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EXTERNAL EQUITY FINANCING OF INNOVATIVE START-UPS: THEORY AND PRACTICE ON NON-ACCOUNTING DRIVERS

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1. INTRODUCTION

Entrepreneurship literature has devoted significant attention to innovative start-ups, which may be defined as firms that are knowledge-intensive and research-based, young and independent and devote significant resources to research and development (R&D) and innovation (Colombelli et al., 2020). These firms are increasingly considered key for economic and regional development as well as technological advancement (Cooke and Leydesdorff, 2006; Autio et al., 2014; Audretsch et al., 2006; Baumol and Strom, 2007) because of their role as carriers, diffusers and co-creators of knowledge that can shape competitive dynamics within an industry and confer competitive advantages to regional and national economies (Miles et al., 1995; Hertog, 2000; Muller and Zenker, 2001; Muller and Doloreux, 2009). Given these premises, it not surprising that this typology of firms has attracted the interest of academics as well as is also considered of crucial importance by many actors in modern economies, first among all, policy makers (Autio et al., 2014; Guerrero and Urbano, 2019).

Innovative start-ups, however, face a series of challenges that can threaten their survival and hinder their effort to grow. One key challenge is the access to sufficient financial resources required to turn technological innovations into marketable products or services (Rasmussen and Sorheim, 2012). This is because, innovative start-ups face uncertainty about the technological development and are confronted with challenges regarding market acceptance of their innovative products or services (Minola et al., 2019; Hyytinen et al., 2015). Innovative start-ups are often engaged in patenting activities which is technologically challenging and financially demanding. In addition, other difficulties may arise due to their lack of stable cashflow, of a lack of collateral and also due to their lack of track records. On the one hand, these factors cause severe information asymmetries which discourage banks and other debt holders from investing in these firms (Wright et al., 2006; Ortín-Ángel and Vendrell-Herrero, 2010; Rasmussen and Sørheim, 2012).

On the other hand, governments have predominately designed and implemented several types of policies in order to alleviate those constraints that may hamper the birth and the growth of innovative start-ups. These policies have been related to access to capital, access to skills, access to networks, fiscal policy and tax incentives (Audretsch et al., 2020). However, the results of such policies have not always been particularly successful. To some extent, there is a substantial ambiguity in the conception of what policy makers mean by the term “innovative start-up” when they design such policies. In fact, innovative start-ups, as suggested by Audretsch et al. (2020), are heterogeneous and differ in terms of their originating context, founding characteristics, post-founding or even by the outputs and impacts that they provide.

All these hurdles seen so far are even more severe for *certain* firms, i.e., *university spinoffs* (hereafter USOs), which are distinctive from other type of innovative start-ups, in that they originate from *university*. These types of firms are regarded as an economically compelling subcategory of innovative start-ups (Shane, 2005). USOs are defined as ventures created to commercialize knowledge and technologies generated at a university and in which the team of founders comprises members from a university (Fryges and Wright, 2014). Since USOs play a key role in developing industrial applications of scientific knowledge thereby contributing to wealth creation (Bigliardi et al., 2013; Baldini, 2010; Shane, 2004; Hayter, 2013), the commercialization of academic research results undertaken by USOs has received increasing attention from university administrators and scholars (Abootorabi et al., 2021; Colombo et al., 2019; Fini et al., 2019). USOs are considered as a potentially valuable but underexplored vehicle to technology transfer by universities (Lockett et al., 2003, Harrison and Leitch, 2010).

Given the above, USOs see equity financing as the most important financing source (Wright et al., 2006). However, there are patterns in how entrepreneurs seek external equity (demand-side) as well as patterns in how investors select these ventures for financing (supply-side), especially in the early stage of venture development. From the demand-side, literature recognizes that there might be limits in the *demand* for capital by USOs. In other words, there might be reasons that make USOs less willing to seek (and not only less able to secure) external equity financing. First of all, reaching the stage in which USOs actively search for external equity financing requires passing across critical stages of development, including the commitment of the founders to the company (Vohora et al., 2004). Since USO founders are often university scientists who are reluctant in allocating time from their academic duties to the development of the venture (Jain et al., 2009), USO might not even reach the stage in which they are in need for and, hence, ready to search for external equity. Moreover, USOs often lack the capabilities to effectively frame the commercial opportunity while approaching external equity providers (Vohora et al., 2004). From the *supply*-side, USOs are typically based on intangible assets, such as technological knowledge and intellectual property, whose value is difficult to assess for external equity investors (Hahn et al., 2019). USOs also originate from a traditionally non-commercial environment (Fini et al., 2019) and their founding teams often lack track record in the business world (Nikiforou et al., 2018). This could lead to a substantial under-provision of funds to USOs because of capital market imperfections.

Nevertheless, more recently, several studies in the entrepreneurial literature have examined the factors that influence the investment process in general (Cassar, 2004; Chandler and Hanks, 1998; Manigart and Struyf, 1997; Fukugawa, 2022; Gubitta et al., 2016; Huyn, 2016). For

example, evidence from the study of Silva (2004) on external equity investors' decision-making show that investors' attention is focused on the entrepreneur, the business idea, its sustainable advantages and growth potential. Thus, this study suggest that financial projections of the prospect do not seem to play an important role in the selection of innovation projects.

Prior literature also shows that USOs led by scientists may pursue non-economic goals such as concerns about the progress of a certain technology or innovation and its benefits to society (Jain et al., 2009). However, these goals often vary because the decision of scientists to engage in commercialization activities and the process of doing so is influenced by formal institutional rules and policies of the university in which they are socially embedded (Kenney and Goe, 2004). It follows that while some scientists tend to embrace entrepreneurship and prioritize commercialization over recognition from the scientific community (Lam, 2011; Jain et al., 2009), others consider their USOs as a means to further research and establish a strong reputation in the scientific community (Hayter, 2011). As such motivations of scientists can influence strategic decisions and firm behavior, which in turn might affect external equity financing. These set of information are considered as "non-accounting" drivers (Amir and Lev, 1996; Amir et al., 2003; Robb et al., 2001; Cinquini et al., 2012; Orens and Lybaert, 2007; Orens and Lybaert, 2010; Sievers et al., 2013) and defined as "information drawn from outside the financial statement" (Barker and Imam, 2008: 313). These studies suggest that there is a great need for a better understanding of external financing and the critical aspects of the financing and entrepreneurial process, for both theoretical and practical reasons (Miloud et al., 2012) as anecdotal evidence from e-Novia S.p.A[1] show.

The objective of this doctoral dissertation is contributing to such advancement by addressing the following overarching research question: "How do non-accounting drivers influence the external equity financing of university spinoffs?".

To do so, the work presented in this dissertation focus on *firm-level/team-level* and *university-level* antecedents and takes the perspective of the two main actors involved in the financing process: *investors on one hand,* and *entrepreneurial team* on the other hand. As I show in the table presented below, the papers included in this dissertation are positioned to capture the different facet of external equity financing. It is known that for financing to take place, valuation

[1] e-Novia S.p.A, a firm founded in 2012 on the initiative of some researchers from Milan Polytechnic. The firm is identified as a "factory of enterprises" because it transforms ideas into companies by financing projects research that can give rise to projects that will become real companies. It manages more than 50 start-ups and is keen to develop a framework that can take into account non-accounting drivers to exploit the distinctiveness of university spinoffs in the context of start-up valuation. e-Novia S.p.A is also the sponsor of this PhD project. For more information www.e-novia.it

of the firm must first take place. For this reason, this dissertation also includes a literature review on the extent to which, and how, the literature has recognized the role of non-accounting drivers of innovative start-ups and their valuation by early-stage equity investors. the contribution of the review is in threefold. First, moving from a literature review on the valuation of innovative start-ups by early-stage equity investors, it advance a theory-informed taxonomy of non-accounting drivers covered by extant research. Second, it identifies three main areas to improve the valuation process for innovative start-ups, namely (i) heterogeneity appraisal of innovative start-ups; (ii) consideration of innovative start-ups' origin; and (iii) more theory-informed valuation approaches. Third, to address the aforementioned problems and advance research and practice of valuation, it proposes a focus on *university-based dimensions* as promising example of non-accounting driver supporting the valuation of innovative start-ups. This study spurred my subsequent research.

From a methodological point of view, the papers of this dissertation build on established theories which have been used in the academic entrepreneurship literature to conceptualize the mechanisms through which USOs characteristics influence external equity financing (Spence, 1978; Connelly et al., 2011; Marquis and Tilcsik, 2013; Colombo et al., 2012; Hahn et al., 2019; O'Shea et al., 2008). In addition, a theory-testing research approach was adopted, and papers included in this dissertation are quantitative.

Table 1. 1 Positioning of papers in the dissertation

Perspective	
Demand-side	**Supply-side**
Paper 3	Literature review
Paper 1	Paper 2

Given that financing USOs is a complex and multi-stage process (Eckhardt et al., 2006), the first paper of this dissertation is aimed at exploring to what extent and under which circumstances non-accounting drivers deriving from the core activities of the Entrepreneurial University affect the development of USOs. In particular, it explores the role played by the dimensions of research activity at university level in driving early-stage equity financing of USOs. To address this gap, it builds on the imprinting perspective to design an explorative study on the

relationship between university research patterns (exploration and exploitation, measured each through both inputs and outputs indicators) at USO's founding and the early-stage equity financing of the USO. Based on a sample of 739 Italian USOs, the analyses reveal that the research indicators connected with the explorative (exploitative) research pattern yield overall positive (negative) effects on the likelihood of USOs to raise early stage-equity financing. These findings offer research contributions and practical implications for the Entrepreneurial University and academic entrepreneurship.

The second paper presented in this dissertation investigate investors' propensity to invest in USOs. By Adopting the theoretical lens of *signaling* (Spence, 1978), It explore to what extent and under which conditions can USOs differentiate themselves by examining how non-accounting drivers, namely parent university-related signals can affect investors' propensity to invest. It is shown in this study that university equity ownership is a positive signal of quality for potential investors and that the reputation of the university positively moderates the association between university equity ownership and investors' propensity to invest in USOs.

The third and final paper is aimed at exploring the effect of non-accounting drivers on seed funding. Borrowing from the willingness and ability paradox in the family business literature (De Massis et al., 2014; Chrisman et al., 2015), it explores the effect founders' growth intentions and experience, on the amount of seed funding raised by USO. this work is based on the assumption that a founder may have the abilities to grow the USO but may still lack growth intentions or vice versa. Thus, willingness and ability are necessary and sufficient conditions. The paper identifies three clusters of growth intentions that can affect seed funding, namely: economic growth intentions; employment growth intentions; academic growth intentions and combined them with founder experience. Results from this explorative study show that founders' growth intentions alone are not enough to receive seed funding, rather a combination of economic growth intentions and management experience as well as the combination of employment growth intentions and industry experience is the way to go. Below is a summary of the papers in this dissertation

Table 1. 2 Summary of the papers in the dissertation

	Paper 1	Paper 2	Paper 3
Focus	**University spinoff**	**University spinoff**	**University spinoff**
Research design	Empirical quantitative	Experiment	Empirical quantitative
Research question	Do exploration and exploitation in university research drive early-stage equity financing USOs?	1. Does investors' propensity to invest differ between USOs and Non-USOs? 2. Among USOs, does university equity ownership affect investors' propensity to invest, and under which conditions?	1. How do different types of growth aspiration impact USO's early stage equity financing? 2. Do different dimensions of experience matter for the growth intentions – USOs early stage external equity financing relationship?
Dependent variable	Early-stage external equity financing	Investors' propensity to invest	Early-stage external equity financing
Level of analysis	Firm	Investor	Firm/team
Sample	739 USOs	165 & 182 early-stahe investors	35 USOs
Theoretical perspective	Imprinting theory	Signaling theory	Behavioral theory

2. LITERATURE REVIEW

Acknowledgement: This chapter is derived from the article 'Agyare, D., Hahn, D., Minola, T., & Vismara, S. (2022). Non-accounting drivers of start-up valuation by early-stage equity investors: literature review and future research agenda. Developments in Entrepreneurial Finance and Technology, 227-268'.

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2.1 Introduction

Innovative start-ups are a driving force for most developed economic systems. Audretsch et al. (2020) suggest that innovative start-ups can be defined based on the features that influence their development and outcome. Accordingly, we define innovative start-ups as "start-ups that are knowledge-intensive and research-based, young and independent and devote significant resources to research and development (R&D) and innovation" (Colombelli et al., 2020, p.1). Innovative start-ups typically present these features (Colombelli et al., 2016): lack of tangible resources and financial information, illiquidity of investment, high level of economic and technological uncertainty, high cash burn rates and most importantly, high level of asymmetric information.

When innovative start-ups require equity financing from early-stage equity investors such as Venture Capitalists (VC) or Business Angels (BAs), the issue of valuation becomes critical (Sievers et al., 2013). The corporate finance literature proposes financial accounting methods such as the Discounted cash flow (DCF), asset-based and earnings multiple approaches. These approaches, however, are problematic when it comes to innovative start-ups (Miloud et al., 2012; Sievers et al., 2013; Sanders and Boivie, 2004). For example, in the DCF approach, due to the uncertainty surrounding the commercialization of the new products or services developed by innovative start-ups, it is challenging to estimate the appropriate discount rate and determine the future cash flows. The net assets approach does not adequately consider the economic value of growth opportunities, while the earning multiple approaches are based on earnings which an innovative start-up often does not have until it reaches later financing stages. To address this, Ge et al. (2005: 3) state that "when it is difficult to value a subject based on output (e.g., future cash flows), pricing it based on inputs (e.g., entrepreneur, industry attractiveness) might be an alternative solution". Non-financial information, non-accounting information, beyond financial-report information, have been used in the valuation literature to describe input variables related – among others – to management and shareholders, background information about the firm, human and intellectual capital (Amir and Lev, 1996; Amir et al., 2003; Robb et al., 2001; Cinquini et al., 2012; Orens and Lybaert, 2007; Orens and Lybaert, 2010; Sievers et al., 2013).

Throughout this chapter, we embrace this perspective and adopt the term "non-accounting", defined as "information drawn from outside the financial statement" (Barker and Imam, 2008: 313). Some recent examples show a surge in the use of non-accounting information in valuation research (Wyatt, 2008; Wessendorf et al., 2020; Moghaddam et al., 2016; Block et al., 2014; Zheng et al., 2010). Yet, we do not know to what extent, and how, the literature has recognized the role of non-accounting drivers of innovative start-ups and their valuation by early-

stage equity investors. Hence, by means of a scoping study, we review 24 studies to detect and depict its most significant shortcomings. Additionally, by proposing university as the context of origin and distinctiveness of many innovative start-ups, we offer a set of University-Based Dimensions (UBDs) to be incorporated in valuation studies and practice. We refer to UBDs as features of innovative start-ups, which capture distinctive characteristics related to the university context from which they are originated. Given the diversity of the theoretical backgrounds in this field, this chapter emphasizes the relevance of a cross-fertilization between different research disciplines as a way to help advance knowledge on non-accounting drivers of early-stage startup valuation.

2.2 Conceptual development

Firm valuation is a fundamental necessity for business investments to occur (Bose and Thomas, 2007). It builds on firm resources, its competitive position within its sector and its future financial expectations. Early-stage investments are meant to support the pre-launch, launch and early-stage development phases of a start-up (Davila et al., 2003). As such, VC firms serve as an important financial intermediary in financial markets and they raise funds from individuals and institutions for investment in early-stage start-ups that offer high potential but high-risk returns (Sahlman, 1990; Gompers, 1995). Next to VC, BAs are wealthy individuals who invest their own money to acquire shares of innovative start-ups. BAs typically take a less structured approach to valuation than VCs; they rely on intuition, heuristics, personal enjoyment, and gut instinct (Drover et al., 2017).

BAs and VCs invest in innovative start-ups and their investments usually concern R&D expenses related to design and marketing of the new product and disbursement for new capital equipment (Hall, 2002). In the VC market, firm valuations are determined through a face-to-face negotiation between management and VC investors. These investors usually adopt a multistage decision-making process and are structured in a way to deal with information asymmetries. Such activities – board positions, frequent interactions with and monitoring of management, etc. – allow VCs to extract management's private information and thus reduce information asymmetries. Research into non-accounting drivers that impact early-stage venture valuation of innovative start-ups has developed over the past decade. In terms of start-ups characteristics, industry relevance and geographical location (Houlihan valuation Advisors, 1998), early adoption of management accounting systems and management control systems (Davila et al., 2015; Davila and Foster, 2005) and firm age (Armstrong et al., 2006) are believed to be decisive factors that determine

start-up valuation by early-stage equity investors. Founder and team characteristics such as number of founders, management team, prior start-up, management and relevant industry experience and level of education have been empirically proven to be valuable resources of a start-up, thereby informing its valuation (Hsu, 2007; Miloud et al., 2012; Sievers et al., 2013; Wasserman, 2017). These studies indicate that non-accounting drivers are receiving growing attention. However, existing literature is fragmented and lacks a theoretical rigor integrating research on such drivers for innovative start-ups by early-stage investors (Cumming and Vismara, 2017). Also, previous reviews in this field either do not focus specifically on innovative start-ups and non-accounting drivers (Köhn, 2018) or do not offer a theory-informed taxonomy of non-accounting drivers (Wessendorf et al., 2019).

2.3 Research Methodology

2.3.1 Planning the review

Following the definitions of Arksey and O'Malley (2005), we develop a scoping study of the literature. Our choice for this methodological approach is underpinned by two important reasons: first, a scoping study is particularly useful because it aims to map rapidly the key concepts underlying a research area and the main sources and types of evidence available, especially where an area is complex or has not been reviewed comprehensively (Mays et al., 2001). Second, it allows to address a framework that addresses a specific topic (i.e., the non-accounting drivers of innovative start-up valuation), by taking a systematic albeit inclusive approach and ensuring rigorous and transparent execution throughout its different structured stages (Pham et al., 2014).

2.3.2 Identifying the research question

The first step in a scoping study is to identify the research question to be addressed so as to build a solid search strategy (Centre for Reviews and Dissemination, 2001). Our guiding research question is the following: "To what extent, and how, has the literature recognized the role of non-accounting drivers of innovative start-up valuation by early-stage equity investors?" Conscious of the fact that scholars use different terms to describe "innovative start-ups", we consulted prior literature studies and reviews to mitigate the threat of variety in relation to terminology (Luger and Koo, 2005; Hsu, 2006; Colombelli et al., 2016; Köhn, 2018; Wessendorf et al., 2019; Audretsch et al., 2020). These studies were particularly useful because they provided

the appropriate concepts and terminology in the area of study; they also helped us in identifying relevant keywords for use in the search for papers.

2.3.3 Identifying relevant studies

The primary focus when scoping the field is to be as systematic as possible in identifying studies for answering a research question. To achieve this, we employed a strategy that required searching for potential papers through different sources: electronic databases, existing networks, and reference lists. Figure 12.1 offers a summary of the search process.

2.3.3.1 Electronic database

Electronic databases are the primary source of bibliographic contents and abstracts of published material. We developed a baseline search strategy for the articles to be inserted in the review. The strategy involved three categories of keywords. The categories were used in Elsevier's Scopus database by combining them as search algorithms using the Boolean search operator "AND" alongside the search operator "OR" for keywords within each category. The focus of the search was within "article title, abstract, or keywords" fields. The following describes each category (details in Figure 2.1):

- The valuation object: refers to the different terminologies used to describe innovative start-ups.
- The valuation perspective: refers to the scope of the papers analyzed. Here, we included the terms "valuation" and "evaluation", as they are sometimes used interchangeably.
- The valuating entity: as different investors might have different approaches to valuation, we include the investor performing the valuation of the start-up in our search strategy.

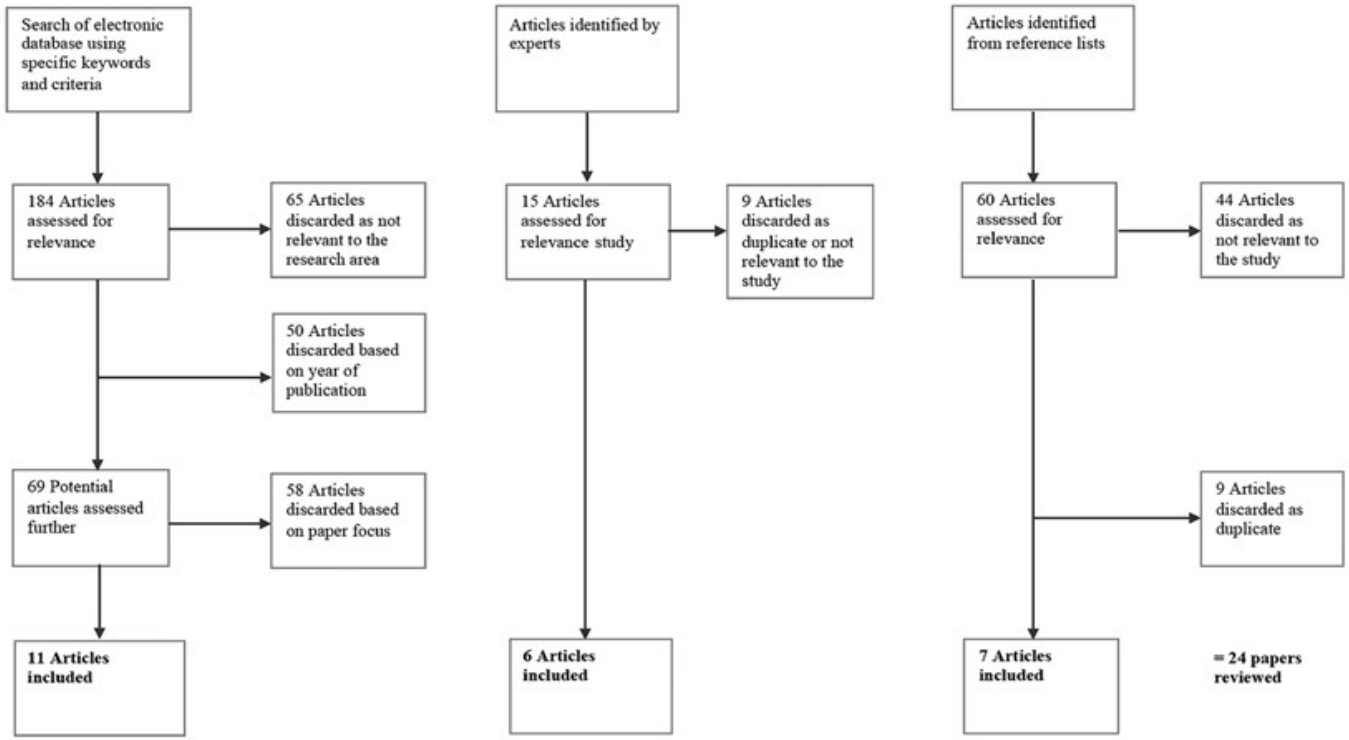
Next, the Scopus database was used for an extensive literature search. Only studies published in the post-dot-com period (i.e., after 2004) were included in the study. The starting date of 2004 was chosen because empirical literature on start-up valuations published before the dot-com period is too distant from the current reality (Köhn, 2018). Only English language articles were considered, as they are viewed in the academic literature as an established body of knowledge. To eliminate studies that did not address our central research question, we included only papers satisfying the following criteria:

i The unit of analysis has to be the firm (i.e., the innovative start-ups).

ii The research topic must concern non-accounting drivers related to valuation in the context of early-stage equity investors.

iii The field of research falls within the area of business management, accounting, economics, econometrics, finance, and decision sciences.

Figure 2. 1 Overview of the review process



A manual assessment was conducted on the 184 potential papers generated by the Scopus database, by reading each paper thoroughly to determine its eligibility (mainly by verifying criteria (1) and (2) above. At the end of this process, we identified 11 relevant papers to be included in our final sample. As noted above, the relatively high number of papers excluded within the overall study selection process is mainly driven by the rigorous inclusion criteria applied and the very specific research question guiding the study.

2.3.3.2 VC interviews

Since practitioners can contribute to improve the selection of papers included in scoping studies (Newbronner and Hare, 2002), we interviewed three VC investors from our network. In the structured interviews. we asked them about the non-accounting drivers they use to evaluate innovative start-ups. Interviews were conducted online using either Microsoft teams or Zoom as the platform for our video conferencing and the time devoted for each interview was approximately 45 minutes. Respondents were also invited to suggest empirical studies from which they draw information regarding non-accounting drivers when dealing with innovative start-ups. This provided 15 additional studies, of which 9 were discarded as duplicates and/or not relevant to the study.

2.3.3.3 Reference lists

To improve completeness, we also checked the bibliographies of 17 studies. We performed a "snowballing" investigation technique using backward and forward citation on the references of the identified articles. This process generated 60 papers, which were subsequently assessed in terms of focus and eligibility. Out of these 60 papers, 7 additional articles were included in our final sample.

