) points out the importance of knowledge in spurring the recent economy, where the intangible assets are the wheel of the economy (Del Giudice 2008). In this context, an enterprise is a vital system which interacts with internally and externally with its organizational environment such as universities, other enterprises, and government within an entrepreneurial society (Carayannis and Alexander 1999; Carayannis et al. 2016; Egorov and Carayannis 1999). Audretsch (2014) reckons that universities are emerged as source of entrepreneurial knowledge, leveraging the born of new venture. The universities, thus, are disseminating both technology and entrepreneurship. Empirical researches have demonstrated that universities play a crucial role in technology transfer (Adams 2006; Lööf and Broström 2008). Despite that, they are also identified as catalysts of innovation rather than drivers (Doutriaux 2003) and not so relevant for the enhancement of enterprises' productivity (Medda et al. 2006). Furthermore, some enterprises are not encouraged in generating patents with universities due to their intellectual property right (Hall 2001). However, although universities are not considered so entrepreneurial due also to their high hierarchical organization and traditional corporate culture (Kirby 2006), nowadays they are turning towards entrepreneurial society, assuming the role of entrepreneurial university (Bercovitz and Feldman 2006). Therefore, today entrepreneurial universities create new market opportunities, generate innovations, take risks, and address challenges, along with the ability to be autonomous, by managing, for instance, their own financial capital (Guerrero et al. 2014; Ryan and Hurley 2007). This has stimulated scholars to study entrepreneurial orientation (EO) within a research context. As instance, Hormiga et al. (2017) examine the effect of EO on academic groups offering innovative solutions (innovative), comfortable working in undefined conditions (risk taker), anticipating changes (pro-active), challenging their competitors (aggressive competition), and bending university's roles to create their own business (autonomous).

Previously, Antoncic and Hisrich (2001) showed the entrepreneurial side of university by analysing the change in strategies and market position. Inzelt (2004) examined the adoption of a collaborative approach from universities. Whereas, Smilor et al. (2007) explored the key pillars that have forged a proactive and an entrepreneurial university. Wong et al. (2007) discussed how Singapore universities changed after globalization. Differently, O'Shea et al. (2005, 2008) observed the entrepreneurial production taking in consideration RBSOs, developed by a university. Additionally, other studies emphasized two crucial academic mechanisms, that are technology transfer office (TTO) and business incubators, which are both great facilitators for a new venture (Mian 1996; 1997; Niosi 2006; Link and Scott 2005). For instance, a TTO might help new ventures in the patent acquisition process; while a business incubator facilitates the development of enterprise, providing infrastructures, mentorship programmes and a sharing cost environment.

Moreover, an entrepreneurial university is also devoted to nurture future entrepreneurs via offering entrepreneurial modules, enhancing skills, abilities, and knowledge (Kirby 2004) and creating close partnerships with their entrepreneurial ecosystem (Guerrero 2008; Guerrero et al. 2006; Ruiz et al. 2004).

2.3 Research Based Spin Offs (RBSOs) and technological innovativeness

In this scenario, entrepreneurial universities generate academic entrepreneurs (Schulte 2004). Audretsch and Lehmann (2005) noted that entrepreneurial universities are evaluated for the amount of new RBSO generated. In fact, an RBSO is an efficient and successful way to sell a scientific research which also brings back money to the university (Visintin and Pittino 2014; Conceição et al. 2012; O'Shea et al. 2008).

RBSOs are proactive to market changes (Sporn 2001), generating a new technology and knowledge spillover (Schillo et al. 2016; Schillo 2018, Acs et al. 2009; Carlsson et al. 2009; Audretsch and Keilbach 2006). This has enhanced the level of employability and so economic growth (Mustar et al. 2008). For instance, RBSOs generated by Oxford University contribute 3.5% of the domestic employment (Smith and Ho 2006). Besides, Google, Lycos, and Genentech can be counted as champion examples of a RBSO (Mathisen and Rasmussen 2019).