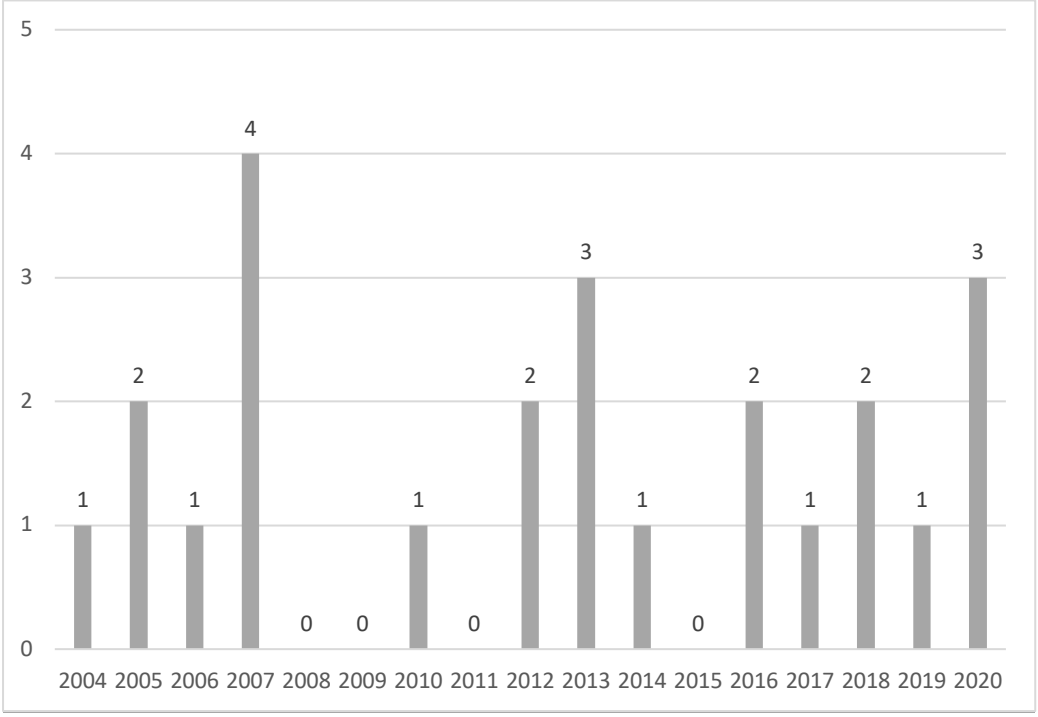
2.3.4 Charting, collating, and summarizing the information

We "charted" key items of information obtained from the 24 papers being reviewed. Ritchie and Spencer (1993) describe the term "charting" as a technique for synthesizing and interpreting qualitative data by screening, extracting data, and sorting material according to key issues and themes. In our case, we focused on author(s), paper title, journal name, theory used, sample and data source, research method, non-accounting criteria covered, and fit with our research question. The data that we charted were then stored using a spreadsheet. This enabled us to depict the main areas of interest and highlight significant academic voids.

2.4 Research findings

This section presents an overview of the 24 identified papers. As highlighted in Figure 2.2, the number of published research papers on non-accounting drivers of start-up valuation is quite steady. Seven papers were published between 2004 and 2007 (excluding the working paper), seven papers between 2010 and 2014, and nine papers between 2016 and 2020.

Figure 2. 2 Number of papers by year of publication

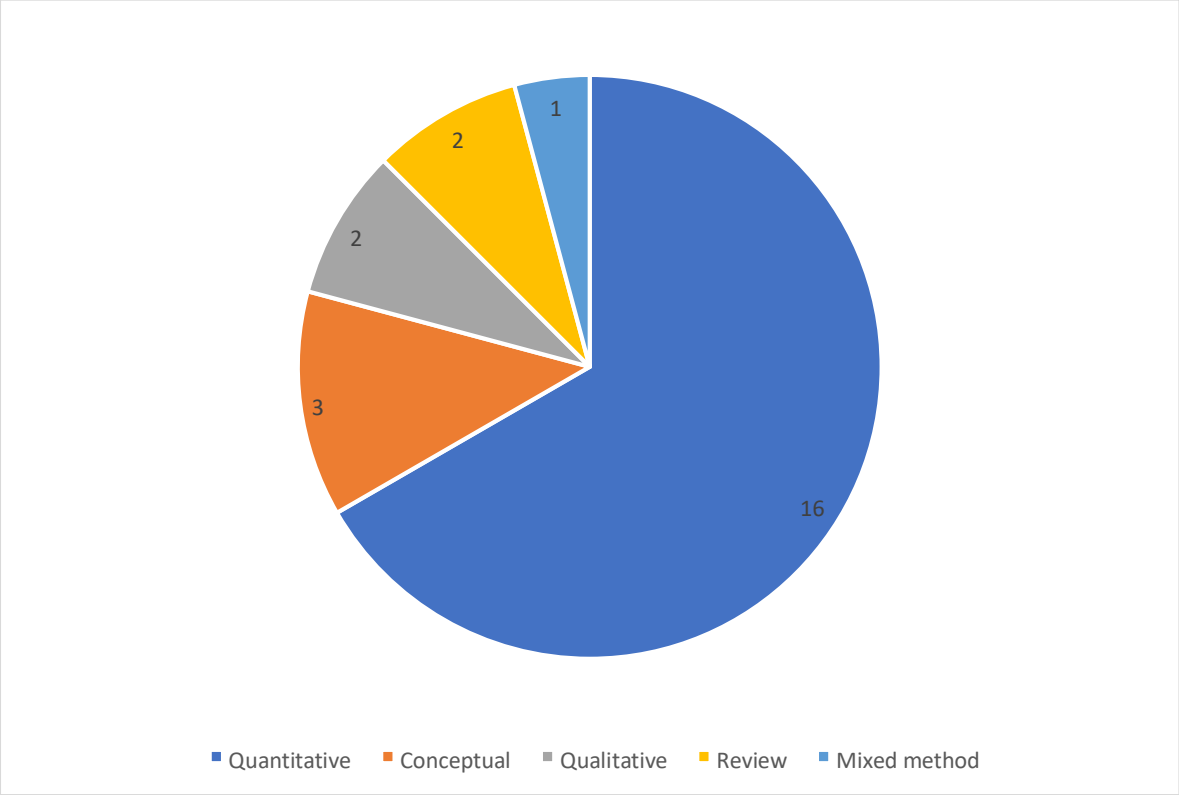


As shown in Figure 2.3, most of the papers are empirical (19) while three papers are conceptual and two other studies are review papers. Sixteen articles in our sample primarily use quantitative methods. Two papers adopt qualitative methods whereas only a single paper employs a mixed method approach (the use of both qualitative and quantitative methods). All the empirical quantitative studies employ the use of a firm's pre-money[2] or post-money[3] valuation as the

[2] Pre-money valuation indicates the value of the start-up before the investment; it is obtained by deducting the money invested at the financing round from the firm's announced worth (Ge et al., 2005).

[3] Post-money valuation is the value of the start-up after the investment has been made; it is obtained by summing the pre-money valuation of the start-up and the amount of funds invested (Block et al., 2014).

Figure 2. 3 Number of papers by methodology type



dependent variable and the start-up's non-accounting value drivers as the main independent variables. Considering the somewhat nascent developmental stage of the literature on the valuation of innovative start-ups, more papers based on qualitative or mixed methods could offer a valuable contribution by inductively adding more nuanced knowledge about contexts, processes, and mechanisms of innovative start-ups' valuation (Yin, 2015; George and Bennett, 2005).

The selected papers have been published in 13 journals highly ranked in the Chartered Association of Business Schools' Academic Journal Guide 2018 (ABS – AJG 2018) (CABS, n.d.). Four of them are ranked 4*: *The Accounting Review* (1 paper), *Research Policy* (1), *Management Science* (1), *Strategic Management Journal* (1). Five journals are rated 4 stars: *Review of Accounting Studies* (1), *Journal of Business Venturing* (3), *Strategic Entrepreneurship Journal* (1). The remaining four journals are ranked 3 stars: *European Financial Management* (1), *Journal of Business Finance and Accounting* (1), *European Accounting Review* (1), *European Management Review* (1). Together, these journals represent 54 percent of the final database (see Figure 2.4). Overall, the papers in the sample stem from 20 different journals.

As shown in Figure 2.5, most of the papers identified stem from the field of *Entrepreneurship and Small Business Management* (8), *Accounting* (4), and *General Management* (3). Collectively, they represent 62.5 percent of the final sample.

Figure 2. 4 Number of papers by Charted ABS Ranking – AJG (2018)

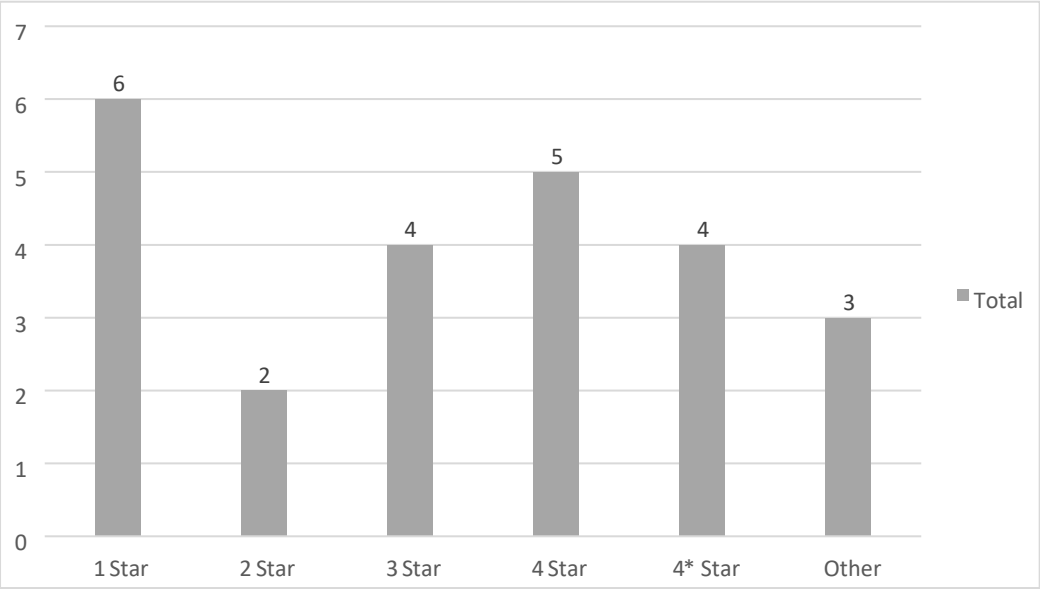
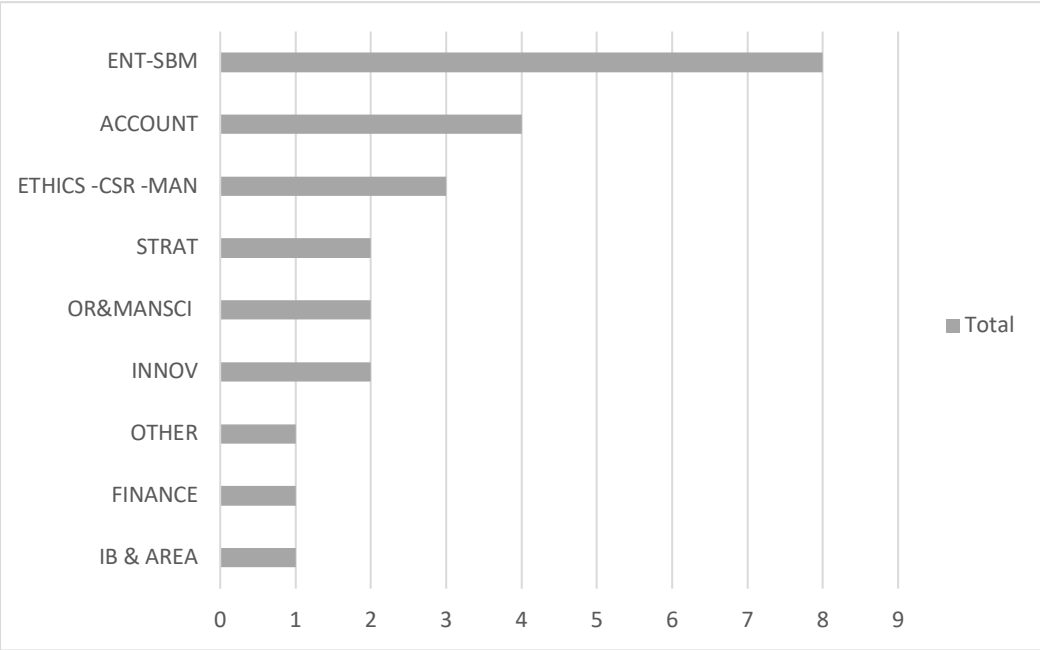


Figure 2. 5 Number of papers by field of study



The remainder emerge from the fields of *Strategy* (2), *Operations Research and Management Science* (2), *Innovation* (2), *Finance* (1), and *International Business and Area Studies* (1).

The journal and subject diversity seem to suggest that the field and the scholarly dialogue is still rather fragmented.

2.4.1 Towards a theory-informed taxonomy of non-accounting drivers

In Table 2.1, we summarize the common theories used in the identified papers and the various non-accounting drivers that the authors investigated, clustered around the primary focus of such theories, which are also used to organize the taxonomy.

2.4.1.1 Structure–Conduct–Performance Paradigm

According to the Structure–Conduct–Performance (SCP) paradigm of industrial organization economics (Bain, 1968), the conditions of supply and demand in an industry will determine its structure. The competitive conditions that result from this industry structure shape the conduct of companies, thereby influencing performance. Conduct refers to a variety of individual actions taken by a firm, which encompasses product differentiation, tacit collusion, price-taking, and exploitation of market power (Berry et al., 2019). Similarly, the performance of the firm can be appraised by looking at several indicators such as productive efficiency, profitability, and allocative efficiency (Lelissa and Kuhil, 2018). Hereafter, we present the key non-accounting drivers relative to the SCP paradigm that emerged in the review, namely industry type, product differentiation within the industry, and industry demand growth. It should be noted that these features are related to the structure of the industry.

2.4.1.1.1 Industry type

Industry characteristics are vital in the valuation of a new venture because start-ups in different industries may have different risk profiles (Ruhnka and Young, 1991). Eisenmann (2020) explored the relationship between a start-up's industry sector and valuation outcomes and found that information technology had the strongest relationship with valuation outcomes. Specifically, information technology start-ups, representing 53 percent of the sample, were less likely to have low valuations and more likely to have high valuations (8 percent low and 66 per cent high), compared to counterparts offering consumer products and services (17 percent low and 58 percent high, representing 19 percent of the sample) or business services (10 percent low and 65 percent high, representing 13 percent of the sample). This is because industries with higher aggregate levels of R&D intensity are linked to higher rates of firm-level innovation, which in turn Integrating theories from selected articles impact on revenue growth (Thornhill, 2006).

Table 2. 1 An inventory of explanations

Theory	Focus	Criteria covered	Description	Example
Structure-Conduct-Performance Paradigm (I/O) (Ge et al. 2005; Miloud et al. 2012; Dhochak and Doliya, 2019;)	Market and Industry Structure	Industry type	Sector in which the new firm compete	High-tech industry Vs Low-tech industry
		Industry demand growth	Current and potential growth of aggregate demand within the industry	Percentage change of revenue in industry Advertising intensity ratio
		Product differentiation	Uniqueness of the new product	R&D intensity
Resource-based view (Ge et al. 2005; Miloud et al. 2012; Dhochak and Doliya, 2019)	Resource and capabilities	Founder(s) experience	Knowledge of how to operate a business in a certain sector	Relevant number of years in a particular industry
		Founding team vs. solo founder	Founding team or individua founders with overall responsibility for the firm	Number of founders
		Management team completeness	Team covering all key managerial positions	CEO/president, VP of marketing, engineering, finance, and manufacturing
		Network size;	External relationships through which founders channel resource flow and shape their strategies	Number of alliance partners
Signaling theory (Greenberg, 2013; Block et al. 2014)	Signals of quality	Patents	Number of patents granted and patent applications and respective scope	Number of Patents applications and number of patents granted
		Trademark	Number of trademarks granted and trademarks applications and respective scope	Number of trademark applications filed by start-up
Agency theory and ownership structure (Wasserman, 2017),	Ownership and control	Founder control and equity division	Percentage of venture ownership	Equal splitting vs unequal splitting

2.4.1.1.2 Product differentiation

Industries characterized by product differentiation present higher margins and economic profitability (Porter, 1985). Accordingly, Miloud et al. (2012), studying 102 new French ventures from 18 industries, found that new ventures in highly differentiated industries receive a higher valuation from VCs. Ge et al. (2005) obtained similar results by analyzing a sample of 210 US-based new business ventures in 48 different industries. In the same vein, Dhochak and Doliya (2020) investigated VCs' opinions about the relative importance of strategic theories in the venture valuation literature. After conducting a survey of 18 Indian venture capital funds and 7 foreign-based venture capital funds, they found that product differentiation is considered among the most important valuation criteria since product differentiation might enable start-ups to quickly gain traction.

2.4.1.1.3 Industry demand growth

The demand growth rate of an industry is a key indicator of its market attractiveness for both new ventures and established firms (Porter, 1985). Since early-stage equity investors usually focus their investments on innovative start-ups with high growth potential (Zider, 1998), a high demand growth rate typically results in a higher valuation (Miloud et al., 2012; Ge et al., 2005).

2.4.1.2 Resource-Based View (RBV)

Understanding sources of sustained competitive advantage is of the utmost importance, not only to entrepreneurs who wish to build the "next big thing", but also to investors who allocate resources to these firms. Consequently, the Resource-Based View (RBV) has become one of the most influential and cited theories in strategic management. The work of Barney (1991) entitled "Firm resources and sustained competitive advantage" is widely acknowledged as focal to the development of this theory. In analyzing sources of competitive advantage, the author focused on the link between a firm's internal characteristics and its performance. The fundamentals of this theory are based on two important assumptions. First, firms within an industry (or group) are heterogeneous in relation to the strategic resources that they control, and second, such heterogeneity persists over time, since resources are not perfectly mobile across firms. Firm resources, such as physical and financial assets,

capabilities, technologies, knowledge, organizational processes, employees, and social networks, enable firms to implement value-creating strategies. Firms achieve competitive advantage when their value-creating strategy is not being introduced concurrently by other existing or potential future competitors. When other firms are also unable to replicate the benefits of that value-creating strategy, the competitive advantage is sustainable. Below, we present a set of firm resources that, according to the extant literature, affect the valuation of innovative start-ups because they contribute to firm competitive advantage.

2.4.1.2.1 Founders' experience

Founders' prior industry experience is associated with a better understanding of customer demand within the industry and provides social ties to suppliers and distributors of the sector in which the new firm operates (Delmar and Shane, 2006). These advantages are reflected in the valuation of start-ups. For example, Ge et al. (2005) found that, *ceteris paribus*, founders' prior industry experience positively affects the valuation of new ventures by VCs.

Since management experience is associated with knowledge about strategies and organizational structures required to manage the growth and development of new firms, it leads to higher start-up valuation by equity investors (Dhochak and Doliya, 2020; Ge et al., 2005; Miloud et al., 2012).

Extant literature suggests that a founder's start-up experience provides valuable entrepreneurial skills, a business reputation, and extensive network contacts, which serve as strategic resources that can be exploited in the future of the business. Such experience also allows founders to accumulate the wealth, power, and legitimacy that can be used to overcome the liability of newness (Starr and Bygrave, 1991). In line with these arguments, Ge et al. (2005) and Miloud et al. (2012) found that a new venture is valued higher if its founder has previous start-up experience.

2.4.1.2.2. Founding team vs. solo founder

Extant literature has emphasized the key role of teams in the context of technological entrepreneurship, because, compared to a single founder, teams are more likely to possess the broad set of skills and capabilities needed to achieve a fit between technology and market (Visintin and Pittino, 2014) and to commercialize first breakthrough innovations (Tushman and Anderson, 1986). This is reflected in the valuation assigned by equity investors, which is

higher for start-ups founded by teams rather than individual entrepreneurs (Ge et al., 2005; Miloud et al., 2012).

2.4.1.2.3 Management team completeness

Recent research points out the importance of having a complete management team as it determines how well and how fast work can be done (Ge et al., 2005). More specifically, a complete team is one where essential business functions such as finance, R&D, production, and marketing are fully covered by the entrepreneurial team (Roure and Keeley, 1990). Management team completeness has a positive impact on the valuation of the new venture by VCs because it reduces the need for investors to address the risks caused by gaps in a start-up's management (Miloud et al., 2012).

2.4.1.2.4 Network size

Liabilities of newness and smallness (Freeman et al., 1993) can be somewhat mitigated by new ventures' network size, defined by Ge et al. (2005) as the number of alliance partners. For Hansen (1995), network size captures the extent to which resources can be accessed by the entrepreneur and the organization. Alliances between organizations therefore facilitate the achievement of strategically significant objectives (Elmuti and Kathawala, 2001). Network size also helps to mitigate the uncertainty surrounding young companies, because alliances can certify the quality of new ventures to third parties (Stuart et al., 1999). Consistently with these arguments, empirical studies show that the size of a venture's network is significantly and positively related to its valuation by VCs (Ge et al., 2005; Miloud et al., 2012). Moreover, in examining the direct effects of strategic alliances on the valuation of 166 US venture-backed software firms, Moghaddam et al. (2016) found that alliances formation positively and significantly affects firm valuations in the software industry.

2.4.1.3 Signaling theory

Signaling theory is useful for describing behavior when two parties (individuals or organizations) have access to different information. Spence's (1973) seminal work on labor markets showed how a job applicant might engage in behaviors to reduce information asymmetry that hinders the selection ability of potential employers. As an example, Spence described how high-quality prospective employees distinguish themselves from low-quality

candidates through the costly signal of rigorous higher education. Signaling theory is frequently used in entrepreneurship literature as well as in management literature to explain the influence of information asymmetry in different strands of research (Connelly et al., 2011). The key concept of the signaling theory involves two actors – the signaler and receiver – as well as the signal itself. Spence describes signalers as insiders (e.g. executives or managers) who have private information about an individual, the product, or the organization that is not available to outsiders. The information obtained can be either positive or negative and could include early-stage R&D results, later-stage news regarding preliminary sales results, or pending lawsuits (Connelly et al., 2011).

Upon receipt of the information, insiders must then decide whether to communicate this information to outsiders. Here, signaling theory suggests that insiders will deliberately communicate only positive information to outsiders, with the hope of conveying positive organization attributes. However, insiders may also send negative signals, but this is often an unintentional consequence of their actions. The signals sent to outsiders must be observable (i.e. outsiders are able to notice the signal); the signaler must be able to bear the costs of launching the signal. Lastly, receivers refer to outsiders who lack information about the organization in question but would like to receive this information.

2.4.1.3.1 Patents

The availability of formal intellectual property rights (IPR) protection may help reduce information asymmetries by allowing new ventures to demonstrate their future potential to external investors. Accordingly, technology start-ups patent to obtain funds and reputation (Graham et al., 2009). Studying Israeli technology start-ups, Greenberg (2013) demonstrates the importance of patents in the valuation of young technology-based ventures. They found a positive relationship between patent applications and firm valuations for non-software-based ventures. The positive impact of patents on valuation was stronger for start-ups that were younger, in their pre-revenue stages, and during early financing rounds.

2.4.1.3.2 Trademarks

Another important component of a firm's IP asset is its trademarks, which offer protection to the firm's brands and marketing assets (Wood, 2000). Trademarks grant their holders the right to exclude others from the use of protected words, signs, or symbols (Besen and Raskind, 1991). Filing of trademarks also signals a start-up's degree of market and growth

orientation and willingness to protect its current and future marketing efforts from the infringement of others (Sandner and Block, 2011). In investigating the influence of the number and breadth of a start-up's trademark applications on VCs' financial valuation of the start-up as well as the effect of trademark applications in later funding rounds, Block et al. (2014) showed that trademarks are strong predictors of VCs' valuation of start-ups. In particular, they found that the number of trademarks and the breadth of their applications provide additional information about the scope and direction of start-ups' marketing strategies. Their findings also indicate that the signaling value of trademarks decreases as the venture progresses into different stages of development.

2.4.1.4 Agency theory

Agency theory is related to the conflicting interests of principals and agents. The work of Jensen and Meckling (1976) on agency costs and ownership structure holds a cardinal role in the corporate governance literature. The focal point of Jensen and Meckling's model is that there is a conflict of interest between firm managers and owners, since both parties seek to maximize their own utility. The mismatch of interests between owners and managers generates agency costs, such as monitoring costs (i.e. principal's activities intended to limit agents' detrimental actions). In the context of entrepreneurial finance, agency theory has been used to describe frictions between founders and resources providers (Wasserman, 2017).

2.4.1.4.1 Equity ownership and control

To acquire resources for their start-ups, founders often have to sacrifice ownership stakes and decision-making control, as the providers of those resources – cofounders, hires, and investors – often trade their capital for equity stakes. Such decisions can create agency costs, which impair start-up value. In line with these arguments, Wasserman (2017) found that such changes of a founder's ownership stakes negatively affect the start-up's valuation. Also, splitting equity equally among founding members negatively affects valuation because it can foster free-riding opportunistic behavior of some founders (Hellmann and Wasserman, 2016).

2.5 Discussion

The literature discussed in the previous section offers at least three areas to extend our knowledge about valuation of innovative start-ups by early-stage equity investors.

Heterogeneity appraisal. A significant shortcoming of the existing studies stems from the lack of elaboration on the heterogeneity in the entrepreneurial opportunities exploited by innovative start-ups and in the actions whereby such opportunities are developed from ideas to actual products or services (cf. Berglund et al., 2020). Innovative start-ups differ substantially, for example in terms of business model, products and services, and technology base (Audretsch et al., 2020). They also differ in terms of entrepreneurial strategies, style, and skills, as well as organizational characteristics (Chan et al., 2006). The direct and indirect effect of these heterogeneity dimensions on the valuation process is rather neglected, thereby reducing the interpretative and explanatory power of these studies.

Origin. In their quest for solutions to complex problems, innovative firms obtain knowledge from different sources (Agarwal and Shah, 2014; Caiazza et al., 2020; Minola et al., 2019). These sources are also known as knowledge contexts. Since knowledge contexts determine the initial performance advantage (or disadvantage) of innovative start-ups (Hahn et al., 2019), they are likely to determine their valuation (Tether and Tajar, 2008). Despite the importance of originating knowledge contexts for innovative start-ups being well acknowledged in the literature (Bose and Thomas, 2007), in the identified papers, we found no empirical study investigating equity investors' approach to valuation based on (or, at least, controlling for) the contexts originating the innovative start-ups. According to Minola et al. (2019), the origin of innovative start-ups is particularly important because it affects the characteristics of the firms' technological knowledge in terms of scope and newness, due to the fact that these firms take advantage of the knowledge spillovers from their knowledge providers (universities, research centers, science parks, corporations, etc.). A clear example of how innovative start-ups' take advantage of the context from which they originate can be provided by looking at start-ups founded by scientists, that is, individuals involved in research and scientific work in academia and other research institutions (Stephan, 2014). During their scientific careers, scientists internalize attitudes towards experimentation (Van Maanen and Schein, 1977) and exchanging knowledge (Jain et al., 2009); in turn, such a mindset assists scientists in the commercialization process (Hahn et al., 2019). Founders with prior experience in an established corporation can also take advantage of the market- and industry-related knowledge acquired during employment to develop and commercialize new products or services and achieve higher growth

rates (Wennberg et al., 2011). Despite the role of innovative start-ups' origin in determining their competitive advantage, innovative behavior, and growth prospect (Hahn et al., 2019), this dimension is still neglected in extant literature.

Narrow scope of theories. In order to address the limitations highlighted above (i.e. lack of heterogeneity appraisal and of empirical investigation of the origin dimension), non-accounting drivers should be informed by a broader set of management and entrepreneurship theories. For example, to explain the link between origin and valuation, imprinting theory represents an exemplar case, where the biography of organizations and their founders are taken into account. Imprinting theory assumes that the founding conditions of new ventures have a long-lasting imprint on their performance (Bamford et al., 2000), particularly in high-technology sectors (Gimmon and Levie, 2020). Imprinting theory also highlights the importance of founders' prior career experiences (Marquis and Tilcsik, 2013). The knowledge, skills, and values internalized by founders during their careers shape the behavior, development, and subsequent performance of their start-ups (Bryant, 2014; Simsek et al., 2015; Burton et al., 2016), thereby affecting their value. Scholars could also take advantage of theoretical perspectives concerned with the design of entrepreneurial opportunities and the actions undertaken by new ventures to transform ideas into marketable new products or services, such as effectuation (Sarasvathy, 2001), entrepreneurial judgment (Foss et al., 2019), and entrepreneurship as design (Berglund et al., 2020). By focusing on how entrepreneurs uniquely manage the uncertainty surrounding the innovation process and the acquisition of resources, these theories help scholars to identify actions undertaken by start-ups (e.g. landing pages, co-creation communities, beta versions, prototyping) that could contribute to their valuation.

In view of the limitations stated above, we propose that recognizing the university as a context of origin of innovative start-ups represents a valuable direction to advance our knowledge on the valuation of innovative start-ups based on non-accounting drivers. Universities play a key role in the generation of innovative start-ups, not only by facilitating the formation of firms founded by faculty members to commercialize research results, but also in providing valuable technological and entrepreneurial knowledge to students and graduates to help them found their own ventures (Shah and Pahnke, 2014).

In the following section, we propose a set of UBDs that could inform research on valuation. We define UBDs as characteristics describing the university context from which innovative start-ups are originated. First, since UBDs illustrate the unique challenges associated with science commercialization (Fini et al., 2019), they help us to appraise the heterogeneity of the innovation processes undertaken by innovative start-ups. Second, since

UBDs capture the distinctiveness of innovative start-ups' originating context (Hahn et al., 2019), they allow researchers to incorporate origin in the valuation literature. Finally, by describing the transition between the university and business worlds, UBDs offer the opportunity to use a broad set of management theories (Fini et al., 2019).

2.6 Conclusion

2.6.1 The University-Based Dimensions of innovative start-ups

The key role of universities in driving innovation and entrepreneurship through science commercialization has been widely acknowledged by scholars and is central in the agenda of policymakers (Agarwal and Shah, 2014; Audretsch and Belitski, 2013; Fini et al., 2019). Based on a wide variety of activities, universities are able to generate knowledge spillovers and enable the transfer of technologies from research labs to the market (Bekkers and Freitas, 2008; Belitski et al., 2019). Prior studies suggest that firms consider more formal activities based on intellectual property – patenting and licensing – as the most important form of accessible knowledge that is being developed by the university (D'Este and Patel, 2007). Other studies indicate that less formal as well as informal and non-commercial activities are equally or even more important forms of knowledge transfer (Abreu and Grinevich, 2013; Caldera and Debande, 2010). Additionally, other third-mission elements, such as collaboration of university researchers with incumbent firms, collaborative research, contracts with industry, contracts with public bodies, and the formation of university spinoffs or student start-ups, represent means to transfer knowledge from the university to the industry (Colombo and Piva, 2020; D'Este and Patel, 2007; Wennberg et al., 2011).

Despite the central role played by universities in the generation of innovative start-ups, we do not know much about its implications for start-up valuation. Only a few studies have analyzed the attractiveness of UBDs to potential investors, probably due to a paucity of data. Previous researchers have analyzed a small number of universities, relied on case studies, or drawn on small-scale surveys to acquire their data. This gap is surprising, since the valuation of innovative start-ups by early-stage equity investors could benefit from signals of scientific quality as well as the substantive benefits associated with university affiliation. For example, affiliation with a prestigious university also provides substantive benefits to affiliated firms. Indeed, previous studies have shown that biotech firms generally maintain close links with universities (Audretsch and Stephan, 1996). Affiliation with a university places the affiliated

firm in an ideal position to leverage the state-of-the-art scientific knowledge produced by the university, because of the social links of its upper echelons. In turn, biotech firms that in-license advanced scientific knowledge from universities are more likely to craft revenue-generating commercial alliances with pharmaceutical firms (Stuart et al., 1999). Affiliated firms also have easier access to the state-of-the-art laboratories of the university and can benefit from the effective administrative and legal support that the university offers to affiliate firms.

From an empirical standpoint, so far scholars have studied initial public offerings (IPOs) of university-affiliated firms in order to document the positive impact of affiliation with a university on the valuation of innovative start-ups. In particular, two studies stand out. First, Bonardo et al. (2011) investigate the valuation of university-based companies and their ability to translate the potential benefits of academic affiliation into long-term performance gains. Among the 499 high-tech small and medium-sized enterprises (SMEs) that went public in Europe between 1995 and 2003, they find that 131 were university-based firms. For firms who publicize the fact that they are university-based and have chosen to go public, affiliation with a university is recognized as beneficial by investors. Second, Colombo et al. (2019) study the combined effect of affiliation with prestigious universities, underwriters, and VCs on the valuation of biotech ventures at IPO and their post-IPO performance. They argue that affiliation to a prestigious university provides the affiliated firm with a quality signal in the scientific domain. The pure quality signaling effect of the affiliation is isolated from the substantive benefits it provides by performing a difference-in-difference approach based on the scientific reputation of scientists in firms' upper echelons. The signal is stronger the weaker is the scientific reputation of scientists of the focal IPO firm and is additive to those provided by prestigious VCs and underwriters.

Despite this evidence, to date research is relatively silent on how the peculiar elements of university context affect the valuation of innovative start-ups specifically. Innovative start-ups originated by universities present some unique "genetic" (Colombo and Piva, 2012) features, which can be categorized along three basic dimensions of "university-based distinctiveness". These three UBDs are resources, governance, and goals (Lockett and Wright, 2005; Sciarelli et al., 2021; Fernández-Alles et al., 2015; Nikiforou et al., 2018; Meoli and Vismara, 2016; Chesbrough, 2003). In the next subsections, we introduce and describe these UBDs and provide some possible exemplary research questions to advance the literature on innovative start-ups valuation (see Table 2.2).

Table 2. 2 The University-Based Dimensions (UBDs) of innovative start-ups

Dimension	Theme	Description	Examples
Resources	Human	Skills, knowledge, and experience possessed by the founder	Presence of original research team, their technical and scientific skills
	Social	Social relationships and social structures	Size of team and cohesion
	Technological	The stock of firm's unique know-how	IPR, publications
	Symbolical	Recognitions and considerations that the founder holds	Reputation/h-index
Governance	Scientist and non-scientist founders	Team diversity	Scientist and scientist founders
	Surrogate entrepreneurs	Entrepreneurs from outside the university assuming the role of entrepreneur	External entrepreneurs
	Corporate governance	How the new venture is directed and controlled	Composition of the Board
	University formal involvement	Participation of the university	Presence of faculty members on the board
Goals	University-oriented goals	Desired results over the short and long-term	Placement of young scholars without academic career
	University-oriented noneconomic goals	Desired results over the short and long-term	Prestige, publication, advancement of science
	Innovation strategy	Approach to innovation	Basic research vs. applied research

2.6.1.1 Resources and related UBDs

The academic setting provides unique resources to innovative start-ups, which distinguish them from other new ventures (Colombo and Piva, 2012). In terms of human resources, innovative start-ups originated from universities present unique human capital, rooted in the academic profile and career of academic entrepreneurs (Bonardo et al., 2011). University education can also provide to students and graduates unique knowledge about technological opportunities and the skills required to exploit them through venture creation (Eesley and Lee, 2020; Shah and Pahnke, 2014), as well as useful contacts and networks that can support the development of new ventures. Despite the unique contribution of founders'

university background to commercialization (Hahn et al., 2019), valuation literature has largely overlooked this aspect. For example, Knockaert et al. (2011) found that the presence of a larger proportion of the original research team in the venture can enhance the transfer of tacit knowledge, which consequently affects the probability of reaching sufficient post-founding speed to successfully launch a first product. Scientists in the founding team are more likely to possess start-of-the-art technological knowledge (Colombo and Piva, 2012), leading to breakthrough innovations (Minola et al., 2019). Future research, thus, could look into how the scientific or university background of the founding team affects the valuation of the start-up. Moreover, even though entrepreneurs' social capital is crucial to firm valuation (Hsu, 2007) and scientists are embedded in a network of contacts providing valuable scientific knowledge and advice (Colombo and Piva, 2012; Stuart and Ding, 2006), the university-originated part of this social capital has not received scholarly attention.

In addition, team size in innovative start-ups that originated from universities is particularly important, as science commercialization requires a different set of capabilities that a single person usually does not possess. Larger teams signal quality (Clarysse and Moray, 2004) and higher growth (Czarnitzki et al., 2014) as team members combine their capabilities to successfully bring new technology to market. Studies of the founding teams of innovative start-ups that originated from university have also revealed some unique dynamics, such as trust and team cohesion, driving the performance of new ventures, even though they have not been considered as non-accounting drivers of start-up valuation.

According to Chen and Wang (2008), trust facilitates the exchange of information within a team whereas it suppresses the free flow of external information, as teams with high levels of trust tend to place more value on internally generated ideas than on ideas coming from outsiders. The cohesion of founding teams appears to have a positive association with team effectiveness (Bjornali et al., 2016) and the financial performance of innovative start-ups (Ensley and Hmieleski, 2005). Trust and cohesion may be affected by the shared educational background of the entrepreneurial team members, in terms of shared experience and ease of communication. In view of this, future research could examine how the unique internal team dynamics of start-ups originated from the academic setting (Ensley and Hmieleski, 2005) affect valuation.

Finally, innovative start-ups can benefit from the academic status of their founders. Zucker et al. (2007) note that "star" scientists from higher-quality academic institutions create innovative firms to capture the rents generated by their intellectual capital. Similarly, Di Gregorio and Shane (2003) conclude that it may be easier for scientists from top-tier

universities to assemble resources to create start-ups due to their increased credibility. Scientist entrepreneurs' credibility and reputation stem from the number of academic papers published in top-ranked journals or the number of citations of these papers. In contrast, the reputation of non-scientist entrepreneurs are rooted in the number of successful start-ups that they have contributed to creating. We maintain it would be interesting to investigate the effect of founders' scientific reputation on the valuation of their start-ups.

2.6.1.2 Corporate governance and related UBDs

The ownership and control of innovative start-ups by university and faculty members generate some unique features in the governance of firms that originated in the academic setting. For example, these ventures may appoint surrogate entrepreneurs (i.e. entrepreneurs from outside the academic institution) to compensate for the lack of market-related knowledge, which often characterizes academic founders (Lockett et al., 2003). Research suggests that innovative start-ups that involve surrogate entrepreneurs perform better than those that do not (Lundqvist, 2014). Yet we do not know to what extent the appointing of surrogate entrepreneurs affects the valuation of start-ups.

Concerning university involvement in start-ups' governance, Ferretti et al. (2019) employ a quantitative method to investigate the engagement of universities in different roles on the boards of directors and in the ownership structures of 194 Italian innovative start-ups. In particular, they found that the involvement of the university affects the performance of innovative start-ups, but a strategy of "neither absent nor too present" is the optimal way for them to support the growth of start-ups. In addition, they find a positive association between the presence of academics on the board and sales growth, as well as a positive association with time to break even. Scientist entrepreneurs may attract experienced and well-connected directors to their boards who can play an important role in accessing critical external resources (Lynall et al., 2003). Studying a sample of 140 high-tech start-ups, Clarysse et al. (2007) found that high-tech start-ups with a public research organization as an external equity shareholder are more likely to include outside board members with complementary skills to the founding team than innovative start-ups with VCs or founders as the main stakeholders. Even though such evidence shows that university involvement in the governance of innovative start-ups matters, the way in which the quality of the public research organization and the extent of its involvement affect the valuation of the start-up has not been investigated so far.

2.6.1.3 Goals and Related UBDs

Different theories, so far neglected in the valuation literature, have been used to shed light on the relationship between the innovative start-up and the university environment in which founders have worked or been trained: imprinting theory (Hahn et al., 2019), identity theories (Jain et al., 2009), institutional theory (Fini and Toschi, 2016), and social embeddedness (Stuart and Ding, 2006) are some examples. These theories converge to the idea that exposure to academic logics influences scientist founders' priorities. In particular, they are often motivated by passion-driven and socio-emotional achievements or reputation in the scientific community and society (Hayter, 2011).

Prior research also suggests that innovative entrepreneurs' drivers differ depending on their attachment to the traditional norms of science (Huyghe et al., 2016). The motivation to advance research and gain a strong reputation and prestige within the scientific community drives some scientists to initiate entrepreneurial activities (Lam, 2011). In turn, the extent to which such drivers are emphasized by innovative start-ups has an impact on the firm commercialization strategies and performance. For example, the extent to which innovative start-ups search for knowledge from external sources is affected by the career imprints of academic founders and the emphasis they put on non-commercial goals (Hahn et al., 2019). Despite the influence of academic logics on the commercialization activities undertaken by innovative start-ups, and on the outcomes of these activities, valuation literature is relatively silent in this respect. Therefore, future research could look at the extent to which academic logics and norms of science permeating innovative start-ups affect their valuation by early-stage equity investors.

Remarks

The scoping review of this chapter offers three main contributions to literature on start-up valuation. First, we present a theory-informed taxonomy of the non-accounting drivers used by early-stage equity investors in the valuation of innovative start-ups. While to date extant research on non-accounting drivers has been fairly fragmented, our taxonomy could represent a starting point for scholars to theoretically advance this vibrant research stream. In particular, given the variety of theoretical perspectives shown in the review, researchers would greatly benefit from cross-fertilization among disciplines. Second, our review revealed three areas for future improvement: (i) appraisal of start-ups' heterogeneity; (ii) consideration of start-ups' originating context; and (iii) extending the scope of theories. Third, to address the aforementioned opportunities and advance research on and the practice of valuation, the

chapter proposes a focus on *university* as the context of origin and distinctiveness of many innovative start-ups. In doing so, it offers a set of UBDs to be incorporated in valuation studies. These contributions also provide implications of interest to those involved in technology transfer at universities. In particular, managers of technology transfer offices should be aware that the distinctive characteristics connected to UBDs could be crucial in determining the valuation of start-ups generated by universities. The chapter also provides interesting insights for investors as it gives evidence on non-accounting drivers of start-up valuation. The chapter also offers some insights on how to approach the valuation of start-ups affiliated with a university, whose technological potential can be particularly appealing for VCs and BAs. Our contributions are also significant for actual academic entrepreneurs who would like to shape the valuation process to their advantage.

3. DO EXPLORATION AND EXPLOITATION IN UNIVERSITY RESEARCH DRIVE EARLY-STAGE EQUITY FINANCING OF UNIVERSITY SPIN-OFFS?

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3.1 INTRODUCTION

University spin-offs (USOs) are firms created to commercialize technologies emerging from research conducted in universities (Lockett et al., 2005; Wright et al., 2006). A USO thus represents a key mechanism through which the "Entrepreneurial University" – a concept describing universities engaged in both knowledge generation and dissemination (Guerrero and Urbano, 2012) – contributes to society (Urbano and Guerrero, 2013). It does so by transferring technological innovation to a new venture embedded in the parent university's ecosystem (Fryges and Wright, 2014; Minola et al., 2021; Bonaccorsi et al., 2014). USOs' contribution to economic development in terms of job creation, innovation and economic growth is well documented (Ferreira et al., 2017; Guerrero et al., 2015). At the regional level, the presence of USOs is important to the formation of new industries and economic dynamism (Guerrero et al., 2016; Klofsten et al., 2019). Thus, the success of USOs is central to the strategic agenda of the Entrepreneurial University, which is known to deliver contributions to society through entrepreneurial activity (Audretsch and Belitski, 2022).

In this respect, literature has devoted attention to USO's access to key resources (in particular financial resources, such as early-stage external equity) (Wright et al., 2006; Widding et al., 2009; Sørheim et al., 2011) that are needed for their development (Rodríguez-Gulías et al., 2018; Hsu, 2006; Davila et al., 2003). Obtaining early-stage equity financing represents a central milestone in the development of USOs (Fini et al., 2017; Vohora et al., 2004). Among factors affecting early-stage external equity financing, prior studies show that characteristics of the USO, its founding team and the regional context matter (Nicolaou and Birley, 2003; Shane and Stuart, 2004). For instance, it has been suggested that specific characteristics of the entrepreneurial team's social networks and their entrepreneurial capabilities are highly correlated with USO's ability to acquire external financing (Huynh et al., 2017). Still, academic entrepreneurship scholars call for more studies on the determinants of early-stage equity financing of USOs (Mathisen and Rasmussen, 2019).

Within this literature, there is a growing interest in university-level antecedents, i.e. what characteristics of the parent university affect USOs' access to early-stage external equity financing (e.g., Fini et al., 2017). Some works have offered initial evidence on the effect of the characteristics of the parent university's network (Soetanto and Van Geenhuizen, 2015), policies (Fini et al., 2017), scientific reputation (Munari and Toschi, 2011) and research performance (Jelfs and Lawton Smith, 2021), thereby increasing our awareness on the effect of the parent university on the fundraising of USOs. In this stream, scholars have surprisingly

overlooked the role of university research patterns (that is how and along which activities, resources and approaches research is conducted at the university level), in particular at USO's founding. While prior studies have considered aggregate measures of research excellence or strength, they have not unpacked different patterns in university research, by considering the effect of different types of research inputs and outputs. This is particularly important because university research patterns could affect USOs networks and team members' cognition and choices at founding (Acs et al., 2013; Colombo and Piva, 2012; Ghio et al., 2016; Hahn et al., 2019) and thus drive both the demand and the supply of early-stage external equity financing to USOs.

On the other hand, research on university level antecedents of USO's behavior and performance has focused extensively on dimensions such as firm creation (Meoli and Vismara, 2016; Bonaccorsi et al., 2014) or location (Heblich and Slavtchev, 2014), while disregarding external financing activities. As a result, early-stage equity financing is surprisingly overlooked in the Entrepreneurial University literature, even though it represents a critical milestone for the development of USOs (Fini et al., 2017), which in turn are one of the main channels through which the Entrepreneurial University generates economic impact (Guerrero et al., 2015). Altogether, these limitations prevent us from understanding the Entrepreneurial University, its constituting missions, and the possible reconciliation of seemingly conflicting dimensions, such as research and entrepreneurship (Ambos et al., 2008, Guerrero and Urbano, 2012; Guerrero et al., 2015). Hence, more research is needed to expand our understanding of the strategic perspective on university core activities (and research in particular) and how USOs can take advantage of them in their development (Audretsch and Belitski, 2022; Pitsakis et al., 2016).

To address this gap, under an imprinting perspective (Marquis and Tilcsik, 2013), we investigate the relationship between USOs' early-stage external equity financing and its parent university's research patterns in terms of exploitation and exploration (Chang et al., 2016; Guerrero et al., 2021). Exploration describes learning gained through processes of combined variation, planned experimentation and play, while exploitation refers to learning gained via local search, experimental refinement and selection and reuse of existing routines (Chang, 2009; Centobelli et al., 2019).

To overcome limitations in extant literature and consider university research patterns, we measure both research exploration and exploitation along input as well as output indicators of university research at the time of the establishment of the USO. Our outcome variable is the likelihood that the USO obtains early-stage external equity financing within five years from its founding. On a unique dataset that covers a sample of 739 USOs from 39 Italian public

universities founded over the period 2011-2019, we thus offer an exploratory contribution to the understanding of the relationship between research patterns (in terms of exploration and exploitation) and USOs' early-stage external equity financing.

Our empirical analysis shows that, when considering the two dimensions of university research patterns, USOs early-stage external equity financing is overall positively associated with exploration research inputs and outputs and negatively associated with exploitation research inputs and outputs.

As such, this study offers three main contributions. First, we add further elements to the understanding of the strategic alignment of the core activities of the Entrepreneurial University (Audretsch and Belitski, 2022; Etzkowitz et al., 2019). By demonstrating how different elements of university research patterns contribute to the development of USOs, we highlight how entrepreneurial Universities can exploit synergies between the research and the third missions, a key challenge with which they are confronted in these times (Kloftsen et al., 2019). Besides, our study extends our understanding of the implications of the Entrepreneurial University core activities on its ultimate ability in science commercialization, by showing how research affects not only the number of USOs created (Berbegal-Mirabent et al., 2015), but more comprehensively USOs' performance in terms of attraction of early-stage external equity. Second, we add to academic entrepreneurship literature, by responding to recent calls to study how relevant university characteristics affect the development and performance of its USOs (Klofsten et al., 2019), and particularly their financing (Agyare et al., 2022; Mathisen and Rasmussen, 2019).

Finally, we extend the research stream on imprinting in academic entrepreneurship (Colombo et al., 2012; Hahn et al., 2019), by showing the value of using imprinting to explore the relationship between the Entrepreneurial University's core activities at founding and the development of their USOs.

3.2 Theory and hypothesis

3.2.1 The problem of early-stage external equity financing in USOs

Obtaining equity from external investors is crucial for USOs in their first years for two main reasons. First, obtaining external equity financing at early-stage shows that USOs have passed investors' scrutiny and therefore it represents a quality signal that might help attract further investments (Lockett, 2002 and 2003; Shane and Stuart, 2002). In fact, early stage equity

financing constitutes a critical milestone in the development of USOs, as it certifies that the firm has reached credibility in front of external resource providers (Vohora et al., 2004)., such as employees and partners (Rasmussen et al., 2011; Wright, 2014). Second, since USOs usually need significant amounts of financial resources to develop their technologies into market-ready products and services (Shane, 2004), early-stage external equity financing can speed up time to market and enable USOs to secure first-mover advantage and higher market shares (Athreye et al., 2021; Eisenhardt and Martin, 2000). Literature on academic entrepreneurship has thus acknowledged that the attraction of funding represents a key performance indicator of USOs (Fini et al., 2017; Jelfs and Lawton Smith, 2021; Mathisen and Rasmussen, 2019).

USOs face severe issues in raising capital both from supply and demand side perspectives. From the supply-side, USOs are typically based on intangible assets, such as technological knowledge and intellectual property, whose value is difficult to assess for external investors (Hahn et al., 2019). USOs also originate from a traditionally non-commercial environment (Fini et al., 2019) and their founding teams often lack a track record in the business world (Nikiforou et al., 2018). For these reasons, the information asymmetries (Carpenter and Petersen, 2002) between new ventures and external equity capital providers are particularly severe for USOs (Politis et al., 2012; Rasmussen and Sørheim, 2012). This could lead to a substantial under-provision of funds to USOs because of capital market imperfections.