This new form of business aims to commercialize knowledge out the university (Rasmussen et al. 2008; Thursby et al. 2001). RBSO is a mean to market new technologies (Malone and Roberts 1996, 1996) and it assumes a crucial role in technology transfer (Rasmussen et al. 2006; Rasmussen and Clausen 2012; Fontes 2005). Schillo et al. (2016) declared that RBSOs lead the "technological spillover effect" (222). This thesis is also enforced by other studies (Carlsson et al. 2009; Audretsch and Keilbach 2006; Acs et al. 2009). RBSO thus exploits market opportunities to find new, innovative solution and to champion existing technologies.

In this context, RBSOs generate knowledge and convert it into a radical innovation. They also bring new technologies, enhance unexploited area of knowledge economy, and actively intermediate the process of knowledge transfer and acquisition among different actors. So, their innovativeness assumes more relevance than their growth capacity (Rasmussen and Clausen 2012).

Along with this asset mode, a RBSO pursues opportunities, acts in an uncertain environment, enhances innovation and foster creativity, anticipates market's needs, and challenges market leader. In a nutshell, they are not just technology based but also entrepreneurial oriented. This new form of an enterprise has spurred new studies based on resources (Mustar et al. 2006; Heirman and Clarysse 2004), types of businesses (Druilhe and Garnsey 2004; Clausen and Rasmussen 2013; Mustar et al. 2006), motivations of running a business (D'Este and Perkmann 2011), their aim to reveal inventions and get them into innovations (Bercovitz and Feldman), create licencing projects (Lowe and Ziedonis 2006), heterogeneity management teams (Fernández-Alles et al. 2015).

3 Methodology

Entrepreneurship and technological innovativeness are complex concepts, particularly when studied in the current socio-economic context where universities and their research-based spin offs operate. These complexities meant that an understanding of the perception of such concepts by the relevant individuals was needed. Qualitative methods are a powerful tool to explore those complexities (Gartner and Birley 2002), since they allow a grasp of the individual's own explanations of the entrepreneurship ecosystem, and behaviours and attitudes within their organisations and in relation to stakeholders. Different to quantitative

approaches, qualitative methods have the potential to produce a wealth of detailed data on a small number of individuals (Patton 1990) which may allow for a deeper understanding of entrepreneurship as a "systemic" phenomenon determined by its economic and institutional context (Fritsch and Kublina 2018).

In the entrepreneurship decision-making process emotions play a role as important as rationality. This is particularly important if we consider that entrepreneurship characteristics range from the motivation, personal characteristics, situation and heredity of the entrepreneur (Storey 1994), to innovativeness, risk-taking, and proactiveness (Miller 1983; Covin and Slevin 1986, 1989). Qualitative research allows for the exploration of such emotions without the constraints of quantitative methods (Suddaby et al. 2015).

While there has been a prevailing quantitative methodological bias in entrepreneurship research in the past, authors such as McDonald et al. (2015) have raised awareness of the issues this bias raises about the nature of the knowledge about the complex phenomenon of entrepreneurship. This study was therefore based on the conduct and analysis of in-depth interviews with individuals playing strategic roles in academic institutions and in research-based spin offs. These qualitative procedures enabled us to gain insight into the underlying issues determining the value of the relationship between academic institutions and entrepreneurs in the creation of successful enterprises. It should be noted that the sample is relatively small, thus the results should not be generalised.

3.1 Sample design and participant selection procedures

According to Eisenhardt and Graebner 2007, and Giraud Voss et al. 2005, to explore deeply a situation a case study is a suitable methodology. Besides, Yin (2017) states that a case needs to be unique and peculiar. Indeed, in this case the sample was selected in a way that a balance of academic and research-based spin offs was achieved. Two academic institutions within the United Kingdom and two research-based spin offs related to at least one of those universities were selected (Table 1). The academic institutions were selected using the University league tables, published by The Guardian (2019), in a way that these represented each of the two main areas defining success of academic institutions, namely teaching and research. The research-based SMEs were identified through the website of two regional Chambers of Commerce, by using the keywords *research*, *information technology* and *information systems*. Thus, participants were selected as follows:

- One university primarily focused on teaching.
- One university with a combined teaching-research strength.
- Two SMEs created as spin offs of an academic institution by entrepreneurs holding academic positions in that institution.