Next to issues in the supply of capital, literature recognizes that there might be limits in the demand for capital by USOs. In other words, there might be reasons that make USOs less willing to seek (and not only less able to secure) early-stage external equity financing. First of all, reaching the stage in which USOs actively search for external funding requires passing across critical stages of development, including the commitment of the founders to the company (Vohora et al., 2004). Since USO founders are often university scientists who are reluctant in allocating time from their academic duties to the development of the venture (Jain et al., 2009), USO might not even reach the stage in which they are in need for and, hence, ready to search for external equity. Moreover, USOs often lack the capabilities to effectively frame the commercial opportunity while approaching external equity providers (Vohora et al., 2004). The process of raising financial capital may also jeopardize founders' time spent in developing their technology and scientists' attention dedicated to research (Shane and Stuart, 2002). Hence, USOs might decide not to engage in the time-consuming and lengthy process of looking for investors and negotiating. Finally, since USOs are often created by university scientists to pursue goals related to the academic sphere, such as increasing reputation in the academic community or advancing research (Hayter, 2011; Lam, 2011), USO founders might lack the

growth aspirations that external investors look for. Even though the importance of early stage equity financing has been recognized as critical for the development of USOs, empirical evidence on its antecedents is still scarce (Mathisen and Rasmussen, 2019).

Some papers study the determinant of USO's equity fundraising, albeit without focusing specifically on the early stage. In particular, founders' social networks, entrepreneurial capabilities and industry experience are positively associated with the likelihood for USOs to raise equity (Huynh et al., 2017; Shane and Cable, 2002; Shane and Stuart, 2002). Also, intellectual property in terms of patents has been shown to be appealing to early-stage equity investors (Munari and Toschi, 2011; Roberts and Malone, 1996; Shane and Stuart, 2002), even though Clarysse et al. (2007) showed that USOs with formal technology transfer do not raise more capital than USOs without formal technology transfer (Clarysse et al., 2007).

While these papers offer some valuable insights on the determinants of USOs fundraising, they do not look at the uniqueness of USOs' originating university, which makes these firms distinctive (Agarwal and Shah, 2014; Fini et al, 2019), particularly in their earlier stages. This is because university origin offers to new ventures and founders' unique technological knowledge and mindset critical for the early stages of the commercialization process (Agarwal and Shah, 2014; Clarysse et al., 2011; Guerrero et al., 2015; Knockaert et al., 2011).

For this reason, recent calls in the academic entrepreneurship literature have suggested to look at the relationship between university characteristics and the development patterns of USOs (Fini et al., 2017; Klofsten et al., 2019), particularly in terms of early-stage equity financing (Agyare et al., 2022; Mathisen and Rasmussen, 2019). Moreover, the debate around entrepreneurial universities increasingly looks for papers that study how university core activities, such as research, contribute to pursuing the entrepreneurial mission (Klofsten et al., 2019). Hence, scholars are urged to explore the relationship between university characteristics and USOs' early-stage equity financing (Fini et al., 2017; Mathisen and Rasmussen, 2019). Some works have already offered initial evidence on the value of such approach, by documenting the effect of parent university's networks (Soetanto and Van Geenhuizen, 2015), technology transfer infrastructures and policies (Fini et al., 2017), scientific reputation (Munari and Toschi, 2011) and research performance (Colombo et al., 2010; Jelfs and Lawton Smith, 2021) on the fundraising of USOs, although not focusing specifically on these firms' earlier stages. From a theoretical standpoint, the link between the parent university and USO development is supported by the imprinting perspective (Colombo et Piva, 2012; Hahn et al., 2019), which offers the theoretical lens to explain the fact that the originating context of firms

has profound implications on their performances and behaviors (Agarwal and Shah, 2014; Clarysse et al., 2011; Minola et al., 2021).

3.2.2 The role of the parent university: an imprinting perspective

Imprinting theory holds that during the "sensitive period" of firm formation, new ventures are exposed to the influence of the surrounding originating context (i.e. the "imprinter") and that such influence has long-term consequences (i.e. proximal and distal outcomes) on firm development (Marquiz and Tilcsik, 2013; Simsek et al., 2015). New firms are imprinted by the conditions of "groups, institutions, laws, population characteristics, and set of social relationships that form the environment of the parent organization" present at founding (Stinchcombe, 1965, p.142). Kimberly (1979, p. 438) argues that "there is the possibility, at least, that, just as for a child, the conditions under which an organization is born and the course of its development in infancy have nontrivial consequences for its later life". USOs inherit from the parent university some "genetic characteristics" in terms of the type of networks that subsequently affect the formation of alliances (Colombo and Piva, 2012). Just like firms, founders are subject to imprinting too (Simsek et al., 2015). During sensitive periods, such as their childhood and early career experiences, individuals internalize specific mental models, norms and capabilities, which later on are imprinted into the ventures they found (Mathias et al., 2015). In the case of USOs, scientist founders develop specific mindsets open toward search and discovery that affect the open innovation behaviors of their USO (Hahn et al., 2019). Recognizing the long-lasting influence of universities on USOs (Colombo et al., 2010; Colombo and Piva, 2012; Wennberg et al., 2011), the imprinting perspective has gained traction in the academic entrepreneurship field (Ciuchta et al., 2016; Huynh et al., 2017; Hahn et al., 2019; Thomas et al., 2020; Tagliazucchi et al., 2021).

Since imprinting explains how conditions at founding (e.g., early-stage team composition) affect new ventures' development – and particularly the time to reaching critical milestones (Simsek et al., 2015), such as subsequent raising of external equity (Beckman et al., 2007; Beckman and Burton, 2008) – it offers valuable theoretical lens to link USOs' university characteristics at founding to early-stage equity financing, thereby offering a research perspective to address the afore-mentioned gap of the literature.

3.2.3. The role of university research patterns in the imprinting of USOs

Among the university-level factors that are crucial in the imprinting of USO, the university research activity has been recognized to play a central role (Colombo and Piva, 2012; Hahn et al., 2019). For example, during their work as scientists, founders of USOs internalize specific norms (i.e., Mertonian norms of science) geared towards the advancement and dissemination of research and these goals might be imprinted into the USOs in which they are involved (Jain et al., 2009). It is not uncommon that because of their imprint from the research environment, USOs are seen by their founders as a vehicle to advance scientific research (Hayter, 2011; Lam, 2011), complementary to university research. Moreover, USOs tend to specialize in technical and scientific functions and to rely on technological alliances with research institutions, thereby deepening the competencies inherited by the research environment from which they emanate (Colombo and Piva, 2012). USOs tend also to replicate the scientific logic geared towards search and openness also by engaging in open innovation relationships to obtain external knowledge from various partners (Hahn et al., 2019).

Literature offers some reasons that draw attention specifically on early-stage equity financing as an outcome of imprinting generated by the research performed at the parent university. For instance, using a sample of 123 USOs established in the UK, Munari and Toschi (2011) found that the scientific quality of their parent university improved their likelihood to attract external equity financing. Jelfs and Lawton Smith (2021) examined the fundraising performance of USOs from six universities in the West Midlands (UK). They found that total funding obtained by the USOs of a given university is positively correlated to its research strength. This indicates that parent university research affects the fundraising ability of their USOs and is likely to play a key role in affecting early-stage equity financing.

However, even though these studies suggest that research of the parent university affects USO's fundraising, they leave some theoretical and empirical puzzles unanswered regarding the relationship between university research patterns and USO early stage-equity financing. From an empirical standpoint, we need to employ fine-grained measures of the different dimensions of university research to shed light on how this affects USOs' funding. For instance, looking at the amount of funds raised by USOs, Jelfs and Lawton Smith (2021: 1968) note that "other factors than the research strength of the parent university are in play". This suggests, for example, the value of considering different types of input and output dimensions of the research process at universities. From a theoretical standpoint, the relationship between university research and the fundraising of their USOs is puzzling, too.

Academic entrepreneurship literature has widely recognized that there are both tensions and synergies between scientific research and technology transfer in USOs (Chang et al., 2016; Fini et al., 2019; Jain et al., 2009). Institutions strongly focused on the traditional research activities might present norms that discourage their members to fully commit to commercialization endeavors (Ambos et al., 2008; Bercovitz and Feldman, 2008). When imprinted in their founders, these norms might deter university scientists from actively developing their ventures across the development stages required to be investment ready (Vohora et al., 2004). Moreover, institutions that are deeply embedded in the scientific community might not offer to their members the right connections to investors, which are crucial to secure early-stage equity financing in USOs (Mosey and Wright, 2007; Nicolau and Birley, 2003).

Conversely, research can be a positive source of imprint for the development of USOs (Hahn et al., 2019). It is a crucial fuel of technology transfer activities (Powers and McDougall, 2005) and allows USOs to benefit from superior technological knowledge at founding (Minola et al., 2021), which is particularly appealing to venture capital investors (Shane, 2004). Additionally, the scientific reputation of the parent university can mitigate the severe information asymmetries that investors face in assessing science-based firms (Bonardo et al., 2011; Colombo et al., 2019). Thus, the profile of parent university's research at founding might have both positive and negative implications on the fundraising of their USOs and a more nuanced scrutiny of the dimensions of university research is needed, to understand which USOs are more likely to secure early-stage equity financing. In particular, we advance that unpacking university research patterns, considering exploration and exploitation, would offer a more nuanced understanding of the imprinting effect on USO early-stage equity financing.

3.2.4 Exploration and exploitation in university research

In studying the Entrepreneurial University, scholars have recently distinguished between exploration and exploitation as typology of research patterns (Chang et al., 2016; Centobelli et al., 2019; Guerrero et al., 2021). Exploration is defined as "learning gained through processes of combined variation, planned experimentation and play" (Centobelli et al., 2019, p.182) and includes behaviors described by terms such as search, variation, risk taking, flexibility, discovery and innovation (March, 1991). Exploitation involves the refinement of knowledge and the reduction of variation in experience (He and Wong, 2004) and includes behaviors described by terms such as choice, production, efficiency, implementation and execution (March, 1991). The concepts of exploration and exploitation have been used also more

specifically to describe the university research activities (Chang et al., 2016). In particular, partnerships with external actors through collaborative publications with industry (Cohen et al., 1998; Miotti and Sachwald, 2003) and the focus on applied research through patenting (Baldini, 2009; Chang and Yang, 2008; Geuna and Nesta, 2006) are research outputs associated with exploitation, as they diverge from traditional research agendas and build on knowledge sources from outside academia. Considering research inputs, leveraging substantially on junior faculty such as postdoctorates can be seen as exploration, as their conception of research is associated with broad search and new discoveries (Pitcher and Åkerlind, 2009).

Conversely, senior faculty members represent an input associated with exploitation, since professors and assistant professors concentrate their efforts on traditional research activities, which are the main vehicle of career advancement and recognition in the academic community (Brew, 2001; Lutter and Schröder, 2016; Neumann, 1993; Siegel et al., 2003). Also, the number of PhD programs, through which universities develop scholars to strengthen their teaching and research activities, serve to reinforce university traditional activities (Stephan et al., 2004) and can thus be seen as a research input linked to exploitation. Finally, traditional publications and citations, which represent the prevalent form of codification and dissemination of academic research (Abramo et al., 2018; Arundel and Geuna, 2004; Bornmann and Mutz, 2015), are research outputs associated with exploitation, since they are main result of traditional research activities conducted within universities.

There are reasons to believe that disentangling exploration from exploitation is useful to uncover the imprinting effect that university research exercises on USO early-stage equity financing. On the one hand, the extent to which the parent university engages in research exploration at the time of USO's founding could have positive implications on their likelihood to raise funds from external equity investors. Since exploration is associated with broader ties with external actors, USOs originating from universities that show high levels of exploration are more likely to inherit stronger networks that include relationships with investors, which are key to early-stage equity financing (Nicolaou and Birley, 2003). Moreover, USOs, which benefit from inherited ties with a variety of non-university actors (e.g., industry partners, potential investors or professional service providers) are more likely to gain the market knowledge required to speed up commercialization (Hahn et al., 2019) and thus to become investment-ready in the eyes of venture capitalists and angel investors (Vohora et al., 2004). Additionally, the frequent interactions with industry partners that scientists develop in exploration-oriented universities could favor the development of an entrepreneurial identity and mindset (Jain et al., 2009), which is crucial for ensuring that scientists put the necessary efforts

to make the USO credible in front of external investors. Finally, the prevalence of junior faculty is usually associated not only with research activities that are fresher and closer to the state of the art (Hakala, 2009), but also with a work environment in which commercialization activities that depart from the more traditional Mertonian norms of science are more legitimized (Ambos et al., 2008). This type of work environment can have a long-lasting imprint on scientist founders (Jain et al., 2009), who will be more likely to commit their time to the development of their USO and to the search of external funding.

Conversely, exploitation in research at USO founding could have negative implications on early-stage equity financing. University focus on exploitation in research makes USOs comparatively less likely to inherit ties with varied partners and more reliant on their parent university's networks, whose members will only marginally complement and extend USOs' founders' knowledge base (Colombo and Piva, 2012). This type of imprint on academic founders will have negative consequences on USOs' ability to advance the commercialization process (Hahn et al., 2019) and become investment-ready (Rasmussen et al., 2011). Moreover, universities focused on exploitations will prioritize traditional research publications (Centobelli et al., 2019), thereby discouraging scientist founders trained, socialized and imprinted in this context to subtract their time from research and allocate it to their USO's development (Chang et al., 2016). In a similar fashion, work environments characterized by a larger fraction of senior faculty members are usually more tied to traditional research activities (Ambos et al., 2008), which could potentially discourage USO founders to commit their time to technology transfer activities (Bercovitz and Feldman, 2008) and, more specifically, to engage in the time-consuming process of raising early-stage equity financing.

Exploration and exploitation in research are both important for university research and are both associated (all else being equal) to a higher level of research input and output (Abramo et al., 2019). Also, under the modern view of university as ambidextrous organizations (Ambos et al., 2008; Chang, 2009), and specifically the Entrepreneurial University (Centobelli et al., 2019; Guerrero et al., 2021), exploration and exploitation can co-exist, thereby not representing the two extremes of a continuum. Hence, given the above arguments (suggesting that exploration and exploitation could have opposed consequences on USO fundraising) and the lack of established research in this field, we advance the need to explore the topic by identifying different proxies of both exploration and exploitation, and to observe possible regularities between these patterns and USO raising of early-stage equity financing.

3.3 Research methodology

3.3.1 The Italian university system

To empirically investigate the relationship between the parent university's research patterns and USOs' ability to attract early-stage external equity financing, we have chosen USOs from the Italian context as an interesting case, for several reasons. First, the phenomenon of USOs has achieved relevance in Italy since the early 2000s, due to a nationwide regulatory reform on university technology transfer that has prompted the creation of a high number of USOs and, consequently, abundant related academic research (Meoli et al., 2019; Horta et al., 2016; Muscio, 2016; Bonaccorsi et al., 2014; Fini et al., 2020). Second, prior studies suggest that the phenomenon of USO is growing rapidly in Italy and in line with the European average (ProTon Europe, 2012). Moreover, USOs in Europe – including those born within the Italian context – share common traits (e.g., in terms of expected growth, reliance on public funds and industry distribution) compared to the more widely studied US and UK ones and only a smaller portion of USOs in Italy are built upon patented inventions (Nosella and Grimaldi, 2009, Grimaldi and Grandi, 2003). Further, other peculiar characteristics of the Italian context such as scant university-industry ties, absence of venture capital market and labor market rigidity are common to other European countries (Muscio et al., 2016) and therefore the findings that we present about Italian USOs can be deemed representative of other European contexts.

3.3.2 Sample

The empirical analysis of this study is based on a novel dataset that relies on data from multiple sources. First, we employed a dataset of all USOs from Italian state-owned universities established between 2011 and 2019, the "Spin-off Italia" database. The decision to exclude USOs created before 2011 was driven by lack of reliable financial data. We initially identified 891 USOs, which are the total number of USOs created in the period 2011-2019. From this database, we obtained firm-specific anagraphic information including USOs' tax code, year of incorporation, geographical location and the name of the parent university from which the firm originates. Second, to collect USOs' financial information, we first matched our sample with "AIDA" (Analisi informatizzata delle aziende) by Bureau van Dijk, which provides accounting data on Italian firms. We then augmented the dataset using Crunchbase to assess the equity financing strategies of USOs. Crunchbase is a database of startup companies operated by

TechCrunch which is increasingly used in entrepreneurial finance studies (e.g., Cumming and Vismara, 2017; Signori and Vismara, 2018). We collected information on the equity financing rounds carried out by each USO. USOs that lacked financial information were excluded from our sample. Third, the Italian Ministry of Education, University and Research (MIUR) database, the ARWU (Academic Ranking of World Universities) ranking, the CWTS Leiden Ranking, the Web of Science (WOS) database and the Scopus database were used to collect information about the parent universities included in our population. Lastly, we completed our dataset with regional-level data from Eurostat database, which provides official statistics on the European Union, EU member states and sub-state regions. Our final sample comprises 739 USOs from 39 Italian public universities (approximately 57% of all Italian public universities).

3.3.3 Measurements

Dependent variable. For each USO, we measure its external equity financing using the share premium account in the firms' balance sheet as the key source for investment received (Jelfs and Lawton Smith, 2021). Our dependent variable (Early-stage external equity financing) is a dummy variable that takes a value of 1 if the USO obtained external equity within the first five years from its establishment, 0 otherwise. Information was retrieved from AIDA and Crunchbase. Early-stage external equity investors included private investors or business angels, venture capitalists, corporate venture capitalists, crowdfunding backers, mutual funds, pension funds and strategic partners.

Independent variables. Our explanatory variables are based on university research characteristics (both input and output) that proxy exploration and exploitation in research patterns. Each variable is calculated based on a 3-year moving average prior to the year of the establishment of USOs. For example, to calculate the variable measuring the average citations per publication for a university from which an USO founded in 2011 is generated, we took the average citations per publication in 2009, 2010 and 2011). A detailed description of how each variable has been calculated is reported in Table 3.1, as mentioned above.

We measure research inputs considering human capital both in terms of investments (i.e. education activities to form scholars) and assets (i.e. research personnel). Considering investments, we used the relevance of PhD programs available at the university as proxy for exploitation, as they mirror investments in reinforcing the human capital allocated to university traditional activities (Stephan et al., 2004). We also considered the relevance of EU sponsored PhD scholarships as a proxy for exploration, since these programs are typically meant to

generate capabilities that enable innovation through utilization of scientific knowledge by the society (Geuna, 2001; Levén et al., 2014; Salter and Martin, 2001). They thus depart from traditional research activities and are more geared towards applied research. In terms of human capital assets, we consider the composition of university staff human capital: percentage of professors (full professors and associate professors), percentage of assistant professors (including tenured and tenure-track), percentage of postdoctoral researchers and percentage of PhD students on overall academic staff. Professors and assistant professors mirror the degree of exploitation as they focus on traditional research activities, through which they obtain career advancement and reputation in the academic community (Brew, 2001; Lutter and Schröder, 2016). Instead, we consider postdoctoral researchers as a proxy for exploration because of their conception of research geared towards discovery and search (Pitcher and Åkerlind, 2009). Further, we measure university research output through four proxies associated both to scientific production and the inventive activity. In terms of scientific production, we included the publication performance calculated as total number of Scopus publications weighted by university size (calculated as total number of enrolled students) and the average citations per publication as proxies for exploitation, since they represent outcomes of traditional activities of research codification and dissemination (Abramo et al., 2018; Bornmann and Mutz, 2015). We also included the percentage of core publications that are collaborative publication with industry as this is linked to exploration, since the engagement with industry partners stimulates new questions that diverge from traditional academic inquiry (Miotti and Sachwald, 2003). Finally, looking at university inventive activity, we consider university patenting activity calculated as the average number of patents granted weighted by the number of STEM faculty members. Since patenting is an output associated with applied research and typically diverges from traditional basic research agendas pursued by scholars (Chang and Yang, 2008), it mirrors the degree of exploration. For comparability, all variables are standardized (with the exception of those that are recorded as binary indicators).

Control variables. We identify controls at (1) university, (2) firm and (3) regional level. The (1) first set comprises university prestige and size. Prestige influences the external perception of an organization. Several scholars have measured university prestige by considering world university rankings (Civera and Meoli, 2018; Saisana et al. 2011; Talylor and Braddock, 2007). We adopt a similar approach to assess the parent university prestige through the ARWU (Academic Ranking of World Universities) ranking (Civera et al., 2020). We use this data to build a dummy equal to 1 if the parent university was listed in the ARWU ranking at the year of founding of the focal USO. We compute the variable university size as

the logarithm of the number of enrolled students at all (undergraduate and postgraduate) levels. The (2) second set of variables comprises firm's size (logarithm of first recorded revenue after foundation), eight industry dummies, and the year of foundation (dummies). The (3) third includes regional GDP measured as the natural logarithms of regional gross domestic product at the year of founding of the focal USO.

3.3.4 Model specification

We use probit regressions to investigate the relationship between USOs' early-stage external equity financing and its parent university's research patterns in terms of exploration and exploitation.

Table 3. 1 Descriptive statistics and description of variables

Variable	Obs	Mean	SD	Min	Max	Variable description
Panel A: dependent variable						
Early-stage external equity financing (%)	739	10.15	30.21	0	100	Dummy = 1 if the USO obtained external equity within the first five years from its founding; 0 otherwise.
Panel B: University-level explanatory variables						
PhD programs	739	2.44	0.90	0.78	5.55	Total number of PhD programs available weighted by the number of departments per university per year.
EU sponsored PhD Scholarship (%)	739	4.24	9.27	0	52.80	Percentage of EU sponsored PhD scholarship on total PhD scholarship per university per year.
Professors (%)	739	28.03	0.05	17.23	43.51	Percentage of full professors and associate professors on total academic staff per university per year.
Assistant professors (%)	739	30.52	9.24	10.22	51.73	Percentage of tenured and tenure-track assistant professors on total academic staff per university per year.
Postdoctoral researchers (%)	739	13.9	5.5	1.5	28.5	Percentage of postdoctoral researchers on total academic staff per university per year.
PhD students (%)	739	27.60	6.51	12.33	47.92	Percentage of PhD students on total academic staff per university per year
Publication performance	739	0.07	0.02	0.02	0.14	Total number of Scopus publications weighted by university size per university per year.
Avg. citations per publication	739	0.88	0.30	0.25	2.20	Total number of WOS citations weighted by the number of Scopus publications per university per year.
University patenting activity	739	0.14	0.25	0	1.80	The average number of university granted patents weighted by the number of STEM faculty members.
Collaborative publications with industry (%)	739	4.42	1.34	1.91	10.87	Percentage of core[4] publications that are co-authored with one or more industrial partners per university per year.

[4] Core publications refers to scientific articles published in journals with an international scope and have sufficiently large number of references to other core journals

Panel C: University - level control variables						
University prestige	739	55.75	49.70	0	100	Dummy = 1 if the parent university was listed in the ARWU ranking at year of founding of the focal USO; 0 otherwise
University size (No.)	739	40,144	22,895	8,893	119,168	Number of enrolled students at all undergraduate and post-graduate levels.
Panel D: firm-level control variables						
Firm size (In thousand euros)	739	20,541	53,268	0	904,000	First recorded revenue after USO establishment
Aerospace	739	0.95	9.69	0	100	Dummy = 1 if USO operates in the aerospace industry; 0 otherwise.
Biomedical	739	6.22	24.17	0	100	Dummy = 1 if USO operates in the Biomedical sector; 0 otherwise.
Electronics	739	3.92	19.43	0	100	Dummy = 1 if USO operates in the electronics sector; 0 otherwise
Energy and environment	739	17.73	38.22	0	100	Dummy = 1 if USO operate in the energy and environment industry; 0 otherwise.
ICT	739	18.94	39.21	0	100	Dummy = 1 if USO operate in the ICT industry; 0 otherwise.
Industrial automation	739	5.82	23.43	0	100	Dummy = 1 if USO operate in the industrial automation industry; 0 otherwise.
Innovation services	739	18.40	38.78	0	100	Dummy = 1 if USO operate in the innovation services industry; 0 otherwise.
Life sciences	739	18.94	39.21	0	100	Dummy = 1 if USO operate in the life sciences industry; 0 otherwise.
Nanotech	739	1.62	12.65	0	100	Dummy = 1 if USO operate in the Nanotech industry; 0 otherwise
Year of foundation	739	2015	2.34	2011	2019	Dummy representing year of establishment of USO
Panel E: Regional-level control variable (NUTS 3)						
Regional GDP (In billion euros)	739	45,117	50,175	2,796	180,750	Regional gross domestic product at year of founding of the focal USO

3.4 Results

We tested the effect of university research patterns – exploration and exploitation (measured by input and output indicators of university research) – on USOs ability to obtain early-stage external equity financing. Table 1 reports descriptive statistics of our sample, including the definition of variables used. To avoid the problem of multicollinearity, we estimated the Variance Inflation Factor (VIF), which was between 1.07 and 3.34, with a total mean of 2.23. this shows that multicollinearity is not a concern as VIF is below the maximum threshold of 10 (Hessels et al., 2008).

Table 3.2 reports the estimates of probit regression models with input measures of university research. Model 1 reports the results of our baseline specifications including the control variables. Models (2-6) add to the former specification the effect of each input measure of university research, i.e, PhD programs, EU sponsored PhD scholarships, percentage of professors, assistant professors, postdoctoral researchers on total academic staff. The first three measures mirror research exploitation and the remaining two, research exploration. Model (7) reports the full model, showing the combined effect of the aforementioned input measures of university research. The coefficients of all but one input measure tested in our model are statistically significant. The coefficients of the variables measuring PhD programs and percentage of assistant professors available at the originating university (measures of exploitation) are negatively and statistically significant in the single model and more pronounced in the full model ($\beta = -0.686$, $p < 0.01$ and $\beta = -0.163$, $p < 0.1$, respectively). EU sponsored PhD scholarship has no effect on the outcome variable. The coefficient of the variable measuring the percentage of professors (measure of exploitation) is negative and significant ($\beta = -0.469$, $p < 0.01$) in the single model, but not in the full model.

The coefficient of the variable measuring postdoctoral researchers (measure of exploration) is positively and statistically significant both in the single model ($\beta = 0.208$, $p < 0.01$) and in the full model ($\beta = 0{,}148$ $p < 0.1$), although at a lower significance level. In sum, our input measures of university research seem to indicate that, between the two dimensions of university research patterns, USOs early-stage external equity financing is overall positively associated with exploration and negatively associated with exploitation in university research (input).

Table 3. 2 Probit regression (research input)

	Dependent variable: USO early-stage external equity financing (yes = 1, no = 0)						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
PhD programs (Exploitation)		-0.163*					-0.231**
		(0.085)					(0.100)
EU sponsored PhD scholarships (Exploitation)			0.068				0.118
			(0.074)				(0.085)
Professors (Exploitation)				-0.469***			0.225
				(0.123)			(0.235)
Assistant professors (Exploitation)					-0.686***		-0.895***
					(0.142)		(0.271)
Postdoctoral researchers (Exploration)						0.208***	0.148*
						(0.075)	(0.079)
University prestige	0.232	0.281	0.269	0.146	0.043	0.183	0.138
	(0.176)	(0.179)	(0.182)	(0.182)	(0.190)	(0.178)	(0.204)
University size (logarithm)	0.232	0.281	0.269	0.146	0.043	0.183	0.138
	(0.176)	(0.179)	(0.182)	(0.182)	(0.190)	(0.178)	(0.204)
Firm size (logarithm)	-0.027*	-0.026*	-0.026*	-0.029**	-0.033**	-0.028*	-0.030*
	(0.014)	(0.014)	(0.014)	(0.015)	(0.015)	(0.014)	(0.015)
Sector dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Regional GDP (logarithm)	0.206***	0.192**	0.203***	0.024	0.070	0.109	0.035
	(0.075)	(0.076)	(0.076)	(0.090)	(0.081)	(0.081)	(0.095)
Constant	-2.020***	-2.109***	-2.047***	-2.466***	-1.256**	-2.035***	-1.013
	(0.469)	(0.484)	(0.470)	(0.499)	(0.512)	(0.480)	(0.691)
Pseudo R2	0.1178	0.1256	0.1194	0.1501	0.1732	0.1342	0.1956
Observations	739	739	739	739	739	739	739

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

In Table 3.3, we test our research question on output measures of university research namely publication performance, average citations per publication, collaborative publications with industry and the university's patenting activity. The first two reflect research exploitation and the latter are linked to research exploration. In Model (1) we test our baseline specifications including the control variables. Model (2-5) reports the single effect of each research output indicator on USOs' ability to obtain early-stage external equity. Model (6) presents the full model. The coefficients of all but one output measure of university research are statistically significant. In particular, the coefficient of the variable measuring publication performance (measure of exploitation) is positively and statistically significant in the single model ($\beta = 0.298$, $p < 0.01$) as well as in the full model ($\beta = 0.315$, $p < 0.01$).

Average citations per publications (measure of exploitation) is negatively and statistically significant in the single model and in the full model whereas the variable measuring university patenting activity does not exert any effect on our outcome variable. Finally, the coefficient of the variable that measures collaborative publications with industry (a measure of exploration) is positively and significantly significant in the single model ($\beta = 0.212$, $p < 0.01$) and in the full model ($\beta = 0.202$, $p < 0.05$).

In sum, between the two dimensions of university research patterns, USOs early-stage external equity financing is overall positively associated with exploration and ambiguously associated with exploitation in university research.

Table 3. 3 Probit regression (research output)

	Dependent variable: USO early-stage external equity financing (yes = 1, no = 0)					
	(1)	(2)	(3)	(4)	(5)	(6)
Publication performance (Exploitation)		0.298***				0.315***
		(0.102)				(0.108)
Citations per publication (Exploitation)			-0.154*			-0.191**
			(0.079)			(0.086)
University patenting activity (Exploration)				-0.106		-0.150
				(0.093)		(0.110)
Collaborative publications with Industry (Exploration)					0.212***	0.202**
					(0.073)	(0.082)
University Prestige	0.232	-0.045	0.322*	0.230	0.224	-0.008
	(0.176)	(0.202)	(0.183)	(0.176)	(0.179)	(0.213)
University size	-0.113	0.046	-0.122	-0.117	-0.041	0.107
	(0.090)	(0.106)	(0.092)	(0.090)	(0.095)	(0.113)
Firm size (logarithm)	-0.027*	-0.034**	-0.026*	-0.027*	-0.028**	-0.034**
	(0.014)	(0.015)	(0.014)	(0.014)	(0.014)	(0.015)
Sector dummy	Yes	Yes	Yes	Yes	Yes	Yes
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes
Regional GDP (logarithm)	0.206***	0.168**	0.166**	0.211***	0.131	0.058
	(0.075)	(0.076)	(0.078)	(0.075)	(0.080)	(0.085)
Constant	-2.020***	-1.859***	-2.092***	-2.030***	-2.038***	-1.942***
	(0.469)	(0.477)	(0.474)	(0.470)	(0.470)	(0.482)
Pseudo R2	0.1178	0.1360	0.1258	0.1207	0.1344	0.1649
Observations	739	739	739	739	739	739

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

3.5 Discussion

A central challenge for entrepreneurial universities is strategically combining the more traditional research core activities with entrepreneurship (Ambos et al., 2018; Chang et al., 2016; Klofsten et al., 2019). In this paper, we show that these two activities can act in synergy and how university research drives the success of university technology transfer activities by answering the question: "From which kind of university do USOs that obtain early-stage equity financing come from?". To do so, we explored how the early-stage equity financing of its USOs is imprinted by their parent university research at founding. In particular, we unpacked exploration and exploitation patterns (Chang et al., 2016; Centobelli et al., 2019; Guerrero et al., 2021).

Taking advantage of this approach, we showed that the amount of research inputs and outputs alone are not sufficient to explain the quality of USOs generated by a given university. In contrast, a more nuanced approach is needed in order to distinguish research inputs and outputs linked to exploration and from those ones linked to exploitation. While exploration in research is associated with the search of resources external to the university to produce novel results, exploitation is linked with the use and refinement of existing resources to efficiently achieve known outcomes (Centobelli et al., 2019). These two patterns, being linked to different imprints in terms of cognition, networks and resources, could yield different outcomes for the early development of USOs.

In fact, our overall results suggest that exploration and exploitation in research at founding have opposite effects on the likelihood of USOs to raise early-stage equity financing. More specifically, considering exploration, the percentage of postdoctoral researchers and collaborative publications with industry have a positive impact on USO's ability to obtain early-stage external equity financing. In contrast, considering exploitation, average citations per publication, PhD programs available at the parent university as well as university human capital including professors and assistant professors are negatively correlated with USO's external equity fundraising. Only the measure of university publications, among our measures of exploitation, has a positive effect.

Contributions to research

Our paper offers three main contributions to extant research. First, we contribute to the vibrant debate on the Entrepreneurial university (Audretsch and Belitski, 2022; Guerrero et al., 2016) in two main respects. From a core activities perspective, our results offer new elements to assess the metrics of university research as well as its relationship with entrepreneurship, a key challenge for entrepreneurial universities (Klofsten et al., 2019). Our paper shows that not all research inputs and outputs are created equal and that the more is not always the better, if the university prioritizes the success of its spinoff activities.

To study the relationship between research and the success of technology transfer activities, scholars and practitioners should therefore consider more customized metrics suitable to their specific outcomes and capable of distinguishing different patterns in university core activities. From a strategic perspective, our study adds to the recent stream of literature (Centobelli et al., 2019; Guerrero et al., 2021) concerned with how exploration and exploitation patterns affect the outcomes of the entrepreneurial university. Our results indicate that, by disentangling these two patterns, we are able to have a more informed view on how to frame the trade-off between research and entrepreneurial missions. More specifically, while exploration in research presents some synergies with the success of spinoff activities, exploitation in research could generate some tensions.

Our findings thus indicate under which circumstances promoting entrepreneurship in universities is consistent or not with strategies allocating resources to research. This challenge is particularly important for today's resource-constrained universities (Kloftsen et al., 2019).

Second, we advance the academic entrepreneurship literature, responding to recent calls (Guindalini et al., 2021; Mathisen and Rasmussen, 2019) to know more about the university-level antecedents of the early development of USOs. The academic entrepreneurship literature is concerned with how the uniqueness of university origin affects the early development trajectories of USOs for the good and the bad (Fini et al., 2019; Hahn et al., 2019).

By looking at early-stage equity financing, a key milestone in the development of USOs (Fini et al., 2017; Rasmussen and Sørheim, 2012; Vohora et al., 2004), we contribute to this literature. More specifically, we explore how different patterns in university research, whose imprinting inherently characterize USOs (Colombo and Piva, 2012; Hahn et al., 2019), affect their fundraising. Our results offer a nuanced view on the relationship between university origin and their development. While exploration in research has positive imprinting effects on USOs early-stage equity financing, exploitation has negative implications.

Finally, we extend the research stream of imprinting in the context of USOs (Colombo et al., 2012; Hahn et al., 2019). By focusing on early-stage equity financing as an outcome of imprinting and by looking at different patterns in university research as the genesis of imprinting, our study endorsed the value of using imprinting to study the unique development trajectories of USOs, linked to their idiosyncratic origin (Minola et al., 2021; Wennberg et al., 2011). In particular, using the imprinting perspective to dig in-depth into the heterogeneity among parent universities and their implications on USOs, we are able to generate more knowledge on why some USOs are more likely to succeed than others (Mathisen and Rasmussen, 2019). In our paper, in fact, imprinting offered a suitable theoretical lens to speculate that different patterns in university research could have lasting implications of USOs development, in terms of early-stage equity financing.

Limitations and future research directions

Before discussing the practical implications of this study, we focus on its limitations and the opportunities for future research that these limitations provide. First, by relying on quantitative observational data on fundraising events, we cannot disentangle the demand from the supply side in the fundraising obtained by USOs. As we discussed in the literature review, both can influence the early-stage equity fundraising of USOs (Rasmussen and Sørheim, 2012; Vohora et al., 2004). However, future research could rely on experimental research designs (e.g., Zunino et al., 2021) to observe which specific characteristics of USO parent universities are more or less appealing to external equity investors.

A second limitation of this study is that we did not have in-depth survey-based information about USOs founding team, resources, goals and strategies (Hahn et al., 2019; Minola et al., 2021; Shankar at al., 2020) that could be imprinted by their university origin and affect the search and obtaining of early-stage equity financing. Future research could rely on longitudinal survey-based studies to study how these firm-level influences interact with university-level factors, thereby affecting the early development of USOs.

A third limitation is that we focused on university-level antecedents, without deepening elements of the broader entrepreneurial ecosystem (Guindalini et al., 2021). By merging university-level data with regional data (e.g., Civera et al., 2020), future research could study how different configurations of the local entrepreneurial ecosystem and of the university jointly affect the early-stage equity financing of USOs.

Finally, while our study is focused on the Italian context to ensure that all USOs are exposed to the same national influences, future research could look at different institutional settings, in which the private equity industry is more or less developed, such as the UK (Munari and Toschi, 2011). Relatedly, our time frame does not consider the exogenous shock caused by Covid-19 on the entrepreneurial financing landscape (Brown and Rocha, 2020). Future research could use this as a natural experiment to study whether university-level factors make the fundraising of USOs more or less resilient to crises.

Practical implications

Our study offers some practical implications to university leaders, scientists, academic entrepreneurs, and external investors. First, university leaders can learn that allocating resources to exploration research patterns, such as hiring junior faculty or promoting research collaboration with industry, could have some positive spill-overs on the fundraising of USOs. Next to developing infrastructures directly supporting USOs, it seems that investing in exploitation research patterns contributes too to the entrepreneurial activities of universities. Second, academic scientists that are interested in developing their research by founding USOs and academic entrepreneurs can learn that, if they come from universities strong in research exploration, they might have an easier time securing funds for their company, a possible source of competitive advantage; conversely, founders of USOs coming from universities strong in research exploitation could consider relying substantially on surrogate entrepreneurs (Visintin and Pittino, 2014) or partnering with industry partners (Colombo and Piva, 2012) as these might mitigate the disadvantages coming from their university imprinting. Universities could share this information internally, as this might encourage academic scientists to engage in entrepreneurial activities, by making them more aware of the probability to get early-stage financing.

Finally, investors specialized in early-stage investment in technology-based companies can learn from our findings that there are some universities to keep monitored as they are more likely to generate USOs that attract external equity financing. They should thus seriously consider strengthening their ties to these universities.

4. THE ROLE OF UNIVERSITY EQUITY OWNERSHIP AND UNIVERSITY REPUTATION ON INVESTORS' PROPENSITY TO INVEST IN UNIVERSITY SPINOFFS: AN EXPERIMENTAL APPROACH.

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4.1 Introduction

University spinoff firms (USOs) are ventures created to commercialize knowledge and technologies generated at a university and/or where the team of founders comprises members from a university (Fryges and Wright, 2014). USOs have become popular and are drawing increasing attention from policymakers, university administrators and scholars studying the commercialization of academic research results, mainly due to their ability to advance industrial application of scientific knowledge and their contribution to wealth creation (technological innovation and employment in high technology industries) (Bigliardi et al., 2013; Baldini, 2010; Shane, 2004; Hayter, 2013).

USOs are considered as a potentially valuable but underexplored vehicle to technology transfer by universities (Lockett et al., 2003, Harrison and Leitch, 2010). Several factors, including uncertainty about the technological development, challenges in terms of market acceptance and entrepreneurial and managerial weaknesses are known to constrain USOs' viability in the early phase of development (Rasmussen et al., 2011; O'shea et al., 2005; Vohora et al., 2004) and the ability to pursue their financial goals (Agyare et al., 2022). Previous literature suggests that under conditions of heightened uncertainty, ventures need to signal their potential value to equity investors by providing credible information about the quality of the venture (Ahlers et al., 2015; Ko and McKelvie, 2018; plummer et al., 2016; Audretsch et al., 2012). It follows that the parent university could play a crucial role in facilitating USOs' access to financial resources, particularly at the early stages of development (Wright et al., 2006; Shane and Stuart, 2002).

Accordingly, some studies examine USOs' originating context in order to gain some insight into which factors impede or enhance USOs' performance generally, though these studies present conflicting evidence. (Sørheim et al., 2011; Chiesa and Piccaluga, 2000; Ferretti et al., 2019; Bolzani et al., 2021; Rasmussen and Sørheim, 2012; Hall, 2002; Scholten et al. 2015; Wennberg et al., 2011; Treibich et al. 2013; Rasmussen et al. 2014). Other studies have investigated the ties between USOs and their parent university and the impact of these ties on USOs' capability in attracting external funding for innovation activity (Gubitta et al.,2016; Soetanto and Van Geenhuizen, 2015, Agyare et al., 2022), the amount of private investment received by the USO (Lauto et al., 2022) or USOs' valuation at IPO (Colombelli et al., 2019; Honjo and Nagaoka, 2018) while considering different university-level variables. However, despite the growing body of research on the topic, the literature of USO studies is partially

incompletely because it is still unclear how the relationship with the parent university influences the investment propensity of potential investors to commit financial resources to the development of USOs. In particular important issues such as the value of a formal equity-based relationship with the parent university (Munari and Toschi, 2011; Bolzani et al., 2021) and the advantage of strong linkages with prestigious research (Di Gregorio and Shane, 2003; O'Shea et al., 2005;) have not been explored yet. To this end, the current study is guided by two primary research questions (RQs) as follows:

- **RQ1**. Does investors' propensity to invest, if at all, differ between USOs and Non-USOs?
- **RQ2**. Among USOs, does university equity ownership affect investors' propensity to invest, and under which conditions?

To address the above research questions, we focus on the supply-side and conduct two randomized, within-subject experimental studies (Aguinis and Bradley, 2014). While study 1 relies on literature and its contrasting arguments to investigate RQ1, study 2, under signaling theory, advances two hypotheses to investigate RQ2. Respondents were prescreened based on their investment experience and were recruited online from www.prolific.co, which is a crowdworking platform specifically designed to conduct social and economic science experiments (Palan and Schitter, 2018).

Our findings are twofold. First, we found that investors' propensity to invest in USOs may not be as straightforward as previously suggested by some studies. This finding suggested that investors' propensity to invest in USOs might be influenced by a set of determinants that differ from those of non-USOs. Second, our results indicate that university equity ownership is a positive signal for potential investors and that the reputation of the university positively and strongly moderates the association among university equity ownership and investors' propensity to invest in USOs.

The remainder of the paper is organized as follows. Section I presents a review of the literature, uniting arguments that may facilitate or hinder investment by external investors in USOs and provides a conceptual framework which builds on signaling theory to explore the problem of information asymmetry. Section II reviews relevant literature and proposes two hypotheses. Section III is devoted to a succinct description of the context and methodology, including the data, variables used for empirical analysis and results. Section IV concludes with references to contributions of the study and limitations.

4.2 Theory and hypothesis

So far, the streams of literature on academic entrepreneurship and entrepreneurial finance have shed some light on what factors push investors - or have them refraining from - investing in USOs. As prior work presents arguments against and in favor of spin-off investing, it is still unclear whether a university origin increases or decreases the investor's propensity to invest in a firm, and which university-level factors affect this propensity. In this section, we present a review of the literature, uniting arguments that may facilitate or hinder investment by external investors in USOs. We then focus our attention on USOs in order to recall the factors affecting investors propensity to invest in this specific type of firms.

Previous studies debate on the existence of a bias by external equity investors against USOs in seeking "demand-side" and obtaining "supply-side" financing to support their growth (Lockett et al., 2002; Murray and Lott,1995; Munari and Toschi, 2011). Seen from the supply-side perspective, the higher degree information asymmetry and uncertainty, coupled with the significant monitoring costs of USOs make investors reluctant and create a liability related to the supply of financing to these firms (Rasmussen and Sørheim, 2012; Hall, 2002).

For example, at the team level, given that USOs originate from a traditionally non-commercial environment (Fini et al., 2019), their founders may not fit the profile of successful entrepreneurs (Burton et al., 2002; Shane and Stuart, 2002). This is because academic founders often lack critical commercial skills (Franklin et al., 2001; Oliveira et al., 2013; Mosey and Wright, 2007 ; Rasmussen and Borch, 2010). In fact, it is widely recognized that investors tend to favor USOs created by founders with significant prior managerial (Macmillan et al., 1985) or entrepreneurial experience (Ucsubaran et al., 2009) in order to facilitate the identification and exploitation of successful business opportunities.

At firm level, there is no guarantee that USOs business activities, which is based on research that can be considered "pure", "basic" or "fundamental, will lead to commercial success or may require long period of time to reach the market (Mathisen and Rasmussen, 2019). USOs present short track records and have limited availability of collateral to minimize investors risks (Carayannopoulos, 2009; Hahn et al., 2019) because they often possess a higher level of intangible assets (e.g., technological knowledge and intellectual property). As a result, investors may experience problems in evaluating the commercial potential of the firm, leading to considerably greater costs connected to screening, pre-investment contracting and monitoring (De Coster and Butler, 2005).

Next to the issues in the supply of capital, literature acknowledge that USOs' might also be less willing to seek external capital (Mina et al., 2013). USOs success in terms of their ability to pass through a series of critical junctures (Vohora et al., 2004) requires, first and foremost, the commitment of its founders (Fu et al., 2022; Grandi and Grimaldi, 2005). However, since USO founders are often university scientists who are reluctant in allocating time from their academic duties because the development of USOs is a lengthy process (Jain et al., 2009), such firms might not even reach the stage in which they demand, and actively search for external financing. Moreover, university scientists' decision to involve in a new firm are often strongly influenced by expected outcomes, such as gain prestige and increase reputation in the academic community, access funding opportunities as well as the possibility of receiving new infrastructure and facilities for conducting research, rather than the pursuit of growth aspirations that investors look for (Hayter, 2011; Lam, 2011).

Conversely, based on previous literature, it is also possible to advance competing arguments, highlighting a potential preference towards USOs by external capital providers. For instance, at firm level, Honjo and Nagaoka (2018) found that the likelihood of an IPO is higher for USOs in the biotechnology industry in Japan. This work suggests that because USOs face a long period of development and require significant injection of capital to sustain their R&D activities, they have strong incentives to access public market quickly, which might offer equity investors a way to recover back their investments. At team level, Criaco et al. (2014) show that university human capital of the USO founding team is positively related to the likelihood of USO survival. One explanation for this finding might be that the higher opportunity cost of academic entrepreneurs motivates them to engage in more self-screening before creating a firm. Concerning the support from the parent university, USOs enjoy unlimited access to skilled personnel and technological knowledge from the university as well cost advantages in accessing a number of information sources, all of which may provide USOs with strong legitimacy and credibility in the eyes of potential investors (Ziaee Bigdeli et al., 2016; Messina et al., 2022; Heblich and Slavtchev, 2014; Muscio et al., 2016). Finally, universities may facilitate USOs development by providing initial networking opportunities with industry (Soetanto and Van Geenhuizen, 2015).

Indeed, these contrasting arguments suggest that the question on whether or not investors' propensity to invest differ between USOs and Non-USOs might actually not be as straightforward as some previous studies suggest. However, Munari and Toschi (2011) contend that theoretical arguments and previous studies do not consider important aspects of USOs that could lead to different outcomes. Among these are the value of a formal equity-based linkage

with the parent university (Bolzani et al., 2021) and the advantage of strong linkages with prestigious research (Di Gregorio and Shane, 2003; O'Shea et al., 2005; Owen-Smith and Powell, 2001). On the one hand, the former might appear attractive to potential investors because it facilitates access to people with expert knowledge and talent (Wennberg et al., 2011) while the latter, on the other hand, might offer the credibility that USOs need to signal their quality in the scientific domain to external investors (Colombo et al., 2019). Thus, investigating these factors is useful to uncover the signaling effect that the parent university exercise on investors propensity to invest in USOs.

4.2.1 The heterogeneity of academic spin-offs

As articulated in the previous section, the literature has provided arguments for why investors would favor (rather than not) investing in USOs. As we argue, the combination of favorable and unfavorable arguments has led to contradictory findings (Lockett et al., 2002; Murray and Lott,1995; Munari and Toschi, 2011) in the literature on whether investors prefer USOs over other early-stage ventures. However, as we argue in what follows, USOs may differentiate themselves from other USOs by sending quality signals which may affect their investment chances. In assessing the value of signals for USOs seeking for finance, we deliberately focus on the role of the parent university. In what follows, we first shed light on signaling theory, and consider the application of signaling theory in the entrepreneurial finance literature. Then, we go on to develop our theoretical framework, in which we consider the role of university equity ownership and university reputation as signals.

4.2.2 Signaling in entrepreneurial finance

Investors are in continuous pursuit of ventures with high growth potential that can achieve high returns but they often find it challenging to evaluate the target firm's prospects for new products and processes (Teece, 1996), leaving many potential ventures unfunded. Particularly, investors and entrepreneurs are faced with information asymmetry as the entrepreneurs have more knowledge about the quality and true value of the venture than potential equity investors (Davila et al., 2003; Courtney et al., 2017). This information asymmetry may lead to market failures, where exchange transactions either fail to occur or are inefficient (Akelof, 1970).
Signaling theory is fundamentally concerned with reducing information asymmetry between two parties (Spence, 2002). For example, in his formulation of signaling theory, Spence (1973)

utilized the labor market to demonstrate how job candidates use costly signals (i.e., formal education) to reduce information asymmetry, which hampers prospective employers' ability to choose the most qualified candidates.

In innovation settings, the information asymmetry problem arises when the inventor has more knowledge about the quality and true value of the USO than potential equity investors do (Hall and Lerner 2010; Stiglitz and Weiss, 1981). Because in this study, the founders are also the inventors (hereafter founders), it is intuitive to expect that they would have greater knowledge - compared to potential investors - about early stage research and development (R&D) results and potential applications as well as other critical information that might influence USOs' future growth. The marketplace for financing USOs, therefore, mirrors the "lemons" market depicted by Akerlof (1970), where top-quality firms are faced with the problem of distinguishing themselves from low-quality firms in the market.