The in-depth interviews were conducted in the UK. The participants were approached by telephone by one of the authors, who explained the purpose of the research and the way the data collected would be treated. After some initial qualifying questions, each individual approached was then invited to participate in the study. Three interviews were conducted on a face-to-face basis while the fourth interview was conducted over the telephone to avoid the need for the author to travel to meet the participant.

Participants U1 and U2—representing academic institutions, work on a fulltime basis for their respective universities, providing support to academics in their engagement with

Table 1 Description of the participants, Roles and background of the individual respondents

Participant	Institution	Role	Background
Participant 1 (U1)	University X	Research Development Executive	Business development strategies
Participant 2 (U2)	University Y	Research Support Officer	Business administration
Participant 3 (E1)	Research-based SME (6 staff)	Chief Executive Officer	Associate Professor in Big Data, IoT, Information Retrieval and Human Factors
Participant 4 (E2)	Research-based SME (5 staff)	Chief Scientific Officer	Associate Professor in Cyber-physical Systems Security

potential sources of funding for their teaching and research activities. These support covers the so-called pre-award and post-award activities, from identification of sources of funding/engagement, writing, costing and submission of proposals, to staffing and delivery issues.

Participants E1 and E2 are academic entrepreneurs who started their own enterprises building on their research at their respective universities. Support from their universities allowed for their research-based spin offs to have succeeded in attracting business for at least the last 3 years in both cases. Both spin offs have established their own facilities: one of them (E1) within the university premises on a rental basis, and the second one (E2) have their offices outside the university but still within the same region. This allows, in both cases, an ongoing communication between the SMEs and the universities that they spun off from and where the entrepreneurs maintain their academic role. This means that both entrepreneurs split their time between their academic roles and their enterprises.

3.2 Interviewing procedures and analysis

The interviews were semi-structured, based on a predefined interview guide, and took an average of 30 min. The focus of the interviews was as follows:

- For universities: on their perception of the university as an entrepreneurial institution, the support they offer to academic entrepreneurs and their success in creating new enterprises.
- For entrepreneurs: on their perception of themselves as entrepreneurs and the support they receive from their respective universities in creating new ideas and turning those into successful products/services.

In all cases, the interviews particularly addressed the perception of the own entrepreneurial orientation of participants in terms of proactiveness, risk-taking and competitive aggressiveness, as well as their own innovativeness and autonomy. To comply with ethical and privacy issues, no personal information was requested from participants, other than their academic background or role within their institutions.

The in-depth interviews were digitally recorded and transcribed. As all participants requested their identities and those of their universities to be kept anonymous, once the interviews had been transcribed, the digital recordings were securely disposed of. The qualitative data analysis software NVivo was used to facilitate the organisation and structuring of the process of coding and categorisation and the identification of relationships among the key concepts driving the research.

This qualitative study was based on a ''grounded theory'' approach (Glaser and Strauss 1967), which provided an interactive framework for data analysis. The data were initially coded into concepts and ideas emerging from the data and the literature review. This analytical process was further iteratively refined throughout a systematic comparison between the data and the concepts and patterns previously identified (Strauss and Corbin 1998). This process allows the theory to emerge from the data in order to gain more insight and enhance understanding of entrepreneurship as the systemic phenomenon being study.

In a three-stage analysis, the interview transcripts were initially analysed line by line, and pertinent excerpts were assigned provisional conceptual codes. The next stage involved the search for relationships between conceptual labels and categories. The goal was to systematically develop and relate categories. Finally, categories were integrated and refined (Strauss and Corbin 1998).

Data analysis was structured around factors reflecting the perception of the relationship between the universities and their academic entrepreneurs, and also between the universities and their spin off enterprises.