The notion of "quality" refers to the underlying, unobservable ability of the signaler to meet the needs or demands of an outsider observing the signal (Connelly et al., 2011). In spence's classic example, quality refers to the unobservable ability of the individual, which is signaled by university graduation. In our context, quality is more related to the functional aspects of the USO and its ability to achieve a better market performance (i.e., generate sales revenues in the long term) through effective technology-transfer and transforming research results to marketable innovative products/services (Gubitta et al., 2016) and not on the behavioral tendency of the founders. Simply stated, this private information provides founders with a privileged perspective regarding the underlying quality of their firm (Agyare et al., 2022).

Three primary elements characterize our signaling model: the signaler, the USO, which is characterized by the unobservable quality of potential financial benefits; the signal, which provides a means for potential investors to make judgments and predictions about actions, in this case the future of the USO; and the receiver, potential investors, who engage in screening and based on the perceived signal, choose whether and how much to invest in the firm.

Signaling theory is particularly relevant in contexts of high information asymmetry (Plummer et al., 2016; Spence, 1973). First, signaling theory has shown great potential in elucidating investment decisions of early-stage equity investors, especially under conditions of scarcity of reliable information about a venture (Bernstein et al., 2017; Payne et al. 2009). Second, signaling theory, in essence, shows how entrepreneurs validate the attractiveness of their business by seeking and obtaining financing from external equity

providers (Connally et al., 2011). Although there are multiple types of information that, when communicated, may affect perceptions about the USO, this paper is particularly interested in two: university equity ownership and university reputation. In the context of this study and based on the signaling theory, we argue that when potential investors are presented with information about university equity ownership and university reputation, they use these characteristics as signals to make inferences about the future potential of the USO and determine whether or not to invest in the USO. the sub-sections below explain how these two types of information affect investors' propensity to invest in the USO.

4.2.3 Parent universities' equity ownership in USOs

Equity ownership in USOs constitute the most common way to formalize the relationship between a USO and its parent university (Bolzani et al., 2021). This form of tie has become increasingly widespread among universities and set forth the formal relationship between USOs and their parent university. For instance, it has been well documented that a larger portion of US research universities have at least one equity deal in a USO (Feldman et al., 2002). The situation in Europe is no different, as most countries have adopted a university ownership model, making equity in USOs more common (Geuna and Rossi, 2011).

This study is particularly interested in the effects of explicitly communicating information about university equity ownership in a USO. Although USOs differ in terms of the degree to which the parent university is involved in the firm (Ferretti et al., 2019), this paper focuses on the effects of communicating that the parent university has equity stakes in the USO in general and not on the communication of a specific percentage of equity stakes or type of involvement. Moreover, even small equity stakes of the parent university in the USO are seen as a significant tie for the development of USO (e.g., Bray and Lee, 2000).

Equity ownership, in general, describes the governance structure of a firm and level of influence that different stakeholders have on the strategic direction of the firm (Baysinger et al., 1991). Additionally, among new firms more generally, equity-based alliances are linked to greater market value creation because the tie created is likely to maintain partner firms' willingness to continue the commitment of resources (Li, 2013). In the context of our study, university equity ownership in USOs not only legitimizes universities' provision of resources to USOs (Bolzani et al., 2021) such as access to organizational services (e.g., mentoring and business advisory, business plan competition, technology opportunity search, support in recruiting external resources, science park and incubator) (Nosella and Grimaldi,

2009; Lubik et al., 2013) and extended networks (e.g., business angels, venture capitalists, agencies specialized in technology transfer) (Vohora et al., 2004; Lockett etal., 2003) but also reveals trust, greater information disclosure and bonding between USOs and their parent universities, all of which might help in reducing uncertainty surrounding any investment.

However, since explicit studies that investigate the relationship between university equity ownership and investors' propensity to invest in USOs do not exist, some authors suggest that the presence of a university in the ownership structure of a USO can provide outsiders with additional credibility and a valuable link to cutting edge science (Lubik et al. 2013). Bolzani et al. (2016) analyzed how, USOs market performance is affected by the linkages maintained over time with the parent university. That study uses data from 551 USOs established between 2000 and 2008 in Italy. The results show that equity-based university linkages increase USOs annual sales revenue and that geographical proximity strengthen this effect. Similarly, Gubitta et al. (2016) investigated the effect of public grant on USOs' ability to attract follow-on investment. Evidence from this study show that, awarded public grants serve as signal that distinguishes USOs that are most worth financing from those that are not.

In our model, universities would seek to take equity ownership in USOs only if it has positive expectations regarding USOs' future financial results. This is a strong form of quality signal because affiliation with low-quality USOs would result in financial or reputation damages. Also, because the assessment process is costly and time-consuming, only high-quality USO will reach this milestone as low-quality USOs will be required to work considerably harder in order to reach this phase. Moreover, false signaling is also mitigated by the limited information asymmetry between the USO and its parent university. From the above argument, we derive hypothesis 1.

Hypothesis 1

Parent universities' equity ownership in USOs is positively related to investors' propensity to invest in the firm.

4.2.4 The combined effect of equity ownership and parent universities' reputation

Because sustained competitive advantage can originate from USOs resource base (e.g., parent university knowledge asset) (Wernerfelt, 1984), the impact of university equity ownership in USOs may depend on the combined effects of factors which could provide certain competitive edge and ensure the growth and survival of USOs into the future amid the highly

competitive environment. Following Sine et al. (2003), we argue that the impact of university equity ownership on investors' propensity to invest in USOs is likely to be moderated by the reputation of the university.

Though university equity ownership in USOs establishes a formal relationship between USOs and their parent university, it does not guarantee that beneficial resources and commercialization success will occur. To produce a positive performance effect, such relation needs to be reinforced (Soda and Zaheer, 2012). The particular characteristics of knowledge assets at university level accessed by USOs may be insufficient to explain their attractiveness to external investors. It has been well documented that knowledge is indivisible, uncertain, often tacit and difficult to appropriate and transfer (e.g., Polanyi, 1962). As a result, university reputation has become more essential in the commercialization of knowledge (Podolny, 1993, Sine et al., 2003).

Reputation affects the evaluations that stakeholders make about organizations (Czinkota et al., 2014, Fombrun et al., 2000, Gotsi and Wilson, 2001) and may be positive, negative or neutral (Shenkar and Yuchtman-Yaar, 1997) depending on the layer in which organizations are positioned in the hierarchy of quality (Bonaccorsi and Daraio, 2007). Four factors influence the reputation of an organization - credibility, reliability, responsibility and trustworthiness – all of which interrelate with each other (Fomburn and Shanley, 1990). Previous studies have shown that favorable reputation has many benefits for universities. For instance, because high-reputation universities have superior ability to access information, by virtue of their structural positions, stakeholders tend to closely watch the choices of the former because of their perceived superiority in evaluating firms (Rao, 1998, Stuart, 2000). Because public funding is provided to universities on a competitive basis (Braun, 2003), high-reputation universities tend to receive more funding. For this reason, such universities may be able to sponsor top-class research, undertake research commercialization activities at the global level and reach a critical mass of human capital endowed with strong scientific and technical expertise, all of which are the main requisites for the development of cutting-edge technologies. Di Gregorio and Shane (2003) show that because the value of a scientific discovery, generally, is unknown even after the development process is completed, the expectations of investors on the future potential of USOs are tied to the university's reputation on prior research and inventions (Di Gregorio and Shane, 2003).

As discussed, university reputation is an invisible vital resource that could potentially enhance USOs quality and increase investors' propensity to invest in the firm. However, such benefits may be limited for USOs unless there is a formal relationship between USOs and their parent

universities, as in the case equity ownership. From the above argument, we derive the following hypothesis.

Hypothesis 2

A higher university reputation strengthens the positive effect of university equity ownership on investors' propensity to invest in USOs.

4.3 Research methodology

In line with Zunino et al. (2022), we employ experimental vignette methodology (EVM) (Aguinis and Bradley, 2014) and recruit participants from an online commercial crowdworking platform – www.prolific.co. EVM entails presenting to participants a carefully constructed and realistic scenarios to evaluate dependent variables including intentions, attitudes and behaviors, thereby optimizing experimental realism and enabling researchers to manipulate and control independent variables (e.g., Aiman-Smith et al., 2002; Graham and Cable, 2001; Ludwick and Zeller, 2001; Shepherd and Zacharakis, 1999; Wilks, 2004. Further, the random assignment of treatment, which is a characteristic of EVM, helps mitigate endogeneity concerns (Aral and Walker, 2014; Bapna, 2019).

Some studies document that a larger of management studies provide evidence concerning covariation between antecedent and outcome variables without answering important questions crucial for establishing causality (Aguinis and Vandenberg, 2014; Aguinis and Bradley, 2014). Owing to this, there have been several calls advocating on the need to implement research designs that improve our knowledge about causal relationship (e.g., Miller and Tsang, 2011; Shepherd, 2011; Uy et al., 2010). Our methodology allows us to include only factors relevant to our research questions while excluding those that might confound the results (Cavanaugh and Fritzsche, 1985).

4.3.1 The platform

Prolific.co is a recently established crowdworking platform (2014) for online subject recruitment and is primarily geared towards researchers and startups. Crowdworking emerged in the form of clickworking in the year 2000, when NASA was seeking to identify and categorize craters on Mars (Szpir, 2002). Because this task required no prior scientific knowledge, NASA turned to the general public for help. People volunteered and even though they were not compensated for their efforts, they laid the foundation for future crowdworking

(Jäger et al., 2019). Nowadays, the terms crowdworking and crowdsourcing are often used interchangeably in cases where a large group of people (crowd) commit to solving a problem, providing data or contributing to a common goal (Howe, 2006; Brabham, 2008; Doan et al., 2011). However, when crowd participants receive financial compensation for their commitment, this is referred to as crowdworking (Durward et al., 2016; Blohm et al., 2013). Several scholars have successfully used commercial crowdworking platforms as a subject pool in different areas including economics (e.g., Marreiros et al., 2017), psychology (e.g., Callan et al., 2017) and finance (e.g., Zunino et al., 2021). Prolific.co combines high recruitment criteria with reasonable cost, and provide fast, reliable and high-quality data collection by connecting diverse participants with researchers.

As of 2020, Prolific.co platform has been used by approximately 10,000 researchers from 1,500 institutions and has instant access to over 130,000 participants worldwide. In a recent study, Palan and Scitter (2018) analysed key features of Prolific.co in terms of its functionality and its usability. They show that in comparison with other crowdworking platform, prolific offers clear guidelines for the handling of submissions, and defines, ex-ante, a minimum fixed payment per unit of time required by participant in order to complete an experiment[5]. Researchers can also pre-screen participants based on pre-screening questions used in earlier studies or can propose their own questions. After searching for and testing several available crowdworking platforms, Peer et al. (2017) found that, though the response rate on Prolific.co was quite low, the rate of attention that participants pay to instructions and the reliability of their responses were quite high. Further, *Prolific.co* participants are more naïve – defined as their level of unfamiliarity with commonly used research materials (Chandler et al., 2015) – and offer a more diverse population in terms of geographical location, ethnicity, etc.

4.3.2 Experimental approach

We present the results of our two EVM studies. In study 1, we explore whether investors' propensity to invest differ between USOs and Non-USOs. In study 2, we focus our attention among USOs and investigate whether university equity ownership affect investors' propensity to invest, and under which conditions.

[5] At the time of writing, the minimum payment per hour was 6 GBP, with fractions of hours requiring proportionally smaller payments. An experiment taking 5 minutes would thus require a minimum payment of 0.50 GBP which, nevertheless, is considered as low and might reduce respondents' willingness to participate in the experiment.

4.4 Study 1

4.4.1 Experimental design

We designed a randomized, between-subjects experiment[6]. Participants were randomly assigned to one of two treatment and asked to evaluate an investment opportunity as equity investors. Each treatment included controlled manipulation of the origin of the firm (the presence/absence of university origin cue). The investment opportunity in our study was based on a real project sourced from a famous equity crowdfunding platform. The firm was seeking $200,000 for a total equity stake of 15%. For privacy purposes, information about the focal firm were slightly modified to fit our study. We purposely chose London as the place where the firm was founded because it is the world's second most innovative city[7] and third in the world for healthtech investment[8]. The investment proposal consisted of 3 sections: summary, frequently asked questions (FAQ) and "signals and news[9]". In the summary section, a brief description of the business, its location, the sector in which it operates and the name of the founders were presented. It also reported the amount of investment sorted and the total equity offered. In the second section, a "FAQ discussion wall" which provide information on frequent questions or concerns from the public. The signals and news session provided information concerning recent news and activities in which the firm was involved or mentioned. Our main experimental manipulation (university origin) was introduced in the first section. More specifically, university origin cue when present, refers to a firm that was founded based on a core technology that the founders developed and transferred from a UK-based university[10]. This is an observable and credible cue and it is also in line with what happens on most equity crowdfunding platform where firms advertise their affiliation with universities in their description of the firm. Table 4.1 show in detail our experimental design.

[6] In our between-subject experimental design, participants were randomly assigned to read one of six vignettes describing the firm.
[7] According to Startup Genome's Global Startup Ecosystem Report 2021, The Global Startup Ecosystem report ranks the leading 140 tech hubs around the world and calculated the value of London's startup ecosystem at more than $142 billion. Despite a turbulent year, the UK capital, along with the four other cities (Silicon Valley, New York, Beijing and Boston) maintained their positions at the top of the rankings.
[8] https://technation.io/uk-healthtech-hub/
[9] Platform label.
[10] This is in line with our definition of USOs (Fryges and Wright, 2014).

Table 4. 1 Overview of Treatment

	Cue reflecting university origin	
	MANIPULATION	
	Start-up has university origin: **Available**	Start-up has university origin: **Not available**
Influx	Influx is a London-based innovative start-up pioneering Artificial Intelligence (AI) in health and was founded in 2019 by two engineers, Philip Dest and Sara Madonna, based on a core technology that they developed and transferred from a UK-based university. Influx is at its early stages of its development and is currently working on a novel idea that will automate medical diagnosis, prognosis, and forecasts. Having developed a first prototype, Influx is currently preparing its technology for scaling across the UK. The firm is seeking financing to achieve its phase 2 milestone and advance its pipeline. Using any number indicated in the scales presented below (Where 1= strongly disagree and 7 = strongly agree), please indicate the number that best indicate your response: *Q1. I would like to find out more information about the start-up.?* *Q2. I would like to do further research into the industry and/or market of the start-up.* *Q3. I would like to meet with the founding team.* *Q4. I would like to find out more information about the founding team.* Using any number indicated in the scales presented below (Where 0 = no chances and 10 = 100% certain), please indicate the number that best indicate your response: *Q5. What are the chances that you would invest in the start-up?*	Influx is a London-based innovative start-up pioneering Artificial Intelligence (AI) in health and was founded in 2019 by two engineers: Philip Dest and Sara Madonna. Influx is at its early stages of its development and is currently working on a novel idea that will automate medical diagnosis, prognosis, and forecasts. Having developed a first prototype, Influx is currently preparing its technology for scaling across the UK. The firm is seeking financing to achieve its phase 2 milestone and advance its pipeline. Using any number indicated in the scales presented below (Where 1= strongly disagree and 7 = strongly agree), please indicate the number that best indicate your response: *Q1. I would like to find out more information about the start-up.?* *Q2. I would like to do further research into the industry and/or market of the start-up.* *Q3. I would like to meet with the founding team.* *Q4. I would like to find out more information about the founding team.* Using any number indicated in the scales presented below (Where 0 = no chances and 10 = 100% certain), please indicate the number that best indicate your response: *Q5. What are the chances that you would invest in the start-up?*

4.4.2. Constructs, internal, external and ecological validity

We performed several steps to establish the validity of our study. First, all scales used in our study are previously validated and drawn from past studies. Second, we asked participants to think, behave and respond as themselves (Hsu et al., 2017). We conducted a pre-test with experts in the field of entrepreneurial finance to examine our material and procedures and also

the extent to which the proposed manipulations align with the definition of theoretically relevant variations including checks on the face validity of the proposed manipulations (Grégoire et al., 2010; Wilson et al., 2010). Fourth, we also conducted pilot tests of the entire data collection procedures by reaching out – via email – to 142 scholars mainly in the field of entrepreneurship and management. Fifth, for sample representativeness, we prescreened potential participants for their investment experience ahead of time and included controls to show that participants are actual investors, or at least, approximate to them.

4.4.3 Experimental Procedure

As mentioned earlier, potential participants were initially pre-screened for their investment experience, gender and geographic location. The pre-screening question referred to "whether the participant had ever made investments, either personal or through his/her employment, in the common stock or shares of a firm". Our experiment targeted a balanced sample (male and female) and because the UK and the US have a high startup culture and their startup ecosystem is one of the top leading ecosystems (Mason and Harrison, 2002; Munari and Toschi, 2015; Samila and Sorenson, 2011), we selected our representative sample from these two countries. The experiment ran as follows. Recruited participants were first given brief guidelines on the technicalities and privacy issues involved. Apart from the formal controls included in our experiment, which we will later explain, participants were also given instruction that stated "as you are completing this exercise, please put yourself in the scenario by considering that you, as an investor, are actively looking for a new venture in which to invest. Please assume the following: this opportunity falls within your target industry and market, as well as your geographic area of interest" (Sohl, 2022). Next, participants were asked to complete an instructional manipulation check (IMC)[11] (Oppenheimer et al., 2009). Subsequent questions covered their prior investments, knowledge in technology, and sociodemographic profiles, which were used as control[12]. On the next page, each participant was presented with one of our two written vignette which consisted of a brief summary description about the firm followed by a "FAQ discussion wall" and news flashes in which the firm was featured. Afterwards, were asked a set of venture-related questions, that is a scale that measures their propensity to invest in a firm. The final page consisted of a manipulation check to confirm that participants had

[11] A tool for detecting participants who are not following instructions.
[12] Information collected include participants' level of education, entrepreneurial experience, type of investor, homeownership, technology knowledge, investment frequency, risk propensity, Age and gender.

seen and understood the treatment as well as two attention checks (Chandler et al., 2014) to assess participants level of attentiveness. Upon completion of the survey, participants were presented with a closing window informing them about the objective of the study and directed to a landing page where a completion code was automatically recorded. In addition to those who did not complete the task, we also excluded from our final sample participants who failed either one of our checks (IMC, manipulation check and attention checks).

4.4.4 Variables

Dependent variable: *Propensity to invest*. Equity investors assess new venture proposals in a multistage evaluation process (Gompers et al. 2020; Tyebjee and Bruno, 1984). Fried and Hisrich (1994) show that investors' decision making typically follows a first-phase and second-phase evaluation, with the former concerning the screening of proposals to meet investors' preferences such as the quality of the founding team and business feasibility while the latter pertains to financial requirements and other aspects of the business. Following this view, we borrow from the study of Clarke et al. (2019) to construct our dependent variable. First, to mirror the first-phase of investors' decision-making process, we used a 4-items Likert scale to measure investment intentions. Based on the investment proposal presented to them, participants were asked to indicate whether (i) they would like to find out more information about the firm (ii) they would do further research into the industry and/or market of the firm (iii) they would like to meet with the founding team and (iv) they would like to find out more information about the founding team. All four items ranged from "1 = strongly disagree" to "7 = strongly agree. Responses to these items were averaged to form a single score of investment intentions (sample 1, α = .90, sample 2, α= .89). Second, to mirror the second-phase of investors' decision-making process, we also included a more nuanced indicator that provides a good indication of the extent to which participants are likely to invest in the firm. This implied asking participants to indicate (iv) how likely they would be to invest in the startup, using an 11-point scale anchored at 0 (% chances) and 10 (100% certain). Our four item intentions measure and single-item investment likelihood measure were significantly correlated (sample 1, $r = .59$, $p<.001$; sample 2, $r = .62$, $p<.001$) and combining the five items yielded a reliable single scale (sample 1, α = .86; sample 2, α = .85). Third, we further conducted a PCA on sample 1 and 2 to ensure that the two measures (intentions measure and investment likelihood) were tapping into a common underlying latent construct. The results indicated that all five items loaded significantly on a single component (sample 1 loadings > .70) with an eigenvalue

of 3.49 and explained 70% of the variance. Finally, we standardized the measures of investment intentions and investment likelihood and then combined them into a single summative indicator, which we termed "*propensity to invest".*

Treatment variables: The treatment variables are binary indicating (i) the origin of the firm (ii) university ownership and (iii) and university reputation. The variable *university origin* is equal to 1 if participant was presented with a treatment indicating a USO[13], otherwise 0. The variable O*wnership* is equal to one if the participant was presented with a treatment indicating university equity ownership in the USO and 0 otherwise. Finally, the variable *Reputation* is equal to one if the participant was presented with a treatment indicating high university reputation and 0 otherwise. This cue was measured using the Times Higher Education's "World University Reputation Rankings 2021".

Control variables. We included several individual characteristics which have been shown to explain variation in investors' propensity to invest. External equity investors tend to favour founding teams that are similar to themselves in types of training and professional experience (Franke et al., 2006), hence we control for participants' level of Education measured as their highest level of education (0 = No education; 1 = High school; 2 = undergraduate; 3 = graduate; 4 = doctorate). According to Warnick et al. (2018), investors' decision-making is affected by their investment and entrepreneurial experience. In fact, they show that investors in former category place greater emphasis on the combination of product passion and openness to feedback while those in the latter rely on the combination of entrepreneurial passion and openness to feedback. Accordingly, we control for participants' *Investment Frequency* – "I often invest in technology start-ups" – measured with a 7-point scale that ranges from "1 = strongly disagree" to "7 = strongly agree" and *Entrepreneurial Experience* measured as a dummy that takes 1 if participant has ever founded a start-up, 0 otherwise. We are aware that distinct investors may use different approaches to evaluate the potential risks concerning their investments in new firms (Van Osnabrugge, 2000), thus, we control for investor type measured as a dummy equal to 1 if the participant is VC, otherwise 0. In addition, because investors vary in their experience with the presented technology (Sohl, 2022), which could potentially lead to unexplained heterogeneity among participants, we thus control for *Technology Knowledge* – "I have knowledge on technology start-ups" – using a 7-point likert scale that ranges from "1

[13] We refer to USOs as firms created to commercialize knowledge and technologies generated at a university and/or that the firm's team of founders comprises members from a university (Fryges and Wright, 2014).

= strongly disagree" to "7 = strongly disagree". *Homeowenship* (measured as a dummy equal to 1 if participant owns a house) *a*ccounts for participant's wealth.

Since perceptions about certain investment proposals may differ across investors in their evaluation (Sohl, 2022), we also controlled for the perceived riskiness of the investment opportunity. *Risk Aversion* – "Investing in a technology start-up is very risky" – is measured using a 7-point Likert scale ranging from "1 = strongly disagree" to "7 = strongly disagree". Finally, we control for other participants' individual differences that might have an impact such as being *Male* (measured as a dummy which is equal to 1 if participant is a male) and Age.

4.4.5 Participants

Participants were offered monetary compensation matching the remuneration for comparable tasks. In study 1, we recruited in total 204 participants, of which 113 were in the treatment group and the remaining 91 represent the control group that did not receive the treatment. Rejected submissions for the treatment group was 1 and 2 for the control group. Approximately 13% and 6% in the control group failed the manipulation and attention checks, respectively. All participants in this group passed the IMC test. Concerning the treatment group, 16% and 3% failed the manipulation and attention checks respectively, while 2% failed the IMC test. Overall, our final sample consisted of 165 respondents

4.4.6 Descriptive results

In table 4.2, we report the descriptive statistics for study 1. The first row describes our dependent variable. On average, participants had at least an undergraduate degree and 27% had entrepreneurial experience. The proportion of venture capitalists account for 26% and 74% owns their own house. Participants' average score on technological knowledge is 3.5 out of 7. They scored approximately 3 out for 7 on frequency of investment and their average risk profile was 5.3 out of 7. Participants were on average 45 years old and the proportion of male respondents were approximately half of the sample (47%). Table 4.3 presents participants characteristics by condition.

Table 4. 2 Descriptive Statistics of Study 1

Variable	Obs	Mean	Std. Dev.	Min	Max
Propensity to Invest[14]	165	0.09	1.77	-4.93	3.493
Education	165	2.00	0.91	0	4
Entrepreneurial experience	165	0.27	0.45	0	1
VC	165	0.26	0.44	0	1
Owns Home	165	0.74	0.44	0	1
Technology knowledge	165	3.50	1.60	1	7
Investment frequency	165	2.67	1.45	1	7
Risk aversion	165	5.25	1.19	2	7
Age	165	45.04	13.72	19	76
Male	165	0.47	0.5	0	1

Table 4. 3 Descriptive Statistics of Study 1 by Condition

Respondents	No university origin cue (n = 73)	University origin cue (n = 92)	t-test	p-value
Education	2.16	1.88	2.0001	0.0471
Entrepreneurial experience	.34	.21	1.7984	0.0740
VC	.23	.27	-0.5663	0.5720
Owns Home	.69	.77	-1.0597	0.2908
Technology knowledge	3.42	3.55	-0.5163	0.6063
Investment Frequency	2.53	2.77	-1.0424	0.2988
Risk aversion	5.26	5.24	0.1134	0.9099
Age	42.87	46.75	-1.8143	0.0715
Male	.38	.53	-1.9157	0.0572

Note: Two-sample t-test show no significant differences across conditions for Male, Age, Risk aversion, Owns Home, Technology knowledge, Investment frequency, VC, and Entrepreneurial experience, except for Education.

4.4.7 Main results

The correlations for all variables and their Variance Inflation Factor (VIF) are presented in Table 4.4. We checked VIF to test the presence of multicollinearity. VIF values for all variables in our model range from 1.09 to 2.16 with a mean value at 1.36. These values are well below the thresholds established in the literature, indicating no multicollinearity concerns (Hair et al., 2010; McDonald and Moffitt, 1980). We employed an OLS regression method to test whether firm origin influence investors' propensity to invest in the firm.

[14] Standardized

Moreover, this method has been used in several experimental studies in the field of entrepreneurship (Zunino et al., 2021; Zaggl and Block, 2019; Nagel et al., 2019; Lazar et al., 2022). Table 4.5 shows the result of the empirical analysis. The base model (model 1) only includes the impact of the control variables on investors' propensity to invest. No variable in model 1 is statistically significant. In model 2, we included the *university origin* variable. The R^2 moving from 0.14 (model 1) to 0.15 (model 2), indicate a satisfactory level of explanation of the performance of *university origin* variable. We found no statistical difference as to whether investors' propensity to invest differ between USOs and non-USOs.

Table 4. 4 Pairwise correlations and multicollinearity diagnosis

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	**VIF**
(1) Propensity to invest[15]	1.000											
(2) University origin	0.080	1.000										1.09
(3) Education	0.134	-0.155*	1.000									1.16
(4) Entrepreneurial experience	0.028	-0.139	0.160*	1.000								1.17
(5) VC	0.096	0.044	-0.065	0.017	1.000							1.13
(6) Owns Home	0.050	0.083	-0.042	-0.163*	-0.097	1.000						1.14
(7) Technology knowledge	0.299*	0.040	0.182*	0.210*	-0.095	-0.083	1.000					2.16
(8) Investment frequency	0.324*	0.081	0.162*	0.131	0.058	-0.051	0.665*	1.000				1.89
(9) Risk aversion	0.022	-0.009	0.032	0.021	-0.052	0.031	0.102	-0.005	1.000			1.11
(10) Age	-0.111	0.141	-0.252*	0.038	-0.210*	0.292*	-0.195*	-0.185*	0.090	1.000		1.37
(11) Male	0.131	0.148	-0.073	-0.055	0.039	-0.026	0.364*	0.291*	0.276*	0.061	1.000	1.35
** p<0.05 represent values equal to or less than .05*										**Mean VIF**		**1.36**

[15] Standardized

Table 4. 5 OLS regressions – Study 1

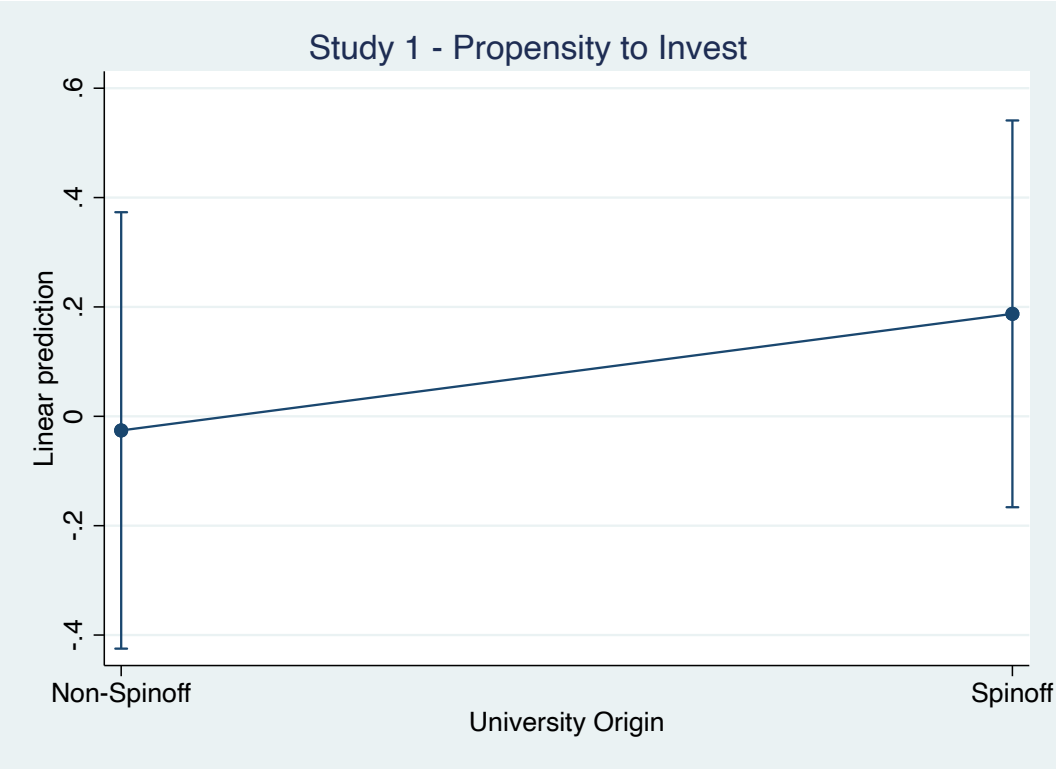
	Dependent variable: Investor propensity to invest	
Variable	(1)	(2)
Education	0.159	0.171
	(0.154)	(0.155)
Entrepreneurial experience	-0.124	-0.091
	(0.316)	(0.319)
VC	0.443	0.427
	(0.319)	(0.320)
Owns	0.361	0.354
	(0.319)	(0.319)
Technology knowledge	0.188	0.185
	(0.120)	(0.121)
Investment frequency	0.232*	0.225*
	(0.124)	(0.124)
Risk aversion	0.006	0.010
	(0.117)	(0.117)
Age	-0.003	-0.004
	(0.011)	(0.011)
Male	0.060	0.039
	(0.304)	(0.306)
University origin		0.213
		(0.276)
Constant	-1.762*	-1.839**
	(0.921)	(0.927)
Observations	165	165
R-squared	0.143	0.146

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

For better comparison between USOs and non-USOs, we show in figure 1 the predicted margins of university origin with 95% Confident intervals. Though university origin is not

statistically significant, it is positive, and it seems that USOs are more attractive to investors than other type of firms in the same development stage.

Figure 4. 1 Predicted margins of university origin with 95% CIs



4.4.8 Discussion

Study 1 confirms what we initial suspected, in that the question on whether investors' propensity to invest differ between USOs and non-USOs may not be as straightforward as previously suggested by the literature. The results of this study suggest that investors' propensity to invest in USOs might be influenced by a set of determinants that differ from those of non-USOs. On the basis of this result, we conducted a second study to further investigate our conceptual framework by taking into account the parent university's equity ownership in the USO and its reputation.

4.5 Study 2

As reported in study 1, our findings reveal that originating from a university per se does not improve investors propensity to invest in a particular firm. However, it may be the case that cross-university variation in terms of the level of involvement in USOs (Ferretti et al., 2019;

Di Gregorio and Shane, 2003) and the credibility of the parent university (Colombo et al., 2019) are likely to lead to different outcomes. Moreover, the likelihood to attract investment in USOs depends of the firm's ability to deliver signals of value, commitment and trust capable of winning external equity financing (Fu, 2022). We seek to disentangle these effects to understand the relative influence they provide to investors' propensity to invest in USOs. In study 2, we introduced, as baseline manipulations, the "university equity ownership cue" – which is the most common arrangement to formalize the relationship between USOs and their parent universities (Feldman et al., 2002; Geuna and Rossi, 2011; Bolzani et al., 2021) and "university reputation cue" which relates to the academic image of the university (Bonaccorsi et al., 2013; Lee and Stuen, 2016). We used the presence of "university equity stakes (without specifying the percentage)" in the USO as credible cue for university ownership and The Times Higher Education "World University Reputation Ranking 2021" as credible cue for university reputation. Study 2 differ from study 1 in that it examines the direct effect of university ownership and the moderating effect of university reputation on the relationship between university ownership and investors' propensity to invest in USOs.

4.5.1 Experimental design and procedure

The experimental procedure of study 2 follows that of study 1 but differs in design. it followed a 2 x 2 factorial randomized, between-subjects design. Each participant received one of four treatment which consisted of controlled manipulation concerning (i) university reputation (high vs. low) and (ii) university equity ownership (present vs. absent). The experiment included two attention checks and two manipulation checks referring to university origin and university reputation, respectively. Because explicitly communicating information about the type of ownership affects perceptions of attractiveness to a firm (Turban et al., 2001), the cue representing university equity ownership was present in the "FAQ discussion wall", which is usually self-reported. University reputation cue was reported in the session "signals and news". Existing studies have suggested that third parties can act as information intermediaries (infomediaries) to convey and assess the information available about a firm and its products (Zuckerman, 1999). Moreover, endorsements from third parties inform the public about the viability of a project and impact the likelihood of the project in attracting external capital (Courtney et al., 2017).

3.5.2 Descriptive results

Participants recruited on the prolific crowdworking platform were pre-screened based on their investment experience and geographical location (The UK and the US). We initially recruited 456 participants, of which 5% failed to complete the task. We also excluded 28% and 42% of participants who failed attention and manipulation checks (university origin), respectively. In addition, the percentage of participants who failed the IMC test account for 2%. Concerning the manipulation check on university reputation, we measured the mean score (a scale from 1 to 7) for each treatment to ensure that participants had seen and understood the treatment. On average, participants who received the treatment on high university reputation scored higher (5.65 and 6.03) than those that received treatment on low university reputation (3.68 and 3.97). Our final sample include 182 participants. Table 4.6 report reports the descriptive statistics for study 2. The first row describes our dependent variable. On average, participants are undergraduate degree holders and 33% have prior entrepreneurial experience. 23% of participants define themselves as venture capitalists and approximately 75% own a house. On a scale from 1 to 7, participants score, on average, 3.6 on technology knowledge, 2.7 on investment frequency and 5.1 on risk propensity. The average age for participant was 45.6 years and the proportion of male participants was approximately 45%. Table 4.7 show participants characteristics per condition.

Table 4. 6 Descriptive Statistics of Study 2

Variable	Obs	Mean	Std. Dev.	Min	Max
Propensity to Invest[16]	182	0.098	1.739	-4.803	3.11
Education	182	2.115	0.843	0	4
Entrepreneurial experience	182	0.33	0.471	0	1
VC	182	0.236	0.426	0	1
Owns Home	182	0.758	0.429	0	1
Technology knowledge	182	3.588	1.666	1	7
Investment frequency	182	2.747	1.538	1	7
Risk aversion	182	5.077	1.144	2	7
Age	182	45.637	13.771	21	80
Male	182	0.451	0.499	0	1

[16] Standardized

Table 4. 7 Descriptive Statistics of Study 2 by condition

	Spinoff characteristics					
Respondents	High university reputation No university equity ownership cue (n = 54)	High university reputation University equity ownership cue (n = 37)	Low university reputation No university equity ownership cue (Not available) (n = 51)	Low university reputation University equity ownership cue (n = 40)	F-test	Prob > F
Education	2.11	1.91	2.17	2.22	0.99	0.4010
Male	0.40	0.56	0.49	0.35	1.47	0.2234
Age	45.94	46.13	45.45	45	0.06	0.9826
Risk aversion	5.27	4.97	5.01	4.97	0.80	0.4940
Owns Home	0.79	0.67	0.75	0.78	0.66	0.5768
Technology knowledge	3.46	3.64	3.68	3.57	0.18	0.9130
Investment frequency	2.68	2.62	2.92	2.72	0.33	0.8045
VC	0.24	0.29	0.21	0.20	0.39	0.7621
Entrepreneurial experience	0.29	0.29	0.35	0.37	0.31	0.8185

Note: One-way anova test show no significant differences across conditions for Education, Male, Age, Risk aversion, Owns home, technology knowledge, Investment frequency, VC and entrepreneurial experience

4.5.3 Main results

The correlations for all variables and their Variance Inflation Factor (VIF) are presented in Table 4.8. We checked VIF to test the presence of multicollinearity resulting from interaction terms. VIF values for all variables in our model range from 1.02 to 2.09 with a mean value at 1.33. Again, these values are well below the thresholds established in the literature, indicating no multicollinearity concerns. We then ran OLS regressions in which our dependent variable is investors propensity to invest.

Table 4.9 shows the result of testing our first and second hypothesis. The base model (model 1) only includes the impact of the control variables on investors' propensity to invest. Entrepreneurial experience and investment frequency have a strong and significant influence on investors' propensity to invest. It seems that, USOs become more attractive for investors with significant investment experience and those with prior entrepreneurial experience. In model 2, we included the *ownership* variable, which is our independent variable. The R^2 moving from 0.20 (model 1) to 0.23, indicate a satisfactory level of explanation of the performance of ownership variable. In hypothesis 1, we predicted a positive and a statistically significant relationship between university equity ownership and investors' propensity to invest. The hypothesis was strongly supported ($\beta = 0.532$, $p < 0.05$). In model 3, we included the interaction term of ownership and reputation. The R^2 moving from 0.23 (model 2) to 0.26 (model 3), again, indicate a satisfactory level of explanation. In hypothesis 2, we predicted that university reputation positively moderates the relationship between university ownership and investors' propensity to invest in USOs. This hypothesis was strongly supported ($\beta = 1.100$, $p < 0.01$).

To make the result more easily interpretable, in figure 4.2, we plotted the predicted values of university equity ownership on investors' propensity to invest for two levels of university reputation (higher or lower reputation). Results show that as university ownership changes (from no equity stakes to having equity stakes in USOs), its effect on investors' propensity to invest in USOs gets stronger for those universities with higher reputation.

Table 4. 8 Correlation matrix

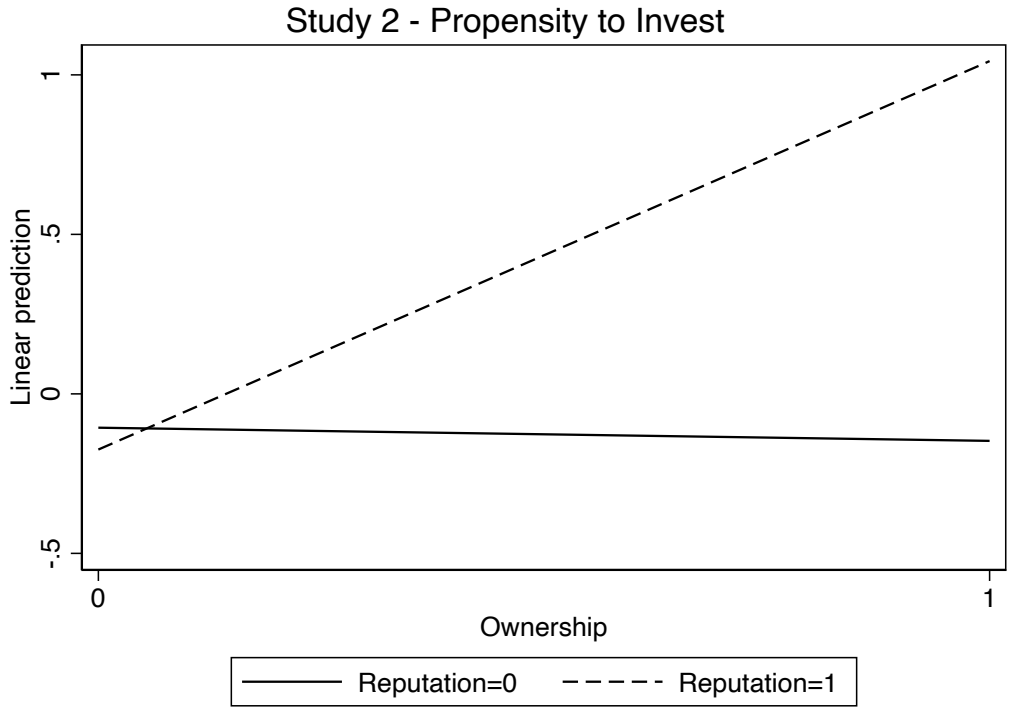
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	VIF
(1) Propensity to Invest[17]	1.000												
(2) Ownership	0.165*	1.000											1.02
(3) Reputation	0.088	-0.033	1.000										1.03
(4) Education	0.032	-0.038	-0.098	1.000									1.06
(5) Entrepreneurial experience	0.118	0.015	-0.070	0.043	1.000								1.24
(6) VC	0.103	0.021	0.065	-0.030	-0.087	1.000							1.11
(7) Owns Home	-0.152*	-0.088	-0.026	-0.075	-0.068	-0.109	1.000						1.12
(8) Technology Knowledge	0.361*	0.012	-0.030	0.132	0.090	0.193*	-0.086	1.000					2.09
(9) Investment Frequency	0.401*	-0.040	-0.057	0.065	-0.006	0.193*	-0.018	0.684*	1.000				2.01
(10) Risk aversion	-0.087	-0.077	0.067	0.077	-0.088	-0.037	0.061	0.118	0.090	1.000			1.21
(11) Age	-0.200*	-0.006	0.028	-0.100	0.322*	-0.133	0.224*	-0.227*	-0.285*	0.122	1.000		1.44
(12) Male	0.011	0.007	0.044	0.060	-0.024	0.120	0.124	0.178*	0.048	0.355*	0.186*	1.000	1.28
*** p<0.01, ** p<0.05, * p<0.1													
Mean VIF													**1.33**

[17] Standardized

Table 4. 9 OLS regressions - Study 2

VARIABLES	(1) PROPENSITY	(2) PROPENSITY	(3) PROPENSITY	(4) PROPENSITY
Education	-0.072	-0.063	-0.032	0.002
	(0.146)	(0.145)	(0.144)	(0.145)
Entrepreneurial experience	0.597**	0.546*	0.666**	0.590**
	(0.283)	(0.281)	(0.278)	(0.281)
VC	0.060	0.010	-0.003	-0.053
	(0.296)	(0.294)	(0.291)	(0.293)
Owns Home	-0.523*	-0.446	-0.463	-0.356
	(0.295)	(0.294)	(0.290)	(0.294)
Technology knowledge	0.080	0.086	0.081	0.088
	(0.104)	(0.103)	(0.102)	(0.103)
Investment frequency	0.334***	0.358***	0.337***	0.359***
	(0.111)	(0.110)	(0.108)	(0.110)
Risk aversion	-0.212*	-0.161	-0.231**	-0.159
	(0.115)	(0.115)	(0.113)	(0.115)
Age	-0.006	-0.009	-0.008	-0.010
	(0.010)	(0.010)	(0.010)	(0.010)
Sex	0.294	0.228	0.306	0.127
	(0.272)	(0.270)	(0.267)	(0.274)
Ownership		0.532**		0.016
		(0.243)		(0.340)
Reputation			0.532**	0.061
			(0.239)	(0.316)
Ownership * Reputation				1.029**
				(0.492)
ω2		0.025	0.014	0.086
Constant	0.574	0.079	0.343	-0.072
	(0.818)	(0.830)	(0.810)	(0.836)
Observations	182	182	182	182
R-squared	0.197	0.225	0.222	0.254

Figure 4. 2 The impact of university equity ownership and reputation



4.5.4 Discussion

In study 2, we examined two factors that might impact investors' propensity to invest in USOs. From signaling theory, we tested two hypotheses. First, we hypothesized that a university's equity stake in an USO is a positive signal for investors. Second, we hypothesized that the university's reputation positively moderates the relationship between university equity ownership and investors' propensity to invest. The data show strong support for hypothesis 1 and 2. Taken together, these results allow for a more comprehensive and informative study that helps clarify the mechanisms through which signals ultimately influence outcomes. Particularly, we demonstrate that university equity ownership is a positive signal of quality for potential investors and that the reputation of the university positively moderates the association between university equity ownership and investors' propensity to invest in USOs.

4.6 Discussion and Conclusion

In this paper, we investigated investors' propensity to invest in USOs. Prior literature (Lockett et al., 2002; Murray and Lott,1995; Munari and Toschi, 2011) offers contrasting arguments on how the university origin uniquely affects external equity investors' propensity to fund USOs Accordingly, we studied whether and under which circumstances university origin hampers or contributes to the investor's propensity to invest in USOs. In particular, we studied whether investors are more propense to invest in USOs vìs-à-vìs otherwise founded innovative new ventures. Additionally, we unpacked university origin – propensity to invest relationship, by exploring how university's equity ownership in the USOs combined with university reputation ownership affects investors' propensity to invest in some rather than other USOs.

To do so, we conducted two experimental studies. Our first study showed that investors' propensity to invest in USOs vs. non-USOs does not significantly differ. This suggests that the status of USO, taken in isolation, is not sufficient to make innovative new venture more or less appealing to investors, ceteris paribus. The second study, thus, unpacks university origin and studies in which circumstances it contributes to propensity to invest in USOs. The results suggest that investors are more propense to invest in USOs if the university has equity ownership in the company, but only when that the parent university has a good scientific reputation.

Our study contributes offers two main contributions to the literature. First, we add to the academic entrepreneurship literature (Soetanto, D., & Van Geenhuizen, M. 2015; Gubitta et al., 2016; Huyn, 2016), by exploring how university origin uniquely affects the development of USOs (Mathisen and Rasmussen, 2019). Evidence from recent studies has shown that university-level factors are attractive to investors. Our study complements other research investigating the drivers of external equity financing in the context of academic venture (Agyare et al., 2022). In particular, we unpack the features of the parent university – USO relationship that could affect external investors' propensity to invest in USOs. While prior literature showed that university affiliation and scientific reputation represent some important assets for USOs (Bonardo et al., 2011; Colombo et al., 2019), our findings further show that they could help alleviating information asymmetries faced by early-stage equity investors interested in these firms.

Second, our work adds more in general to entrepreneurial finance literature showing whether and under which circumstances the firm origin could act as a positive signal for investors, thereby extending a recent stream of research (Colombo et al., 2019) taking advantage of experimental methods, which are particularly suitable to isolate the drivers of investors' perceptions and judgment (Bernstein et al., 2017; Hoenig et al., 2015; Zunino et al., 2021). Specifically, our

results show that university origin per se might not be sufficient to alleviate information asymmetries. In contrast, to increase investors' propensity to invest in USOs, the university origin needs to take some specific configuration, combining equity ownership and excellent reputation.

Our study has boundary conditions that open opportunities for future work. First, we focus on investors' propensity to invest in USOs. We know that investors preferences are important during the first-phase of an investment proposal (Fried and Hisrich ,1994). However, investors assess new venture proposals in a multistage evaluation process (Gompers et al. 2020; Tyebjee and Bruno, 1984) where aspects concerning the financial requirements and other aspects of the business may also be critical. Future research can explore whether investors propensity to invest in USOs changes in the second-phase of venture evaluation while considering these aspects. To accomplish this aim, we recommend longitudinal studies. Second, while our study focuses on university level factors and their influence on investors' propensity to invest leaving fixed team characteristics. However, since founders in the early stages make the fundamental decision in USOs, future works can explore the effect of founders' growth intentions on investors' propensity to invest in USOs. In particular, it would be intriguing to look at how university-level factors interact with team-level variables.

Our results have implications for investors, entrepreneurs and universities. Investors learn that how their propensity to invest might be influenced by some specific features of the university origin. Based on our findings, we suggest investors to ask more information about the relationship USO have with their parent university, as this could help accelerating the screening process. Academic entrepreneurs learn from our results the value of being originated and participated from a prestigious university. Our findings suggest to academic entrepreneurs to search the participation of the parent university, if it is prestigious. Conversely, in case of less prestigious universities, academic entrepreneurs could allocate elsewhere their efforts. We also recommend to "surrogate entrepreneurs" to look for involvement in USOs owned by prestigious universities. Finally, our findings could inform the policies adopted by universities and technology transfer offices in managing the governance of USOs. The study suggests that, by investing in its USOs, prestigious universities send an important positive signal to external investors. In contrast, less prestigious universities should be aware that they are less likely to be in the position of sending positive signals.

5. DIFFERENT GROWTH ASPIRATIONS BUT SAME OUTCOMES? HOW FOUNDER EXPERIENCE CAN ENHANCE THE AMOUNT OF FIRST EQUITY FINANCING OF UNIVERSITY SPINOFFS.

Acknowledgement: This chapter is derived from the working paper 'Agyare, D., & Minola, T. (2022). Different growth aspirations but same outcomes? how founder experience can enhance the amount of first equity financing of university spinoffs.

For this paper, I am very grateful for the advice and insights received from my supervisor. I am also grateful for the precious advice received from members of the CYFE research group. I would also like to thank Thomas, a colleague I met in Belgium during my visiting period for his friendly review.

5.1 Introduction

Several studies have established the role of innovation as a significant engine of economic growth (Cooke and Leydesdorff, 2006; Autio et al., 2014; Audretsch et al., 2006; Baumol and Strom, 2007). Innovation occupies a central position in the agenda of policymakers, as it is one of the important ways for national governments to build a strong knowledge-based economy and stimulate employment growth in the European region (European commission, 2000, 2005). In this context, a considerable attention has been placed on university spinoffs (hereafter USOs), which are ventures that encapsulate a core technology or key scientific knowledge generated at a university with founding team comprising of researchers that left the parent university (Fryges and Wright, 2014). USOs can be, thus, considered as effective vehicles for creating and capturing value from scientific inventions (Nilsson et al., 2010; O'Shea et al., 2005; Boh et al., 2016).