4 Results

All interviewees were asked to talk about their perception of their own entrepreneurial attitude, both as individuals and as an institution. They were then asked to comment on the environment they operate in, and how they approach entrepreneurship in that environment. Then, universities were given a chance to talk about their perception of their relationship with their spin offs, while entrepreneurs were asked about their relationship with their academic institutions. While both SMEs had a relatively similar perception of their own role in the marketplace, there was a noticeable difference in the responses by both universities, determined by whether research was part of the primary focus of their work.

4.1 Respondents self-assessment of their entrepreneurship

4.1.1 Entrepreneurial attitude

All interviewees agreed that they had, either individually or as institutions, an entrepreneurial attitude.

Both SMEs considered themselves to be entrepreneurs and pointed out their long-term interest in establishing their own commercial ventures and their relatively recent success on doing so. E2 also highlighted their current engagement in another commercial prototyping activity to push out another strand of research, with potential for a further commercial development or spin out.

Both U1 and U2 described their respective institutions as entrepreneurial universities. They seek to "instil an entrepreneurial culture through engagement with businesses with support from their research support offices" and encourage and facilitate the development of entrepreneurial academics. However, both universities argued that their entrepreneurship was either limited or not necessarily inherent to their business. U1 argued that "whether by nature or by force", the university takes a very active position when it comes to engaging with business, and seeking and creating new opportunities, while U2 acknowledged that they were an entrepreneurial university "only to a limited extent". This was justified, in the views of U2, by the teaching tradition built over many years by that specific university, and the fact that it has only been in the last 10–15 years that they had had to respond to the changes in the environment by encouraging their own staff first to engage in research. U2 insisted that, though an entrepreneurial institution, teaching remains central to their strategy.

4.1.2 Outcomes of their entrepreneurial attitude

There have been significant outcomes for their entrepreneurial attitudes for all organisations involved in the research. Individual academics (E1 and E2) have both created what they consider a successful enterprise, and one of them (E2) is currently developing new ideas potentially leading to other spin offs. While E1 argues that their enterprise was built upon their own idea, E2 sustains that their SME was the result of a joint innovation

within the university that they spun out from. Both E1 and E2 were able to mention a patent created by their respective enterprises. For universities, however, the outcomes differ: although none of the two interviewees could mention the exact number of spin offs created by their university over the last 5 years, U1 could refer to around 100 SMEs having spun off from their university with different levels of success. U2, however, would only be able to remember 10–20 spin offs over the same period. A relatively similar number of co-invention patents were mentioned, respectively, by each university.

4.2 The university-academic entrepreneur relationship

When asked about their relationship with academic entrepreneurs, universities seemed satisfied with the level of support they provided to their staff.

4.2.1 Technology transfer offices

Both universities have technology transfer offices, with different degrees of complexity and focus. While U1 argues that theirs is "very effective in helping transfer knowledge from the university to businesses through research projects", U2 referred to it as "a small team of 5 colleagues helping with engagement with industry". U2 went on to explain that in many cases those staff are more focused on finding placements for their students, describing it as 'a form of knowledge transfer'.

The views from the spin off enterprises in terms of the support received from their respective universities were less comprehensive that what the universities considered. E1 described the support received from their university as limited to "identifying new business opportunities", while E2 refers to his university support as facilitating IP transfer and financially investing in the new commercial entity. In terms of the technology transfer offices at the corresponding universities, E1 describes it as "mainly on Intellectual Property and with the management of legal requirements and documents", with E2 describing it as having "helped filed a patent application and negotiate shareholder split into the new commercial venture".

4.2.2 Financial support from universities to entrepreneurs

While the funding available for each university differs according to the place that research holds in their overall strategy, both universities referred to internal sources of funding that allow for financially supporting new ideas, potentially enabling entrepreneurs in their development. Paradoxically, both E1 and E2 described during the interview the financial support they received from their respective universities only during or after the creation of their enterprises.

4.3 Entrepreneurial orientation

The views of all participants on this domain were determined by their common understanding of the dynamic and complex nature of the environment where they operate, particularly in relation to technology developments, main driver of their business success.