Despite the growing importance of USOs, particularly in regional economic development (Vincett, 2010; Colombelli et al., 2020), it is recognized that obtaining early-stage equity – defined as the initial external financing provided before there is a real product or company organized (NVCA, 2004) – is a major challenge for these firms (Lindstrom and Olofsson 2001; Widding et al., 2009). Research has indicated that the lack of commercial skills of USOs' founders, the presence of heightened uncertainty surrounding the novel technologies being commercialized, the asymmetric information that exist between founders and potential investors and the lack of collateral might be major impediment of USOs to access early-stage equity financing (Baldock 2015; Carpenter and Petersen 2002; Lehner et al., 2015). Consequently, over the recent years, researchers have devoted significant efforts to improve our understanding of how USOs' could increase their chances of raising early-stage equity financing, by particularly focusing on founders' human and social capital as a proxy of their *ability* to raise seed funds.

However, this perspective alone might not be sufficient. Since founders, in the early stages, make the fundamental decision in USOs, and borrowing from family firms distinctiveness perspective (De Massis et al., 2014), we claim that also a *willingness* perspective is needed, so that the process of USOs' growth, through the acquisition of early-stage equity financing, may be the result of a combination of founders' ability and willingness to grow. In fact, for example, the study of Riding et al. (2012), which included one particular dimension of growth intention such as control, found that among other factors, firms' demand for early-stage equity financing varies according to the firm's growth intention and firm type. Hence, we claim that the combination of behavioral aspects (like growth intention) and resource-based aspects (like human capital), may better explain USOs' early-

stage equity financing and that entrepreneurs could indeed use these such elements as a channel to communicate the growth potential of their USOs to external investors. Borrowing from family firms is particularly motivated since USOs – like family firms – are socially embedded and highly driven by behavioral and non-economic drivers. While this research direction might be promising, it is yet rather unexplored.

To address such gap, in this paper we explore the impact of USO founders' *growth intentions* on early-stage equity financing and discuss whether this relationship is contingent to founders 'managerial and industry experience, as a proxy of human capital. In doing so, we refer to the concept of growth intentions, as desired organizational outcomes that can be used to guide action, predict firm behavior and appraise firm performance, yet distinct from measurable targets (Mohr, 1973; March and Simon, 1958, Kotler et al., 2018). early-stage equity financing Our independent variables consist of three growth intentions: (i) economic growth intentions, (ii) employment growth intentions, (iii) academic growth intentions. Our dependent variable is amount of early-stage equity financing raised within five years from the establishment of the USO. Our moderating variables are industry and managerial experience.

We explore our research question in a sample of 35 Italian USOs established in 2014. Our findings show that the amount of early-stage equity financing raised is linked to the combination of USO founders' ability and willingness to grow. In particular, the result from this study suggests that founders' economic growth intentions and those with employment growth intentions should, respectively, be combined with substantial managerial experience and industry experience to raise equity from external investors.It has been widely recognized that extant literature has mainly focused on the criteria used to evaluate investment projects, rather than the process by which they are evaluated (Maxwell et al., 2011; Rasmussen and Sorheim, 2012). The study of Brush et al (2012) even show that the importance of different investment criteria varies at different stages of the evaluation process but more importantly, Politis et al. (2012) found that the mindset of different founders' of USOs influences the financing process. Pounding on the inconsistencies in existing research, Rasmussen and Sorheim (2012) call for more research that looks into the financial performance of new ventures and suggest founders' goals, motivation and intentions as the way forward. In bringing into the discussion the willingness dimension and linking it to the current theoretical perspective on human capital, we contribute to the academic entrepreneurship literature (Huyn, 2016; Mathisen and Rasmussen 2019) by providing insights into how founders' growth intentions might be the missing element that can help us fully understand USOs' early-stage equity financing.

5.2 Conceptual development

USOs can be considered as effective vehicles for creating and capturing value from scientific inventions (Thomas et al., 2022). The literature has placed considerable attention on these types of firms because of their ability to generate radical innovation (Delgado-Verde et al., 2016) while their knowledge spillover activities positively affect industrial dynamics (Block et al., 2017), resulting in the development of new markets and increased competition within the market space (Etzkowitz and Leydesdorff, 1998; Decket et al., 2014). USOs are also one of the key drivers of economic change and growth (Bercovitz and Feldman, 2006). Compared to independent start-ups, USOs typically outperform in terms of employment growth (e.g., Czarnitzki et al., 2014; Wennberg et al., 2011), likelihood of survival (e.g., Criaco et al., 2014) and revenue growth rate (e.g., Zahra et al., 2007). This is because USOs often exploit radical technologies that cannot be easily imitated and enjoy unique advantages deriving from their closer ties with parent universities (Fryges et al., 2014; Lejpras, 2014; Agarwal et al., 2004; Colombo and Piva, 2012).

Despite their innovative drive, it is noted that USOs face a *chicken-egg-problem* in the early stages, thus, they require substantial capital to finance their early stage tasks of market evaluation, product development and market entry (Honjo and Nagaoka, 2018; Sørheim et al., 2011). However, several structural problems including longer time horizon in developing a viable product, substantial information asymmetries between USOs and capital providers (He and Wang, 2009), lack of tangible assets (Hsu, 2007, Montresor and Vezzani, 2016) and founders' deficit in commercial skills (Shane, 2003) may constraint investment decisions in USOs and impede their access to early-stage equity financing. Early-stage equity funding is deemed a critical juncture for early ventures (Vohora et al., 2004), for several reasons. First, Early-stage equity financing received indicate a key performance milestone for USOs because it may influence the range of choices to be considered by the entrepreneurs and shape firm strategies. It may increase the chances of survival in the short term, as it may enhance cash flow problems. Early-stage equity financing may also provide other important benefits, for example by offering more freedom to invest in the best managers that are well connected and trusted, gaining first mover advantage over competitors and may even alleviate the "liabilities of newness and smallness" that these ventures face. Because founders have profound influences on ventures – including their initial strategies and subsequent growth (Boeker, 1988) – at the early stages of development (Aldrich and Ruef, 2006), it follows that their human capital (i.e., founders' characteristics and knowledge) can influence investment decisions (Colombo and Grill, 2010) and USOs' growth (Shane and Stuart, 2002). Previous studies show a positive relationship between founders' human capital and USOs early-stage equity financing. For example, Gimmon and Levie (2010) examined the extent to which human capital of founders of high-tech ventures attract external

investors. This study used survey data consisting of 193 founders of 643 high-tech ventures. Interestingly, they found that the academic status of the founders and previous managerial experience positively affects funds received from external investors. Huyn (2016) investigated the role of founders' human capital – measured by industrial, managerial and entrepreneurial experience – on USOs early-stage equity financing of USOs. This study found a positive effect of founders' human capital on propensity to receive early-stage equity financing. On the other hand, other studies have also found opposite results.

However, results from other studies show that this association seem to be rather negative. For example, Cassar (2004) show that external investors do not consider the education and experience of founders in their financing decisions. A similar result is also reported by Colombo and Grilli (2010) and Gubitta et al. (2016). This suggest that human capital, as a proxy of ability, might not be enough. For instance, a founder may have the abilities to grow the firm but may still lack growth intentions. Alternatively, a founder may have growth intentions but may still not have reconfigured his/her abilities. Borrowing from the willingness and ability perspective – introduced to explain the strategic and behavioral distinctiveness of family firms in the family business literature (De Massis et al., 2014; Chrisman et al., 2015) –, we recognize that USO's founders are socially embedded and as such are driven by economic and non-economic goals (Hamilton, 2011; Wang and Altinay, 2012; Aldrich and Cliff, 2003). Since founders, in the early stages, make the fundamental decision in USOs, we claim that the process of USOs' growth, through the acquisition of early-stage equity financing, may be the result of a combination of founders' ability and willingness to grow.

So far, studies that look into the combination of founders' ability and willingness to grow is limited in the current literature. In particular, factors such as founders' growth intentions and their human capital have not yet been explored. Moreover, traditionally, firm growth has been linked to the key role of founder's motivation. Because firm growth can be considered a deliberate individual decision (Kolvereid, 1992; Liao and Welsch, 2003), intentions for growth might be a valuable predictor of firm behavior and actual growth (Wiklund and Shepherd, 2003) and can also influence investment decisions (Macmillan et al., 1985, Miloud et al., 2012). In particular, it is reasonable to hypothesize that there exist different types of growth aspiration; particularly in the case of USOs where founders are socially embedded within their parent university, Thus, their motivation to grow may vary and this distinguishes high-growth USOs from low-growth USOs (Jaine et al., 2009; Liam, 2011; Autio and Acs, 2007). To this end, the current study is guided by two primary research questions (RQs) as follows:

- **RQ1**. How do different types of founders' growth aspiration impact USO's early-stage equity financing?

- **RQ2**. Do different dimensions of founders' experience matter for the growth intentions – USO's early-stage equity financing relationship?

5.3 Methodology

5.4.1 Sample

To explore the link between founders' growth aspiration, human capital and early-stage equity financing raised, we relied on an existing dataset collected in 2015 (via interview) from Italian innovative start-ups that started business in 2014. The list of firms was initially drawn from a register issued by the Italian government. To be eligible for this registry, the activity of innovative start-ups had to focus on the development, production and commercialization of innovative products or services with high technological value out of 4,787 registered innovative start-ups, it was possible to collect the contact information of about 837 innovative start-ups and this was done mainly through the web and other online repositories. A survey was administered to the entrepreneur leading the founding team (I.e., CEO or President) in 2015 using a Computer-Assisted Telephone interview (CATI), resulting in a 45% per cent response rate. Since the focus was on early-stage innovative firms, only start-ups which, at founding, did not have a market-ready innovation but in the process of developing a product or service were selected.

In 2017, the database was updated to collect longitudinal information on the innovative start-up. After dropping out some firms due to missing data, the final sample was 211. In 2021, we updated the database by including accounting and financial information of firms. Here, we checked to see whether a firm had received early stage equity financing within the first five years of the foundation of the firm. Were present, the information was download from the AiDA BvD database using firms' fiscal code. Since the focus of this study is on USOs, we categorized firms based on our definition of USOs (Fryges and Wright, 2014). Thus, to be considered as an USO, the innovative start-up had to meet the following criteria: (i) core technology or key scientific knowledge generated at a university and/or (ii) founding team comprising of researchers who left the parent university. This information had already been collected in 2015. This process generated 167 USOs, out of which only 35 received an early stage external equity financing. Hence, our final sample consist of 35 USOs established in 2014.

Information about Regional Gross Domestic product (GDP) per capita at year of foundation of the focal firm was retrieved from EUROSTAT, which is the statistical office of the European

Union, using the NUTS 3 (Nomenclature of Territorial Units for Statistics) as our unit of analysis. Our final sample consist of 35 USOs which had received early-stage equity financing within the first five years of their foundation. For the purpose of this study, we analyze only the 35 USOs which received early-stage equity financing within their first 5 years of foundation. Our sample is composed of companies founded mainly in 2014, operating for the vast majority in the ICT (29%), knowledge intensive (40%).

5.4.2 Construct and measures

The dependent variable "*early-stage equity financing*". For each USO, we measure its external equity financing using the share premium account in the firms' balance sheet as the key source for investment received (Jelfs and Lawton Smith, 2021). This variable refers to the amount raised as first equity financing within the first five years from USOs establishment. This Information was retrieved from AIDA and investors included private investors or business angels, venture capitalists, corporate venture capitalists, crowdfunding backers, mutual funds, pension funds and strategic partners. This variable was obtained through the share premium account on the balance sheet of USOs.

The independent variables "growth intentions" were measured, on a 1 to 5 points Likert scale referring to the level of importance, via a self-report in the survey. A measurement instrument was developed on nine items capturing the following: (i) growth in commercial relations (ii) growth in turnover (iii) obtain external funding (iv) growth in number of employees (v) create more jobs for skilled individuals (vi) growth in efficiency (vii) service to the society (viii) growth and recognition in the scientific community (ix) growth in innovation activities. This item had already been used in the literature to measure founders' growth intentions (Davila et al., 2003, Eddleston et al., 2008; Chang, 2004; Beggs et al., 1989). A number of tests were then conducted to assess the constructs' validity and reliability. First, in Table 5.1, we performed a principal component analysis on the nine growth intention variables which revealed three underlying constructs (factors), namely (i) economic growth intentions (ii) employment growth intentions and (iii) academic growth intentions. Factor loadings for the indicator variables ranged from 0.62 and 0.79. Second, in Table 5.2 we perform reliability test using the average extracted variance (AVE) and alpha Cronbach. Our constructs ranged between 0.47 and 0.52 and 0.54 and 0.99, respectively. These coefficients were slightly lower than the acceptable threshold. For this reason, we performed the composite reliability test, which is also a measure on internal consistency comparable to coefficient alpha (Fornel & Larcker, 1981). However, this measure is superior to Cronbach alpha in that it does not assume equal item loadings (Howell,

1996). All scales demonstrated acceptable levels of reliability with coefficients ranging from 0.73 to 0.77.

Table 5. 1 Factor loadings (Principal-component Factor Analysis)[18]

Variable	Factor1	Factor2	Factor3	Uniqueness
Economic growth intentions				
Commercial relations	0.763			0.355
Turnover	0.715			0.378
Obtain Funds	0.690			0.490
Employment growth intentions				
No. of Employees		0.796		0.362
Create jobs		0.670		0.405
Efficiency		0.622		0.492
Academic growth intentions				
Service to society			0.743	0.424
Scientific community			0.664	0.487
Innovation			0.653	0.495

[18] Bartlett test of sphericity and KMO are below .05 and above 0.5 respectively for our three construct variables. This suggest that there is substantial correlation in the data.

Table 5. 2 Assessing convergent and discriminant validity

Variable	AVE[19]	CR	ALPHA
Economic growth intentions	0.52	0.77	0.59
Commercial relations			
Turnover			
Obtain Funds			
Employment growth intentions	0.49	0.74	0.59
No. of Employees			
Create jobs			
Efficiency			
Academic growth intentions	0.47	0.73	0.54
Service to society			
Scientific community			
Innovation			

Lastly, we check the extent to which our constructs are empirically distinct from one another. To do so, we perform discriminant validity evaluation, which is aimed to measure that each of the construct is unique, and therefore, each of them is used to represent a phenomenon that other constructs do not (Astrachan et al., 2014). Table 3 present the discriminant validity evaluation. At the construct level, discriminant validity is evaluated by comparing the square root of the AVE value of a construct with its construct's correlations and other constructs. This is based on the Fornell-Larcker criterion (Hair et al., 2017). In Table 5.3, the square root of AVE for each construct is greater than that of particular construct' correlations and other constructs. This result indicates that discriminant validity is well established.

[19] According to Forrell & Lacker (1981), an Average Variance Extracted (AVE) below .50 could be considered if Composite Reliability (CR) is above .70.

Table 5. 3 Discriminant Validity - Forrell & Lacker Criterion[20]

Variable	CR	AVE	(1)	(2)	(3)
(1) Economic growth ambition	0.77	0.52	**0.72**		
(2) Employment growth ambition	0.74	0.49	0.254	**0.70**	
(3) Academic growth ambition	0.73	0.47	0.257	0.368	**0.69**

Since founders, in the early stages, make the fundamental decision in USOs, we claim that the process of USOs' growth, through the acquisition of early-stage equity financing, may be the result of a combination of founders' ability and willingness to grow. With that in mind, we check whether the combination of founder's human capital and their growth intentions affect early-stage equity financing raised by the USO. We used two proxies of founders' human capital which has been frequently used in the entrepreneurship literature: (i) managerial experience and (ii) industry experience. We measured founders' managerial experience as the number of years of managerial experience of the most experienced founder within the founding team while founders' industry experience indicates the number of years of industry experience of the most experienced founder withing the founding team.

Finally, we control for other variables that may potentially affect the relationship between growth intentions and early-stage equity financing. We created three dummy variables for the sector in which the USO operate. Team size was measured as the total number of team members and the number of founders and regional GDP measured as the natural logarithms of regional gross domestic product per capita at the year of founding of the focal USO.

5.4 Results

The descriptive statistics in Table 5.4 show that on average USOs raised approximately €196,000, with a minimum of €9,460 and a maximum of approximately €1,165,000. In terms of growth intentions, financial growth intentions (an average score of 4.02) and employment growth ambition (an average score of 4.00) seem to be the number one priority for USOs, as compared to academic growth intentions (average score of 3.85): the number of years of industry experience and managerial experience of the most experienced founder within the founding team were approximately

[20] Diagonals are sqrt of AVE and should be greater than its highest correlation with any other construct (both horizontally and vertically)

were quite similar (11 years and 10.8 year, respectively).The vast majority of the USOs included in our sample operated in the knowledge intensive sector (40%) and ICT sector (28%), while the least were found in the machinery sector (8.5%). The founding team consist of an average of 4.28 members. The average regional gross domestic product per capita (NUTS 3) at the year of founding of the USO was around £55,7000.

Table 5.5 shows the correlations between the variables analyzed. The correlations between employment growth intentions and see funding is negative and significant, as is the correlations of team size variable with early-stage equity financing. the other correlation between. To avoid the problem of multicollinearity, we estimated the Variance Inflation Factor (VIF), which was between 1.28 and 2.67. thus, VIF is below the cut-off rule of 5. This imply that there is no problem of multicollinearity in our models.

Table 5. 4 Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Early-stage equity financing (€ 000)	35	196.35	260.60	9.46	1165.89
Financial Growth Intentions (No.)	35	4.02	0.59	2.67	5
Employment Growth Intentions (No.)	35	4.00	0.78	2.33	5
Academic Growth Intentions (No.)	35	3.85	0.80	2	5
Industry Experience (No. Years)	35	11.02	9.60	0	30
Managerial Experience (No. Years)	35	10.80	11.00	0	35
ICT (%)	35	28.57	45.83	0	100
Knowledge Intensive (%)	35	40.00	49.70	0	100
Machinery (%)	35	8.57	28.40	0	100
Other firms (%)	35	22.80	35.50	0	100
Team size (No.)	35	4.28	3.52	1	22
Regional GDP per capita (NUTS 3) (€ 000)	35	55.74	63.39	4.98	160.17

Table 5. 5 Pairwise correlations matrix

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) Early-stage equity financing	1.000										
(2) Economic Growth Intentions	-0.265	1.000									
(3) Employment Growth Intentions	-0.388**	0.254***	1.000								
(4) Academic Growth Intentions	-0.018	0.257***	0.368***	1.000							
(5) Industry Experience	0.170	0.076	0.110	0.086	1.000						
(6) Managerial Experience	-0.214	0.138*	0.001	0.028	0.189**	1.000					
(7) ICT	-0.282*	0.111	0.154**	-0.053	-0.003	-0.110	1.000				
(8) Knowledge Intensive	0.321*	-0.132*	-0.115	0.027	-0.068	0.183**	-0.658***	1.000			
(9) Machinery	-0.131	-0.086	-0.095	0.016	0.061	0.028	-0.200***	-0.254***	1.000		
(10) Team size	0.480***	0.010	-0.036	0.131*	0.214***	0.212***	-0.178**	0.116	0.026	1.000	
(11) Regional GDP (NUTS 3)	0.068	0.119	-0.125*	-0.160**	-0.137*	-0.015	0.045	-0.032	-0.101	-0.006	1.000

**** p<0.01, ** p<0.05, * p<0.1*

Table 5.6 shows the results of OLS models that estimate the factors that affect the USOs' early-stage equity financing. The baseline model (Models 1) shows an influence of USOs founding team size and early-stage equity financing. model 2 test the effect of economic growth intentions on early-stage equity financing. as shown, this variable is negative and statistically significant ($\beta = 0.190$, $p < 0.1$), although this effect is slightly weak. in model 3, the variable measuring founders' employment growth intentions is negative and statistically significant ($\beta = 0.150$, $p < 0.05$) while the variable measuring academic growth intentions (model 4) is not significant. The complete model (Model 5) also includes the combination of growth intentions and founder's human capital. Economic growth intention and academic growth intentions are not significant in the full the model, while employment growth is negative and statistically significant. The combined effect of economic growth intentions and management experience, as well as that of employment growth intentions and industry experience are positively related to early-stage equity financing. In sum, the results show that growth intentions and ability act as complement and together are necessary in understanding USOs early-stage equity financing.

Table 5. 6 OLS regression

	Dependent variable: Early-stage equity financing				
VARIABLES	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
ICT	-0.176	-0.215	-0.338	-0.284	0.313
	(0.424)	(0.405)	(0.407)	(0.471)	(0.447)
Knowledge Intensive	0.567	0.220	0.262	0.530	0.230
	(0.390)	(0.413)	(0.395)	(0.401)	(0.404)
Machinery	-0.186	-0.753	-0.517	-0.216	-0.279
	(0.606)	(0.647)	(0.593)	(0.616)	(0.603)
Regional GDP (NUT3)	0.041	0.067	-0.062	0.009	0.160
	(0.131)	(0.126)	(0.133)	(0.145)	(0.151)
Team size	0.329***	0.348***	0.300***	0.327***	0.132
	(0.104)	(0.099)	(0.099)	(0.105)	(0.137)
Economic growth intentions		-0.371*			-0.301
		(0.190)			(0.229)
Employment growth intentions			-0.320**		-0.301*
			(0.150)		(0.171)
Academic growth intentions				-0.094	0.227
				(0.169)	(0.185)
Economic growth intentions x Industry experience					0.208
					(0.215)
Economic growth intentions x Management experience					0.422**
					(0.202)
Employment growth intentions x Industry experience					0.392*
					(0.190)
Employment growth intentions x Management experience					-0.072
					(0.173)
Academic growth intentions x Industry experience					-0.191
					(0.256)
Academic growth intentions x Management experience					0.171
					(0.145)
Constant	-0.290	-0.034	-0.079	-0.247	-0.458
	(0.325)	(0.337)	(0.323)	(0.338)	(0.341)
Observations	35	35	35	35	35
R-squared	0.358	0.435	0.448	0.365	0.699

5.4 Concluding remarks

This paper adds to the literature on the determinants of USOs' early-stage equity financing by providing deeper and more granular insights into the role played by founders' ability and willingness to grow. In particular, this exploratory work provides empirical evidence on the effects of founders' growth intentions (mirroring willingness) and experience (mirroring ability) on USOs early-stage equity financing. Our work is based on the assumption that a founder may have the abilities to grow the USO but may still lack growth intentions or vice versa. Thus, willingness and ability are necessary and sufficient conditions. Therefore, our empirical analysis takes into account the impact of growth intentions on early-stage equity financing, together with founder's experience which has been studied widely in the literature. The analysis was based on the Italian context, which present some per peculiar characteristics compared to the more widely studied UK and US ones (Nosella and Grimaldi, 2009, Grimaldi and Grandi, 2003). We identify three clusters of growth intentions that can affect early-stage equity financing: economic growth intentions; employment growth intentions; academic growth intentions and combined them with founder experience.

First, we find that, economic growth intentions and employment growth intentions are negatively associated with early-stage equity financing, while academic growth intentions are not significantly associated. This suggest that growth intentions alone are not sufficient for USOs aiming to raise early-stage equity financing from external investors.

Second, the combination of economic growth intentions and management experience of founders as well as the combination of employment growth intentions and industry experience are positively associated with early-stage equity financing. This confirms our initial claim that the combination of both ability and willingness to grow might provide in-depth understanding of USOs' early-stage equity financing. Our result also confirms that, founding members who are keen to raise early-stage equity financing are those that possess or hire new personnel endowed with managerial or industry experience, depending on the growth intentions of the founders.

However, it is also worth noting that our paper has some major limitations, which open pathways to future research. First, results are based on a relatively small sample. Even though our sample involved just 35 USOs, our results may be generalized to only USOs established in Italy. Nevertheless, we encourage future research to investigate whether our results hold in other contexts and explore cross-country effect. Second, our results confirmed that to better understand USOs early-stage equity financing, elements of founders' human capital should be integrated with their growth intentions and showed that USOs differ widely in their capability to raise early-stage equity financing. what remains unknow is how different growth intentions influence different aspects of USOs'

performance. future studies could encourage more exploration on the impact of different growth intentions on the total amount of funds raised from external financiers.

6. CONCLUSION

This dissertation has studied the importance of non-accounting drivers in external financing, a key milestone in the development of USOs. In particular, it proposes a focus on *university* as the context of origin and distinctiveness of many innovative start-ups. In doing so, it offers a set of dimensions to be incorporated in the decision-making process of external financiers. This dissertation also advances the academic entrepreneurship literature, responding to recent calls (Guindalini et al., 2021; Mathisen and Rasmussen, 2019) to know more about the university-level antecedents of the early development of USOs. Finally, while to date extant research on non-accounting drivers has been fairly limited, the work done in this dissertation could offer a starting point for scholars to theoretically advance this vibrant research stream.

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