4.3.1 Competitive aggressiveness

All interviewees described themselves and/or their organisations as innovators. E1 referred to innovation, quality and timely delivery of their products and –where appropriate, their services as the key to success. E2, however, adopts a more cautious position and describes themselves as "less proactive at this stage", as they are currently developing their products. They acknowledge, however, that the next phase for their enterprise consists of "going out there to identify and work with customers".

For universities, both U1 and U2 confirmed their intention to offer their students the best learning experience and their researchers the best chances to contribute to the community. Actions mentioned by university interviewees as examples of competitive aggressiveness included investing to have outstanding facilities, providing the best quality teaching and learning experience, training and development for local businesses and engaging with local government in supporting the community.

4.3.2 Risk appetite

While all interviewees described themselves as aggressive and proactive, entrepreneurs seemed more prompt to take risks in the current economic and institutional environment and their respective entrepreneurship ecosystems.

U1 described their approach as "cautious but certain", and argued that they are willing to wait just what is necessary to understand the risks and then adopt a position of strength based on the experience of their academics and their reputation as a forward-looking institution. U2 referred to strengthening their position within the resources available as a strategy to deal with risks and uncertainty.

Both enterprises, however, were positive in their lack of fear of failure, with E1 describing their attitude as 110% willing to risk their resources if would lead to innovation, quality and timely delivery of their products and services.

5 Discussion

5.1 Entrepreneurship in the current economic and institutional context

Our research suggests that entrepreneurship has become an imperative to succeed in the context where British institutions currently operate. Entrepreneurship brings the necessary technological innovation to the university and its students, which results in better positioning of the university at national and international levels, with the subsequent impact on their ability to attract not only new students and academics but also funding to conduct their research. Additionally, entrepreneurship brings along innovation and, thereby, it fosters local and regional development, thus allowing for the university to make a wider impact on their community. This economic and institutional context, which is visible across Europe, complements the presence of key entrepreneurship characteristics in academics to increase the level and type of new business formation (Sternberg 2011) and the actual effects that new businesses have on innovation (Qian et al. 2013) and development (Fritsch 2013). This becomes particularly relevant given

the dynamic and complex nature of the technology domain where the organisations involved in this research operate.

In terms of success of entrepreneurial efforts in the current economic and institutional context, our research shows that individual academics with the right entrepreneurial characteristics may have an opportunity to succeed, since "habitually create and innovate to build something of recognised value around perceived opportunities", in line with Bolton and Thompson's (2000) views of successful entrepreneur. For academic institutions, however, a direct correlation was found between the priority of research for the university strategy and the number of patents created by and enterprises spun out from that university. The university with a stronger focus on research (in addition to teaching) seemed to have performed better in this domain over the last 5 years.

5.2 Entrepreneurial attitude

We have found that while universities perceive market aggressiveness, proactiveness and risk-taking as the actions taken to establish themselves as centres of excellence when it comes to teaching, research and businesses training, enterprises working directly with the university go one step further. Despite perceived by participants as a relatively rigid management structure, universities seek to remain committed to developing their technology base, from information to other technologies that support their teaching and research strategies. Alongside, a new way of transfer knowledge is introduced where knowledge shifts from a mere invention to an innovation to be sold (Martin-Perez and Martin-Cruz 2015, Matsuo 2015, Krylova, Vera and Crossan 2016, Stadler and Fullagar 2016; Omar Sharifuddin Syed-Ikhsan and Rowland 2004). Entrepreneurs, however, appeared more conscious of the complexity of their socio-economic environment, their total responsibility for the success of their enterprises and the urgency of being proactive, willing to take risks and able to innovate with autonomy. According to Audretsch (2014), this scenario generated a spill over effect, moving from a mere knowledge producer to a commercialised knowledge. Indeed, the commercialization out of the universities has introduced new ways to transfer knowledge– not only research and development (R&D) within an enterprise but there is also the involvement of research institution in joint initiatives with enterprises (Carayannis and Alexander 1999).

5.3 The relationship between the university and its spin offs

Our research suggests that the perception of the support provided by universities to their entrepreneurs differs between the two parties. While universities argued that they provide a wide range of support to entrepreneurs, the enterprises felt that the support was 'limited' and only focused on legal support such as the management of Intellectual Property and –in one case, financial investments in the new venture.

It is interesting to note that the perceived limitation of the support received by entrepreneurs from the academic institutions that their enterprises have spun out from does not seem to have a direct impact on their entrepreneurship attitude. Neither does it seem to have a negative effect on their ability to succeed in the market. However, it must be mentioned that an enterprise that have received direct investments from their university has adopted a relatively different path to the one relying fully on their innovation. While the former has embarked in a period of product development with financial support from the university, the second has felt a greater urgency to take risks, find and

meet potential customers, turn their discussions into formal requirements and proceed to the effective and timely delivery of their products.

Therefore, universities seek to nurture new entrepreneurs, teaching them how to be autonomous, by managing, for instance, their own financial capital (Guerrero et al. 2014; Ryan and Hurley 2007). Universities, thus, are more collaborative Inzelt (2004) and proactive (Smilor et al. 2007). They offer technology transfer office (TTO) and business incubators, which are both great facilitators for a new venture (Mian 1996; 1997; Niosi 2006; Link and Scott 2005). However, that seems not enough to drive entrepreneurial orientation. This result shows that entrepreneurial orientation (EO) needs to be more explored and contextualised to the current economy.

6 Conclusion

This qualitative study has highlighted some relevant key factors that define the changing role of academic institutions in the current technology-driven and therefore dynamic and complex economic and institutional environment. Driven by the changing needs of business and society, universities have embraced new strategies, adopted an entrepreneurship attitude and invested in entrepreneurship skills in its students and academics, as a mean to influence regional and national development. Our research shows that even those universities that have a long-standing tradition of teaching currently seek to support individuals who have entrepreneurial characteristics so that they can innovate around perceived opportunities and create products and services of recognised value. Such support takes many forms, from providing funding for early career researchers to develop their ideas within the institution to establish mechanisms for their engagement with other teams in industry and academia. Furthermore, our study shows that universities are increasingly taking risks and investing on new commercial ventures driven by their own academics, and putting in place the structures that will support those entrepreneurs in establishing their initiatives based on their own ideas and those of others within and outside the institution.

The research has also highlighted the proactive attitude, risk appetite and drive to succeed of academic entrepreneurs when it comes to innovate from their own enterprises with the support of universities while in many cases continuing to deliver on their academic responsibilities. In studying the relationship between the entrepreneur and the academic institution, we found that academic entrepreneurs build on their own innovative ideas and those of their institutions, and often find the resources to finance their innovation while maintaining a close relationship with the university. As a stakeholder, the university becomes a source of legal advice and in some cases an investor. Thus, an entrepreneurial orientation in the university serves to enable entrepreneurship in its students and workforce.

This research adds to the existing literature on the role of the economic, social and –mainly, institutional contexts in the ability of entrepreneurs to develop their technological innovations and take them to market. Despite the limitations derived from the study of two universities and their spin offs in the context of the United Kingdom, this research informs management practice on the need for universities to strengthen their collaboration with their entrepreneurial ecosystem. Future research is expected to analyse the relationships between universities and their spin offs in other socio-economic environments.

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Affiliations

Veronica Scuotto[1,2] · Manlio Del Giudice[3,4,5] · Alexeis Garcia-Perez[6] · Beatrice Orlando[7] · Francesco Ciampi[8]

1 Research Center, Leonard de Vinci, Pole Universitaire, 92 916, Paris La Défense, France

2 Department of Management, University of Turin, Corso Unione Sovietica, 218bis, 10134 Turin, Italy

3 Link Campus University, Rome, Italy

4 Paris School of Business, Rue Nationale, Paris, France

5 National Research University Higher School of Economics, Moscow, Russia

6 Research Centre for Business in Society, Coventry University, Priory Street, Coventry CV1 5FB, UK

[7] Department of Management, Sapienza University of Rome, Via del Castro Laurenziano 9, 00161 Rome, Italy

[8] Department of Economics and Management, University of Florence, Via delle Pandette, 32, 50127 Florence, Italy